JUNE 1, 2020

GLASTONBURY BID #: GL-2020-19

WELLES TURNER MEMORIAL LIBRARY

ADDITION AND RENOVATIONS

CONSTRUCTION DOCUMENTS SPECIFICATIONS

VOLUME 2 of 2

ARCHITECTS
TSKP STUDIO, LLC
146 WYLLYS STREET
HARTFORD, CT
(860) 547-1970

SYSTEMS
CONSULTING ENGINEER SERVICES
301 MAIN STREET
DANBURY, CT
(203) 778-1017

STRUCTURAL ENGINEERS
GM2
151 MEADOW ST
BRANFORD, CT
(203) 481-8600

CIVIL ENG./LANDSCAPE
LANGAN
22 1ST ST
STAMFORD, CT
(203) 327-0500

PROJECT MANUAL
TABLE OF CONTENTS

INCLUDED HERE IS AN EXCERPT FROM THE BIDDING AND CONTRACTING REQUIREMENTS WHICH HAVE BEEN ISSUED IN THEIR ENTIRETY IN A SEPARATE VOLUME TITLED: "RENOVATIONS AND ADDITION TO THE WELLES-TURNER MEMORIAL LIBRARY".

EXCERPT: ATTACHMENT 3: FORM OF CONTRACT

VOLUME 1

PROJECT MANUAL
TABLE OF CONTENTS

PROJECT MANUAL
TABLE OF CONTENTS

PROJECT MANUAL
TABLE OF CONTENTS

PROJECT MANUAL
TABLE OF CONTENTS

SECTION 230400 - GENERAL CONDITIONS FOR MECHANICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

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

B. This section applies to certain sections of Division 26, "Electrical," and this section applies to all sections of Division 23, "Mechanical" of this project specification unless specified otherwise in the individual sections.

C. Refer to Section 01 91 13 Commissioning General Requirements for all commissioning requirements.

1.2 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

1.3 INTENT

A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.

B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.

C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.

D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.4 DEFINITIONS

A. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.

B. “Approved equal” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

D. “Finished” refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

E. “Furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.

F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

G. “Install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.

H. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

I. “Provide” shall mean furnish (or supply) and install as necessary.

J. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

K. Remove: The term “remove” means “ to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”

L. Special Warranties: The term “Special Warranties” are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

M. Standard Product Warranties: The term “Standard Product Warranties” are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

N. "Subcontractor" means specifically the subcontractor working under this Division. Other Contractors are specifically designated "Plumbing Subcontractor", "General Contractor" and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.

O. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."

P. "Wiring" shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.

D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.6 SURVEYS AND MEASUREMENTS

A. Before submitting his Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which work will be installed. This Contract includes all modifications of existing systems required for the installation of new equipment. This Contract includes all necessary offsets, transitions and modifications required to install all new equipment in existing spaces. All new and existing equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions he makes, any omissions or errors he makes as a result of his failure to become fully familiar with the existing conditions at the site and the Contract Documents.

B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

1.7 CODES AND STANDARDS

A. Reference Standard Compliance

1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

B. The Following Codes and Standards listed below apply to all mechanical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
Connecticut State Building Code with Amendments
The International Building Code
The International Mechanical Code
The International Plumbing Code
The International Energy Conservation Code
The National Electrical Code
NFPA 101 Life Safety
ASHRAE 90.1

C. The following Standards shall be used where referenced by the following abbreviations:

AABC	Associated Air Balance Council
ACGIH	American Conference of Governmental Industrial Hygienists
ADC	Air Diffusion Council
AGA	American Gas Association
AIA	American Institute of Architects
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CGA	Compressed Gas Association
CSA	Canadian Standards Association
CISPI	Cast Iron Soil Pipe Institute
EJMA	Expansion Joint Manufacturing Association
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
HIS	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	Insurance Services Office
MCAA	Mechanical Contractors Association of America
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau

NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOFI	National Oil Fuel Institute
NSC	National Safety Council
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SBI	Steel Boiler Industry (Division of Hydronics Institute)
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
STI	Steel Tank Institute
UL	Underwriters' Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.8 PERMITS AND FEES

A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.9 EQUIPMENT SUBSTITUTIONS

A. In these Specifications and on the accompanying Drawings, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate from those mentioned herein shall also conform to these standards.

B. Where no specific make of material, apparatus or appliance is mentioned any first-class product made by a reputable manufacturer may be submitted for the Engineers review.

C. Where two or more names are given as equivalents, the Contractor must use the specified item or one of the named equivalents. Where one name only is used and is followed by the words "or approved equal", the Contractor must use the item named or he may apply for a substitution. Where one name only is used, the Contractor must use that item named.

D. Equipment, material or devices submitted for review as an "equivalent" shall meet the following requirements:
   1. The equivalent shall have the same construction features such as, but not limited to:
      a. Material thickness, gauge, weight, density, etc.
      b. Welded, riveted, bolted, etc., construction.
      c. Finish, undercoating, corrosion protection.
   2. The equivalent shall perform with the same or better operating efficiency.

3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as AMCA or ARI labels.

E. Where the Contractor proposes to deviate from the equipment or materials as hereinafter specified, he shall do so by making a request in writing. The Contractor shall state in his request the amount of credit or extra cost involved. A copy of said request shall be included in the Mechanical Base Bid with manufacturer's equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

F. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Designers of Record at the expense of the Contractor and at no additional cost to the Owner.

G. Where such accepted substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, with the acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the substitution.

H. Equipment, material or devices submitted for review as a "substitution" shall meet the following requirements:
1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer.
   a. Submit three (3) copies of each request for substitution for consideration.
   b. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
      1) Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
      2) Samples, where applicable or requested.
      3) A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
      4) Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.
      5) A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
      6) Cost information, including a proposal of the net change, if any in the Contract Sum.
      7) Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional

payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.

2. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
3. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
   a. The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
   b. A substantial advantage is offered to the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.10 SUBMITTAL PROCEDURES

A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for re-submittals.
1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
2. If an intermediate submittal is necessary, process the same as the initial submittal.
3. Allow two weeks for reprocessing each submittal.
4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
1. Include the following information on the label for processing and recording action taken.
   a. Project name.
   b. Date.
   c. Name and address of Engineer.
   d. Name and address of Contractor.

e. Name and address of subcontractor.
f. Name and address of supplier.
g. Name of manufacturer.
h. Number, title and paragraph of appropriate Specification Section.
i. Drawing number and detail references, as appropriate.

E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.

G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

1.11 SHOP DRAWINGS

A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Mechanical Contract. Refer to Division 1 for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.

C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.

E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.

G. "No Exception Taken" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.

H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.

I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.

J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.

K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

L. Prepare sheetmetal and piping shop drawings drawn in the latest AutoCAD version to a minimum scale of 1/4" = 1'- 0". Final approved drawings shall be turned over to the Owner in electronic format per the owners requirements.

1.12 COORDINATION DRAWINGS

A. Prepare coordination drawings drawn in the latest REVIT version in accordance with Division 1 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
      a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
      b. Equipment connections and support details.
      c. Exterior wall and foundation penetrations.
      d. Fire-rated wall and floor penetrations.
      e. Sizes and locations of required concrete pads and bases.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

E. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.

F. Work shall not be performed until coordination drawings have been approved by the architect and engineer.

G. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. The cost for these floor plans is a lump sum fee of $ 1,500.00. If the Contractor elects to obtain the Engineers electronic files a REVIT File Release Form must be submitted with payment. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the REVIT File Release Form, and payment, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the REVIT File Release Form is appended to the end of this specification section

1.13 COORDINATION WITH OTHER DIVISIONS

A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.

B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.

C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.

D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

1.14 WORKMANSHIP

A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

E. All labor for installation of mechanical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.15 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.

B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.16 TEMPORARY UTILITIES

A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. First Aid Supplies: Comply with governing regulations.

D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.

E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.

F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.

G. Temporary Heat-Cool-Dehumidification: Provide temporary services required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate temporary services to produce the ambient condition required and minimize consumption of energy. The building’s permanent HVAC systems shall not be used for these purposes.

H. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

I. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.17 PROTECTION OF MATERIALS AND EQUIPMENT

A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.

B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.18 ADJUSTING AND TESTING

A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.

B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing, that the equipment was installed according to manufacturers recommendations and is operating as intended by the manufacturer.

1.19 CLEANING

A. The Contractor shall thoroughly clean and flush all piping, ducts and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.

B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

C. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter. Contractor to follow per SMANCA Duct Cleanliness for New Construction Guidelines.

D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
1. Remove labels that are not permanent labels.
2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
5. The Contractor shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications. The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. The return air grilles, return air ducts to the air handling unit (AHU), the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, supply air ducts, fan housing, fan blades, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the HVAC system. The HVAC system may also include other components such as dedicated exhaust and ventilation components and make-up air systems.
   a. Source Removal Cleaning Methods: The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select Source Removal methods that will render the HVAC system Visibly Clean.
      1) All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.
      2) All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet-vacuums.
      3) All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices.

4) Fibrous thermal or acoustical insulation elements present in any equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.
5) Coil Cleaning: Any cleaning method may be used which will render the Coil Visibly Clean and capable of passing Coil Cleaning Verification. Coil drain pans shall be subject to Non-Porous Surfaces Cleaning Verification. The drain for the condensate drain pan shall be operational. Cleaning methods shall not cause any appreciable damage to, displacement of, inhibit heat transfer, or erosion of the coil surface or fins, and shall conform to coil manufacturer recommendations when available. Coils shall be thoroughly rinsed with clean water to remove any latent residues.
6) Biocidal agents shall only be applied if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing. Only biocidal agents registered by the U.S. Environmental Protection Agency (EPA) specifically for use within HVAC system shall be used.

F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.

G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.20 OPERATING AND MAINTENANCE

A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner’s representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

D. An authorized manufacturer’s representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.

E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

F. Demonstration shall be recorded on VHS audio/video tape with two (2) tapes turned over to the Owner.

1.21 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare five (5) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.

B. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing and operating instructions including lubrication charts and schedules.
5. Emergency and safety instructions.
6. Spare parts list.
7. Copies of warranties.
8. Wiring diagrams.
9. Recommended "turn around" cycles.
10. Inspection procedures.
11. Approved Shop Drawings and Product Data.
12. Equipment Start-up Reports.
13. Temperature control diagrams and written sequences of operations.
14. Balance reports.

C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.

D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.22 ACCEPTANCES

A. The equipment, materials, workmanship, design and arrangement of all work installed under the Mechanical Sections shall be subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, the Mechanical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Mechanical Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.

C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner’s representative.

D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used

as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Mechanical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.

F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.23 RECORD DRAWINGS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
1. Dimensional change
2. Revision to drawing detail
3. Location and depth of underground utility
4. Revision to pipe routing
5. Revision to electrical circuitry
6. Actual equipment location
7. Duct size and routing
8. Location of concealed internal utility
9. Changes made by Change Order
10. Details not on original Contract Drawing
11. Information on concealed elements which would be difficult to identify or measure later

C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.

D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.

E. Note related Change Order numbers where applicable.

F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

G. These shall be clearly marked for Record Drawings on a clean set of reproducible mylar sepias at the completion of the work and turned over to the Owner.

H. Final record documents shall be prepared in the latest AutoCad version and CD Rom of all drawings and a clean set of reproducible mylar sepias shall be turned over to the Owner at the completion of the work.

1.24 WARRANTIES AND BONDS

A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
1. General close-out requirements included in Division 1.
2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions-2 through -26.
3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.25 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for

warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
1. Refer to individual Sections of Divisions-2 through -26 for specific content requirements, and particular requirements for submittal of special warranties.

J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.26 GUARANTEES

A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

1.27 CONSTRUCTION MANAGEMENT PLAN - DURING CONSTRUCTION

A. Construction manager shall draft and enforce IAQ management plan. This plan shall be documented and clearly understood by all sub contractors and field personnel prior to start of construction activities. IAQ management plan shall be topic of discussion at all pre-construction and construction progress meetings.

B. IAQ management plan shall at a minimum satisfy the following:

1. During construction meet or exceed the control measures of SMACNA IAQ guidelines for occupied buildings under construction, 1995, chapter 3. Above mentioned SMACNA guidelines focus on five major areas below:
   a. HVAC Protection
   b. Source Control
   c. Pathway Interruption
   d. Housekeeping
   e. Scheduling
2. Do not use permanently installed air handlers during construction. If air handlers are used during construction a minimum of MERV 8 filtration shall be used at each return grille. All filtration shall be replaced immediately prior to occupancy.
3. The protection of absorptive materials both installed and stored on site (waiting to be installed) from moisture damage.

C. During project the construction manager shall document how IAQ plan is being enforced and followed. Documentation shall include photos and written narratives.

D. Upon completion of construction the following documents shall be submitted to engineer or record.
1. A copy of the projects indoor air quality management plan.
2. Confirmation if the permanently installed air handling equipment was or was not used during construction.
3. Photos and written narrative which highlight the implementation of the IAQ plan.
4. List of all filtration which was used during construction and confirmation that each media was removed prior to occupancy. List shall include for each filter (location, manufacturer, model number and MERV rating).

1.28 BUILDING FLUSH OUT

A. The following procedures address the requirements of the CT High Performance Building Standards. The Mechanical trade contractor will be responsible for the scheduling and documenting of the flush-out. The CM and the Commissioning Agent will confirm the schedule, oversee this process, and review the documentation once submitted. The flush-out will be done as described below:
1. The building flush-out shall begin after all work is completed, final cleaning has been performed and all furnishing have been placed but prior to building occupancy.
2. All mechanical systems that supply outside air will flush the building continuously for 10 Days with outdoor air, while maintaining an internal temperature of between 60˚ F and 78˚ F and a relative humidity no higher than 60%.
3. Filters at central air handling units (AHU's) that are operated during flush-out: Prior to use, each AHU will be equipped with filters having a minimum rating of MERV 13 per ASHRAE 52.2-1999 (AHU's that have been operated during construction will already be so equipped per the above section "Use of Mechanical Systems during Construction").
4. After flush-out, all filters shall be replaced by the mechanical contractor.

B. Upon completion of the building flush out the following documents shall be submitted to engineer or record.
1. A copy of the projects Building Flush Out plan.
2. Photos and written narrative which highlight the implementation of the Building Flush-out plan.

1.29 PROJECT CLOSE-OUT

A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents in accordance with Division 1.

B. Deliver tools, spare parts, extra stock, and similar items.

C. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

D. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

E. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
   1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
   2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION 230400

REVIT File Release Form

DELIVERY OF REVIT FILES FOR: _____
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ _____
Client's Signature Date

_____
Company - Title

_____ _____
Architects' Signature Date

_____
Firm - Title

_____ _____
Owner's Signature Date

_____
Company - Title

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Identification for HVAC Piping and Equipment.
2. Sleeves.
3. Mechanical sleeve seals.
4. Formed steel channel.

1.2 SUBMITTALS

A. Shop Drawings: Submit for piping and equipment identification list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

B. Product Data for Pipe and Equipment Identification: Submit for mechanical identification manufacturers catalog literature for each product required.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with State of Connecticut building code standards and all applicable referenced codes.

B. Maintain one copy of each document on site.

PART 2 PRODUCTS

2.1 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

A. Manufacturers:
1. Seaton
2. Craftmark
3. Safety Sign
4. Substitutions: Permitted

B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light background color.

C. Plastic Tags: Laminated three-layer plastic with engraved black letters on light background color, minimum 1-1/2 inches diameter.

D. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Color and Lettering: Conform to ASME A13.1.

E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Color and Lettering: Conform to ASME A13.1.

F. Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.2 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

E. Sealant: Acrylic

2.3 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. Fernco
3. BWM
4. Substitutions: Permitted

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.4 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Unistrut Corp.
4. Substitutions: Permitted

B. Product Description:Galvanized 12 gage) thick steel. With holes 1-1/2 inches on center.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION - PIPING AND EQUIPMENT IDENTIFICATION

A. Install plastic nameplates with adhesive.

B. Install plastic tags with corrosion resistant metal chain.

3.3 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel escutcheons at finished surfaces.

END OF SECTION 230500

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes single- and three-phase motors for application on equipment provided under other sections.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
3. Section 26 05 53 - Identification for Electrical Systems.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.

C. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years [documented] experience.

B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

A. Manufacturers:
1. Cooper Industries Inc.
2. Eaton Corp.
3. General Electric Co.
4. Substitutions: Section 01 60 00 - Product Requirements

B. Motors 3/4 hp and Larger: Three-phase motor as specified below.

C. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer’s standard.

D. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
1. Voltage: As indicated on Drawings.
2. Service Factor: 1.0.
3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
5. Insulation System: NEMA Class F.
6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
9. Sound Power Levels: Conform to NEMA MG 1.

E. Single Phase Motors:
1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Voltage: 115volts, single phase, 60 Hz.

F. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned motors

B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing motors to remain or are to be reinstalled.

3.2 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

B. Install engraved plastic nameplates in accordance with Section 26 05 53.

C. Ground and bond motors in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements, 01 60 00 - Product Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION 230513

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Globe valves.
2. Ball valves.
3. Check valves.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and installation requirements for pipe hangers and supports.
3. Section 23 07 00 - HVAC Insulation: Product and installation requirements for insulation for valves.
4. Section 23 21 13 - Hydronic Piping: Product and installation requirements for piping used in hydronic piping systems.
5. Section 23 21 16 - Hydronic Piping Specialties: Product and installation requirements for piping specialties used in hydronic piping systems.

1.2 REFERENCES

A. ASTM International:
1. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
2. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
3. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

B. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
7. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

C. Underwriters Laboratories Inc.:
1. UL 842 - Valves for Flammable Fluids.

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures.

B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures.

B. Project Record Documents: Record actual locations of valves.

C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 - Product Requirements.

B. Do not install valves underground when bedding is wet or frozen.

1.9 WARRANTY

A. Section 01 – Closeout Procedures.

B. Furnish one year manufacturer warranty for valves excluding packing.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.10 EXTRA MATERIALS

A. Section 01 – Closeout Procedures.

B. Furnish two packing kits for each size valve.

PART 2 PRODUCTS

2.1 GLOBE VALVES

A. Manufacturers:
1. Crane Valve, North America
2. Victaulic
3. Milwaukee Valve Company
4. NIBCO, Inc.
5. Stockham Valves & Fittings
6. Watts
7. N-Vent Substitutions: Section 01 60 00 - Product RequirementsGL-1 2 inches and Smaller: MSS SP 80, bronze body, bronze trim, union bonnet, hand wheel, Buna-N composition disc, solder or threaded ends.

B. GL-2 2-1/2 inches and Larger: MSS SP 85, cast iron body, bronze trim, hand wheel, outside screw and yoke, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.2 BALL VALVES

A. Manufacturers:
1. Crane Valve, North America
2. Victaulic
3. Milwaukee Valve Company
4. NIBCO, Inc. Stockham Valves & Fittings
5. Watts
6. N-Vent
7. Substitutions: Section 01 60 00 - Product Requirements

B. 2 inches and Smaller: MSS SP 110, bronze, two piece body, chrome plated bronze ball, regular port, teflon seats, blow-out proof stem, solder or threaded ends with union, extended lever handle.

2.3 BALL VALVES (Press Style)

A. Manufacturers:
1. Viega
2. Milwaukee Valve Company
3. Watts
4. Substitutions: Not Permitted.

B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, chrome plated bronze ball, regular port, teflon seats, blow-out proof stem and lever handle.

C. Press Fitting: Copper press fitting shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. Sealing elements for copper or copper alloy press fittings shall be EPDM.

2.4 CHECK VALVES

A. Horizontal Swing Check Valves:
1. Manufacturers:
a. Crane Valve, North America
b. Hammond Valve
c. Milwaukee Valve Company
d. NIBCO, Inc.
e. Stockham Valves & Fittings
f. Watts
g. Substitutions: Section 01 60 00 - Product Requirements
2. 2 inches and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N disc, solder or threaded ends.
3. 2-1/2 inches and Larger: MSS SP 71, Class 125, cast iron body, bolted cap, bronze or cast iron disc, [renewable disc seal and seat,] flanged ends.

B. Spring Loaded Check Valves:
1. Manufacturers:
a. Crane Valve, North America
b. Hammond Valve
c. Milwaukee Valve Company
d. NIBCO, Inc.
e. Stockham Valves & Fittings
f. Watts
g. Substitutions: Section 01 60 00 - Product Requirements
2. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded] ends.
3. 2-1/2 inches and Larger: MSS SP 71, Class 125, wafer globe style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

2.5 CHECK VALVES (Press Style Fittings)

A. Spring Loaded Check Valves :
1. Manufacturers:
a. Viega
b. Milwaukee Valve Company
c. Watts
d. Substitutions: Not Permitted.
2. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat.
3. Press Fitting: Copper press fitting shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. Sealing elements for copper or copper alloy press fittings shall be EPDM.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install 3/4 inch gate valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

D. Install valves with clearance for installation of insulation and allowing access.

E. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.

F. Refer to Section 23 05 29 for pipe hangers.

G. Refer to Section 23 07 00 for insulation requirements for valves.

H. For installation of valves in hot water, chilled water piping systems refer to Section 23 21 13.

3.3 INSTALLATION – PRESS STYLE FITTINGS

A. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer’s installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting

alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.

3.4 VALVE APPLICATIONS

A. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.

B. Install ball valves (unless otherwise specified) for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install globe valves for throttling, bypass, or manual flow control services.

D. Install ball valves adjacent to equipment when functioning to isolate equipment.

E. Install ball valves in heating, chilled and condenser water systems for shut-off service.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Equipment curbs.
6. Sleeves.
7. Mechanical sleeve seals.
8. Formed steel channel.
9. Firestopping relating to HVAC work.
10. Firestopping accessories.
11. Equipment bases and supports.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 07 84 13 - Firestopping: Product requirements for firestopping for placement by this section.
4. Section 07 92 00 - Joint Sealants: Product requirements for sealant materials for placement by this section.
5. Section 09 91 23 - Painting: Product and execution requirements for painting specified by this section.
6. Section 23 05 03 - Pipes and Tubes for HVAC Piping and Equipment: Execution requirements for placement of hangers and supports specified by this section.
7. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and execution requirements for vibration isolators.
8. Section 23 21 13 - Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:
1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
2. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

B. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable codes, FM and UL for fire resistance ratings and surface burning characteristics.

1.6 SUBMITTALS

A. Section 01 - Submittal Procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

E. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

F. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

H. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7 QUALITY ASSURANCE

A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
a. Floor Penetrations Within Wall Cavities: T-Rating is not required.

B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.

2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

F. Perform Work in accordance with applicable authority for welding hanger and support attachments to building structure.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.9 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Section 01 - Product Requirements.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

1.12 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.13 WARRANTY

A. Section 01 – Closeout Procedures.

B. Furnish one year manufacturer warranty for pipe hangers and supports.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
1. Nibco
2. Empire
3. Flex-Weld, Inc.
4. Glope Pipe Hanger Products Inc.
5. Michigan Hanger Co.
6. Superior Valve Co.
7. Substitutions: Section 01 60 00 - Product Requirements

B. Hydronic Piping:
1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.

12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, carbon steel ring.

C. Refrigerant Piping:
1. Conform to ASME B31.5.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated carbon-steel ring.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

A. Manufacturers:
1. Thunderline Link Seal
2. Fernco
3. BWM
4. Substitutions: Section 01 60 00 - Product Requirements

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:
1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 EQUIPMENT CURBS

A. Manufacturers:
1. Trimco
2. Cambridgeport
3. PateModel
4. By Equipment Manufacturer
5. Substitutions: Section 01 60 00 - Product Requirements

B. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, 1-1/2 inch thick insulation, factory installed wood nailer.

2.6 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

E. Sealant: Acrylic.

2.7 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation
3. Fernco
4. BWM
5. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.8 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division
4. Unistrut Corp. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.9 FIRESTOPPING

A. Manufacturers:
1. Dow Corning Corp.
2. Fire Trak Corp.
3. Hilti Corp.
4. International Protective Coating Corp.
5. 3M fire Protection Products
6. Specified Technology, Inc.
7. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer’s full range of colors.

2.10 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

C. General:
1. Furnish UL listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

D. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 – Project Management.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing materials to arrest liquid material leakage.

D. Obtain permission from Architect/Engineer before using powder-actuated anchors.

E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support vertical piping at every floor.

G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide lead packing between hanger or support and piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

L. Provide clearance in hangers and from structure and other equipment for installation of insulation.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Provide rigid anchors for pipes after vibration isolation components are installed.

3.6 INSTALLATION - FLASHING

A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.

C. Provide curbs for roof installations 14 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.

D. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing firestopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Remove dam material after firestopping material has cured.

D. Fire Rated Surface:
1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
   a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
   b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
   c. Pack void with backing material.
   d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

E. Non-Rated Surfaces:
1. Seal opening through non-fire rated wall, partition, floor, ceiling, and roof opening as follows:
   a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
   b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
   c. Install type of firestopping material recommended by manufacturer.
2. Install escutcheons where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.

3.9 FIELD QUALITY CONTROL

A. Section 01 – Closeout Procedures.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

A. Section 01 – Closeout Procedures.

B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Section 01 – Closeout Procedures.

B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 2)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4

B. Note 1: Refer to manufacturer’s recommendations for grooved end piping systems.

C. Note 2: 20 feet maximum spacing, minimum of one hanger for each pipe section close to joint behind bell. Provide hanger at each change of direction and each branch connection. For pipe sizes 6 inches and smaller, subjected to loadings other than weight of pipe and contents, limit span to maximum spacing for water service steel pipe.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 INTENT

A. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.

B. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.

C. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.

D. All such systems must be installed in strict accordance with seismic codes, component manufacturer's recommendations and building construction standards. Whenever a conflict occurs between the manufacturer's recommendations or construction standards, the most stringent shall apply.

E. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).

F. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.2 SUMMARY

A. Section Includes:
   1. Certification of seismic restraint designs and installation supervision.
   2. Certification of seismic attachment of housekeeping pads.
   3. NOTE: For all mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included.
   4. Seismic restraint products
      a. Vibration isolation elements.
      b. Equipment isolation bases.
      c. Piping flexible connections.
      d. Seismic restraints for isolated and non-isolated mechanical and electrical items.

5. Acoustic reduction products
   a. Duct silencers.
   b. Cross-talk silencers.
   c. Acoustic housings.
   d. Ductwork lagging.
   e. Acoustical louvers.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Section 07 92 00 - Joint Sealants
3. Section 08 91 19 – Fixed Louvers.
4. Section 23 04 00 – General Conditions for Mechanical Trades
5. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product requirements for anchors and piping expansion compensation.
6. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports.
7. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this section.
8. Section 23 33 00 - Air Duct Accessories: Product requirements for both solid and flexible duct connectors for duct silencers specified for placement by this section.

1.3 REFERENCES

A. Air Movement and Control Association International, Inc.:
1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

B. American National Standards Institute:
1. ANSI S1.4 - Sound Level Meters.
2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
3. ANSI S1.13 - Methods for the Measurement of Sound Pressure Levels in Air.
4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

C. Air-Conditioning and Refrigeration Institute:
1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.

D. American Society of Heating, Refrigerating and:
1. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
2. ASHRAE Handbook - HVAC Applications.

E. ASTM International:
1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
3. ASTM E596 - Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures.

F. Sheet Metal and Air Conditioning Contractors':
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.4 RELATED WORK

A. Housekeeping Pads
1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel
1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

C. Attachments
1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.5 SEISMIC FORCE LEVELS

A. Installations shall be designed to safely accept external forces determined in accordance with the International Building Code –2015, Section 1621 in any direction for all rigidly supported equipment without failure and permanent displacement of the equipment. Seismic restraints shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.

1.6 PERFORMANCE REQUIREMENTS

A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping and ductwork.

B. Provide minimum static deflection of isolators for equipment as follows:
1. Basement, Under 20 hp
a. 400 - 600 rpm: 1 inch
b. 600 - 800 rpm: 0.5 inch
c. 800 - 900 rpm: 0.2 inch
d. 1100 - 1500 rpm: 0.14 inch
e. Over 1500 rpm: 0.1 inch

2. Basement, Over 20 hp
   a. 400 - 600 rpm: 2 inch
   b. 600 - 800 rpm: 1 inch
   c. 800 - 900 rpm: 0.5 inch
   d. 1100 - 1500 rpm: 0.2 inch
   e. Over 1500 rpm: 0.15 inch
3. Upper Floors, Normal
   a. 400 - 600 rpm: 3.5 inch
   b. 600 - 800 rpm: 2 inch
   c. 800 - 900 rpm: 1 inch
   d. 1100 - 1500 rpm: 0.5 inch
   e. Over 1500 rpm: 0.2 inch
4. Upper Floors, Critical
   a. 600 - 800 rpm: 3.5 inch
   b. 800 - 900 rpm: 2 inch
   c. 1100 - 1500 rpm: 1 inch
   d. Over 1500 rpm: 0.5 inch

C. Consider upper floor locations critical unless otherwise indicated.

D. Use concrete inertia bases for fans having static pressure in excess of 3.5 inches water column or motors in excess of 40 hp, and on base mounted pumps over 10 hp.

E. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.

F. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook., HVAC Applications.
   1. Libraries: 35

1.7 DEFINITIONS

A. Life Safety Systems:
   1. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flow paths to fire protection and/or emergency lighting systems.
   2. All medical and life support systems.
   3. Fresh air relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.

B. Positive Attachment:
   1. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable trays, or any other equipment are not acceptable on this project as seismic anchor points.

C. Transverse Bracing:
   1. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

D. Longitudinal Bracing:
1. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

E. Failure
1. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" (3mm) and/or horizontal permanent deformation greater that 1/4" (6mm).

1.8 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings:
1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
2. Provide Drawings showing methods of suspension and support guides for conduit, piping, ductwork and ceiling hung equipment.
3. Record actual locations and installation of vibration isolators and seismic restraints including attachment points.
4. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
5. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
6. Drawings showing methods for isolation of conduits, pipes and ductwork penetrating walls and floor slabs.
7. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and/or pipe and duct locations.

C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

D. Seismic Certification and Analysis:
1. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
2. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing

and calculations must include both shear and tensile loads as well as one test or analysis at 45 degrees to the weakest mode.

3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.06 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

E. Design Data: Submit calculations indicating maximum room sound levels are not exceeded. The silencer manufacturer shall provide, for approval, acoustical system calculations for all duct systems with silencers to demonstrate that the submitted silencers will reduce mechanical fan noise to the NC values stated below in the occupied space. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as express in Table 34 of Chapter 47, “Sound and Vibration Control” of the 2003 ASHRAE Handbook – HVAC Applications, shall be used.

F. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.

G. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.

H. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

I. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.9 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures.

1.10 QUALITY ASSURANCE

A. Perform Work in accordance with ANSI S12.36 standards and recommendations of ASHRAE 68.

B. Maintain one copy of each document on site.

1.11 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

C. Design application of duct silencers and seismic snubbers under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Connecticut.

1.12 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.13 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.14 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall have the following responsibilities:
1. Determine vibration isolation and seismic restraint sizes and locations per specifications.
2. Provide and install isolation systems and seismic restraints as scheduled or specified.
3. Guarantee specified isolation system deflection.
4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
5. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
6. Substitution of "Internally Isolated" mechanical equipment in lieu of the specified isolation of this section is acceptable

1.15 WARRANTY

A. Section 01 – Closeout Procedures.

B. Furnish one year manufacturer warranty for inertia bases.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Mason Industries Inc. models listed below.

B. Other approved manufacturers providing equivalent products include:
1. Vibro Acoustics
2. Vibration Eliminator Co.
3. Amber/Booth Co.

2.2 PRODUCT DESCRIPTIONS

A. Vibration Isolators and Seismic Restraint Specifications – Products used are listed in table at the end of this section.
   1. Specification 1 - Neoprene Pad
      a. Two layers of 3/4" (19mm) thick neoprene pad consisting of 2" (50mm) square waffle modules separated horizontally by a 16 (1.5mm) gauge galvanized shim. Load distribution plates shall be used as required.
      b. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
   2. Specification 2 - Bridge-Bearing Neoprene Mountings
      a. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
      b. Mountings shall be Type BR as manufactured by Mason Industries, Inc.
   3. Specification 3 – Bushing Assemblies
      a. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality.
      b. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.
   4. Specification 4 - Neoprene Bushing
      a. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact.
      b. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
   5. Specification 5 – Spring Isolators
      a. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6mm) neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.
      b. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.

6. Specification 6 – Restrained Spring Mountings
   a. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Preapproval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings.
   b. Mountings shall be SLR as manufactured by Mason Industries, Inc.
7. Specification 7 – Spring Mountings
   a. Spring mountings as in specification 5 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4" (6mm) travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Preapproval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
   b. Mountings shall be SSLFH as manufactured by Mason Industries, Inc.
8. Specification 8 – Air Springs
   a. Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8" (3mm). Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician.
   b. Air Springs shall be Type MT and leveling valves Type LV as manufactured by Mason Industries, Inc.
9. Specification 9 – Restrained Air Springs
   a. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces.
   b. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc.

10. Specification 10 – Hangers
    a. Hangers shall consist of rigid steel frames containing minimum 1 1/4" (32mm) thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30o arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30o capability.
    b. Hangers shall be type 30N as manufactured by Mason Industries, Inc.
11. Specification 11 – Hangers
    a. Hangers shall be as described in 10, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30o capability.
    b. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
12. Specification 12 - Seismic Cable Restraints
    a. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be prestretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings.
    b. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.
13. Specification 13 – Seismic Solid Braces
    a. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "R" number from OSHPD in the state of California verifying the maximum certified load ratings.
    b. Solid seismic brace assemblies shall be type SSB as manufactured by Mason Industries, Inc.
14. Specification 14 – Rod Clamp Assemblies
    a. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.

b. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.

15. Specification 15 – Clevis Hanger Cross Brace
    a. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.
    b. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
16. Specification 16 - All-Directional Seismic Snubbers – Small Neoprene
    a. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" (6mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm2). A minimum air gap of 1/8" (3mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
    b. Snubber shall be Type Z-1225 as manufactured by Mason Industries, Inc.
17. Specification 17 - All-Directional Seismic Snubbers – Large Rubber
    a. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" (19mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm2). Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" (3mm) nor more that 1/4" (6mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" (9mm) deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" (12mm) deflection in the x, y and z planes. Snubbers shall have an anchorage preapproval "R" number from OSHPD in the state of California verifying the maximum certified horizontal and vertical load ratings.
    b. Snubbers shall be series Z-1011 as manufactured by Mason Industries, Inc.
18. Specification 18 – Stud Wedges
    a. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads.
    b. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.
19. Specification 19 – Female Wedge Anchors
    a. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety

shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying to its allowable loads.

b. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.

20. Specification 20 – Equipment Bases
    a. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split case pump shall include supports for suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14" (350mm) provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1" (25mm).
    b. Bases shall be type WF as manufactured by Mason Industries, Inc.
21. Specification 21 – Inertia Foundations
    a. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6" (150mm). The base depth need not exceed 12" (300mm) unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" (12mm) bars welded in place on 6" (150mm) centers running both ways in a layer 1 1/2" (38mm) above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" (25mm) clearance below the base. Wooden formed bases leaving a concrete rather then a steel finish are not acceptable.
    b. Base shall be type BMK or K as manufactured by Mason Industries, Inc.
22. Specification 22 – Curbs
    a. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushings shall be a minimum of 1/4" (6mm) thick. Steel springs shall be laterally stable and rest on 1/4" (6mm) thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2" (50mm) of insulation. The roof curbs shall be built to seismically contain the rooftop unit. The unit must be solidly fastened to the top floating rail, and the lower Z section anchored to the roof structure. Curb shall have anchorage preapproval "R" from

OSHPD in the state of California attesting to the maximum certified horizontal and vertical load ratings.

b. Curb shall be type RSC as manufactured by Mason Industries, Inc.

23. Specification 23 – Expansion Joints
    a. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Kevlar7 tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" (50mm) and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16" (400mm) to 24" (600mm) may be single sphere. Sizes 3/4" (19mm) to 1 2" (38mm) may have threaded two piece bolted flange assemblies, one sphere and cable retention. Connectors shall be rated at 250 psi (1.72MPa) up to 170o F (77oC) with a uniform drop in allowable pressure to 215 psi (1.48MPa)at 250o F (121oC) in sizes through 14"(350mm). 16" (400mm) through 24" (600mm) single sphere minimum ratings are 180 psi (1.24MPa) at 170o F (77oC) and 150 psi (1.03 MPa) at 250o F (121oC). Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
    b. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods. If control rods are used, they must have 2" (12mm) thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi (.7 kg/mm2) maximum on the washer area.
    c. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves.
    d. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.
24. Specification 24 – Flexible Stainless Steel Hoses
    a. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" (75mm) and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

Flanged		Male Nipples	
3 x 14	10 x 26	1/2 x 9	1 1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2 1/2 x 18
6 x 20	16 x 32	1 1/4 x 12	

8 x 22			

b. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.
c. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

25. Specification 25 - All-Directional Acoustical Pipe Anchor
    a. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi (.35 kg/mm2) and the design shall be balanced for equal resistance in any direction.
    b. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.
26. Specification 26 – Pipe Guides
    a. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (12mm) thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of + 1 5/8" (41mm) motion, or to meet location requirements.
    b. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.
27. Specification 27 - Split Wall Seals
    a. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" (19mm) thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of l" (25mm) past either face of the wall. Where temperatures exceed 240o F (115oC), 10# (4.5kg) density fiberglass may be used in lieu of the sponge.
    b. Seals shall be Type SWS as manufactured by Mason Industries, Inc.
28. Specification 28 - Horizontal Thrust Restraint
    a. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the duct work or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit.
    b. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc.

B. Table for Project: the list of Product Specification Type 1 through Type 28 to be used for project is located in at the end of the EXECUTION section.

2.3 DUCT SILENCERS

A. Manufacturers:
1. Vibro Acoustics
2. Substitutions: Section 01 60 00 - Product Requirements

B. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Configuration: Rectangular with lined splitters with radius nose and contoured tails, as indicated on Drawings

D. Materials:
1. Outer Casing: Minimum 20 gagethick galvanized steel stiffened with welded seams, 2 inch long, 11 gage slip joints on both ends.
2. Inner Casing and Splitters: Minimum 24 gage thick perforated galvanized steel.
3. Fill: Glass fiber or mineral wool of minimum 4 lb/cu ft density.
4. Fill Liner: Bonded glass fiber matting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 – Project Management.

B. Verify equipment, ductwork and piping is installed before work in this section is started.

3.2 EXISTING WORK

A. Provide access to existing piping and ductwork and other installations remaining active and requiring access.

B. Extend existing piping and ductwork installations using materials and methods.

3.3 INSTALLATION OF VIBRATION ISOLATORS

A. Vibration isolators and seismic restraint systems shall control excessive noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolators and seismic restraint units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.

B. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

C. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

E. The contractor shall not install any equipment, piping, duct or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

F. Coordinate work with other trades to avoid rigid contact with the building.

G. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.

H. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractors expense.

I. Correct, at no additional cost, all installations that are deemed defective in workmanship and materials at the contractor’s expense.

J. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
1. Flanges of structural beams.
2. Upper truss cords in bar joist construction.
3. Cast in place inserts or wedge type drill-in concrete anchors.

K. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

L. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.

M. At locations where specification 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with specification 14 braces.

N. At all locations where specification 12 or 13 restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with specification type 15 braces.

O. Drill-in concrete anchors for ceiling and wall installation shall be specification type 18, and specification type 19 female wedge type for floor mounted equipment.

P. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project. Each fan and motor assembly shall be supported on a single structural steel frame.

Q. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed specification 23 capabilities.

R. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification 27 wall seals.

S. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be specification type 28 (see selection guide).

T. Install isolation for motor driven equipment.

U. Bases:
1. Set steel bases for 1 inch clearance between housekeeping pad and base.
2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.

V. Adjust equipment level and install spring hangers without binding. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions. Locate isolation hangers as near to the overhead support structure as possible.

W. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

X. Provide pairs of horizontal limit springs on fans with more than 6.0 inch static pressure, and on hanger supported, horizontally mounted axial fans.

Y. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.

Z. Support piping connections to isolated equipment resiliently as follows:
1. Up to 4-inch Diameter: First three points of support.
2. 5 to 8-inch Diameter: First four points of support.
3. 10-inch Diameter and Over: First six points of support.
4. Select three hangers closest to vibration source for minimum 1.0-inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0-inch static deflection or 1/2 static deflection of isolated equipment.

3.4 INSTALLATION OF ACOUSTIC PRODUCTS

A. Support duct silencers independent of ductwork. With flexible duct connections, lagged with leaded vinyl sheet on inlet and outlet. Refer to Section 23 33 00.

B. Install cross-talk silencers in wall. Calk wall penetrations; refer to Section 07 90 00.

C. Lag ductwork, where indicated by wrapping with insulation and covering. Apply covering to be airtight. Do not attach covering rigidly to ductwork. Coordinate with vapor barrier(s) requirements in other specification sections and as scheduled on drawings.

D. Attach ductwork to acoustic louvers with flexible duct connections. Refer to Section 23 33 00.

3.5 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

C. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

D. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

E. Pipe Isolation Schedule:

Pipe Size Inch	Isolated Distance from Equipment diameters
1	120
2	90 diameters
3	80 diameters
4	75 diameters
6	60 diameters
8	60 diameters

3.6 VIBRATION ISOLATION AND SEISMIC RESTRAINT INSTALLATION

A. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in specification 11. Specification 11 hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps specification 14. Floor supported piping shall rest on isolators as described in specification 6. Heat exchanger's and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.

B. Riser isolation: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to ± 25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

C. Seismic Restraint of Piping
1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables if isolated. Specification 12 or 13 restraints may be used on unisolated piping.
   a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 1" (25mm) I.D. or larger.
   b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" (32mm) I.D. and larger.
   c. All other piping 2 1/2" (64mm) diameter and larger.
2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
5. For fuel oil and all gas piping transverse restraints must be at 20' (6m) maximum and longitudinal restraints at 40' (12m) maximum spacing.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" (600m) of the elbow or TEE or combined stresses are within allowable limits at longer distances.
7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.
9. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly in Zones 2B, 3 and 4 shall be braced as in sections 3.2.D.2 and 3. For Zones 0, 1 and 2A, 2 band clamps may be used with reduced spacings of 1/2 of those listed in sections 3.2.D.2 and 3.

D. Vibration Isolation of Ductwork
1. All discharge runs for a distance of 50' (15m) from the connected equipment shall be isolated from the building structure by means of specification 10 hangers or specification 5 floor isolators. Spring deflection shall be a minimum of 0.75" (19mm).
2. All duct runs having air velocity of 1000 fpm (5 m/s) or more shall be isolated from the building structure by specification 11 hangers or specification 5 floor supports. Spring deflection shall be a minimum of 0.75" (19mm).

3. Flexible duct connections shall be provided at inlet and discharge ducts. Refer to Section 15910.

E. Seismic Restraint of Ductwork
1. Seismically restrain all duct work with specification 12 or 13 restraints as listed below:
   a. Restrain rectangular ducts with cross sectional area of 6 sq.ft. (.5 m^2) or larger.
   b. Restrain round ducts with diameters of 28" (700mm) or larger.
   c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
2. Transverse restraints shall occur at 30' (9mm) intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
3. Longitudinal restraints shall occur at 60' (18m) intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' (1.2m) of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
4. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
6. Walls, including gypsum board non bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
7. Chimneys and stacks passing through floors are to be bolted at each floor level or secured above and below each floor with riser clamps and specification type 13 for seismic solid brace restraints.
8. Chimneys and stacks running horizontally to be braced every 30’ with specification type 12 seismic cable restraints or specification type 13 for seismic solid brace restraints.

F. Vibration Isolation and Seismic Restraint of Mechanical Equipment
1. All mechanical equipment shall be vibration isolated and seismically restrained as per the schedules in part 3.5 of this specification.
2. Equipment mounted on housekeeping pads: Pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
3. Requirements for installation on concrete inertia bases shall be as follows:
   a. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".
   b. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
   c. The isolators shall be installed without raising the machine and frame assembly.

d. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
e. Install equipment with flexibility in wiring connection.
f. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".
g. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators, or seismic restraints.

3.6 SEISMIC RESTRAINT EXCLUSIONS

A. General: All mechanical and electrical components and systems that are considered exempt from the requirement for seismic restraint, in accordance with The International Building Code – 2003, Section.1621 and all related State of Connecticut Supplements, shall not require seismic restraint.

B. Piping
1. Piping in boiler and mechanical rooms less than 1 1/4" (32mm) inside diameter.
2. All other piping less than 2 1/2" (64mm) inside diameter.
3. All piping suspended by individual hangers 12" (300mm) or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" (300mm) limit is exceeded by any hanger in the run, seismic bracing is required for the run.
4. The 12" (300mm) exemption applies for trapeze supported systems if the top of each item supported by the trapeze qualifies.

C. Ductwork
1. Rectangular and square and ducts that are less than 6 square feet in cross sectional area.
2. Oval ducts that are less than 6 square feet (.5m^2) in cross sectional area based on nominal size.
3. Round duct less than 28" (.5m^2) in diameter.
4. All duct suspended by hangers 12" (300mm) or less in length as measured from the top of the duct to the point of attachment to the structure. Hangers must be attached within 2" (50mm) of the top of the duct with a minimum of two #10 sheet metal screws. If the 12" (300mm) limit is exceeded by any hanger in the run, seismic bracing is required for the run.

3.7 INSPECTION

A. Examine systems under provisions of Division 1.

B. On completion of installation of all vibration isolation devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as

properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

3.8 SCHEDULES

	ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR SOLID CONCRETE FLOORS 4" AND THICKER (NOTE 7)									
	Ground Supported Slab or Basement		20' Floor Span Possible Floor Defl. – 0.67"		30' Floor Span Possible Floor Defl. – 1.0"		40' Floor Span Possible Floor Defl. – 1.33"		50' Floor Span Possible Floor Defl. – 1.67"	
SPECIFICATION SELECTION GUIDE	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.
REFRIG. MACHINES										
Centrifugal Chillers or Heat Pumps										
Cooler Condenser Mounted Hermetic Compressors	2-20-23	0.35	6-20-23	0.75	6-20-23	1.5	6-23	1.5	6-20-23	2.5
Cooler Condenser Alongside Hermetic Compressor	2-23	0.35	6-23	0.75	6-23	1.5	6-23	1.5	6-23	2.5
Open Type Compressor (note 3)	2-23	0.35	6-23	0.75	6-23	1.5	6-20-23	1.5	6-20-23	2.5
Refrig. Reciprocating Compressors										
500 rpm to 750 rpm	6-23	0.75	6-23	1.5	6-23	1.5	6-20-23	2.5	6-20-23	3.5
751 rpm and Over	6-23	0.75	6-23	~~0.25~~ **0.75**	6-23	1.5	6-20-23	2.5	6-20-23	3.5
Reciprocating Chillers or Heat Pumps										
500 rpm to 750 rpm	6-23	0.75	6-23	1.5	6-23	1.5	6-20-23	2.5	6-20-23	3.5
751 rpm and Over	6-23	0.75	6-23	0.75	6-20-23	1.5	6-20-23	2.5	6-20-23	3.5

	ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR SOLID CONCRETE FLOORS 4" AND THICKER (NOTE 7)									
	Ground Supported Slab or Basement		20' Floor Span Possible Floor Defl. – 0.67"		30' Floor Span Possible Floor Defl. – 1.0"		40' Floor Span Possible Floor Defl. – 1.33"		50' Floor Span Possible Floor Defl. – 1.67"	
SPECIFICATION SELECTION GUIDE	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.
PUMPS										
Closed Coupled										
Thru 5 hp	2-21-23	0.35	5-16-21-23	0.75	5-16-21-23	0.75	5-16-21-23	1.5	5-16-21-23	1.5
7 ½ hp and Larger	5-16-21-23	0.75	5-16-21-23	0.75	5-16-21-23	1.5	5-16-21-23	1.5	5-16-21-23	2.5
Base Mounted (note 2)										
Thru 60 hp	5-16-21-23	0.75	5-16-21-23	0.75	5-16-21-23	1.5	5-16-21-23	1.5	5-16-21-23	2.5
75 hp and Larger	5-16-21-23	0.75	5-16-21-23	1.5	5-16-21-23	2.5	5-16-21-23	2.5	5-16-21-23	3.5
Suspended Units (for Fan Heads see Blowers Guide)										
Thru 5 hp	10-12	1.0	10-12	1.0	10-12	1.0	10-12	1.0	10-12	1.0
7 ½ hp and Larger – 275 rpm to 400 rpm	10-12	1.5	10-12	1.5	10-12	1.5	10-12	1.5	10-12	1.5
7 ½ hp and Larger – 401 rpm and Over	10-12	1.0	10-12	1.0	10-12	1.0	10-12	1.5	10-12	2.5
Floor Mounted Units (for Fan Heads see Blowers Guide)										
Thru 5 hp	2	0.35	7	0.75	7	0.75	7	~~0.25~~ **0.75**	7	0.75
7 ½ hp and Larger – 275 rpm to 400 rpm	2	0.35	7	1.5	7	1.5	7	1.5	7	1.5

	ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR SOLID CONCRETE FLOORS 4" AND THICKER (NOTE 7)									
	Ground Supported Slab or Basement		20' Floor Span Possible Floor Defl. – 0.67"		30' Floor Span Possible Floor Defl. – 1.0"		40' Floor Span Possible Floor Defl. – 1.33"		50' Floor Span Possible Floor Defl. – 1.67"	
SPECIFICATION SELECTION GUIDE	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.
7 ½ hp to 40 hp – 401 rpm and Over	2	0.35	7	0.75	7	0.75	7	1.5	5-16-20	2.5
50 hp and Larger – 401 rpm and Over	2	0.35	7	0.75	7	1.5	5-16-20	2.5	5-16-20	3.5

	DEFLECTION AND MOUNTING CRITERIA FOR SOLID CONCRETE FLOORS 4" OR THICKER (NOTE 7)					
	Ground Supported Slab or Basement		20' Floor Span Possible Floor Defl. – 0.67"	30' Floor Span Possible Floor Defl. – 1.0"	40' Floor Span Possible Floor Defl. – 1.33"	50' Floor Span Possible Floor Defl. – 1.67"
SPECIFICATION SELECTION GUIDE	Engr Spec	Min Static Defl (in) (note 1)	Engineer Specifications and Minimum Static Deflection as tabulated below (note 1)			
Blowers						
Utilities Set						
Floor Mounted (note 5)	2	0.35	Spec 7 for 0.75" and 1/5" deflection and Spec 5-20-16 for over 1.5" deflection with deflection from Blower Minimum Deflection Guide, but not to exceed 2.5"			
Roof Mounted			Spec 5-21-16 with deflection from Blower Minimum Deflection Guide. If roof will not handle concrete base load use Spec 6 for 0.75 and 1.5" deflection and Spec 6-20 for over 1.5" deflection			
Suspended Unit (note 5)			Spec 10-12 with deflection from Blower Minimum Deflection Guide, not to exceed 2.5" deflection			
Centrifugal Blowers (note 6)	2-21	0.35	Spec 5-21-16 with deflection from Blower Minimum Deflection Guide			
Fan Heads						

	DEFLECTION AND MOUNTING CRITERIA FOR SOLID CONCRETE FLOORS 4" OR THICKER (NOTE 7)					
	Ground Supported Slab or Basement		20' Floor Span Possible Floor Defl. – 0.67"	30' Floor Span Possible Floor Defl. – 1.0"	40' Floor Span Possible Floor Defl. – 1.33"	50' Floor Span Possible Floor Defl. – 1.67"
SPECIFICATION SELECTION GUIDE	Engr Spec	Min Static Defl (in) (note 1)	Engineer Specifications and Minimum Static Deflection as tabulated below (note 1)			
Floor Mounted	2-28	0.35	Spec 7-28 if 0.75" or 1.5" deflection or Spec 5-20-16-28 for deflection over 1.5" to 4.5" from Blower Minimum Deflection Guide.			
Suspended Units			Spec 10-12-28 with deflection from Blower Minimum Deflection Guide			
Tubular Centrifugal and Axial Fans						
Suspended Units			Spec 10-12 with deflection from Blower Minimum Deflection Guide, Spec 10-12-28 for over 4" static pressure			
Floor Mounted with Motor on/in Fan Casing	2	0.35	Spec 7 for 0.75" to 1.5" deflection and Spec 5-20-16 for over 1/5" deflection with deflection from Blower Minimum Deflection Guide, Spec 5-21-16 or 5-16-28 for over 4" static pressure			
Floor Mounted Arrangement 1 or any Separately Mounted Motor	2-21	0.35	Spec 5-21-16 with deflection from Blower Minimum Deflection Guide			
Cooling Towers & Condensing Units	2	0.35	Spec 6 with deflection from Blower Minimum Deflection Guide			

Blower Minimum Deflection Guide					
Fan Speed RPM	**Required Deflection for Ground Supported Slab or Basement**	**Required Deflection for 20' Floor Span**	**Required Deflection for 30' Floor Span**	**Required Deflection for 40' Floor Span**	**Required Deflection for 50' Floor Span**
500 and up	0.35"	0.75"	1.5"	2.5"	3.5"
375-499	0.35"	1.5"	2.5"	3.5"	3.5"
300-374	0.35"	2.5"	2.5"	3.5"	3.5"

225-299	0.35”	3.5”	3.5”	3.5”	3.5”
175-225	0.35”	3.5”	4.5”	4.5”	4.5”

When blowers are 60 HP or larger, select deflection requirements for next larger span. A minimum of 2.5" should be used unless larger deflections are called for on the chart or these fans are located in the lowest sub-basement or on a slab on grade.

Notes:

1. Minimum deflection called for in this specification are not 'nominal' but certifiable minimums. The 0.75", 1.5", 2.5", 3.5", and 4.5" minimums should be selected from manufacturers nominal 1", 2", 3", 4" and 5" series respectively. Air spring isolation specifications 8 & 9 may be substituted for steel springs above in highly sensitive noise free locations.

2. Vacuum, Condensate or Boiler Feed Pumps shall be mounted with their tanks on a common spec. 21 base with deflections as specified for base mounted pumps.

3. The base described in specification 20 is used under the drive side. Individual mountings as described in specification 6 are used under the Cooler and Condenser.

4. This type of compressor is highly unbalanced and sometimes requires inertia bases weighing 5 to 7 times equipment weight to reduce running motion.

5. Limit deflection f or utility sets 18" wheel diameter and smaller to 1 1/2".

6. FLOATING CONCRETE INERTIA BASES. Floating concrete inertia bases do not reduce vibration transmitted to the structure through the mountings. These bases will reduce vibratory motion, provide a very rigid machine base and minimize spring reactions to fan thrust. Engineers preferring steel bases rather than the concrete mentioned above in specification 5-21 should change the designation to 5-20. Concrete is preferred for all fans operating at static pressure above 4" and on roof tops.

7. LIGHT FLOOR CONSTRUCTION. When floors or roofs are lighter than 4" solid concrete a localized mass shall be introduce under the vibration mountings in the form of a sub-base. This sub-base should be 12" thick and 12" longer and wider than the mechanical equipment above it. When this mass is provided the 30' minimum static deflection requirements will suffice even in longer bays. The mass is also useful for unusually large bays over 50'. When floors are lighter than the 4" concrete or the location is in a particularly sensitive area and the mass described above cannot be introduced, select deflection requirements for the next larger span.

8. For equipment where increased resiliency and decreased accelerations are required change specification 16 snubbers to specification 17 snubbers.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Sections:
1. Division 09 21 23 – Painting.
2. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Samples: Submit two tags, labels, & pipe markers size used on project.

E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 – Closeout Procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Division 1 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 EXTRA MATERIALS

A. Division 1 – Closeout Procedures.

B. Furnish two containers of spray-on adhesive.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
1. Craftmark Identification Systems.
2. Safety Sign Co.
3. Seton Identification Products.
4. Substitutions: Division 1 - Product Requirements.

B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Plastic Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Refer to Division 1 - Product Requirements.
2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.

B. Metal Tags:
1. Manufacturers:
a. Craftmark Identification Systems.
b. Safety Sign Co.
c. Seton Identification Products.
d. Substitutions: Refer to Division 1 - Product Requirements.
2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

C. Information Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products.
d. Substitutions: Refer to Division 1 - Product Requirements permitted.
2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

D. Tag Chart: Typewritten letter size list of applied tags and location in plastic laminated frame.

2.3 STENCILS

A. Manufacturers:
1. Craftmark Identification Systems
2. Safety Sign Co.
3. Seton Identification Products.
4. Substitutions: Division 1 - Product Requirements.

B. Stencils: With clean cut symbols and letters of following size:
1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inch high letters.
4. Ductwork and Equipment: 1-3/4 inch high letters.

C. Stencil Paint: As specified in Division 9, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
1. Manufacturers:
a. Craftmark Identification Systems.
b. Safety Sign Co.
c. Seton Identification Products.
d. Substitutions: Refer to Division 1 - Product Requirements permitted.
2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
1. Manufacturers:
a. Craftmark Identification Systems.
b. Safety Sign Co.
c. Seton Identification Products.
d. Substitutions: Refer to Division 1 - Product Requirements permitted.
2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:
1. Manufacturers:
a. Seaton Model.
b. Electro Tape.
c. Pratt Tyco.
d. Substitutions: Refer to Division 1 - Product Requirements.
2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.5 CEILING TACKS

A. Manufacturers:
1. Craftmark Identification Systems.
2. Safety Sign Co.
3. Seton Identification Products.
4. Substitutions: Division 1 - Product Requirements.

B. Description: Steel with 3/4 inch diameter color-coded head.

C. Color code as follows:
1. HVAC equipment: Yellow.
2. Fire dampers/smoke dampers: Red.
3. Plumbing valves: Green.
4. Heating/cooling valves: Blue.

2.6 LABELS

A. Manufacturers:
1. Craftmark Identification Systems
2. Safety Sign Co.
3. Seton Identification Products.
4. Substitutions: Division 1 - Product Requirements.

B. Description: Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

2.7 LOCKOUT DEVICES

A. Lockout Hasps:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Refer to Division 1 - Product Requirements
2. Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

B. Valve Lockout Devices:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products.
d. Substitutions: Refer to Division 1 - Product Requirements .
2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 9 for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting in accordance with Division 9.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify air terminal units and radiator valves with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers or stenciled painting. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. For exposed natural gas lines other than steel pipe, attach yellow pipe labels with "GAS" in black lettering, at maximum 5 foot spacing.

N. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

O. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Testing adjusting, and balancing of air systems.
2. Testing adjusting, and balancing of hydronic and refrigerating systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.

B. Related Sections:
1. Section 01 91 13 –Commissioning General Requirements.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 09 00 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
4. Section 23 09 95 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.2 REFERENCES

A. Associated Air Balance Council:
1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:
1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

A. Division 01 - Submittal Procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or NEBB Report forms. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

D. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty or a Copy of NEBB Certificate of Conformance Certification.

E. Submit draft copies of report for review prior to final acceptance of Project.

F. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 - Closeout Procedures.

B. Project Record Documents: Record actual locations of flow measuring stations, balancing valves and rough setting.

C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of Connecticut standard.

B. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance and NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

C. Maintain one copy of each document on site.

D. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.

1.6 QUALIFICATIONS

A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years experience certified by AABC.

B. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

A. Division 01 - Summary: Work sequence.

B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

A. Division 01 – Project Management.

B. Schedule and provide assistance in final adjustment and test of smoke control system with Fire Authority.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 01 – Project Management.

B. Verify systems are complete and operable before commencing work. Verify the following:
1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.

3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

A. Division 01 – Closeout Procedures.

B. Verify recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

E. Report defects and deficiencies noted during performance of services, preventing system balance.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.

M. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

3.6 WATER SYSTEM PROCEDURE

A. Adjust water systems, after air balancing, to obtain design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.

C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.7 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
   1. Fire Pumps.
   2. Plumbing Pumps.
   3. Domestic Water System.

4. Domestic Hot water heaters.
5. HVAC Pumps.
6. Condensing Boilers.
7. Air Cooled Water Chillers.
8. Split System Air Conditioners.
9. Variable Refrigerant Systems.
10. Air Coils.
11. Fan Coil Units.
12. Air Handling Units.
13. Dedicated Outdoor Air Units.
14. Energy Wheels.
15. Heat Recovery Ventilators.
16. Gas Fired Make up Air Units.
17. Fans.
18. Kitchen hoods.
19. Air Filters.
20. Air Terminal Units.
21. Air Inlets and Outlets.
22. Unit Heaters.
23. Radiant Ceiling Panels.
24. Glycol Make up units.
25. Heat Exchangers.
26. Hot Water Recirculation Pumps.

B. Report Forms
1. Title Page:
   a. Name of Testing, Adjusting, and Balancing Agency
   b. Address of Testing, Adjusting, and Balancing Agency
   c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
   d. Project name
   e. Project location
   f. Project Architect
   g. Project Engineer
   h. Project Contractor
   i. Project altitude
   j. Report date
2. Summary Comments:
   a. Design versus final performance
   b. Notable characteristics of system
   c. Description of systems operation sequence
   d. Summary of outdoor and exhaust flows to indicate building pressurization
   e. Nomenclature used throughout report
   f. Test conditions
3. Instrument List:
   a. Instrument
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Range

f. Calibration date

4. Electric Motors:
   a. Manufacturer
   b. Model/Frame
   c. HP/BHP and kW
   d. Phase, voltage, amperage; nameplate, actual, no load
   e. RPM
   f. Service factor
   g. Starter size, rating, heater elements
   h. Sheave Make/Size/Bore
5. V-Belt Drive:
   a. Identification/location
   b. Required driven RPM
   c. Driven sheave, diameter and RPM
   d. Belt, size and quantity
   e. Motor sheave diameter and RPM
   f. Center to center distance, maximum, minimum, and actual
6. Pump Data:
   a. Identification/number
   b. Manufacturer
   c. Size/model
   d. Impeller
   e. Service
   f. Design flow rate, pressure drop, BHP and kW
   g. Actual flow rate, pressure drop, BHP and kW
   h. Discharge pressure
   i. Suction pressure
   j. Total operating head pressure
   k. Shut off, discharge and suction pressures
   l. Shut off, total head pressure
7. Combustion Test:
   a. Manufacturer
   b. Model number
   c. Serial number
   d. Firing rate
   e. Overfire draft
   f. Gas meter timing dial size
   g. Gas meter time per revolution
   h. Gas pressure at meter outlet
   i. Gas flow rate
   j. Heat input
   k. Burner manifold gas pressure
   l. Percent carbon monoxide (CO)
   m. Percent carbon dioxide (CO2)
   n. Percent oxygen (O2)
   o. Percent excess air
   p. Flue gas temperature at outlet
   q. Ambient temperature
   r. Net stack temperature
   s. Percent stack loss
   t. Percent combustion efficiency

u. Heat output

8. Air Cooled Condenser:
   a. Identification/number
   b. Location
   c. Manufacturer
   d. Model number
   e. Serial number
   f. Entering DB air temperature, design and actual
   g. Leaving DB air temperature, design and actual
   h. Number of compressors
9. Chillers:
   a. Identification/number
   b. Manufacturer
   c. Capacity
   d. Model number
   e. Serial number
   f. Evaporator entering water temperature, design and actual
   g. Evaporator leaving water temperature, design and actual
   h. Evaporator pressure drop, design and actual
   i. Evaporator water flow rate, design and actual
   j. Condenser entering water temperature, design and actual
   k. Condenser pressure drop, design and actual
   l. Condenser water flow rate, design and actual
10. Heat Exchanger:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Model number
   f. Serial number
   g. Steam pressure, design and actual
   h. Primary water entering temperature, design and actual
   i. Primary water leaving temperature, design and actual
   j. Primary water flow, design and actual
   k. Primary water pressure drop, design and actual
   l. Secondary water leaving temperature, design and actual
   m. Secondary water leaving temperature, design and actual
   n. Secondary water flow, design and actual
   o. Secondary water pressure drop, design and actual
11. Cooling Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual
   f. Entering air DB temperature, design and actual
   g. Entering air WB temperature, design and actual
   h. Leaving air DB temperature, design and actual
   i. Leaving air WB temperature, design and actual
   j. Water flow, design and actual
   k. Water pressure drop, design and actual

l. Entering water temperature, design and actual
m. Leaving water temperature, design and actual
n. Saturated suction temperature, design and actual
o. Air pressure drop, design and actual

12. Heating Coil Data:
    a. Identification/number
    b. Location
    c. Service
    d. Manufacturer
    e. Air flow, design and actual
    f. Water flow, design and actual
    g. Water pressure drop, design and actual
    h. Entering water temperature, design and actual
    i. Leaving water temperature, design and actual
    j. Entering air temperature, design and actual
    k. Leaving air temperature, design and actual
    l. Air pressure drop, design and actual
13. Electric Duct Heater:
    a. Manufacturer
    b. Identification/number
    c. Location
    d. Model number
    e. Design kW
    f. Number of stages
    g. Phase, voltage, amperage
    h. Test voltage (each phase)
    i. Test amperage (each phase)
    j. Air flow, specified and actual
    k. Temperature rise, specified and actual
14. Unit Ventilator and Fan Coil Data:
    a. Manufacturer
    b. Identification/number
    c. Location
    d. Model number
    e. Size
    f. Air flow, design and actual
    g. Water flow, design and actual
    h. Water pressure drop, design and actual
    i. Entering water temperature, design and actual
    j. Leaving water temperature, design and actual
    k. Entering air temperature, design and actual
    l. Leaving air temperature, design and actual
15. Air Moving Equipment:
    a. Location
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Arrangement/Class/Discharge
    f. Air flow, specified and actual
    g. Return air flow, specified and actual
    h. Outside air flow, specified and actual

i. Total static pressure (total external), specified and actual
j. Inlet pressure
k. Discharge pressure
l. Sheave Make/Size/Bore
m. Number of Belts/Make/Size
n. Fan RPM

16. Return Air/Outside Air Data:
    a. Identification/location
    b. Design air flow
    c. Actual air flow
    d. Design return air flow
    e. Actual return air flow
    f. Design outside air flow
    g. Actual outside air flow
    h. Return air temperature
    i. Outside air temperature
    j. Required mixed air temperature
    k. Actual mixed air temperature
    l. Design outside/return air ratio
    m. Actual outside/return air ratio
17. Exhaust Fan Data:
    a. Location
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Air flow, specified and actual
    f. Total static pressure (total external), specified and actual
    g. Inlet pressure
    h. Discharge pressure
    i. Sheave Make/Size/Bore
    j. Number of Belts/Make/Size
    k. Fan RPM
18. Duct Traverse:
    a. System zone/branch
    b. Duct size
    c. Area
    d. Design velocity
    e. Design air flow
    f. Test velocity
    g. Test air flow
    h. Duct static pressure
    i. Air temperature
    j. Air correction factor
19. Duct Leak Test:
    a. Description of ductwork under test
    b. Duct design operating pressure
    c. Duct design test static pressure
    d. Duct capacity, air flow
    e. Maximum allowable leakage duct capacity times leak factor
    f. Test apparatus
        1) Blower

2) Orifice, tube size
3) Orifice size
4) Calibrated

g. Test static pressure
h. Test orifice differential pressure
i. Leakage

20. Air Monitoring Station Data:
    a. Identification/location
    b. System
    c. Size
    d. Area
    e. Design velocity
    f. Design air flow
    g. Test velocity
    h. Test air flow
21. Flow Measuring Station:
    a. Identification/number
    b. Location
    c. Size
    d. Manufacturer
    e. Model number
    f. Serial number
    g. Design Flow rate
    h. Design pressure drop
    i. Actual/final pressure drop
    j. Actual/final flow rate
    k. Station calibrated setting
22. Terminal Unit Data:
    a. Manufacturer
    b. Type, constant, variable, single, dual duct
    c. Identification/number
    d. Location
    e. Model number
    f. Size
    g. Minimum static pressure
    h. Minimum design air flow
    i. Maximum design air flow
    j. Maximum actual air flow
    k. Inlet static pressure
23. Air Distribution Test Sheet:
    a. Air terminal number
    b. Room number/location
    c. Terminal type
    d. Terminal size
    e. Area factor
    f. Design velocity
    g. Design air flow
    h. Test (final) velocity
    i. Test (final) air flow
    j. Percent of design air flow

24. Sound Level Report:
    a. Location
    b. Octave bands - equipment off
    c. Octave bands - equipment on
    d. RC level - equipment on
25. Vibration Test:
    a. Location of points:
        1) Fan bearing, drive end
        2) Fan bearing, opposite end
        3) Motor bearing, center (when applicable)
        4) Motor bearing, drive end
        5) Motor bearing, opposite end
        6) Casing (bottom or top)
        7) Casing (side)
        8) Duct after flexible connection (discharge)
        9) Duct after flexible connection (suction)
    b. Test readings:
        1) Horizontal, velocity and displacement
        2) Vertical, velocity and displacement
        3) Axial, velocity and displacement
    c. Normally acceptable readings, velocity and acceleration
    d. Unusual conditions at time of test
    e. Vibration source (when non-complying)

END OF SECTION 230593

SECTION 23 0700 - HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. HVAC piping insulation, jackets and accessories.
2. HVAC equipment insulation, jackets and accessories.
3. HVAC ductwork insulation, jackets, and accessories.
4. Acoustical Plenum Lining

B. Related Sections:
1. Section 07 84 43 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 91 23 - Painting
3. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 REFERENCES

A. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
14. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

15. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
16. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
17. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
18. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
19. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
20. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
21. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
22. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
23. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

B. Sheet Metal and Air Conditioning Contractors':
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

C. Underwriters Laboratories Inc.:
1. UL 1978 - Standard for Safety for Grease Ducts.

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

E. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 – Project Management.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 - Product Requirements.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 01 – Closeout Procedures.

B. Furnish five-year manufacturer warranty for manmade fiber.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all

aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
   1. CertainTeed.
   2. Knauf.
   3. Johns Manville.
   4. Owens-Corning.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
   1. Aeroflex. Aerocell.
   2. Armacell, LLC. Armaflex.
   3. Nomaco. K-flex.

C. Manufacturers for Polyisocyanurate Foam Insulation Products:
   1. Dow Chemical Company.
   2. Substitutions: Section 01 60 00 - Product Requirements.

D. Manufacturers for Extruded Polystyrene Insulation Products:
   1. Dow Chemical Company.
   2. Johns Manville
   3. Green Poly ISO

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
   1. Thermal Conductivity: 0.23 at 75 degrees F.
   2. Operating Temperature Range: 0 to 850 degrees F.
   3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C534, Type II, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.25 at 75 degrees F.
   2. Operating Temperature Range: Range: Minus 297 to 180 degrees F.
   3. Jacketing: Factory Applied 12 Mil Laminated Covering.

C. TYPE P-3: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:
   1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 10 mil.
3. Connections: Brush on welding adhesive.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.EQUIPMENT INSULATION

J. TYPE E-1: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
1. Thermal Conductivity: 0.27 at 75 degrees F .
2. Operating Temperature Range: Range: Minus 70 to 220 degrees

2.5 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:
1. Product Description: ASTM D1785, sheet material, off-white color.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 150 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
Thickness: 10 mil.
5. Connections: Pressure sensitive color matching vinyl tape.

B. Aluminum Equipment Jacket:
1. ASTM B209 Thickness: 0.020 inch thick sheet.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.02 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.02 inch thick aluminum.

C. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

D. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

2.6 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

2.7 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Operating Temperature: 250 degrees F.
3. Density: 1.0 pound per cubic foot.

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied all service facing meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Density: 6.0 pound per cubic foot.

C. TYPE D-3: Inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978.
1. Thermal Conductivity: 0.42 at 500 degrees F.
2. Weight: 1.4 pound per square foot.
3. Surface Burning Characteristics: Maximum 0/0 flame spread/smoke developed index when tested in accordance with ASTM E84.

D. TYPE D-4-: ASTM C1071, ASTM 1104, Type II, rigid, glass fiber duct liner with coated air side.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Density: 3.0 pound per cubic foot.
3. Maximum Operating Temperature: 250 degrees F.
4. Maximum Air Velocity: 6,000 feet per minute.

E. TYPE D-5: Closed Cell Elastomeric Insulation with 12 Mil Laminated Covering
1. ASTM C534, Type II, flexible, closed cell elastomeric insulation.
2. Thermal Conductivity: 0.25 at 75 degrees F per Inch.
3. Service Temperature Range: Range: Minus 297 to 180 degrees F.
4. Jacketing: Factory Applied 12 Mil Laminated Covering.

2.8 DUCTWORK INSULATION JACKETS

A. Aluminum Duct Jacket:
   1. ASTM B209.
   2. Thickness: 0.020 inch thick sheet.
   3. Finish: Smooth.
   4. Joining: Longitudinal slip joints and 2 inch laps.
   5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

B. Vapor Retarder Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film 0.0032 inch vinyl.
   2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
   3. Secure with pressure sensitive tape.

2.9 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Liner Fasteners: Galvanized steel, self-adhesive pad with head.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.

I. Membrane Adhesives: As recommended by membrane manufacturer.

2.10 ACOUSTICAL DUCT LINING

A. Rigid fiber glass board specifically designed for lining HVAC plenums and air distribution ductwork:
   1. Product Description: ASTM C 1071, Type II duct liner requirements, Black color.
   2. Minimum Service Temperature: -40 degrees F.
   3. Maximum Service Temperature: 250 degrees F. ASTM C411
   4. Water Repellancy: >6 per INDA IST 80.6 .
      Thickness: 10 mil.

5. Coated with durable, smooth surface that is resilient to dust, dirt and microbial growth.
6. Fungi resistance: ASTM G21
7. Bacteria Resistance: ASTM G22

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify piping, equipment and ductwork has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces Provide with PVC Plastic pipe jacketing for additional protection. Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Hot Piping Systems:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

F. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
   a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
   b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

G. Insulation Terminating Points:
1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

H. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer’s recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

I. Pipe Exposed in Mechanical Equipment Rooms and similar spaces or Finished Spaces less than 10 feet above finished floor: Finish with PVC jacket and fitting covers.

J. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o’clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

K. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

L. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

M. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

N. Prepare pipe insulation for finish painting. Refer to Section 09 90 00.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F Or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140 degrees F:
1. Insulate flanges and unions with removable sections and jackets.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

I. Cover glass fiber, cellular glass, cellular foam insulation with metal mesh and finish with heavy coat of insulating cement.

J. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

K. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

3.4 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions.

B. Insulated ductwork conveying air below ambient temperature:
1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:
1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces below 10 feet above finished floor: Finish with canvas jacket sized for finish painting.

E. External Glass Fiber Duct Insulation:
1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

F. External Elastomeric Duct Insulation:
1. Adhere to clean oil-free surfaces with full coverage of adhesive.
2. Seal seams and butt joints with manufacturer’s recommended adhesive.
3. When application requires multiple layers, apply with joints staggered.
4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
5. Lift ductwork off trapeze hangers and insert spacers.

G. Duct and Plenum Liner:
1. Adhere insulation with adhesive for 90 percent coverage.
2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

H. Kitchen Exhaust Ductwork:
1. Cover duct by wrapping with insulation using overlap method and butt joint with collar method.
2. Overlap seams of each method by 3 inches.
3. Attach insulation using steel banding or by welded pins and clips.
4. Install insulation without sag on underside of ductwork. Use additional fasteners to prevent sagging.

I. Ducts Exterior to Building:
1. Install insulation according to external duct insulation paragraph above.
2. Provide external insulation with vapor retarder jacket. Cover with outdoor jacket finished with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
3. Finish with aluminum duct jacket.
4. Calk seams at flanges and joints. Located major longitudinal seams on bottom side of horizontal duct sections.

J. Prepare duct insulation for finish painting. Refer to Section 09 90 00.

3.5 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Chilled Water Supply and Return (Interior to Building)	P-1	All Sizes	1.5
Chilled Water Supply and Return (Exterior to Building)	P-2	All Sizes	1.5
Refrigerant Liquid, Suction, or Hot Gas (Interior to Building)	P-3	All sizes	1.0
Refrigerant Liquid, Suction, or Hot Gas (Exterior to Building)	P-2	All sizes	1.0
Condensate	P-3	All sizes	1.0

B. Heating Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Heating Water Supply and Return (Interior to Building)	P-1	1.5 inches and smaller 1.5 inches and larger	1.5 2.0
Heating Water Supply and Return (Exterior to Building)	P-2	1.5 inches and smaller 1.5 inches and larger	1.5 2.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Chilled Water Pump Bodies	E-1	1.0
Chilled Water Air Separators	E-1	1.0
Chilled Water Expansion Tanks	E-1	1.0

D. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE	INSULATION THICKNESS inches
Combustion Air	D-1	2
Kitchen Exhaust Duct (2 layers of 2 inch each)	D-3	4
Supply Ductwork / Outside Air From DOAs (Externally insulated and located within the thermal building envelope).	D-1	1.5
Return / Exhaust Ductwork to DOAs (Externally insulated and located within the thermal building envelope).	D-1	1.5
Supply Ductwork (Externally insulated and located within the thermal building envelope).	D-1	1.5
Return Ductwork (Externally insulated and located within the thermal building envelope).	D-1	1.5
Transfer Air Ducts (Internally Insulated, Entire Length)	D-4	1.0

Return Ductwork (Externally insulated and located exterior the thermal building envelope).	D-5	2.0
Supply Ductwork (Externally insulated and located exterior the thermal building envelope).	D-5	2.0
Ductwork Liner (Internally Insulated for First Ten (10) Feet of Ductwork from all AHUs, DOAs, VRFs and VRVs. All lined ductwork shall also be be externally insulated to thickness specified).	D-4	1.0
Return/Exhaust Grill Plenums (Internally Insulated All Sides and Top. All lined plenums shall also be externally insulated to thickness specified).	D-4	1.0

END OF SECTION 230700

SECTION 230900 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Control panel enclosures.
2. Humidistats.
3. Thermostats.
4. Time clocks.
5. Control air dampers.
6. Electric damper actuators.
7. Control valves.
8. Electric valve actuators.
9. Air measuring and modulation device.
10. Direct digital control system components.
11. Differential pressure monitor.
12. Glycol Refractometer

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors.
3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
4. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for thermometer sockets and gage taps for placement by this section. Installation requirements for piping products furnished in this section.
5. Section 23 33 00 - Air Duct Accessories: Product requirements for duct mounted thermometers. Installation requirements for dampers and other duct mounted products furnished in this section.
6. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Products Supplied But Not Installed Under This Section:
1. Control valves.
2. Flow switches.
3. Wells, sockets and other inline hardware for water sensors (temperature, pressure, flow).

B. Products Installed But Not Supplied Under This Section:
1. None.

C. Work Required Under Other Divisions Related to This Section:
1. Power wiring to line side of motor starters, disconnects or variable frequency drives.

2. Provision and wiring of smoke detectors and other devices relating to fire alarm system.
3. Campus LAN (Ethernet) connection adjacent to JACE network management controller.

1.3 WORK INCLUDED

A. Furnish an extension of the existing Building Automation System comprised of a network utilizing high-speed BACnet for communications between Building Controllers and PC Workstations. LonTalk or BACnet sub-networks shall be used for communications between Building Controllers, Custom Application Controllers and Application Specific Controllers. Include an operator's workstation using Microsoft Windows 7 Professional as the operating system based on a distributed control system in accordance with this specification. The operator's workstation and all building controllers shall communicate using protocols and network standards as defined by ANSI/ASHRAE Standard 135–2012, BACnet. Programmable controllers, and all input/output devices shall communicate using the LonTalk FTT-10 and LonMark profiles and/or use BACnet MSTP protocols and network standards as defined by ANSI/ASHRAE Standard 135–2012, BACnet. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to existing systems or to systems installed under other sections.

B. Provide all necessary LonTalk and/or BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and the System Controller

C. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

D. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

E. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

F. Provide and install all interconnecting cables between supplied cabinets, Programmable controllers, and input/output devices.

G. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

H. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

I. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

J. Provide a comprehensive operator and technician training program as described herein.

K. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

L. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

1.4 SYSTEM DESCRIPTION

A. This project requires an extension of the existing Alerton Integrated Automation System constructed using a Niagara Framework with BACnet Field Level Devices. New Alerton field level controllers shall be required to be added to the existing single Global controller.

B. The Contractor will be required to perform the following:
1. Furnish, install, configure and commission fully programmable DDC controllers as an extension of the existing Niagara Framework with BACnet compatibility for the equipment shown including all components, software required to meet the sequence of operation and the design/performance intent of the systems.
2. Provide fully programmable field controllers as specified herein and as indicated on the drawings. Provide I/O and ancillary devices as specified herein, as indicated on the drawings, and as necessary to perform the sequences of operation.
3. Application Specific or "Configurable" controllers will not be accepted.
4. Provide BACnet BTL AWS (Advanced Work Station) certification for the Control System Server (CSS). All Network Controllers (NCs) shall be BTL BBC certified.
5. Furnish and install all low voltage step-down transformers with associated low voltage connections, power supplies and power/communication/input/output cabling necessary for the control system.
6. Furnish and install conduit, junction boxes, fittings, panels, enclosures, and hardware as specified in these specifications, on the drawings and as required by Code.
7. Provide Graphical User Interface Development for all of the devices identified above.
8. It is the contractor's responsibility to review all of the design documents and specifications and report any discrepancies to the owner.

1.5 APPROVED MANUFACTURERS

A. Provide bid based on one of the following manufacturers

B. Approved Control Manufacturers
1. Basis of Design: Alerton as provided by Automated Building Systems – Glastonbury – Drew Appleton (860) 657-9257 or dappleton@absddc.com
2. Substitutions: Will Not Be Permitted.

C. Above listed manufacturers must meet all portions of the specifications. Listed vendors cannot assume they are acceptable without meeting all requirements.

1.6 QUALITY ASSURANCE

A. The Control System Contractor shall have a full service DDC office within 50 miles of the job site. This office shall be staffed with sales engineering and support, applications engineers, software engineers and field technicians. This office shall maintain parts inventory and shall have all testing and diagnostic equipment necessary to support this work, as well as staff trained in the use of this equipment. BMS vendors that do not utilize local engineering and sales support personnel for this project in a branch office within 50 miles of the jobsite shall not be acceptable under any circumstances.

B. Single Source Responsibility of Supplier: The Control System Contractor shall be responsible for the complete installation and proper operation of the control system. The Control System Contractor shall exclusively be in the regular and customary business of design, installation and service of computerized building management systems similar in size and complexity to the system specified. The Control System Contractor shall be the manufacturer of the primary DDC system components or shall have been the authorized representative for the primary DDC components manufacturer for at least 5 years.

C. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in the production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.

D. The BAS system shall be designed and installed, commissioned and serviced by factory trained personnel. Manufacturer shall have an in-place support facility within 1 hours response time of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment.

E. The Bidder shall be regularly engaged in the installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

F. The BAS system manufacturer must have a Dealer or Customer Support call-in Center located at the corporate headquarters or corporate manufacturing facilities. The Customer Support call-in Center will be staffed by fully trained and certified technicians.

G. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

H. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

I. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

J. Control system shall be engineered, programmed and supported completely by representative’s local office that must be within 50 miles of project site.

1.7 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof , shall govern design and selection of equipment and material supplied:
1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
2. ANSI/ASHRAE Standard 135-2012, BACnet.
3. ANSI/EIA/CEA-709.1 (LonTalk)
4. ANSI MC85.1 - Terminology for Automatic Control
5. Uniform Building Code (UBC), including local amendments.
6. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
7. National Electrical Code (NEC).
8. FCC Part 15, Subpart J, Class A
9. EMC Directive 89/336/EEC (European CE Mark)
10. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

1.8 SUBMITTALS

A. Drawings
1. The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.
2. Drawings shall be submitted in the following standard sizes: 11” x 17” (ANSI B).
3. Eight complete sets (copies) of submittal drawings shall be provided.
4. Drawings shall be available on CD-ROM.

B. System Documentation

C. Include the following in submittal package:
1. System configuration diagrams in simplified block format.
2. Riser diagram including all system controllers, front end hardware and devices, network communication and third party integration.
3. All input/output object listings and an alarm point summary listing.
4. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
5. Complete bill of materials, valve schedule (including calculated pressure drop) and damper schedule.
6. System graphics showing monitored systems, data (connected and calculated) point addresses, and operator notations. [Submit demonstration diskette containing graphics.]
7. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

8. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.
9. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.
10. For operator’s workstation(s) and building controller(s) provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2012.
11. Provide complete description and documentation of any proprietary services and/or objects used in the system.
12. A list of all functions available and a sample of function block programming that shall be part of delivered system.

D. Project Management
1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents and shall indicate timing and dates for system installation, debugging, and commissioning.

1.9 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.
2. Submit data specified in "Submittals" in final "Record Documents" form.

C. Operation and Maintenance Data:
1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered system components and devices.
2. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.10 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of control systems for one years from Date of Substantial Completion.

C. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

D. Perform work without removing units from service during building normal occupied hours.

E. Provide emergency call back service during working hours for this maintenance period.

F. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

G. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.

H. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.13 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.

C. This warranty shall apply equally to both hardware and software.

D. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.14 EXTRA MATERIALS

A. Furnish one (1) extra control valves for the systems listed below and label all valves uses.
   1. Fin Tube Valves
   2. Fan Coil Unit Valves

B. Furnish two (2) Wall Sensors of each type used.

PART 2 PRODUCTS

2.1 OPERATOR'S WORKSTATION

A. The extension of the existing Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, a network area controller, graphics and programming and other control devices for a complete system as specified herein.

B. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 clients simultaneously.

C. BACnet Conformance
   1. Operator's workstation shall as a minimum support Point-to-Point (PTP) and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a BACnet device. Operator's terminal shall comply with the requirements of a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:
      a. Clock Functional Group
      b. Event Response Functional Group
      c. Time Master Functional Group
      d. Device Communications
   2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
   3. Standard BACnet object types accessed by the workstation shall include as a minimum: Analog Value, Analog Input, Analog Output, Binary Value, Binary Input, Binary Output, Calendar, Device, Event Enrollment, File, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
   4. The Operator Workstation shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs). Workstation shall support

Foreign Device Registration to allow temporary workstation connection to IP network.

D. Displays

1. Operator's workstation shall display all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's workstation shall display all data using three-dimensional graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. Workstation shall allow user to change all field-resident EMCS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.
2. All displays and programming shall be generated and customized by the local EMCS supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.
3. Binary objects shall be displayed as ACTIVE/INACTIVE/NULL or with customized text. Text shall be justified left, right or center as selected by the user. Also, allow binary objects to be displayed as individual change-of-state graphic objects on the display screen such that they overlay the system graphic. Each binary object displayed in this manner shall be assigned up to three graphic files for display when the point is ON, OFF or in alarm. For binary outputs, toggle the object's commanded status when the graphic item is selected with the system mouse. Similarly, allow the workstation operator to toggle the binary object's status by selecting with the mouse a graphic of a switch or light, for example, which then displays a different graphic (such as an "ON" switch or lighted lamp). Additionally, allow binary objects to be displayed as an animated graphic. Animated graphic objects shall be displayed as a sequence of multiple graphics to simulate motion. For example: when a pump is in the OFF condition, display a stationary graphic of the pump. When the operator selects the pump graphic with the mouse, the represented object's status is toggled and the graphic of the pump's impeller rotates in a time-based animation. The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF. Allow operator to change graphic file assignment and also create new and original graphics online. System shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.
4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic. Each analog input object may be assigned a minimum of five graphic files, each with high/low limits for automatic selection and display of these graphics. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint. Analog output objects, when selected

with the mouse, shall be displayed as a prompted dialog (text only) box. Selection for display type shall be individual for each object. Analog object values may be changed by selecting either the "increase" or "decrease" arrow in the analog object spinner box without using the keypad. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trend logs.

5. Analog objects may also be assigned to an area of a system graphic, where the color of the defined area changes based on the analog object's value. For example, an area of a floor-plan graphic served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint. All editing and area assignment shall be created or modified online using simple icon tools.
6. A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
7. A mouse shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.

E. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.

   Each operator's terminal shall provide security for 200 users minimum. Each user shall have an individual User ID, User Name and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 0–8 characters, User Name shall be 0–29 characters, and Password shall be 4–8 characters long. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal. Each user shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct security levels for assignment to users.

   System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

F. Operator Activity Log
1. Operator Activity Log shall be included with system that tracks all operator changes and activities. System shall track what is changed in the system, who performed this change, date and time of system activity and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation.
2. Log shall be gathered and archived to hard drive on operator workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.
3. Any displayed data, that is changeable by the operator, may be selected using the right mouse button and the operator activity log shall then be selectable on the screen. Selection of the operator activity log using this method shall show all operator changes of just that displayed data.

G. Scheduling
1. Operator's workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily with events being the highest.
2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
4. System shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right clicking on value displayed on graphic and then selecting Schedule.
5. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

H. Alarm Indication and Handling.
1. Operator's workstation shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s),currently running. Printout of alarms shall be sent to the assigned terminal and port.
2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment and identification of operator acknowledging alarm .

3. Alarm messages shall be in user-definable text (English or other specified language) and shall be entered either at the operator's terminal or via remote communication.
4. System shall include an Alarm Wizard for set up of alarms. Wizard shall walk user through all steps necessary for alarm generation. Wizard shall have its own pull-down selection for startup or may be started by right clicking on value displayed on graphic and then selecting alarm setup.

I. Trendlog Information
1. System server shall periodically gather historically recorded data stored in the building controllers and archive the information Archived files shall be appended with new sample data, allowing samples to be accumulated. Systems that write over archived data shall not be allowed, unless limited file size is specified. Samples may be viewed at the operator's workstation. Operator shall be able to scroll through all trended data. All trendlog information shall be displayed in standard engineering units.
2. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to ten object types at the same time in different colors. Graphs shall show object values relative to time.
3. Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.
4. System shall include a trend Wizard for setup of logs. Wizard shall walk user through all necessary steps. Wizard shall have its own pull-down selection for startup, or may be started by right clicking on value displayed on graphic, and then selecting Trendlogs from the displayed menu.

J. Energy Log Information
1. System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.
2. All data shall be stored in data base file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
3. Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
4. System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format the user shall be able to select a specific period of data to view.

K. Demand Limiting
1. System shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
2. Binary shedding shall include minimum of 5 priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one the loads shall be shed/restored in a "first off-first on" mode and in the other the loads are just shed/restored in a linear fashion.
3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.
4. Status of each and every load shed program shall be capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

L. Configuration/Setup
1. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

M. Field Engineering Tools – Engineering Tools Must Be Submitted on.
1. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.
2. User shall be able to pick graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
3. Programming tools shall include a real time operation mode. Function blocks shall display real time data and be animated to show status of data inputs and outputs when in real time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.
5. Field engineering tool shall include Device Manager for automatic detection of devices connected anywhere on the BACnet network by scanning of the entire network. This function shall display device instance, network identification, model number and description of connected devices. It shall record and display

software file loaded into each controller. A copy of each file shall be stored on the computers hard drive. If needed, this file shall be downloaded to the appropriate controller by selection using the mouse.

6. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media.

N. Software

1. At the conclusion of project, contractor shall leave with owner a CD ROM that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

A. The system provided shall incorporate hardware and software resources sufficient to meet the functional requirements of these Specifications. The Facility Local Area Network (FAC LAN) and Device Level Network (DLN) shall be based on industry standard open platforms as specified herein and utilize commonly available operation, management and application software. All software packages and databases shall be licensed to the Owner to allow unrestricted maintenance and operation of the IAS. Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

B. The system architecture shall implement a new building IAS which is based on the Niagara N4 Framework and consists of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) that supports NCs, PCUs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable.

C. Facility Local Area Network (FAC LAN): The FAC LAN shall be an Ethernet-based, 10/100/1000 Ethernet LAN connecting Local NCs, IAS Server and OWSs. The FAC LAN serves as the backbone for the NCs communications path. Contractor shall provide a FAC LAN as a dedicated LAN for the control system. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 6 cable with switches and routers that support 1000base-T gigabit Ethernet throughput.

1. Device Level Network (DLN): Network used to connect PCUs and ASCs. These shall be Peer to Peer devices as defined in the BTL standard. Network speed shall be 78K bits per second.
2. ARCnet and/or Token-Ring based FAC LANs and DLNs shall not be acceptable.
3. Remote Data Access: The system shall support the Internet Browser-based remote access to the building data. The IAS contractor shall coordinate with the Owner's IT department to insure all remote browser access (if desired by the owner) is protected with the latest Niagara N4 Software updates and a VPN (Virtual Private Network) must be installed to protect the owner's network from cyberattacks.
4. Browser-based access: A remote/local user using a standard browser will be able access all control system facilities and graphics via the WAN or direct connection, with proper username and password. Only native Internet browser-based user interfaces (HTML5, Java, XML, CCS3 JAVA Script, etc.) that do not require plug-ins (thin clients) are acceptable. The system shall be capable of

supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, Firefox™ or Chrome™.

5. The communication speed between the controllers, LAN interface devices, CSS, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition.
6. Niagara Framework Control Systems Server (CSS): A server that maintains the systems configuration and programming database. It shall allow secure multiple-access to the control information.
7. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server that resides on the FAC LAN. User tools for DLN and FAC LAN management shall be provided and licensed to the Owner and shall allow unrestricted configuring, updating, maintaining, and expanding of all current devices, configurations and settings.
8. Database Schema shall be published and provided to the Owner to facilitate easy access to DLN and FAC LAN data.

2.3 WEB INTERFACE

A. Web Browser Navigation: The web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic setpoint controls, configuration menus for operator access, reports and reporting actions for events.

B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and password. Navigation in the system shall be dependent on the operator's role privileges and geographic area of responsibility.

C. Navigation: Navigation through the GUI shall be accomplished by clicking on appropriate level of a navigation tree (consisting of expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
   1. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
   2. Groups View shall display Scheduled Groups and custom reports.
   3. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

D. Action Pane: The Action Pane shall provide several functional views for each HVAC or mechanical/electrical subsystem specified. A functional view shall be accessed by clicking on the corresponding button:
   1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment

drawings, active graphic setpoint controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.

2. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an ' accept/cancel' button.
3. Schedules: Shall be used to create, modify/edit and view schedules based on the systems geographical hierarchy (using the navigation tree).
4. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
5. Trends: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling.
6. Logic - Live Graphic Programs: Shall be used to display' live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
7. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

E. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active setpoint graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI workstation software shall graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.
4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability. .
5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
    a. Each piece of equipment monitored or controlled including each terminal unit.
    b. Each building.
    c. Each floor and zone controlled.

F. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with password access) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention

would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

1. Schedules: Schedules shall comply with the LonWorks and BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
   a. Types of schedule shall be Normal, Holiday or Override.
   b. A specific date,.
   c. A range of dates,.
   d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
   e. Wildcard (example, allow combinations like second Tuesday of every month).
2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

G. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:
   1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event

templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.

2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.
8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
    a. Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
    b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
    c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
    d. Write Property: The write property reporting action updates a property value in a hardware module.

e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
f. Run External Program: The Run External Program reporting action launches specified program in response to an event.

H. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.
1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
7. Copy/Paste. The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).
8. Trending data shall include the following features:
a. Software that is capable of graphing the trend-logged object data shall be included.
b. Access and ability to create, edit and view are restricted to users by user account credentials
c. Specific and repeatable URL defines the trendlog(s) views for browser bookmarking and email compatibility.
d. Call out of trendlog value at intersection of trend line and mouse-over vertical axis.
e. Trendlog or Energy log and companion logs can be configured to display on one of two independent vertical scales embedded in the display.
f. Click zoom for control of data set viewed along either graph axis.
g. User-specifiable start and end dates as well as a fast scroll features that supports click zoom of macro scale view of the data for quickly finding data set based on visual signature.
h. User export of the viewed data set to MS Excel.
i. Web browser-based help.

j. Optional min/max ranges (Upper Control Limits, Lower Control Limits) for each value.

I. Energy Log Information
1. AWS shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.
2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
3. AWS operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
4. AWS shall display data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.
5. Web client shall display data in tabular format and graphical format. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

J. Demand Limiting
1. AWS shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator-selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.
3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.
4. AWS shall be able to display the status of each and every load shed program. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

K. Reports
1. AWS shall be capable of periodically producing reports of trendlogs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.
2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or

saved to a folder, either on the server hard drive or on any network drive location.

L. Security Access: Systems that Security access from the web browser GUI to BAS server shall require a Login Name and Password. Access to different areas of the BAS system shall be defined in terms of Roles, Privileges and geographic area of responsibility as specified:
1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of ' easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
b. Edit Privileges shall comprise: Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.
c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.
2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

M. Workstation Hardware and Accessories:
1. Existing workstation shall be existing to remain.

N. Software
1. At the conclusion of the project, contractor shall leave with owner an electronic copy that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

2.4 BUILDING CONTROLLER

A. General Requirements
1. Shall be approved by the BTL as meeting BACnet Building Controller requirements.
2. Building controller shall be of scalable design such that the number of trunks and protocols may be selected to fit the specific requirements of a given project.
3. The controller shall be capable of panel-mounted on DIN rail and/or mounting screws.
4. The controller shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller.
5. The controller shall be capable of running up to six (6) independent control strategies simultaneously. The modification of one control strategy does not interrupt the function or runtime others.
6. The software program implementing the DDC strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-

programmed global strategies that cannot be modified by field personnel on-site, using a wide area network (WAN) or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.

7. Programming shall be object-oriented using control function blocks and support DDC functions. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.
8. The programming tool shall provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator's workstation or field computer.
9. Controller shall have 6,000 Analog Values and 6,000 Binary Values.
10. Controller IP configuration can be done via a direct USB connect with an operator's workstation or field computer.
11. Controller shall have at a minimum a Quad Core 996Ghz processor to ensure fast processing speeds.
12. Global control algorithms and automated control functions shall execute using a 64-bit processor.
13. Controller shall have a minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus to ensure high speed data recording, large data storage capacity and reliability.
14. Controller shall support two (2) on-board EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
    a. Ports are capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
15. Controller shall support two (2) ports—each of gigabit speed—Ethernet (10/100/1000) ports.
    a. Ports are capable of supporting various Ethernet protocols including, but not limited to BACnet IP, FOX, and Modbus.
16. All ports shall be capable of having protocol(s) assigned to utilize the port's physical connection.

B. Power Supply
1. Input for power shall be as shown on the contract documents.
2. Optional rechargeable battery for shutdown of controller including storage of all data in flash memory.
3. On-board capacitor will ensure continuous operation of real-time clocks for minimum of 14 days.

C. Controller shall be in compliance with the following:
1. UL 916 for open energy management
2. FCC Class B
3. ROHS
4. IEC 60703
5. C-Tick Listed

D. Controller shall operate in the following environmental conditions:
1. -4 to 149 °F (-20 to 65 °C) without optional battery, or 32 to 122 °F (0 to 50 °C) with optional battery.
2. 0 to 95% relative humidity (RH), non-condensing.

E. Niagara Framework
   1. Controller shall utilize the Tridium Niagara Framework.
      a. Niagara Framework shall be latest version.
      b. All Niagara licensing shall be stored on a removable MicroSD card for fast in-field replacement of controller.
      c. The controller shall be programmable via Niagara Workplace programming tool.
      d. The controller shall be programmable via a Niagara embedded Workplace programming tool.

F. Building Controller shall consist of a power supply, BACnet Ethernet-MS/TP, BACnet MS/TP, LonTalk FTT-10, and modem module for telephone communication as a minimum. Those projects that require special interfaces may use Modbus modules as needed. However, all Ethernet communications and all controllers including central plant controllers, advanced Programmable controllers and unitary controllers supplied by BMS manufacturer shall utilize the LonTalk or BACnet protocol standards.

G. All communication with operator workstation shall be via BACnet Ethernet. All communication with Programmable controllers shall be LonTalk FTT-10 or BACnet MS/TP Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP, FTT-10 LANS. Ethernet – MS/TP, FFT module shall also route messages from all other Building Controller modules onto the BACnet Ethernet network.
   1. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps.
   2. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).

H. The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs) and function as a BACnet Broadcast Management Device (BBMD).

I. Building Controller MS/TP module communications shall be via BACnet master slave token passing (MS/TP) LAN. Building Controller FFT-10 module communications shall be via LONtalk FFT-10 LAN using transceivers to all advanced Programmable and Programmable specific controllers. MS/TP module shall also route messages to Ethernet-MS/TP module for communication over WAN.
   1. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps
   2. Configuration shall be via RS-232 connection.

J. All controllers shall be capable of providing global control strategies for the system based on information from any objects in the system regardless if the object is directly monitored by a building controller. The software program implementing these strategies shall be completely flexible and user definable. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, via a wide area network or downloaded via remote communications are not acceptable. Changing global strategies via firmware changes is also unacceptable.

K. Programming shall be object-oriented using control function blocks, supporting DDC functions, 1000 Analog Values and 1000 Binary Values. All flowcharts shall be generated and automatically downloaded to controller.

L. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator's workstation or field computer.

M. Controller shall have a memory needed to ensure high performance and data reliability. Battery shall provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery back up shall maintain real-time clock functions for a minimum of 20 days.

N. Global control algorithms and automated control functions shall execute via 32-bit processor.

O. Schedules
1. Each building controller module shall support a minimum of 80 BACnet Schedule Objects and 80 BACnet Calendar Objects.
2. Building controller modules shall provide normal 7 day scheduling, holiday scheduling and event scheduling.

P. Logging Capabilities
1. Each building controller shall log as minimum 320 values. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
2. Logs may be viewed both on-site or off-site via WAN or remote communication.
3. Building controller shall periodically upload trended data to networked operator's workstation for long term archiving if desired.
4. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

Q. Alarm Generation
1. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
2. Each alarm shall be emailed out to Facility personnel per Owner coordia
3. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications.
4. Controller must be able to handle up to 320 alarm setups stored as BACnet event enrollment objects – system destination and actions individually configurable.

R. Demand Limiting
1. Demand limiting of energy shall be built a built in function that shall be user configurable. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
2. Load shedding programs in Building Controller Modules shall operate as defined in section 2.1.J of this specification.

3. Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
4. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
5. Forecast demand (kW): Predicted by sliding window method.
6. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
7. Demand Target: Minimum of 3 for each demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
8. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
9. Limits: Include control band (upper and lower limits).
10. Output advisory when loads are not available to satisfy required shed quantity, advise shed requirements [and requiring operator acknowledgment].

S. Duty Cycling:
1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by equal quantity off portion is reduced.
3. Set and modify following parameters for each individual load.
   a. Minimum and maximum off time.
   b. On/Off time in one-minute increments.
   c. Time period from beginning of interval until cycling of load.
   d. Manually override the DDC program and place a load in an On or Off state.
   e. Cooling Target Temperature and Differential.
   f. Heating Target Temperature and Differential.
   g. Cycle off adjustment.

T. Automatic Time Scheduling:
1. Self-contained programs for automatic start/stop/scheduling of building loads.
2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
3. Special day’s schedule supporting up to 30 unique date/duration combinations.
4. Number of loads assigned to time program; with each load having individual time program.
5. Each load assigned at least 16 control actions for each day with 1 minute resolution.
6. Furnish the following time schedule operations:
   a. Start.
   b. Optimized Start.
   c. Stop.
   d. Optimized Stop.
   e. Cycle.
   f. Optimized Cycle.
7. Capable of specifying minimum of 30 holiday periods up to 100 days in length for the year.
8. Create temporary schedules.

9. Broadcast temporary "special day" date and duration.

U. Start/Stop Time Optimization:
1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
2. Adaptive and self-tuning, adjusting to changing conditions unattended.
3. For each point under control, establish and modify:
   a. Occupancy period.
   b. Desired temperature at beginning of occupancy period.
   c. Desired temperature at end of occupancy period.

V. Night Setback/Setup Program: Reduce heating space temperature set point or raise cooling space temperature set-point during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.

W. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.
1. Employ arithmetic, algebraic, Boolean, and special function operations.
2. Treat calculated values like any other analog value; use for any function where a "hard wired point" might be used.

X. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.
1. Define time interval between each control action between 0 to 3600 seconds.
2. Output may be analog value.
3. Provide for "skip" logic.
4. Verify completion of one action before proceeding to next action. When not verified, program capable of skipping to next action.

Y. Direct Digital Control: Furnish with each control unit Direct Digital Control software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.
1. Control loops: Defined using "modules" are analogous to standard control devices.
2. Output: Paired or individual digital outputs for pulse width modulation, and analog outputs.
3. Firmware:
   a. PID with analog or pulse-width modulation output.
   b. Floating control with pulse-width modulated outputs.
   c. Two-position control.
   d. Primary and secondary reset schedule selector.
   e. Hi/Low signal selector.
   f. Single pole double-throw relay.
   g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
4. Direct Digital Control loop: Downloaded upon creation or on operator request. On sensor failure, program executes user defined failsafe output.
5. Display: Value or state of each of lines interconnecting DDC modules.

Z. Fine Tuning Direct Digital Control PID or floating loops:
1. Display information:

a. Control loop being tuned.
b. Input (process) variable.
c. Output (control) variable.
d. Set-point of loop.
e. Proportional band.
f. Integral (reset) Interval.
g. Derivative (rate) Interval.

2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" versus "variable".

AA. Trend logging:
1. Each control unit capable of storing samples of control unit's data points.
2. Update file continuously at operator assigned intervals.
3. Automatically initiate upload requests and then stores data on hard disk.
4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
5. Co-ordinate sampling with specified on/off point- state.
6. Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

BB. Tenant Activity Logging
1. Tenant Activity logging shall be supported by Building Controller Module. Each independent module shall support a minimum of 80 zones.
2. Tenant Activity logging shall functions as defined in section 2.1.K of this specification.

2.5 CENTRAL PLANT AND AIR HANDLER APPLICATION CONTROLLERS

A. Provide one or more native BACnet application controllers for each air handler and provide native BACnet application controllers as needed for central plant control that adequately cover all objects listed in object list. All controllers shall interface to building controller through either MS/TP LAN using BACnet protocol, or Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. BACnet Conformance
1. Application controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.
2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Multi-state Values, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part

of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000 ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs with 12-bit resolution shall support either 0–10VDC or 0–20mA. Binary outputs shall have LED indication of status. Software shall include scaling features for analog outputs. Application controller shall include 20VDC voltage supply for use as power supply to external sensors.

1. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.
2. The position of each and every HOA switch shall be available system wide as a BACnet object property.

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal.

1. The following control blocks shall be supported:
    a. Natural Log
    b. Exponential
    c. Log base 10
    d. X to the power of Y
    e. Nth square root of X
    f. 5th Order Polynomial Equations
    g. Astronomical Clock (sunrise/sunset calculation)
    h. Time based schedules

E. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

F. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

G. Schedules

1. The controller shall support a minimum of 3 BACnet Schedule Objects and have a real time clock on board with battery backup to maintain time through a power loss.

H. Logging Capabilities
1. Controller shall support a minimum of 50 trendlogs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

I. Alarm Generation
1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

J. The controller processor shall be a 32-bit processor.

K. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

2.6 TERMINAL UNIT PROGRAMMABLE CONTROLLERS (Including but not limited to Heat Pumps, AC Units, Fan Coils)

A. Provide one native BACnet fully programmable field controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

B. BACnet Conformance
1. Application controllers shall, as a minimum, support MS/TP BACnet LAN types. They shall communicate directly using this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements and support all BACnet services necessary to provide the following BACnet functional groups:
a. Files Functional Group
b. Reinitialize Functional Group
c. Device Communications Functional Group
2. Please refer to Section 22.2, BACnet Functional Groups in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the

system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.7 OTHER CONTROL SYSTEM HARDWARE

A. Motorized control dampers that will not be integral to the equipment shall be furnished by the Control System Contractor. Control damper frames shall be constructed of galvanized steel, formed into changes and welded or riveted. Dampers shall be galvanized, with nylon bearings. Blade edge seals shall be vinyl. Blade edge and tip seals shall be included for all dampers. Blades shall be 16-gauge minimum and 6 inches wide maximum and frame shall be of welded channel iron. Damper leakage shall not exceed 10 CFM per square foot, at 1.5 inches water gauge static pressure.

B. Control damper actuators shall be furnished by the Control System Contractor. Two-position or proportional electric actuators shall be direct-mount type sized to provide a minimum of 5 in-lb torque per square foot of damper area. Damper actuators shall be spring return type. Operators shall be heavy-duty electronic type for positioning automatic dampers in response to a control signal. Motor shall be of sufficient size to operate damper positively and smoothly to obtain correct sequence as indicated. All applications requiring proportional operation shall utilize truly proportional electric actuators.

C. Control Valves: Control valves shall be 2-way or 3-way pattern as shown and constructed for tight shutoff at the pump shut-off head or steam relief valve pressure. Control valves shall operate satisfactorily against system pressures and differentials. Two-position valves shall be ' line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (unless otherwise noted or scheduled on the drawings). Valves with sizes up to and including 2 inches (51 mm) shall be "screwed" configuration and 2-1/2 inches (63.5 mm) and larger valves shall be "flanged" configuration. All control valves, including terminal unit valves, less than 2 inches (51 mm) shall be globe valves. Electrically-actuated control valves shall include spring return type actuators sized for tight shut-off against system pressures (as specified above) and, when specified, shall be furnished with integral switches for indication of valve position (open-closed).

D. Control Valve Actuators: Actuators for VAV terminal unit heating coils shall be "drive-open; drive-closed" type. All actuators shall have inherent current limiting motor protection. Valve actuators shall be 24-volt, electronic type, modulating or two-position as required for the correct operating sequence. Actuators on valves needing ' fail-safe' operation shall have spring return to Normal position. Modulating valves shall be positive positioning in response to the signal. All valve actuators shall be UL listed.

E. All control valves 2-1/2 inches (63.5 mm) or larger shall have position indication. All hot water control valves shall be Normally-Open arrangement; all chilled water control valves shall be Normally-Closed arrangement.

F. Wall Mount Room Temperature sensors: Each room temperature sensor shall provide temperature indication to the digital controller, provide the capability for a software-limited occupant set point adjustment (warmer-cooler slider bar or switch) and limited operation override capability. Room Temperature Sensors shall be 10,000-ohm thermistor type with a temperature range of -40 to 140 degrees F (-38 to 60 degrees C). The sensor shall be complete with a decorative cover and suitable for mounting over a standard electrical utility box. These devices shall have an accuracy of 0.5 degrees F (.024 degrees C) over the entire range.

G. Duct-mounted and Outside Air Temperature Sensors: 10,000-ohm thermistor temperature sensors with an accuracy of ± 0.2 degrees C. Outside air sensors shall include an integral sun shield. Duct-mounted sensors shall have an insertion measuring probe of a length appropriate for the duct size, with a temperature range of -40 to 160 degrees F(-38 to 71 degrees C) The sensor shall include a utility box and a gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 8 feet (2438 mm) long sensor element. These devices shall have accuracy of 0.5 degrees F (.024 degrees C) over the entire range.

H. Humidity sensors shall be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 0 to 90% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). Operating range shall be 0 to 100% RH and 32 to 140 degrees F (0 to 60 degrees C). Sensors shall be selected for wall, duct or outdoor type installation as appropriate.

I. Carbon Dioxide Sensors (CO2): Sensors shall utilize Non-dispersive infrared technology (N.D.I.R.), repeatable to plus or minus 20 PPM. Sensor range shall be 0 - 2000 PPM. Accuracy shall be plus or minus five percent (5%) or 75 PPM, whichever is greater.

Response shall be less than one minute. Input voltage shall be 20 to 30 VAC or DC. Output shall be 0 - 10 VDC. Sensor shall be wall or duct mounted type, as appropriate for the application, housed in a high impact plastic enclosure.

J. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

K. Differential Analog (duct) Static Pressure Transmitters Provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy shall be plus or minus 1% of full range; range shall be selected for the specific application. Provide zero and span adjustment capability. Device shall have integral static pickup tube.

L. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches shall have adjustable setpoints and barbed pressure tips.

M. Water Flow Switches: Provide a SPST type contact switch with bronze paddle blade, sized for the actual pipe size at the location. If installed outdoors, provide a NEMA-4 enclosure. Flow switch shall be UL listed.

N. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. All electrical devices within a control panel shall be factory wired. A complete set of ' as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

O. Pipe and Duct Temperature sensing elements: 10,000-ohm thermistor temperature sensors with and accuracy of ±1% accuracy. Their range shall be -5 to 250 degrees F (-20 to 121 degrees C). Limited range sensors shall be acceptable provided they are capable of sensing the range expected for the point at the specified accuracy. Thermal wells with heat conductive gel shall be included.

P. Low Air Temperature Sensors: Provide SPST type switch, with 15 to 55 degrees F (-9 to 13 degrees C), range, vapor-charged temperature sensor. Honeywell model L482A, or approved equivalent.

Q. Relays: Start/stop relay model shall provide either momentary or maintained switching action as appropriate for the motor being started. All relays shall be plugged in, interchangeable, mounted on a subbase and wired to numbered terminals strips. Relays installed in panels shall all be DPDT with indicating lamp. Relays installed outside of controlled devices shall be enclosed in a NEMA enclosure suitable for the location. Relays shall be labeled with UR symbol. RIB-style relays are acceptable for remote enable/disable.

R. Transducers: Differential pressure transducers shall be electronic with a 4-20 mA output signal compatible to the Direct Digital Controller. Wetted parts shall be stainless steel. Unit shall be designed to operate in the pressure ranges involved.

S. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers shall be sized for the load, but shall be sized for 50

watts, minimum. Transformers shall be UL listed Class 2 type, for 120 VAC/24 VAC operation.

2.8 SENSORS AND MISCELLANEOUS DEVICES

A. Temperature Sensors
1. All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches about finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day.

B. Intelligent Room Sensor with LCD Readout
1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator.
2. The Intelligent Room Sensor shall display room setpoint, room temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. Unit must have the capability to show temperatures in Fahrenheit or Centigrade.
3. Override time count down shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.
4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list.
5. Field service mode shall be customizable to fit different applications.

C. Wall Sensor
1. Standard wall sensor shall use solid-state sensor identical to intelligent room sensor and shall be packaged in aesthetically pleasing enclosure. Sensor shall provide override function, warmer/cooler lever for set point adjustment. Override time shall be stored in Operator Workstation and be adjustable on a zone-by-zone basis. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller.

D. Dew Point Sensor
1. Dew point sensors (EE10-04 or equal) shall employ a non-reactive organic bobbin material to give precise dew point readings with error of no more than plus or minus 1.3 degrees at 68 degrees F. The dew point sensor shall incorporate an integral draft shield as part of the instrument for air velocities in excess of 50 feet per minute. Sensor shall be suitable for wall mounting with the accuracy mentioned above and required in the sequence of operation and the time constant necessary for stable, hunt free, control.

E. LCD Operator Terminal
1. The LCD operator terminal is a small wall- or panel-mounted operator terminal that connects directly to the BACnet or LonTalk LANs. The communication design and messaging structure shall comply with ANSI/ASHRAE Standard 135-2012, BACnet or ANSI/EIA/CEA-709.1 (LonTalk). Each operator terminal shall be able to display any object from anywhere in the network.
2. Each of these operator's terminals shall have a keypad and an adjustable backlit LCD, with a simple menu structure to give occupants and technicians intuitive access to system information. It shall have a minimum 4-line by 20-character display to allow an operator to query and adjust system values.
3. The system shall allow the connection of up to 16 LCD operator terminals to each Building Controller. The operator shall have the ability to connect to each of these operator terminals with a laptop computer via an RS-232 cable to gain system access, troubleshooting, and display programming.
4. Provide LCD operator terminals in the locations shown on the drawings.

2.9 ELECTRONIC ACTUATORS AND VALVES

A. Quality Assurance for Actuators and Valves
1. UL Listed Standard 873 and C.S.A. Class 4813 02 certified.
2. NEMA 2 rated enclosures for inside mounting, provide with weather shield for outside mounting.
3. Five-year manufacturers warranty. Two-year unconditional and three-year product defect from date of installation.

B. Execution Details for Actuators and Valves
1. Furnish a Freeze-stat and install "Hard Wire" interlock to disconnect the mechanical spring return actuator power circuit for fail-safe operation. Use of the control signal to drive the actuators closed is not acceptable.
2. Each DDC analog output point shall have an actuator feedback signal, independent of control signal, wired and terminated in the control panel for true position information and troubleshooting. Or the actuator feedback signal may be wired to the DDC as an analog input for true actuator position status.
3. VAV box damper actuation shall be Floating type or Analog (2-10vdc, 4-20ma).
4. Booster-heat valve actuation shall be Floating type or Analog (2-10vdc, 4-20ma).
5. Primary valve control shall be Analog (2-10vdc, 4-20ma).

C. Actuators for Damper and Control Valves ½" to 6" shall be Electric unless otherwise specified, provide actuators as follows:
1. UL Listed Standard 873 and Canadian Standards association Class 481302 shall certify Actuators.
2. NEMA 2 rated actuator enclosures are. Use additional weather shield to protect actuator when mounted outside.
3. 5 year Manufacturers Warranty. Two-year unconditional + Three year product defect from date of installation.
4. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
5. Position indicator device shall be installed and made visible to the exposed side of the Actuator. For damper short shaft mounting, a separate indicator shall be provided to the exposed side of the Actuator.

6. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for Butterfly Valve actuators.
7. A push button gearbox release shall be provided for all non-spring actuators.
8. Modulating actuators shall be 24Vac and consume 10VA power or less.
9. Conduit connectors are required when specified and when code requires it.

D. Damper Actuators:
1. Outside Air and Exhaust Air Damper Actuators shall be Mechanical Spring Return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.
2. Economizer Actuators shall utilize Analog control 2-10 VDC, Floating control is not acceptable.
3. Electric damper actuators (including VAV box actuators) shall be direct shaft mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or setscrew type fasteners are not acceptable.
4. One electronic actuator shall be direct shaft mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.
5. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per damper section. (See below execution section for more installation details.)

E. Valve Actuators ½" to 6"
1. Mechanical spring shall be provided on all actuators for pre-heat coil and actuators for AHU heating or cooling coil when units are mounted outside. See plans for fail save flow function: Normal Open or Normal Closed. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
2. All zone service actuators shall be non-spring return unless otherwise specified.
3. The valve actuator shall be capable of providing the minimum torque required for proper valve close off for the required application.
4. All control valves actuators shall have an attached 3-foot cable for easy installation to a junction box.
5. Override handle and gearbox release shall be provided for all non-spring return valve actuators.

F. Control Valves ½” to 6”: The BAS contractor shall furnish all specified motorized control valves and actuators. BAS contractor shall furnish all control wiring to actuators. The mechanical contractor shall install all valves. Equal Percentage control characteristic shall be provided for all water coil control valves. Linear valve characteristic is acceptable for 3-way valves 2½ inch and above.
1. Characterized Control Valves shall be used for hydronic heating or cooling applications and small to medium AHU water coil applications to 100GPM. Actuators are non-spring return for terminal unit coil control unless otherwise

noted. If the coil is exposed to the Outside Air stream then see plans for Spring Return requirement.

a. Leakage is Zero percent, Close-off is 200psi, Maximum differential is 30psi. Rangeablity is 500:1.
b. Valves 1/2 inch through 2 inches shall be nickel-plated forged brass body, NPT screw type connections.
c. Valves 1/2 inch through 1-1/4 inches shall be rated for ANSI Class 600 working pressure. Valves 1-1/2 inch and 2 inches shall be rated for ANSI Class 400 working pressure.
d. The operating temperature range shall be 0° to 250° F.
e. Stainless steel ball & stem shall be furnished on all modulating valves.
f. Seats shall be fiberglass reinforced Teflon.
g. Two-way and three-way valves shall have an equal percentage control port. Full stem rotation is required for maximum flow to insure stable BTU control of the coil.
h. Three-way valve shall be applicable for both mixing and diverting.
i. The characterizing disc is made of TEFZEL and shall be keyed and held secure by a retaining ring.
j. The valves shall have a blow out proof stem design.
k. The stem packing shall consist of 2 lubricated O-rings designed for on-off or modulating service and require no maintenance.
l. The valves shall have an ISO type, 4-bolt flange, for mounting actuator in any orientation parallel or perpendicular to the pipe.
m. A non-metallic thermal isolation adapter shall separate valve flange from actuator.
n. One fastening screw shall secure the direct coupling of the thermal isolation adapter between the actuator and the valve. This will prevent all lateral or rotational forces from affecting the stem and it's packing O-rings.

2. Globe valves ½" to 2" shall be used for steam control or water flow applications.
   a. Valves shall be bronze body, NPT screw type, and shall be rated for ANSI Class 250 working pressure.
   b. Valves 1/2 inch (DN15) through 2 inches (DN50) with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (.1%).
   c. The operating temperature range shall be 20° to 280° F.
   d. Spring loaded TFE packing shall protect against leakage at the stem.
   e. Two-way valves shall have an equal percentage control port.
   f. Three-way valves shall a linear control and bypass port.
   g. Mixing and diverting valves must be installed specific to the valve design.
3. Globe Valve 2 ½ to 6"
   a. Valves 2-1/2 inch (DN65) through 6 inches (DN50) shall be iron body, 125 lb. flanged with Class III (.1%) close-off leakage at 50 psi differential.
   b. Valves with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (.1%).
   c. Flow type for two-way valves shall be equal percentage. Flow type for three-way valves shall be linear.
   d. Mixing and diverting valves must be installed specific to the valve design.

G. Butterfly valves
1. Butterfly Valves shall be sized for modulating service at 60-70 degree stem rotation. Isolation valves shall be line-size. Design velocity shall be less than 12 feet per second when used with standard EPDM seats.
a. Body is Cast Iron.
b. Disc is Aluminum Bronze standard.
c. Seat is EPDM Standard.
d. Body Pressure is 200 psi, -30F to 275F.
e. Flange is ANSI 125/250.
f. Media Temperature Range is –22F to 240F.
g. Maximum Differential Pressure is 200 psi for 2” to 6” size.

H. Butterfly Valve Industrial Actuators
1. 1. Actuators shall be approved under Canadian Standards Association or other Nationally Recognized Testing Laboratory to UL standards. CSA Class 4813 02 or equal. Enclosure shall be NEMA 4 (weatherproof) enclosure and will have an industrial quality coating.
a. Actuator shall have a motor rated for continuous duty. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120 VAC, 1 pH, 60 Hz supply. Two adjustable cam actuated end travel limit switches shall be provided to control direction of travel. A self-resetting thermal switch shall be imbedded in the motor for overload protection.
b. Reduction gearing shall be designed to withstand the actual motor stall torque. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.
c. Actuator shall have a 6 ft wiring harness provided for ease in field wiring (above 1500 in-lbs). Two adjustable SPDT cam-actuated auxiliary switches, rated at 250 VAC shall be provided for indication of open and closed position. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.
d. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator and when in manual operation electrical power to the actuator will be permanently interrupted. The hand wheel will not rotate while the actuator is electrically driven.
e. The actuator shall be Analog, floating, or two position as called out in the control sequence of operation. All Analog valves shall be positive positioning, and respond to a 2-10 VDC, 4-20 mA, or adjustable signal as required. Analog actuators shall have a digital control card allowing any voltage input for control and any DC voltage feedback signal for position indication.
2. Performance Verification Test
a. Control loops shall cause productive actuation with each movement of the actuator and actuators shall modulate at a rate which is stable and responsive. Actuator movement shall not occur before the effects of previous movement have affected the sensor.
b. Actuator shall have capability of signaling a trouble alarm when the actuator Stop-Go Ratio exceeds 30%.

3. Actuator Mounting for Damper and Valve arrangements shall comply to the following:
   a. Damper Actuators: Shall not be installed in the air stream
   b. A weather shield shall be used if actuators are located outside. For Damper Actuators use clear plastic enclosure.
   c. Damper or valve actuator ambient temperature shall not exceed 122 degrees F through any combination of medium temperature or surrounding air. Appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation shall be provided as necessary
   d. Actuator cords or conduit shall incorporate a drip leg if condensation is possible. Water shall not be allowed to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point shall be avoided to prevent water from condensing in conduit and running into actuator.
   e. Damper mounting arrangements shall comply to the following:
      1) The ventilation subcontractor shall furnish and install damper channel supports and sheet metal collars.
      2) No jack shafting of damper sections shall be allowed.
      3) Multi-section dampers shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per section.
   f. Size damper sections based on actuator manufacturers specific recommendations for face velocity, differential pressure and damper type. In general:
      1) Damper section shall not exceed 24 ft-sq. with face velocity £ 1500 FPM.
      2) Damper section shall not exceed 18 ft-sq. with face velocity £ 2500 FPM.
      3) Damper section shall not exceed 13 ft-sq. with face velocity £ 3000 FPM.
   g. Multiple section dampers of two or more shall be arranged to allow actuators to be direct shaft mounted on the outside of the duct.
   h. Multiple section dampers of three or more sections wide shall be arranged with a 3-sided vertical channel (8'' wide by 6" deep) within the duct or fan housing and between adjacent damper sections. Vertical channel shall be anchored at the top and bottom to the fan housing or building structure for support. The sides of each damper frame shall be connected to the channels. Holes in the channel shall allow damper drive blade shafts to pass through channel for direct shaft mounting of actuators. Open side of channel shall be faced down stream of the airflow, except for exhaust air dampers.
   i. Multiple section dampers to be mounted flush within a wall or housing opening shall receive either vertical channel supports as descried above or sheet metal standout collars. Sheet metal collars (12" minimum) shall bring each damper section out of the wall to allow direct shaft mounting of the actuator on the side of the collar.
4. Valve Sizing for Water Coil
   a. On/Off Control Valves shall be line size.
   b. Modulating Control Valve Body Size may be reduced at most two pipe sizes from the line size or not less than ½ the pipe size. The BAS

contractor shall size all water coil control valves for the application as follows:

1) Booster-heat valves shall be sized not to exceed 4-9psi differential pressure. Size valve for 50% Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.
2) Primary valves shall be sized not to exceed 5-15psi differential pressure. Size valve for 50% Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.
3) Butterfly valves shall be sized for modulating service at 60-70 degree rotation. Design velocity shall be 12 feet per second or less when used with standard EPDM seats.

c. Valve Mounting arrangements shall comply to the following:

1) Unions shall be provided on all ports of two-way and three-way valves.
2) Install three-way equal percentage Characterized Control valves in a mixing configuration with the "A" port piped to the coil.
3) Install 2½ inch and above, Three-Way globe valves, as manufactured for mixing or diverting service to the coil.

2.10 ENCLOSURES

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

C. Enclosures shall have hinged, locking doors.

D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8" thick sized appropriately to make label easy to read.

2.11 AIRFLOW/TEMPERATURE MEASUREMENT DEVICES

A. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans.
1. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.

B. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.
1. Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
2. Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
3. The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output.

4. The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.
5. Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.
6. Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
7. Devices using less than two thermistors in each sensor assembly are not acceptable.
8. Devices using platinum wire RTDs are not acceptable.
9. Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
10. Vortex shedding devices are not acceptable.

C. All Sensor Probes
1. Each sensor assembly shall independently determine the airflow rate and temperature at each measurement point.
2. Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
3. Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range.
   a. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
4. Temperature accuracy shall be +/-0.15° F over the entire operating temperature range of -20° F to 160° F.
5. The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).
6. Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
7. Each sensor assembly shall not require matching to the transmitter in the field.
8. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

D. Duct and Plenum Probes
1. Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
2. Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
   a. Insertion mounted through the side or top of the duct
   b. Internally mounted inside the duct or plenum
   c. Standoff mounted inside the plenum
3. The number of sensor housings provided for each location shall be as follows:

Duct or Plenum Area (sq.ft.)	Total # Sensors / Location
<2	4

2 to < 4	6
4 to < 8	8
8 to <16	12
>=16	16

4. The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

E. Fan Inlet Probes
1. Sensor assemblies shall be mounted on 304 stainless steel housings.
2. Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
3. Mounting feet shall be constructed of 304 stainless steel.
4. The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.

F. Differential pressure switches
1. Differential pressure switches shall be provided for all fans connected to the smoke control system. Switched shall be UUKL rated, adjustable, weatherproof, and capable of operating at elevated temperatures.

2.12 Glycol Refractometer (GR) shall be AFAB Enterprises Model PR-111, Misco Model M-111 or approved equal. Power supply shall be 120V, 1 phase or 24 VAC, 1 phase. BMS contractor shall provide branch circuit power to device. GR shall be provided with stainless steel sensing element, 4-20 mA output and 0-100% analog display meter. Provide adapters for varying pipe sizes. GR shall be calibrated over a 60ºF range for types of glycol and % of solution as shown on the drawings.

2.13 AIRFLOW MEASUREMENT DEVICES

A. Approved manufacturers
1. Approved manufacturers:
a. Ebtron
b. Air Monitor Corporation
c. Paragon Controls

B. Duct Mounted Configurations
1. Installation applications shall conform to manufacturer’s recommended minimum and maximum velocity requirements
2. Installation locations shall comply with manufacturer’s recommended straight lengths of duct upstream and downstream of station.
a. Provide open parallel cell air straightener–equalizer honeycomb upstream of station, where required, to meet manufacturer’s straight length recommendations. Honeycomb and probes to be mounted in 14 ga. (minimum) galvanized steel, welded casing in 8" depth with 90º connecting flanges in a configuration and size equal to that of the duct it is mounted into
3. Thermal type (anemometer) airflow measuring system
a. Each probe array shall consist of one or more multi-point measuring probes and a single microprocessor based transmitter. The transmitter

shall be supplied by the same manufacturer as the measuring station or probe array.

b. Each multi-point probe shall be assembled using heavy wall anodized aluminum tubing, aluminum mounting plates, aerodynamically optimized molded sensing apertures to ensure accurate measurement in angular airflow conditions, and neoprene mounting gasket.

c. The probe array shall be connected to the transmitter using a single cable, of up to 100' in length, included with the transmitter.

d. Each stand-alone sensing point shall use an ambient temperature thermistor and an externally heated thermistor to determine the point velocity and temperature. Automatic equal area averaging of the individual point measurements shall be performed in the transmitter.

e. Each airflow sensor shall have an operating range of 5,000 FPM, with a NIST traceable accuracy of ±2% of reading for velocity measurement and 0.1ºF for temperature measurement.

f. The number of sensors for each rectangular probe array shall be:

Station Area	Sensor Density
1 to < 15 Sq. Ft.	1.50 Sq. Ft. Per Sensor
15 to < 30 Sq. Ft.	1.67 Sq. Ft. Per Sensor
30 to < 60 Sq. Ft.	2.10 Sq. Ft. Per Sensor
60 to 100 Sq. Ft.	3.13 Sq. Ft. Per Sensor

g. Individual sensors shall be fully field serviceable without need for field calibration, not requiring that the probe be returned to the Factory for repair and/or calibration.

h. Each transmitter shall be capable of averaging as many as thirty-two (32) sensors,

i. The transmitter will have a high visibility backlit LCD for display of either the averaged or individual sensor airflow and temperature measurements, in user selectable units of measure. The transmitter shall be factory configured to output duct air volume for plug and play operation.

j. All transmitter configuration, scaling, and diagnostic functions shall be performed by means of a password protected, cover mounted membrane keypad.

k. The transmitter outputs shall be dual analog (4-20mA, 0-5VDC or 0-10VDC) for airflow and temperature or optional LonWorks® communication interface.

l. The operating temperature range of the transmitter shall be from -20º to 140ºF. The transmitter shall be located where it will be sheltered from water or weather.

m. Input power to each transmitter shall be 24VAC/24VDC.

n. When installed per the manufacturer’s minimum installation requirements, the transmitter with accompanying station or probe array shall measure with an accuracy of ±2-3% of actual flow.

4. Pitot type (differential pressure) airflow measuring system

a. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s),

and shall be the offset (Fechheimer) type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30º. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket, and signal fittings suitable for HVAC duct installation.

b. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular ducts) or at equal concentric area centers (for circular ducts) along the probe length.

c. Probes shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of ±2% without the use of correction factors. The maximum allowable unrecovered pressure drop caused by the probes shall not exceed .025" w.c. at 2000 FPM, or .085" w.c. at 4000 FPM.

d. The Transmitter shall have an accuracy of ±0.5% of Natural Span and user selectable square root function. The Transmitter shall be housed in a NEMA 1 aluminum with universal 1/8" FPT signal connection ports. The transmitter shall be supplied by the same manufacturer as the measuring station or probe array.

C. Fan Inlet Configurations

1. Provide only pitot type air flow measuring systems for fan inlet configurations.
2. The Airflow Measuring Station shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probes and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system airflows.
3. The Airflow Measuring Station shall have symmetrical averaging signal takeoffs, and shall be of aluminum construction with hard anodized finish [copper construction] with galvanized steel mounting hardware.
4. The Airflow Measuring Station shall not significantly impact fan performance or contribute to fan generated noise levels. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.
5. The Transmitter shall have an accuracy of ±0.5% of Natural Span and user selectable square root function. The Transmitter shall be housed in a NEMA 1 aluminum enclosure with universal 1/8" FPT signal connection ports. The transmitter shall be supplied by the same manufacturer as the measuring station or probe array.

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 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 GENERAL

A. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

B. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the Control System Contractor in accordance with these specifications.

C. Equipment furnished by the Mechanical Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the Control System Contractor.

D. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

3.4 WIRING

A. All electrical control wiring to the control panels shall be the responsibility of the Control System Contractor.

B. All wiring shall be in accordance with the Project Electrical Specifications (Division 16), the National Electrical Code and any applicable local codes. All control wiring shall be installed in raceways.

C. Excess wire shall not be looped or coiled in the controller cabinet.

D. Incorporate electrical noise suppression techniques in relay control circuits.

E. There shall be no drilling on the controller cabinet after the controls are mounted inside.

F. Careful stripping of wire while inside the cabinet is required to ensure that no wire strand fragments land on circuit boards.

G. Use manufacturer-specified wire for all network connections.

H. Use approved optical isolation and lightning protection when penetrating building envelope.

I. Read installation instructions carefully. Any unavoidable deviations shall be approved by owner's rep prior to installation.

3.5 ACCEPTANCE TESTING

A. Upon completion of the installation, the Control System Contractor shall load all system software and start-up the system. The Control System Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. The Control System Contractor shall perform tests to verify proper performance of components, routines and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. System Acceptance: Satisfactory completion is when the Control System Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 OPERATOR TRAINING

A. During system commissioning and at such time acceptable performance of the Control System hardware and software has been established, the Control System Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. The Control System Contractor shall provide 8 total hours of comprehensive training for system orientation, product maintenance and troubleshooting, programming and engineering, if not provided under a previous contract at the site using the same brand and type of controllers within the previous 3 years.

3.7 WARRANTY PERIOD SERVICES

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the BMS due to faulty materials, methods of installation or workmanship shall be promptly repaired or replaced by the Control System Contractor at no expense to the Owner.

C. Maintenance of Computer Software Programs: The Control System Contractor shall maintain all software during the warranty period. In addition, all factory or sub-vendor upgrades to software shall be added to the systems, when they become available, at no additional cost. New products are not considered upgrades in this context.

D. Maintenance of Control Hardware: The Control System Contractor shall inspect, repair, replace, adjust, and calibrate, as required, the controllers, control devices and associated peripheral units during the warranty period. The Control System Contractor shall then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work, and description of the corrective actions taken. The report shall clearly certify that all software is functioning correctly.

E. Service Period: Calls for service by the Owner shall be honored within 24 hours and are not to be considered as part of routine maintenance.

F. Service Documentation: A copy of the service report associated with each owner-initiated service call shall be provided to the owner.

3.8 WARRANTY ACCESS

A. The Owner shall grant to the Control System Contractor reasonable access to the BMS during the warranty period. Remote access to the BMS (for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period) will be allowed.

3.9 OPERATION & MAINTENANCE MANUALS

A. See Division 1 for requirements. O&M manuals shall include the following elements, as a minimum:
1. As-built control drawings for all equipment.
2. As-built Network Communications Diagram.
3. General description and specifications for all components.
4. Completed Performance Verification sheets.
5. Completed Controller Checkout/Calibration Sheets.

3.10 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 230900

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Related Sections:
1. Section 23 0400 – General Conditions for Mechanical Trades
2. Section 23 0900 - Instrumentation and Control for HVAC: For equipment, devices, and system components to implement sequences of operation.
3. Section 23 09 00 - Direct-Digital Control System for HVAC: For equipment, devices, system components, and software to implement sequences of operation.
4. Division 26 - Electrical
5. Division 27 - Communication
6. Division 28 - Electronic Safety and Security.
7. Alternates: Refer to Division 01 Section “Alternates” for description of Work of this Section affected by alternates.”

1.2 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate mechanical system controlled and control system components.
1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
2. Submit flow diagrams for each control system, graphically depicting control logic.
3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
4. Coordinate submittals with information requested in Section 23 0900 and 23 0923.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures.

B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 GENERAL

A. Provide all controls, low voltage control wiring, hardware points (analog in, analog out, binary in, binary out) and accessories as required to perform the control sequences indicated. Additionally, provide hardware points indicated regardless that such points may not be required to perform the control sequences indicated.

B. Unless otherwise indicated, setpoints and values listed in the sequence of controls shall be adjustable by the Owner thru the DDC(direct digital controls) or BMS(Building Management System)(BMS and DDC are used interchangeably and share same meaning) graphical interface; the Owner shall not be required to edit operating code in order to change any of the setpoints and values.

C. All Setpoints values in the sequence of controls shall be adjustable by the Owner thru the Building Automation System (BAS). The Building Automation System (BAS) or direct digital controls (DDC) or Building Management System (BMS) are used interchangeably and share the same meaning.
   1. There will be two independent interfaces for global settings for Corridors, restrooms, electrical closets, data rooms and mechanical rooms.
   2. Each temperature zone will be initially set to default to the global settings, with a flag or similar to override the global setting for each of the values for that zone.

D. Other than utility rooms and corridors, space temperature sensor shall be capable of placing the associated systems into the occupied mode for a period of two hours, (adj).

E. All temperature sensors, humidity levels, CO2 levels, damper actuator position indicators, and relay o/off status will be displayed at the Advanced Work Station (AWS).

F. Any temperatures proven to be “out of range” will be alarmed at the AWS

G. Any fan motors not proven to be running after being enabled will be alarmed at the AWS.

H. Any pump motors not proven to be running after being enabled will be alarmed at the AWS.

I. All air filters associated with Air Handling Units, DOAS Units or Roof Top Units will be monitored for differential pressure level. Filter differential will be measured with Analog (0-10vdc or 4-20mA) transmitters. Switches will not be acceptable. If the pressure exceeds the setpoint limit, an alarm will be active at the AWS.

J. Any dampers not reaching proper positioning as indicated by a “hardwired feedback” to the DDC controller in 120 seconds will be alarmed at the AWS.

K. Each valve position will be monitored except Fin tube, CUH, UH, and Radiant floors.

L. Heating Shall only be enabled when the system is indexed to heating mode (shall occur when outside air temperature is below 65 deg. F.

M. On detection of low supply air temperature, all AHU, RTU, DOAS fans shall be off, outdoor air and exhaust air dampers will close and valves will close. An alarm will then be generated at the AWS. A manual reset will be required at the low limit thermostat to restart the fan system. Freeze stat to be set at 38 deg. (Adj). Hot water valve to open in this condition to provide heating.

N. On detection of smoke by duct mounted smoke detectors or by signal from the fire alarm panel All AHU, RTU, DOAS fans shall be off, outdoor air and exhaust air dampers will close and valves will close. An alarm will then be generated at the AWS.

3.2 INITIAL GLOBAL SETPOINTS

A. Sensors will be brushed chrome blank plates. Corridors, restrooms, vestibules, storage rooms, janitor closets, electrical closets, data closets and mechanical rooms.
1. Occupied Heating = 68 deg.
2. Occupied Cooling = 75 deg.
3. Un-Occupied Heating = 65 deg.
4. Un-Occupied Cooling = 78 deg.

B. Other Spaces:
1. Occupied Heating = 68 deg.
2. Occupied Cooling = 75 deg.
3. Un-Occupied Heating = 65 deg.
4. Un-Occupied Cooling = 78 deg.

C. Occupied Override: Temperature sensors will be provided with an Occupancy override button. On activation of the button, the zone will go into Occupied mode for a pre-determined amount of time. (Initially set at 2 hours).

3.3 CHILLED WATER SYSTEM

A. The Chilled water system will be enabled when the outdoor air temperature is above 60 degrees or the DOAS Units require Dehumidification.

B. The BAS will communicate with the chiller manufacturer supplied control panels via BACnet.

C. The operation of the chillers shall be by integral controls to the chillers. The initial CHW supply setpoint will be 42 deg.

D. The BAS will modulate the chiller isolation valves and control pump operations.

E. Chilled water pumps P-2A & P-2B
1. General
a. Shall be in a lead/lag configuration. The lead and lag designations will rotate weekly.
b. The lead pump will operate continuously below 65 deg OA.

c. The speed of the lead pump shall modulate based on the pump curve which is pre-programmed in the pump controller
d. The lag pump will remain off unless the lead pump fails to operate. Failure will be detected by current switch.
e. Minimum pump speed shall be limited using pressure sensors across chiller barrels shown on piping diagrams(M5.02), curves from specific chiller shall be utilized to determine minimum flow, minimum flow thru chillers shall be manufactures recommendation plus 10%. Bypass valve shown on piping plans shall be modulated to maintain minimum flow thru chiller.

2. Alarms
   a. High Hot Water Supply temperature
   b. Low Hot Water Supply temperature
   c. High supply / return differential pressure (25% above setpoint)
   d. Lead pump failure
   e. Lag pump failure
3. Additional Hardwired control points
   a. P-2A VFD fault
   b. P-2B VFD fault
   c. P-2A VFD speed feedback
   d. P-2B VFD speed feedback

F. System Soft Start: The chiller plant control system will initiate a “soft start” mode whenever the chilled water supply temperature exceeds the chilled water setpoint by 20 degrees or more on start up. The chiller plant controller will increase cooling capacity during soft start mode if the return water temperature is not declining at a rate of at least 0.5 deg. Per minute.

G. Chiller rotation shall be initiated based on an operator entered day interval or the cycling of a binary input. The method of sequence shall be operator selectable.

H. Chiller Status Report shall include:
1. Compressor On/Off Status
2. Compressor Starts /Run Hours
3. Compressor Phase 1/2/3 Percent RLA – Separate for each compressor
4. Compressor Current Draw -RLA percent
5. Active Chiller Diagnostics or Alarms
6. Leaving CHW temperature
7. Entering CHW temperature
8. Evaporator Flow Rate
9. Chilled Water Setpoint
10. Refrigerant Temperature
11. Operating Mode.
12. Chiller Model and Serial Number
13. Outside Air Dry Bulb
14. Outside Air Wet Bulb
15. KW per Ton while chiller is operational.

3.4 GLYCOL MONITOR / MAKE-UP

A. (1) Glycol monitor for each of the Hot Water and Chilled Water systems will monitor the glycol level in each system via the refractometers. If a concentration of less than 27% is detected, an alarm will be generated at the AWS.

B. Connect alarm contacts of the global make-up package
1. System Enable
2. Low Glycol Level
3. Pump Operation status
4. Alarm

3.5 UNIT VENTILATOR (UV-1)

A. ATC shall provide and install all end devices and controllers to ensure desired sequence of operations.

B. UV-1 will toggle between Occupied and UN-Occupied Mode base on time of day schedules.

C. Upon detection of smoke by any of the duct smoke detectors of by any other signal from the fire alarm system, the supply fan shall be off. The outside air damper will be closed.

D. All filters will be monitored via differential pressure transmitter (Analog)

E. Occupied Mode: The outdoor air damper will be open. The damper positions will be monitored by the BAS.

F. The Supply fan speed will operate at constant volume.

G. Supply Air Temperature Control
1. Heating Warm-Up (morning): The hot water coil control valve will modulate to maintain a discharge air temperature setpoint of 85 deg. Until the space served is at heating setpoint. Outside air damper will be closed.
2. Heating Mode: The return air sensor shall reset the discharge air temperature setpoint to maintain the following:
   a. An inversely proportional linear algorithm shall modulate the hot water coil control valve to maintain a discharge air temperature of 68 deg at 75 deg return air and 70 deg at 70 deg return air temperature.
3. Cooling Mode: Cooling shall be enabled on when the economizer is at 100% outside air, the building is indexed to cooling mode and the OAT is above 55 deg. The cooling discharge air temperature setpoint will be reset by the following schedule:
   a. 70 deg. At 75 deg return air.
   b. 70 deg at 70 deg return air.
   c. Should the space dewpoint exceed 53 deg., the cooling coil control valve will modulate to maintain a 53 deg. Supply air dewpoint.

H. UN-Occupied: The Outdoor air damper will be closed. The supply fan will cycle on a call for heating or cooling. The hot water coil control valve will modulate to maintain the night setback temperature setpoint. The cooling will be off.

3.6 VRF FAN COIL UNITS

A. The VRF system will be integrated via BACnet into the BMS system.

B. Each Zone will be provided with a Space temperature sensor and CO2 level transmitter unless noted otherwise. Each space temperature sensor will have an integral timed override push button to allow manual override of Occupancy schedule. The override will initially be set at 2 hours.

C. An Occupancy sensor, provided by Division 26 with a contact dedicated for the BAS system, will be monitored. If a zone is in Un-Occupied mode and Occupancy is sensed for more than 5 minutes, the zone setpoint will revert to Occupied Mode. The minimum On time will be 30 minutes (adj.)

D. The BMS will provide operating modes, and send setpoints to the VRF global controller to provide the following:

E. The modes are Heating, Cooling and Fan mode.

F. Occupied Heating: If the zone temperature is within the heating / cooling dead-band the BMS will set the VRF into Off mode.

G. Occupied Heating Mode: If no hot water perimeter radiation is available and room temperature is less than the Occupied heating setpoint, the VRF will be set to heating mode and an Occupied heating setpoint will be issued. If hot water heating is available, the VRF will be the second stage of heating and be enabled when the space temperature is 4 deg (adj.) lower than the Occupied setpoint for more than 15 minutes (adj.)

H. Occupied Cooling Mode: If zone is within the heating and cooling deadband, the VRF system will be in Off mode. If the space temperature is above the setpoint, the BAS will set the VRF into Cooling mode and issue a cooling setpoint. The BAS will not allow any zone to be in cooling mode if any of the perimeter heating Is enabled.

I. Un-Occupied Heating Mode: If zone is within the heating and cooling deadband, the VRF system will be Off. If no hot water perimeter radiation is available and room temperature is less than the Un-Occupied heating setpoint, the VRF will be set to heating mode and an Un-Occupied heating setpoint will be issued. If hot water heating is available, the VRF will be the second stage of heating and be enabled when the space temperature is 4 deg (adj.) lower than the Un-Occupied setpoint for more than 15 minutes (adj.)

J. Un-Occupied Cooling Mode: If zone is within the heating and cooling deadband, the VRF system will be Off. If the space temperature is above the setpoint, the BAS will set the VRF into Cooling mode and issue a Un-Occupied mode cooling setpoint.

K. The ATC contractor will be responsible for installation and communications wiring fo all VRF control components. The ATC will supply low voltage wiring for VRF remote space temperature sensors for ducted units. In addition to the ATC wall mounted controller, the ATC is responsible to read the room temperature provided by the VRF manufacturer. The BAS will control perimeter heating valves.

L. BAS system shall read the following setpoints from the VRF control system”
   1. ON /Off status
   2. Operating Mode Status
   3. Alarm status
   4. Error Code

M. VRF temperature setpoints will follow as below: All setpoints shall be individually adjustable and globally adjustable:
   1. Occupied Heating temperature
   2. Un-Occupied Heating temperature
   3. Occupied Cooling temperature
   4. Un-Occupied Cooling temperature
   5. Heat / Cool occupied dead band temperature range shall be the delta between the occupied heating and cooling setpoints
   6. Heat / Cool Un-occupied dead band temperature range shall be the delta between the Un-occupied heating and cooling setpoints

N. Condensing Units shall operate in accordance to manufacturer’s specifications to maintain system heating / cooling mode loads.

3.7 HOT WATER FIN TUBE RADIATION (STAND ALONE)

A. A wall mounted space temperature sensor will be provided. If the space temperature drops below the space temperature setpoint, the hot water valve will open.

B. When the space temperature rises to satisfy the space temperature setpoint, the valve will be closed.

3.8 SPLIT SYSTEM AC UNITS

A. Units will maintain space temperature through manufacturers supplied controllers.

B. ATC will monitor:
1. Space temperature – Separate from manufacturer.
2. AC unit status
3. Condensate alarm

3.9 GENERATOR

A. Monitor Generator and provide the following
1. Generator Run Status
2. Generator Alarm Status
3. Gas Pressure Transmitter (Analog)

END OF SECTION 230993

SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Heating water piping, buried.
2. Heating water piping, above ground.
3. Chilled water piping, buried.
4. Chilled water piping, above grade.
5. Equipment drains and over flows.
6. Unions and flanges.
7. Pipe hangers and supports.

B. Related Sections:
1. Section 07 84 46 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 09 91 23 - Painting and Coating: Product requirements Painting for placement by this section.
4. Section 23 04 00 – General Conditions for Mechanical Trades
5. Section 23 21 13 - Pipes and Tubes for HVAC Piping and Equipment: Product and installation requirements for piping materials applying to various system types.
6. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product and execution requirements for expansion compensation devices use in heating and cooling piping systems.
7. Section 23 05 23 - General-Duty Valves for HVAC Piping: Product requirements for valves for placement by this section.
8. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.
9. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
10. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
11. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
12. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties used in heating and cooling piping systems.
13. Section 23 21 23 - Hydronic Pumps: Product and execution requirements for pumps used in heating and cooling piping systems.
14. Section 23 25 00 - HVAC Water Treatment: Product and execution requirements for cleaning and chemical treatment of heating and cooling piping systems.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Gray Iron Threaded Fittings.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B31.1 - Power Piping.
6. ASME B31.9 - Building Services Piping.
7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM B32 - Standard Specification for Solder Metal.
6. ASTM B75 – Standard Specification for Seamless Copper Tube.
7. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
8. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
9. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
10. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
11. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
12. ASTM D2310 - Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
13. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
14. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
15. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
16. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
17. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
18. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
19. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
20. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:
1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
2. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
5. AWWA C606 - American National Standard for Grooved and Shouldered Joints.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and Grooved coupling couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

C. Provide pipe hangers and supports in accordance with ASME B31.1.

D. Use ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

E. Use ball valves for throttling, bypass, or manual flow control services.

F. Use spring loaded check valves on discharge of hot water and chilled water pumps.

G. Use plug valves for throttling service. Use non-lubricated plug valves only when shut-off or isolating valves are also provided.

H. Use butterfly valves in heating water systems and in chilled systems interchangeably with gate and globe valves.

I. Use only butterfly valves in chilled water systems for throttling and isolation service.

J. Use grooved or lug end butterfly valves to isolate equipment.

K. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

L. Flexible Connectors or Grooved coupling Flexible Couplings: Use at or near pumps where piping configuration does not absorb vibration.

1.4 SUBMITTALS

A. Section 01 - Submittal Procedures.

B. Shop Drawings: Indicate schematic layout of piping system, including equipment, critical dimensions, and sizes.
1. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Grooved coupling style or series number.

C. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.

D. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Welders’ Certificate: Include welders’ certification of compliance with ASME Section IX.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures.

B. Project Record Documents: Record actual locations of valves, equipment and accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.1 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with applicable authority for welding hanger and support attachments to building structure.

C. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Section 01 - Product Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 COORDINATION

A. Section 01 – Project Management.

1.13 WARRANTY

A. Section 01 - Closeout Procedures.

1.14 EXTRA MATERIALS

A. Section 01 - Closeout Procedures.

PART 2 PRODUCTS

2.1 HEATING WATER PIPING, BURIED

A. Copper Tubing: ASTM B88, Type L, annealed.
1. Fittings: ASME B16.22, wrought copper.
2. Joints: Solder, lead free, ASTM B32,95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.2 HEATING WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M, Schedule 40, black, cut or rolled grooved ends.
1. Fittings: ASTM A536 ductile iron, or ASTM A53 forged steel or fabricated from carbon steel pipe, grooved ends designed to accept Grooved coupling standard or AGS “W” series couplings.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.
a. Housing Clamps: STM A536 ductile iron, enamel coated Tyco-Grinnell or Victaulic, compatible with steel piping sizes, rigid Tyco-Grinnell style 772 or Victaulic style 107 or flexible Grinnell style 707 or Victaulic 77 where expansion and contraction, or noise and vibration reduction are preferred.
1) Rigid Type: 2 inch through 8 inch: “Installation ready” rigid coupling with angle pattern bolt pads designed for direct ‘stab’ installation onto grooved end pipe without prior disassembly of the coupling and Grade “EHP” EPDM gasket.
2) Flexible Type: 2 inch through 12 inch: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.
b. Grade “EHP” EPDM Gasket: Elastomer composition for operating temperature range from -20 degrees F to 220 degrees F.
c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type L drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

D. Copper Tubing: ASTM B88, Type L drawn.
1. Press Fittings: IAPMO PS 117, ANSI LC1002, NSF61-G, EPDM sealing element and leak detection feature

2.3 CHILLED WATER PIPING, BURIED

A. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black with AWWA C105 polyethylene jacket, or double layer, half-lapped 10 mil polyethylene tape.
   1. Fittings: ASTM A234/A234M forged steel welding type with double layer, half-lapped 10 mil polyethylene tape.
   2. Joints: Welded.

B. Copper Tubing: ASTM B88, Type K annealed.
   1. Fittings: ASME B16.22, wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.4 CHILLED WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
   1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
   2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger**.**

B. Steel Pipe: ASTM A53/A53M Schedule 40, black, cut or rolled grooved ends.
   1. Fittings: ASTM A536 ductile iron, or ASTM A53 forged steel or fabricated from carbon steel pipe, grooved ends designed to accept Grooved coupling standard or AGS “W” series couplings.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: STM A536 ductile iron, enamel coated Tyco-Grinnell or Victaulic, compatible with steel piping sizes, rigid Tyco-Grinnell style 772 or Victaulic style 107 or flexible Grinnell style 707 or Victaulic 77 where expansion and contraction, or noise and vibration reduction are preferred.
         1) Rigid Type: 2 inch through 8 inch: “Installation ready” rigid coupling with angle pattern bolt pads designed for direct ‘stab’ installation onto grooved end pipe without prior disassembly of the coupling and Grade “EHP” EPDM gasket.
         2) Flexible Type: 2 inch through 12 inch: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.
      b. Grade “EHP” EPDM Gasket: Elastomer composition for operating temperature range from -20 degrees F to 220 degrees F.
      c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type L drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

D. Copper Tubing: ASTM B88, Type L drawn.
1. Press Fittings: IAPMO PS 117, ANSI LC1002, NSF61-G, EPDM sealing element and leak detection feature

2.5 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized.
1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
2. Joints: Threaded for pipe 2 inch and smaller; flanged for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized, cut or rolled grooved ends.
1. Fittings: ASTM A536 ductile iron, or ASTM A53/A53M forged carbon steel or fabricated from carbons steel pipe grooved ends designed to accept Grooved coupling or AGS “W” series couplings.
2. Joints: Grooved mechanical couplings meeting ASTM F1476 by Tyco Grinnell or Victaulic.
a. Housing Clamps: ASTM A536 ductile iron, enamel coated compatible with steel piping sizes, rigid or flexible type.
1) Rigid Type: 2 inch through 8 inch: “Installation ready” rigid coupling with angle pattern bolt pads designed for direct ‘stab’ installation onto grooved end pipe without prior disassembly of the coupling and Grade “EHP” EPDM gasket.
2) Flexible Type: 2 inch through 12 inch: Use in locations where vibration attenuation and stress relief are required.
b. Grade “EHP” EPDM Gasket: Elastomer composition for operating temperature range from -20 degrees F to 220 degrees F.
c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type K drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F. For 2” and larger, Victaulic CTS System may be used

D. Copper Tubing: ASTM B88, Type K drawn.
1. Press Fittings: IAPMO PS 117, ANSI LC1002, NSF61-G, EPDM sealing element and leak detection feature

2.6 COMBUSTION AIR PIPING

A. CPVC Pipe: ASTM F441/F441M, Schedule 80, chlorinated polyvinyl chloride (CPVC) material.
1. Fittings: ASTM F439, CPVC, Schedule 80, socket type. ASTM F437, CPVC, Schedule 80, threaded.
2. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement. Prime joints with a contrasting color.

2.7 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
   1. Ferrous Piping: Class 150, malleable iron, threaded.
   2. Copper Piping: Class 150, bronze unions with soldered.
   3. Dielectric Connections:
      a. Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
      b. Waterway fitting with zinc electroplated steel or ductile iron body, male thread, grooved, or plain end, water impervious isolation barrier.
   4. CPVC Piping: CPVC.

B. Flanges for Pipe 2-1/2 inches and Larger:
   1. Ferrous Piping:
      a. Class 150, forged steel, slip-on flanges.
      b. Grooved joint flange adapter, flat face, for direct connection to ANSI Class 125 and 150 flanges. For direct connection to ANSI Class 300 flanges
   2. Copper Piping:
      a. Class 150, slip-on bronze flanges.
      b. Grooved joint flange adapter, flat face, for direct connection to ANSI Class 125 and 150 flanges.
   3. CPVC Piping: CPVC flanges.
   4. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.8 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Carpenter & Paterson Inc.
   2. Creative Systems Inc.
   3. Flex-Weld, Inc.
   4. Glope Pipe Hanger Products Inc.
   5. Michigan Hanger Co.
   6. Superior Valve Co.

B. Furnish materials in accordance with Owner’s guidelines.

C. Conform to ASME B31.1.

D. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.

E. Hangers for Cold Pipe Sizes 2-1/2 inches and Larger: Carbon steel, adjustable, clevis.

F. Hangers for Hot Pipe Sizes 2 to 5 inches: Carbon steel, adjustable, clevis.

G. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

H. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.

I. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.

J. Vertical Support: Steel riser clamp.

K. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

L. Floor Support for Hot Pipe 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

M. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.

N. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

O. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

P. Rigid couplings may be used on IPS steel piping systems, which meet the support and hanging requirements of ASME B31.1 and B31.9. An adequate number of flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. The tubing end shall be wiped clean and dry.

F. For coper tubing the burrs on the tubing shall be reamed with a deburring or reaming tool.

G. Copper tubing shall be cut with a wheeled tubing cutter or approved copper tubing cutting tool. The tubing shall be cut square to permit proper joining with the fittings.

H. After completion, fill, clean, and treat systems. Refer to Section 23 25 00.

3.3 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9.

B. Support horizontal piping as scheduled.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

H. Provide sheet lead packing between hanger or support and piping.

I. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.5 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Install Work in accordance with Owner’s guidelines.

B. Route piping parallel to building structure and maintain gradient.

C. Install piping to conserve building space, and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.

F. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

G. Install pipe identification in accordance with Section 23 05 53.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.

J. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

L. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 91 00.

M. Install valves with stems upright or horizontal, not inverted.

N. Insulate piping and equipment; refer to Section 23 07 00.

3.6 INSTLLATION – GROOVED / ROLLED JOINTS

A. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. A factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

1. Install the AGS piping system in accordance with the latest installation instructions. Use grooving tools with AGS roll sets to groove the pipe. Follow guidelines for tool selection and operation. Coupling installation shall be complete when visual metal-to-metal contact is reached. AGS products shall not be installed with standard grooved end pipe or components. Installing AGS products in combination with standard grooved end products could result in joint separation and/or leakage.

3.7 INSTALLATION – PRESS STYLE FITTINGS

A. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer’s installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully

engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.

3.8 FIELD QUALITY CONTROL

A. Section 01 77 00 - Closeout Procedures: Field inspecting, testing, adjusting, and balancing.

B. Test heating water piping system and chilled water piping system in accordance with ASME B31.9.

C. Water Testing: The copper tubing system shall be water tested for joint tightness. The piping system shall be filled with water. The system shall be pressurized to the maximum pressure and length of time required by the code or standard. The system shall have no leaks at the rated pressure.

D. Air Testing: The copper tubing system shall be air tested for joint tightness. The piping system shall be pressurized with air to the maximum pressure of the system or to the code or standard required minimum for the required length of time. The system shall have no leaks at the rated pressure.

3.9 SCHEDULES Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 1)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4

Note 1: Refer to manufacturer’s recommendations for grooved end piping systems.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Positive displacement meters.
2. Heat consumption meters.
3. Liquid flow meters.
4. Pressure gages.
5. Pressure gage taps.
6. Thermometers.
7. Thermometer supports.
8. Test plugs.
9. Flexible connectors.
10. Diaphragm-type expansion tanks.
11. Air vents.
12. Air separators.
13. Strainers.
14. Pump suction fittings.
15. Combination pump discharge valves.
16. Flow controls.
17. Relief valves.
18. Glycol charging equipment.
19. Glycol solution.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 21 13 - Hydronic Piping: Execution requirements for piping connections to products specified by this section.
3. Section 23 21 23 - Hydronic Pumps: Execution requirements for piping connections to products specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.
2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

C. American Water Works Association:
1. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
2. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
3. AWWA C702 - Cold-Water Meters - Compound Type.
4. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
5. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

D. Underwriters Laboratories Inc.:
1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.3 PERFORMANCE REQUIREMENTS

A. Flexible Connectors: Provide at or near pumps or motorized equipment where piping configuration does not absorb vibration.

1.4 SUBMITTALS

A. Division 1 - Submittal Procedures.

B. Product Data: Submit for manufactured products and assemblies used in this Project.
1. Manufacturer’s data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
4. Submit electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Division 1 - Closeout Procedures.

B. Project Record Documents: Record actual locations of actual locations of components and instrumentation, flow controls and flow meters.

C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience , and with service facilities within 100 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Division 1- Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Division 1- Product Requirements.

B. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Division 1- Product Requirements.

B. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.10 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

1.11 WARRANTY

A. Division 1- Closeout Procedures.

B. Furnish five year manufacturer warranty for piping specialties.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.12 MAINTENANCE SERVICE

A. Division 1- Closeout Procedures.

B. Furnish service and maintenance of glycol fluid and glycol charging components for two years from Date of Substantial Completion.

C. Furnish monthly visit for one year starting from Date of Substantial Completion to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

1.13 MAINTENANCE MATERIALS

A. Division 1- Closeout Procedures.

B. Furnish two bottles of red gage oil for static pressure gages.

1.14 EXTRA MATERIALS

A. Division 1- Closeout Procedures.

B. Furnish four pressure gages with pulsation damper and dial thermometers.

C. Furnish one extra 50 gallon drum of propylene glycol.

PART 2 PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:
1. Trerice
2. Ernst
3. Davis
4. Substitutions: Division 1- Product Requirements.

B. Gage: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
1. Case: Cast aluminum
2. Bourdon Tube: Brass.
3. Dial Size: 3-1/2 inch diameter.
4. Mid-Scale Accuracy: One percent.
5. Scale: As shown on drawings.

2.2 PRESSURE GAGE TAPS

A. Manufacturers:
1. Trerice
2. Ernst
3. Davis

B. Ball Valve: Brass 1/4 inch NPT for 250 psi.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:
1. Trerice
2. Ernst
3. Davis

B. Thermometer: ASTM E1, red appearing mercury, lens front tube, cast aluminum case with enamel finish.
1. Size: 9 inch scale.
2. Window: Clear glass.
3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
4. Accuracy: ASTM E77 2 percent.
5. Calibration: Degrees F.

2.4 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions, and with cap and chain.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.5 TEST PLUGS

A. Manufacturers:
1. Omega
2. Imac
3. Peterson

B. 1/4 inch NPT or 1/2 inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with:
1. Neoprene core for temperatures up to 200 degrees F.
2. Nordel core for temperatures up to 350 degrees F.
3. Viton core for temperatures up to 400 degrees F.

2.6 FLEXIBLE CONNECTORS

A. Manufacturers:
1. Mason
2. Vibration Eliminator
3. Metra Flex Model
4. Substitutions: Division 1- Product Requirements.

B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 300 psig.

2.7 DIAPHRAGM-TYPE EXPANSION TANKS

A. Manufacturers:
1. Armstong
2. Taco
3. B+G
4. Amtrol

B. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible butyl diaphragm sealed into tank , and steel support stand.

C. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 12 psig.

D. Automatic Cold Water Fill Assembly: Pressure reducing valve, double check back flow prevention device, test cocks, strainer, vacuum breaker, and by-pass valves.

2.8 AIR VENTS

A. Manufacturers:
1. Armstong
2. B+G
3. Amtrol
4. Taco
5. Substitutions: Division 1 - Product Requirements

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

C. Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

D. Washer Type:
1. Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.9 AIR SEPARATORS

A. Manufacturers:
1. Armstong
2. Spirotherm
3. B+G.
4. Taco .

B. Dip Tube Fitting: For 125 psig operating pressure; to prevent free air collected in boiler from rising into system.

C. In-line Air Separators: Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; tested and stamped in accordance with ASME Section VIII; for 125 psig operating pressure.

D. Combination Air Separators/Strainers: Steel, tested and stamped in accordance with ASME Section VIII; for 125 psig operating pressure, with integral galvanized steel strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.10 STRAINERS

A. Manufacturers:
1. Sarco
2. Armstrong
3. Yarway
4. Substitutions: Division 1- Product Requirements.

B. Size 2 inch and Smaller:
1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:
1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.11 PUMP SUCTION FITTINGS

A. Manufacturers:
1. B+G
2. Taco
3. Armstrong
4. Substitutions: Division 1 - Product Requirements.

B. Fitting: Angle pattern, cast-iron body. Threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger. Rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blow-down tapping in bottom, gage tapping in side.

2.12 COMBINATION PUMP DISCHARGE VALVES

A. Manufacturers:
1. B+G
2. Taco
3. Armstrong
4. Substitutions: Division 1- Product Requirements.

B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.13 AUTOMATIC FLOW CONTROLS (MANUAL BALNCING VALVES ARE NOT ACCEPTABLE)

A. Manufacturers:
1. Nexus
2. Griswold
3. Flow Design
4. Macon

B. Construction: Brass or bronze body with union on inlet, and outlet, temperature and pressure test plug on inlet and outlet combination blow-down and back-flush drain.

C. Calibration: Control within 5 percent of design flow over entire operating pressure.

D. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.

E. Accessories: In-line strainer on inlet and ball valve on outlet.

2.14 RELIEF VALVES

A. Manufacturers:
1. Watts
2. Tyco
3. Parker Hannifin
4. B+G
5. Substitutions: Division 1- Product Requirements.

B. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

2.15 GLYCOL CHARGING

A. The make-up systems shall be Wessels or approved equal. See plans.

B. The pumping assembly shall be mounted in a sturdy steel frame with legs to keep it off the floor. It shall include a 1.8 GPM at 50 psig pump, a 1/3 HP motor, a magnetic starter, a pressure tank with a pressure control, a priming valve, a PRV, a shut-off valve and a pressure gauge. Pump shall be 120 volt, single phase.

C. It shall feature a cut-off and alarm arrangement which will stop the pump in case of excessive pressure, or a low solution level, and activate an audible (which can be silenced) and a visual alarm. A 110 V signal shall also be available for a remote alarm.

D. A translucent 50 gallon polyethylene solution container, complete with a lid, shall be mounted on the pumping assembly and shall include a strainer and a shut off valve.

2.16 GLYCOL SOLUTION

A. Manufacturers:
1. Dow
2. Dupont
3. Exxon

B. Inhibited propylene glycol and water solution mixed 30 percent glycol - 70 percent water, suitable for operating temperatures from -50degrees F to 325 degrees F.

PART 3 EXECUTION

3.1 INSTALLATION - METERS

A. Install positive displacement meters in accordance with AWWA M6, with isolating valves on inlet and outlet.

3.2 INSTALLATION - THERMOMETERS AND GAGES

A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.

B. Install gage taps in piping

C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage. Extend nipples to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.

E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets as required.

F. Coil and conceal excess capillary on remote element instruments.

G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.3 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Locate test plugs adjacent to pressure gages and pressure gage taps as indicated on Drawings.

B. Where large air quantities accumulate, provide enlarged air collection standpipes.

C. Install manual air vents at system high points.

D. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

E. Provide air separator on suction side of system circulation pump and connect to expansion tank.

F. Provide drain and hose connection with valve on strainer blow down connection.

G. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.

H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.

I. Support pump fittings with floor mounted pipe and flange supports.

J. Provide radiator valves on water inlet for the following terminal heating unit types: radiation, unit heaters, and fan coil units.

K. Provide radiator-balancing valves on water outlet for the following terminal heating unit types: radiation, unit heaters, and fan coil units.

L. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

M. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

N. Pipe relief valve outlet to nearest floor drain.

O. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

P. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 12 psig.

3.4 FIELD QUALITY CONTROL

A. Division 1 - Quality Requirements, Division 1- Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test for strength of glycol and water solution and submit written test results.

3.5 CLEANING

A. Division 1- Execution and Closeout Requirements: Requirements for cleaning.

B. Clean and flush glycol system before adding glycol solution.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

A. Division 1 - Execution and Closeout Requirements: Requirements for protecting installed construction.

B. Do not install hydronic pressure gauges until after systems are pressure tested.

3.7 SCHEDULES

A. Pressure Gages.
   1. Pumps.
      a. Location: Suction & discharge of all pumps, circulators.
      b. Scale range:0-75 PSIG
   2. Expansion tanks.
      a. Location: On tank.
      b. Scale range: 0-75 PSIG
   3. Pressure reducing valves.
      a. Location: Inlet & discharge.
      b. Scale range: 0-75 PSIG

B. Pressure Gage Tapping Location:
   1. Major coils - inlets and outlets.
   2. Chiller - inlets and outlets.
   3. Boiler - inlets and outlets.

C. Stem Type Thermometers:
   1. Boilers - inlets and outlets.
      a. Location: inlets and outlets.
      b. Scale range: 50-250 Degrees F.
   2. Chiller - inlets and outlets.
      a. Location: inlets and outlets.
      b. Scale range: 50-250 Degrees F.
   3. After major coils.
      a. Location: inlets and outlets.
      b. Scale range: 50-250 Degrees F.

END OF SECTION 232116

SECTION 23 2300

REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Check valves.

G. Pressure regulators.

H. Pressure relief valves.

I. Filter-driers.

J. Solenoid valves.

K. Expansion valves.

L. Receivers.

M. Flexible connections.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Division 07 - Thermal and Moisture Protection

C. Division 08 - Openings

D. Division 09 - Finishes

E. Section 23 0400 – General Conditions for Mechanical Trades

F. Section 23 0716 - HVAC Equipment Insulation.

G. Section 23 0719 - HVAC Piping Insulation.

H. Section 23 0993 - Sequence of Operations for HVAC Controls.

I. Section 23 5400 - Furnaces.

J. Section 23 6100 - Refrigerant Compressors.

K. Section 23 6213 - Packaged Air-Cooled Refrigerant Compressor and Condenser Units.

L. Section 23 6313 - Air Cooled Refrigerant Condensers.

M. Section 23 8124 - Computer Room Air Conditioners - Floor Mounted.

N. Section 23 8200 - Convection Heating and Cooling Units: Air coils.

O. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers

B. AHRI 710 - Performance Rating of Liquid-Line Driers.

C. AHRI 730 (I-P) - Flow Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers

D. AHRI 750 - Thermostatic Refrigerant Expansion Valves

E. AHRI 760 - Performance Rating of Solenoid Valves for Use With Volatile Refrigerants

F. ASHRAE Std 15 - Safety Standard for Refrigeration Systems

G. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants

H. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels

I. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications

J. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings

K. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes

L. ASME B31.5 - Refrigeration Piping and Heat Transfer Components

M. ASME B31.9 - Building Services Piping

N. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

O. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

P. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

Q. ASTM B88 - Standard Specification for Seamless Copper Water Tube

R. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

S. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers

T. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.

U. AWS D1.1 - Structural Welding Code - Steel

V. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation

W. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

1.4 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

C. Liquid Indicators:
1. Use line size liquid indicators in main liquid line leaving condenser.
2. If receiver is provided, install in liquid line leaving receiver.
3. Use line size on leaving side of liquid solenoid valves.

D. Valves:
1. Use service valves on suction and discharge of compressors.
2. Use gage taps at compressor inlet and outlet.
3. Use gage taps at hot gas bypass regulators, inlet and outlet.
4. Use check valves on compressor discharge.
5. Use check valves on condenser liquid lines on multiple condenser systems.

E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.

F. Strainers:
1. Use line size strainer upstream of each automatic valve.
2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
3. On steel piping systems, use strainer in suction line.
4. Use shut-off valve on each side of strainer.

G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.

H. Filter-Driers:
1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

I. Solenoid Valves:
1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
2. Use in liquid line of single or multiple evaporator systems.
3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

J. Receivers:
1. Use on systems 10 tons and larger, sized to accommodate pump down charge.
2. Use on systems with long piping runs.

K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Product Data: Provide general assembly of specialties, including manufacturer’s catalogue information. Provide manufacturers catalog data including load capacity.

C. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

D. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

E. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

F. Test Reports: Indicate results of leak test, acid test.

G. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

H. Submit welders certification of compliance with ASME BPVC-IX.

I. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

J. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 - General Requirements

2. Extra Filter-Dryer Cartridges: One of each type and size.
3. Refrigeration Oil Test Kits: One, each containing everything required to conduct one test.
4. Extra Refrigerant: One container of refrigerant, 5 pounds size.

1.6 QUALITY ASSURANCE

A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.

B. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

C. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum [10] years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

C. Welders Certification: In accordance with ASME BPVC-IX.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.2 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
1. Fittings: ASME B16.22 wrought copper.
2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

B. Copper Tube to 7/8 inch OD: ASTM B88 , Type K (A), annealed.
1. Fittings: ASME B16.26 cast copper.
2. Joints: Flared.

C. Steel Pipe: ASTM A53, Schedule 40, black.
   1. Fittings: ASTM A234/A234M, wrought steel welding type.
   2. Joints: Welded in accordance with AWS D1.1/D1.1M.

D. Steel Pipe Sizes 12 Inch and Over: ASTM A53, 0.375 inch wall, black.
   1. Fittings: ASTM A234, wrought steel welding type.
   2. Joints: Welded in accordance with AWS D1.1.

E. Pipe Supports and Anchors:
   1. Provide hangers and supports that comply with MSS SP-58.
      a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
   7. Vertical Support: Steel riser clamp.
   8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   10. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   11. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
   12. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
      a. Bases: High density, UV tolerant, polypropylene or reinforced PVC.
      b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
      c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
      d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
      e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
      f. Manufacturers:
         1) PHP Systems/Design
         2) Portals Plus; Pedestal Plus
         3) Greenlink Eco Engineering – Heavy Pipe Support (to strap over insulation)
         4) Substitutions: See Division 01 6000 - General Requirements.

2.3 REFRIGERANT

A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

B. Refrigerant: R-134a, tetrafluoroethane as defined in ASHRAE Std 34.

C. Refrigerant: R-410a, R-32/125 (50%/50%) as defined in ASHRAE Std 34.

2.4 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:
1. Henry Technologies
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.5 VALVES

A. Manufacturers:
1. Hansen Technologies Corporation
2. Henry Technologies
3. Flomatic Valves
4. Substitutions: See Division 01 - General Requirements.

B. Diaphragm Packless Valves:
1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F .

C. Packed Angle Valves:
1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F .

D. Ball Valves:
1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F

E. Service Valves:
1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.6 STRAINERS

A. Manufacturers:
1. Hansen Technologies Corporation
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Straight Line or Angle Line Type:
1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

C. Straight Line, Non-Cleanable Type:
1. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of _____ psi.

2.7 CHECK VALVES

A. Manufacturers:
1. Hansen Technologies Corporation
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Globe Type:
1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 425 psi.

C. Straight Through Type:
1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.8 PRESSURE REGULATORS

A. Manufacturers:
1. Hansen Technologies Corporation
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi range, for maximum working pressure of 450 psi.

2.9 PRESSURE RELIEF VALVES

A. Manufacturers:
1. Hansen Technologies Corporation

2. Henry Technologies
3. Sherwood Valve/Harsco Corporation
4. Substitutions: See Division 01 - General Requirements.

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi .

2.10 FILTER-DRIERS

A. Manufacturers:
1. Flow Controls Division of Emerson Electric
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Performance:
1. Flow Capacity - Liquid Line: 5 ton, minimum, rated in accordance with AHRI 710.
2. Flow Capacity - Suction Line: 5 ton, minimum, rated in accordance with AHRI 730 (I-P).
3. Water Capacity: ____ drops at 75 degrees F, ____ drops at 125 degrees F , rated in accordance with AHRI 710.
4. Water Capacity: As indicated in schedule, rated in accordance with AHRI 710.
5. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
6. Design Working Pressure: 350 psi, minimum.

C. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

D. Construction: UL listed.
1. Replaceable Core Type: Steel shell with removable cap.
2. Sealed Type: Copper shell.
3. Connections: As specified for applicable pipe type.

2.11 SOLENOID VALVES

A. Manufacturers:
1. Flow Controls Division of Emerson Electric
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.

C. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

2.12 EXPANSION VALVES

A. Manufacturers:
1. Flow Controls Division of Emerson Electric
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.

C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.13 ELECTRONIC EXPANSION VALVES

A. Manufacturers:
1. Flomatic Valves
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan, a Division of Parker Hannifin
4. Substitutions: See Division 01 - General Requirements.

B. Valve:
1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
2. Capacity: compatible with compressor size it serves

C. Evaporation Control System:
1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.

D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.14 RECEIVERS

A. Manufacturers:
1. Henry Technologies
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sherwood Valve/Harsco Corporation.

4. Substitutions: See Division 01 - General Requirements.

B. Internal Diameter 6 inch (150 mm) and Smaller:
1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

C. Internal Diameter Over 6 inch :
1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.15 FLEXIBLE CONNECTORS

A. Manufacturers:
1. Circuit Hydraulics, Ltd
2. Flexicraft Industries
3. Penflex
4. Substitutions: See Division 01 - General Requirements.

B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Inserts:
1. Provide inserts for placement in concrete formwork.

2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

G. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.5.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Provide copper plated hangers and supports for copper piping.

H. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Provide clearance for installation of insulation and access to valves and fittings.

J. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 3100.

K. Flood piping system with nitrogen when brazing.

L. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

M. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Division 09- Finishes.

N. Insulate piping and equipment; refer to Section and Section 22 0716.

O. Insulate piping and equipment; refer to Section and Section 23 0716.

P. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

Q. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

R. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

S. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

T. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

U. Fully charge completed system with refrigerant after testing.

V. Provide electrical connection to solenoid valves. Refer to Section 26 2717.

3.3 FIELD QUALITY CONTROL

A. See Division 01 - General Requirements

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.4 SCHEDULES

A. Hanger Spacing for Copper Tubing.
1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch (6.3 mm).
2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. 3-1/8 inch OD: Maximum span, 10 feet; minimum rod size, 3/8 inch.
8. 3-5/8 inch OD: Maximum span, 11 feet; minimum rod size, 1/2 inch.
9. 4-1/8 inch OD: Maximum span, 12 feet; minimum rod size, 1/2 inch.

B. Hanger Spacing for Steel Piping.
1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 11 feet minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.

END OF SECTION

SECTION 232500 - HVAC WATER TREATMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. System cleaner.
2. Closed system treatment (water).

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures.

B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

C. Product Data: Submit chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout products.

B. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

C. Operation and Maintenance Data: Submit data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of Connecticut standard for addition of non-potable chemicals to building systems and for discharge to public sewers.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

A. Section 01 – Closeout Procedures.

B. Furnish one year manufacturer warranty for pumps, valves and water meters.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.10 MAINTENANCE SERVICE

A. Section 01 – Closeout Procedures.

1.11 MAINTENANCE MATERIALS

A. Section 01 – Closeout Procedures.

B. Furnish chemicals for treatment and testing during warranty period.

PART 2 PRODUCTS

2.1 SYSTEM CLEANER

A. Manufacturers:
1. Biomin
2. Culligan
3. Aptech
4. Substitutions: Section 01 - Product Requirements.
5. Product Description: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tri-Poly phosphate and sodium molybdate.

2.2 CLOSED SYSTEM TREATMENT (WATER)

A. Manufacturers:
1. Biomin
2. Culligan
3. Aptech
4. Substitutions: Section 01- Product Requirements

B. Sequestering agent to reduce deposits and adjust pH.

C. Corrosion inhibitors boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulfites.

D. Conductivity enhancers; phosphates or phosphonates.

PART 3 EXECUTION

3.1 PREPARATION

A. Operate, fill, start and vent systems prior to cleaning. Use water meter to record capacity in each system. Place terminal control valves in open position during cleaning.

3.2 CLEANING

A. Concentration:
1. As recommended by manufacturer.
2. One pound per 100 gallons of water contained in the system.
3. One pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.
4. Fill steam boilers only with cleaner and water.

B. Hot Water Heating Systems:
1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.

3. Circulate for 6 hours at design temperatures, then drain.
4. Refill with clean water and repeat until system cleaner is removed.

C. Chilled Water Systems:
1. Circulate for 48 hours, then drain systems as quickly as possible.
2. Refill with clean water, circulate for 24 hours, then drain.
3. Refill with clean water and repeat until system cleaner is removed.

D. Use neutralizer agents on recommendation of system cleaner supplier and acceptance of Architect/Engineer.

E. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

F. Remove, clean, and replace strainer screens.

G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

A. Install Work in accordance with State of Connecticut standards.

3.4 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and interconnecting piping. Install around balancing valve downstream of circulating pumps as indicated on Drawings.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

3.5 DEMONSTRATION

A. Section 01 – Closeout Procedures.

B. Furnish four hour training course for operating personnel, instruction to include installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.

END OF SECTION 232500

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Duct Materials.
2. Insulated flexible ducts.
3. Single wall spiral round ducts.
4. Transverse duct connection system.
5. Casings.
6. Ductwork fabrication.
7. Kitchen hood exhaust ductwork fabrication.
8. Duct cleaning.

B. Related Sections:
1. Division 3 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Division 9 - Painting and Coating: Execution requirements for Weld priming, weather resistant, paint or coating specified by this section.
3. Division 11 - Foodservice Equipment: Product requirements for kitchen range hoods for placement by this section.
4. Section 23 04 00 – General Conditions for Mechanical Trades
5. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
6. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.2 REFERENCES

A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
4. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
5. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
6. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
7. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

8. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
9. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
10. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
11. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
12. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
3. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - Fibrous Glass Duct Construction Standards.
2. SMACNA - HVAC Air Duct Leakage Test Manual.
3. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

D. Underwriters Laboratories Inc.:
1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 PERFORMANCE REQUIREMENTS

A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 SUBMITTALS

A. Division 1 - Submittal Procedures.

B. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire rated and other walls.
7. Terminal unit, coil, and humidifier installations.

8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

C. Product Data: Submit data for duct materials duct liner duct connectors.

D. Samples: Submit two samples of typical shop fabricated duct fittings.

E. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

F. Manufacturer's Installation Instructions: Submit special procedures for glass fiber ducts.

1.5 CLOSEOUT SUBMITTALS

A. Division 1 -Closeout procedures.

B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

B. Construct ductwork to NFPA 90A and NFPA 96 standards.

C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

A. Division 1 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Division 1 - Product Requirements.

B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

C. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Division 1 – Closeout Procedures.

B. Furnish five year manufacturer warranty for ducts.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

PART 2 PRODUCTS

2.1 DUCT MATERIALS

A. Manufacturers:
1. United McGill Model.
2. Semco Model.
3. ACME Model.
4. Nufab Model.
5. Substitutions: Division 1- Product Requirements.

B. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G60 zinc coating of in conformance with ASTM A90/A90M.

C. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.

D. Stainless Steel Ducts: ASTM A240/A240M or ASTM A666, Type 316.

E. Fasteners: Rivets, bolts, or sheet metal screws.

F. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 INSULATED FLEXIBLE DUCTS

A. Manufacturers:
1. Thermaflex Model M-KF
2. Technaflex Model.
3. Tuttle + Bailey Model.
4. Substitutions: Division 1 - Product Requirements.

B. Product Description: Two ply vinyl film supported by helical wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -10 degrees F to 160 degrees F.
4. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.

2.3 SINGLE WALL SPIRAL ROUND DUCTS

A. Manufacturers:
1. McGill AirFlow Corporation.
2. Semco Incorporated.
3. Tangent Air Corp.
4. Spiral Mfg. Co., Inc.
5. Substitutions: Division 1 - Product Requirements.

B. Product Description: UL 181, Class 1, round spiral lock seam duct constructed of galvanized steel.

C. Construct duct with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	26
15 inches to 26 inches	24
28 inches to 36 inches	22
38 inches to 50 inches	20
52 inches to 84 inches	18

D. Construct fittings with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	24
15 inches to 26 inches	22
28 inches to 36 inches	20
38 inches to 50 inches	20
52 inches to 60 inches	18
62 inches to 84 inches	16

2.4 TRANSVERSE DUCT CONNECTION SYSTEM

A. Manufacturers:
1. United McGill Model.
2. Semco Model.
3. ACME Model.
4. Nufab Model.

5. Substitutions: Division 1 - Product Requirements.

B. Product Description: SMACNA "E" rated or SMACNA "F" rated or SMACNA "J" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.5 CASINGS

A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.

B. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection. Fabricate acoustic casings with reinforcing turned inward. Furnish 16 gage back facing and 22 gage perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb./cu ft minimum glass fiber media, on inverted channels of 16 gage.

2.6 DUCTWORK FABRICATION

A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards), and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

G. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
1. Sealants, Mastics and Tapes: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
2. Do not provide sealing products not bearing UL approval markings.

2.7 KITCHEN HOOD EXHAUST DUCTWORK FABRICATION

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.

B. Exposed Kitchen Hood Exhaust Ducts: Construct of stainless steel ASTM ASTM A240/A240M OR ASTM 666, type 316 using continuous external welded joints.

C. Concealed Kitchen Hood Exhaust Ducts: Construct of 16 gage carbon steel or 18 gage stainless steel ASTM ASTM A240/A240M OR ASTM 666, type 316 using continuous external welded joints.

D. Grease Duct: Provide factory built commercial grease ducts labeled and listed in accordance with UL 1978.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Coordination and project conditions.

B. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

C. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 and smaller.

D. Install duct hangers and supports in accordance with Section 23 05 29.

E. Use double nuts and lock washers on threaded rod supports.

F. Connect flexible ducts to metal ducts with liquid adhesive plus draw bands.

G. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.

H. Casings: Install floor mounted casings on 4 inch high concrete curbs. Refer to Division 3. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, furnish liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.

I. Install kitchen range hoods in accordance with NFPA 96. Refer to Division 11.

J. Install residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for clean out.

K. Kitchen hood exhaust ducts: Use stainless steel for ductwork exposed to view and stainless steel or carbon steel where ducts are concealed.

L. For outdoor ductwork, protect ductwork, ductwork supports, linings and coverings from weather.

M. Exhaust Outlet Locations:
1. Minimum Distance from Property Lines: 3 feet.
2. Minimum Distance from Building Openings: 3 feet.
3. Minimum Distance from Outside Air Intakes: 25 feet.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

B. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

C. Connect air terminal units air to supply ducts directly.

3.4 CONCEALED GREASE DUCT TESTING

A. Prior to concealing, wrapping, or insulating grease ductwork, or placing grease duct in service, perform leakage test in accordance with ICC IMC, in presence of authority having jurisdiction.

B. Perform light test by pulling minimum 100 W light through duct and observing for light leaks at duct joints.

C. Test complete extent of duct installed, including joint at which duct connects to exhaust hood.

3.5 CLEANING

A. Division 1 – Closeout Requirements.

B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.

C. Clean duct systems with high power vacuum machines. Protect equipment with potential to be harmed by excessive dirt with filters, or bypass during cleaning. Install access openings into ductwork for cleaning purposes.

3.6 TESTING

A. For ductwork designed for 3 inches w.c. above ambient, pressure test 100 percent of ductwork after duct cleaning, but before duct insulation is applied or ductwork is concealed.
   1. Test in accordance with SMACNA HVAC Air Duct Leakage Test Manual.
   2. Maximum Allowable Leakage: In accordance with ICC IECC.

3.7 SCHEDULES

A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply (Heating Systems)	Galvanized Steel.
Supply (System with Cooling Coils)	Galvanized Steel.
Return and Relief	Galvanized Steel.
General Exhaust	Galvanized Steel.
Kitchen Hood Exhaust	Stainless Steel, Carbon Steel or Factory Duct System
Dishwasher Exhaust	Stainless Steel
Fume Hood Exhaust	Stainless Steel
Outside Air Intake	Galvanized Steel
Combustion Air	Galvanized Steel
Intake and Exhaust	Galvanized Steel

B. Ductwork Pressure Class Schedule:

AIR SYSTEM	PRESSURE CLASS
Constant Volume Supply	3 inch wg regardless of velocity.
Supply (Heating Systems)	3 inch wg
Supply (System with Cooling Coils)	3 inch wg
Return and Relief	2 inch wg regardless of velocity.
General Exhaust	1 inch wg regardless of velocity.
Dishwasher Exhaust	1 inch wg
Fume Hood Exhaust	2 inch wg

END OF SECTION 233100

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Back-draft dampers.
2. Combination fire-and-smoke dampers.
3. Duct access doors.
4. Dynamic fire dampers.
5. Smoke dampers.
6. Volume control dampers.
7. Flexible duct connections.
8. Duct test holes.
9. Dial thermometers.
10. Static pressure gages.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 09 00 - Instrumentation and Control for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
3. Section 23 09 00 - Direct-Digital Control System for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
4. Section 23 31 00 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
5. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 92A - Recommended Practice for Smoke-Control Systems.

D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:
1. UL 555 - Standard for Safety for Fire Dampers.
2. UL 555C - Standard for Safety for Ceiling Dampers.
3. UL 555S - Standard for Safety for Smoke Dampers.

1.3 SUBMITTALS

A. Division 01 - Submittal Procedures.

B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.

C. Product Data: Submit data for shop fabricated assemblies and hardware used.

D. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
1. Fire dampers including locations and ratings.
2. Smoke dampers including locations and ratings.
3. Backdraft dampers.
4. Flexible duct connections.
5. Volume control dampers.
6. Duct access doors.
7. Duct test holes.

E. Product Data: For fire dampers, smoke dampers, combination fire and smoke dampers submit the following:
1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
2. Indicate materials, construction, dimensions, and installation details.
3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

F. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout procedures.

B. Project Record Documents: Record actual locations of access doors, test holes.

C. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.5 QUALITY ASSURANCE

A. Dampers tested, rated and labeled in accordance with the latest UL requirements.

B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

C. Perform Work in accordance with State of Connecticut standard.

D. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 - Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements.

B. Protect dampers from damage to operating linkages and blades.

C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

D. Storage: Store materials in a dry area indoor, protected from damage.

E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 COORDINATION

A. Section 01 0 – Project Management.

B. Coordinate Work where appropriate with building control Work.

1.11 WARRANTY

A. Section 01 - Closeout Procedures.

B. Furnish five year manufacturer warranty for duct accessories.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for

extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.12 EXTRA MATERIALS

A. Section 01 - Closeout Procedures.

B. Furnish two of each size and type of fusible link.

PART 2 PRODUCTS

2.1 BACK-DRAFT DAMPERS

A. Manufacturers:
1. Ruskin
2. Air Balance
3. Greenheck
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized 16 gage thick steel. Blades, maximum 6 inch width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

2.2 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
1. Ruskin.
2. Air Balance.
3. Greenheck.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with NFPA 90A, UL 555, and UL 555S.

C. Fire Resistance: 1-1/2 hours unless noted otherwise on the drawings.

D. Leakage Rating: Class I, maximum of 8 cfm at 4 inches wg differential pressure.

E. Damper Temperature Rating: 250 degrees F or 350 degrees F.

F. Frame: 16 gage, galvanized steel.

G. Blades:
1. Style: Airfoil-shaped, single piece, double skin.
2. Action: Opposed.
3. Orientation: Horizontal.
4. Material: Minimum 13 gage equivalent thickness, galvanized steel.
5. Width: Maximum 6 inches.

H. Bearings: Stainless steel pressed into frame.

I. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.

J. Linkage: Concealed in frame.

K. Release Device: Close in controlled manner and allow damper to be automatically reset.

L. Actuator:
1. Type: Electric 24 volt with transformer or 120 volt, 60 hertz, two-position, fail close or electric 24 volt, 60 hertz, two-position, fail close.
2. Mounting: External.

M. Fusible Link Release Temperature: 165 degrees F.

N. Finish: Mill galvanized.

O. Factory installed sleeve and mounting angles. Furnish silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

2.3 DUCT ACCESS DOORS

A. Manufacturers:
1. Ruskin.
2. Air Balance.
3. Greenheck.
4. Substitutions: Section 01 60 00 - Product Requirements

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
1. Less than 12 inches square, secure with sash locks.
2. Up to 18 inches Square: Furnish two hinges and two sash locks.
3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Furnish additional hinge.
5. Access panels with sheet metal screw fasteners are not acceptable.

2.4 DYNAMIC FIRE DAMPERS

A. Manufacturers:
1. Ruskin.
2. Air Balance.
3. Greenheck.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with NFPA 90A and UL 555.

C. Fire Resistance: 1-1/2 hours unless otherwise noted on the drawings.

D. Dynamic Closure Rating: Dampers classified for dynamic closure to 2000 fpm and 4 inches wg static pressure.

E. Construction:
1. Integral Sleeve Frame: Minimum 20 gage roll formed galvanized steel. Length: 12 inches, 14 inches or16 inches.
2. Blades:
a. Style: Curtain type.
b. Action: Spring or gravity closure upon fusible link release.
c. Material: Minimum 24 gage roll formed, galvanized steel.
3. Closure Springs: Type 301 stainless steel, constant force type, if required.

F. Fusible Link Release Temperature: 165 degrees F.

G. Mounting: Vertical or horizontal as indicated on Drawings.

H. Duct Transition Connection, Damper Style:
1. A style - rectangular connection, frame and blades in air stream.
2. B style - rectangular connection, blades out of air stream, high free area.
3. G style - A style connection, grille mounting tabs at end of sleeve for grille.
4. CR style - round connection, sealed.
5. CO style - oval connection, sealed.
6. R style - round connection, blades in air stream, non-sealed.
7. LR style - round connection, blades out of air stream, non-sealed.
8. LO style - oval connection, non-sealed.

I. Finish: Mill galvanized.

2.5 SMOKE DAMPERS

A. Manufacturers:
1. Ruskin.
2. Air Balance.
3. Greenheck.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Furnish materials in accordance with State of Connecticut standards.

C. Fabricate in accordance with NFPA 90A and UL 555S.

D. Fire Resistance: 1-1/2 hours.

E. Leakage Rating: Class I, maximum of 8 cfm at 4 inches wg differential pressure.

F. Damper Temperature Rating: 250 degrees F or 350 degrees F.

G. Frame: 16 gage, galvanized steel.

H. Blades:
1. Style: Airfoil-shaped, single piece, double skin.
2. Action: Opposed.
3. Orientation: Horizontal.
4. Material: Minimum 13 gage equivalent thickness, galvanized steel.
5. Width: Maximum 6 inches.

I. Bearings: Stainless steel pressed into frame.

J. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.

K. Linkage: Concealed in frame.

L. Actuators:
1. For actuators used in the smoke control system related to MAF-1,2,3 or SEF-1,2,3,4:
a. Type: Electric 24 volt with transformer or 120 volt, 60 hertz, two-position, fail close or electric 24 volt, 60 hertz, two-position, fail close.
b. Mounting: Internal. Provide curb mounted access door for service from the roof.

2. For all actuators NOT used in the smoke control system:
a. Type: Electric 24 volt with transformer or 120 volt, 60 hertz, two-position, fail close or electric 24 volt, 60 hertz, two-position, fail close.
b. Mounting: External.

M. Sleeve: Factory installed 16 gage sleeve, minimum 12 inches long.

N. Finish: Mill galvanized.

2.6 VOLUME CONTROL DAMPERS

A. Manufacturers:
1. Ruskin.
2. Air Balance.
3. Greenheck.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Splitter Dampers:
1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 3/8 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
4. Single Blade Dampers: Fabricate for duct sizes up to 12 x 48 inch.

D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.

E. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg.

F. Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.7 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
1. United McGill.
2. Semco.
3. Tuthill + Bailey.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Connector: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
2. Net Fabric Width: Approximately 6 inches wide.
3. Metal: 3 inch wide, 24 gage galvanized steel.

D. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs. per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.8 DUCT TEST HOLES

A. Manufacturers:
1. Dwyer.
2. Flow Kinetics
3. Air Balance.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

2.9 DIAL THERMOMETERS

A. Manufacturers:
1. Trerice.
2. Ernst.

3. Davis.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
1. Size: 3-1/2inch diameter dial.
2. Lens: Clear glass.
3. Accuracy: 1 percent.
4. Calibration: Degrees F.

2.10 STATIC PRESSURE GAGES

A. Manufacturers:
1. Trerice.
2. Ernst.
3. Davis.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Furnish materials in accordance with State of Connecticut standards.

C. Dial Gages: 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full scale accuracy.

D. Inclined Manometer: Plastic with red liquid on white background with black figures, front calibration adjustment, 3 percent of full scale accuracy.

E. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify rated walls are ready for fire damper installation.

C. Verify ducts and equipment installation are ready for accessories.

D. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.

B. Install motorized back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.

C. Access Doors: Install access doors at the following locations and as indicated on Drawings:
1. Spaced every 50 feet of straight duct.
2. Upstream of each elbow.
3. Upstream of each reheat coil.
4. Before and after each duct mounted filter.
5. Before and after each duct mounted coil.
6. Before and after each duct mounted fan.
7. Before and after each automatic control damper.
8. Before and after each fire damper, smoke damper and combination fire and smoke damper.
9. Downstream of each VAV box.
10. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96.

D. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and. Install 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
1. Mark access doors for fire and smoke dampers on outside surface, with minimum 1/2 inch high letters reading: FIRE/SMOKE DAMPER, SMOKE DAMPER, OR FIRE DAMPER.

E. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

F. Install fire dampers, combination fire and smoke dampers and smoke dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
2. Install dampers square and free from racking with blades running horizontally.
3. Do not compress or stretch damper frame into duct or opening.
4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.3 INSTALLATION - THERMOMETERS

A. Install thermometers in air duct systems on flanges.

B. Where thermometers are provided on local panels, duct mounted thermometers are not required.

C. Locate duct-mounted thermometers minimum 10 feet downstream of mixing-dampers, coils, or other devices causing air turbulence.

D. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.

E. Provide instruments with scale ranges selected according to service with largest appropriate scale.

F. Install thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

G. Adjust thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.4 DEMONSTRATION

A. Section 01 - Closeout Procedure.

B. Demonstrate re-setting of fire dampers to Owner's representative.

END OF SECTION 233300

SECTION 233400 - HVAC FANS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Upblast centrifugal sidewall-mounted fans.
2. Alternates: Refer to Division 01 Section “Alternates” for description of Work of this Section affected by alternates.”

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
4. Section 23 07 00 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
5. Section 23 09 00 - Instrumentation and Control for HVAC: Product requirements for control components to interface with fans.
6. Section 23 09 00 - Direct-Digital Control System for HVAC: Controls remote from unit.
7. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
8. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
9. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:
1. AMCA 99 - Standards Handbook.
2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Refrigeration Institute:
1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.

D. ASTM International:
1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

E. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. Underwriters Laboratories Inc.:
1. UL 705 - Power Ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Wind-Borne Debris Loads: Design louvers located within 30 feet of grade to withstand ASTM E1996; large missile impact test.

1.4 SUBMITTALS

A. Section 01 Submittal Procedures.

B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit fan manufacturers instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures.

B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300 ,and bear AMCA Certified Sound Rating Seal.

C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

D. Balance Quality: Conform to AMCA 204.

E. Energy Recovery Unit Wheel Energy Transfer Rating: Meet ARI 1060.

F. Perform Work in accordance with State of Connecticut.

G. Maintain one copy copies of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Section 01 - Closeout Procedures.

B. Furnish one year manufacturer’s warranty for fans.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.12 MAINTENANCE SERVICE

A. Section 01 - Closeout Procedures.

B. Furnish service and maintenance of fans for one years from Date of Substantial Completion.

C. Examine each fan components monthly. Clean, adjust, and lubricate equipment.

D. Include systematic examination, adjustment, and lubrication of fans, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

E. Perform work without removing fans from service during building normal occupied hours.

F. Provide emergency call back service at all hours for this maintenance period.

G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

H. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.

I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.13 EXTRA MATERIALS

A. Furnish two sets of belts for all each belt driven fan.

PART 2 PRODUCTS

2.1 UPBLAST CENTRIFUGAL WALL MOUNTED FANS

A. Manufacturers:
1. Loren Cook Company
2. Greenheck Corp.
3. Penn Ventilation
4. Substitutions: Section 01 - Product Requirements.

B. Fan Unit: Upblast type. Direct drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Motor: Totally enclosed fan cooled NEMA MG1.

E. Roof Curb: self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips , ventilated double wall, hinged curb adapter, and factory installed nailer strip.

F. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 1 enclosure.

G. Accessories:
1. Fan speed controller.

H. Electrical Characteristics and Components:
1. Electrical Characteristics: In accordance with Section 26 05 03 and the Mechanical Schedules.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 – Project Management.

B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 PREPARATION

A. Furnish roof curbs for installation.

3.3 INSTALLATION

A. Secure roof fans with cadmium plated steel lag screws to roof curb.

B. Suspended Fans: Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

C. Install backdraft dampers on inlet to roof exhaust fans.

D. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.

E. Install safety screen where inlet or outlet is exposed.

F. Pipe scroll drains to nearest floor drain.

G. Install backdraft dampers on discharge of exhaust fans. Refer to Section 23 33 00.

H. Provide sheaves required for final air balance.

3.4 MANUFACTURER'S FIELD SERVICES

A. Furnish services of factory trained representative for minimum of two days to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.5 CLEANING

A. Section 01 – Closeout Procedures.

B. Vacuum clean coils and inside of fan cabinet.

3.6 DEMONSTRATION

A. Section 01 – Closeout Procedures.

B. Demonstrate fan operation and maintenance procedures.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 – Closeout Procedures.

B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

3.8 SCHEDULES: Refer to Mechanical drawings for schedule information.

3.9 COMMISSIONING

A. Verify that equipment is installed and commissioned as per requirements of Section 01 91 13 and manufacturer's written instructions.

B. Complete installation and startup checks and functional tests according to Section 01 91 13 and manufacturer's written instructions.

END OF SECTION 233400

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Diffusers.
2. Registers
3. Grilles.
4. Louvered penthouses.
5. Roof hoods.
6. Goosenecks.

B. Related Sections:
1. Division 8 - Louvers: Wall Louvers.
2. Division 9 – Painting.
3. Section 23 04 00 – General Conditions for Mechanical Trades
4. Section 23 09 00 - Instrumentation and Control for HVAC: Operators for adjustable louvers.
5. Section 23 09 00 - Direct-Digital Control System for HVAC: Operators for adjustable louvers.
6. Section 23 33 00 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures.

B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Samples: Submit two of each required air outlet and inlet type.

D. Test Reports: Rating of air outlet and inlet performance.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 - Closeout Procedures.

B. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500.

C. Perform Work in accordance with State of Connecticut standard.

D. Maintain two copies of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

1.7 PRE-INSTALLATION MEETINGS

A. Division 1 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.8 WARRANTY

A. Section 01 – Closeout Procedures.

B. Furnish five year manufacturer warranty for air outlets and inlets.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.9 EXTRA MATERIALS

A. Section 01 – Closeout Procedures.

B. Furnish one of each type and size extra air outlets and inlets.

PART 2 PRODUCTS

2.1 ROUND CEILING DIFFUSERS

A. Manufacturers:
1. Krueger.
2. Titus.
3. Price

B. Product Description: Type: Round, adjustable pattern, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sector baffles where indicated. Diffuser collar not more than 1 inch above ceiling.

C. Fabrication: Aluminum with baked enamel finish, color by architect.

D. Accessories: Multi-louvered equalizing grid with damper adjustable from diffuser face.

2.2 CEILING SUPPLY DIFFUSER (Type-A)

A. Manufacturers:
1. Krueger.
2. Titus.
3. Price

B. Type: Architectural square panel ceiling diffuser with one piece square face plaque not exceeding 18”x18” for 24”x24” and constructed of 16 gage steel with rounded corners that have a minimum radius of 3/4”. Face plaques that have a secondary wrapper are not acceptable. The face plaque shall not extend below the ceiling more than 3/8” and shall be removable from the backpan for access to the optional damper. The diffuser backpan shall be one piece stamped construction of 22 gage steel and have an integrally drawn round neck.

C. Frame: Lay-In T-Bar or Surface Mount, Coordinate with Architectural Plans.

D. Fabrication: Steel with factory applied anodic acrylic paint. Color shall be selected by architect.

E. Damper: None

2.3 WALL/CEILING EXHAUST AND RETURN REGISTERS/GRILLES (Type-B & Type-C)

A. Manufacturers:
1. Krueger.
2. Titus.
3. Price

B. Type: Return grille shall with 35° deflection blades on 3/4” centers made of 22 gage. The blades must be held in place by mullions placed behind the grille and welded to the frame. The frame of the grille must be constructed of 22 gage steel.

C. Frame: Lay-In T-Bar 24x24 Panel or Surface Mount, Coordinate with Architectural Plans.

D. Fabrication: Steel with factory applied anodic acrylic paint. Color shall be selected by architect.

E. Damper: None

F. Options: Type–C Only, Provide 2" Filter Frame with ¼ Turn Fasteners.

2.4 WALL SUPPLY REGISTERS/GRILLES (Type-D)

A. Manufacturers:
1. Krueger.
2. Titus.
3. Price

B. Type: Double deflection supply grille with individually adjustable blades on 3/4" centers with friction pivots (plastic blade pivots are not acceptable) made of 22 gage steel. The frame of the grille must be constructed of 22 gage steel with a border

C. Frame: Surface Mount with Concealed Mounting

D. Fabrication: Steel with factory applied anodic acrylic paint. Color shall be selected by architect.

E. Damper: Opposed Blade Damper shall be made of heavy gage steel and operable from the face of the supply grille.

2.5 CEILING SUPPLY LINER SLOT DIFFUSER (Type-E)

A. Manufacturers:
1. Krueger.
2. Titus.
3. Price

B. Type: Linear slot diffusers with slot widths of 1", 1 1/2", 2", 2 1/2", and 3" (Refer to Schedule). Linear slot diffusers shall be available in single piece construction. Multiple diffusers and will be joined together with end alignment strips to form a continuous slot appearance. Alignment strips shall be provided by the manufacturer.

C. Frame: Provide a 3/16" flange on both sides of the linear. Coordinate End border with floor plans.

D. Fabrication: Aluminum with factory applied anodic acrylic paint. Color shall be selected by architect.

E. Damper: Damper in Plenum.

F. Options: Provide fully insulated plenum. Plenum shall have integral balancing damper capable of adjustment from diffuser face.

2.6 CEILING SUPPLY LOUVERED FACE DIFFUSER (Type-F)

A. Manufacturers:
1. Krueger.
2. Titus.
3. Price

B. Type: Ceiling diffuser shall be louver face with adjustable pattern controllers for horizontal or vertical discharge airflow. The pattern controllers shall be accessible from the face. These diffusers shall have a square or rectangular neck of the sizes and frame styles shown on the drawings. The square or rectangular neck shall be an integral part of the backpan and a square-to-round adapter will be an available option to accommodate round duct connections. The diffuser shall have an easily removable core with fixed blades in 1, 2, 3, or 4-way configurations.

C. Frame: Lay-In T-Bar 24x24 Panel or Surface Mount, Coordinate with Architectural Plans.

D. Fabrication: Steel with factory applied anodic acrylic paint. Color shall be selected by architect.

E. Damper: None

F. Options: Provide Square to round adapters.

2.7 CEILING SUPPLY LOUVERED FACE DIFFUSER (Type-P)

A. Manufacturers:
1. Krueger.
2. Titus.
3. Price

B. Type: Perforated face supply diffuser shall have a perforated face with 3/16” diameter holes on 1/4” centers resulting in a 51% free area. The diffuser backpan shall be constructed of heavy gage steel and provide a square neck. The diffuser shall have no pattern deflectors.

C. Frame: Lay-In T-Bar 24x24 Panel or Surface Mount, Coordinate with Architectural Plans.

D. Fabrication: Steel with factory applied anodic acrylic paint. Color shall be selected by architect.

E. Damper: None

F. Options: Provide Square to round adapters.

2.8 ALUMINUM EGG CRATE GRILLES (TYPE-Q)

A. Manufacturers:
1. United Enertech
2. Krueger.
3. Titus.
4. Price Company

B. Type: Extruded aluminum bars, 2” grille depth, 2” minimum spacing with zero deflection.

C. Frame: flat bar perimeter frame.

D. Fabrication: 0.125” extruded aluminum bars with factory baked enamel finish , color as selected by Architect.

2.9 WALL SUPPLY REGISTERS/GRILLES (Type-S)

A. Manufacturers:
1. Krueger.
2. Titus.
3. Price

B. Type: Double deflection supply grille with individually adjustable blades on 3/4” centers constructed of extruded aluminum formed to an airfoil shape (hollow blades are not acceptable). The blades shall extend through the side of the frame and shall be held in place with tension wire. The frame of the grille must be constructed of 20 gage steel frame and shall have a border of 1 1/4” around all sides of the grille with mitered corners.

C. Frame: Surface Mount

D. Fabrication: Steel with factory applied anodic acrylic paint. Color shall be selected by architect.

E. Damper: Opposed Blade Damper shall be made of heavy gage steel and operable from the face of the supply grille.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Coordination and project conditions.

B. Verify inlet and outlet locations.

C. Verify ceiling, wall systems are ready for installation.

3.2 INSTALLATION

A. Install diffusers to ductwork with airtight connection.

B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00.

C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Division 9.

D. Do not locate air registers, diffusers or grilles in floors of toilet or bathing rooms.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION 233700

SECTION 234000 - HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Disposable, extended area panel filters.
2. Disposable panel filters.
3. Extended surface non-supported media filters.
4. Extended surface retained media filters.
5. Filter frames and housings.
6. Filter gages.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
3. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for wiring products for placement by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
1. ARI 850 - Commercial and Industrial Air Filter Equipment.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

C. Military Standardization Documents:
1. MIL MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components, and Related Products: Performance-Test Methods.

D. Underwriters Laboratories Inc.:
1. UL 586 - High-Efficiency. Particulate, Air Filter Units.
2. UL 867 - Electrostatic Air Cleaners.
3. UL 900 - Air Filter Units.

1.3 PERFORMANCE REQUIREMENTS

A. Conform to ARI 850 Section 7.4.

B. Dust Spot Efficiency: Plus or minus 5 percent.

1.4 SUBMITTALS

A. Section 01 - Submittal Procedures.

B. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.

C. Product Data: Submit data on filter media, filter performance data, dimensions, and electrical characteristics.

D. Samples: Submit two samples of replacement filter media of each type and each filter frame.

E. Manufacturer's Installation Instructions: Submit assembly and change-out procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures.

B. Operation and Maintenance Data: Submit instructions for operation, changing, and periodic cleaning.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 – Product Management.

B. Convene minimum one week prior to commencing work of this section.

1.8 WARRANTY

A. Section 01 – Closeout Procedures.

B. Furnish five year manufacturer warranty for air cleaning devices.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.9 EXTRA MATERIALS

A. Section 01 – Closeout Procedures.

B. Furnish one set of disposable panel filters.

PART 2 PRODUCTS

2.1 DISPOSABLE, EXTENDED AREA PANEL FILTERS

A. Manufacturers:
1. Air Guard Model
2. Camfil Farr
3. American Air
4. Substitutions: Section 01 60 00 - Product Requirements

B. Media: UL 900 Class 2 pleated, lofted, non-woven, reinforced cotton and synthetic fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
1. Frame: Beverageboard
2. Nominal size: 12 x 24 inches, 16 x 20 inches, 16 x 25 inches, or 24 x 24 inches
3. Nominal thickness: 2 inches.

C. Rating, ASHRAE 52.1:
1. Dust spot efficiency: 25-35 percent.
2. Weight arrestance: 90-92 percent.
3. Initial resistance at 500 fpm face velocity: 0.25 inch wginch wg.
4. Recommended final resistance: 2.0 inch wg.

2.2 DISPOSABLE PANEL FILTERS

A. Manufacturers:
1. Air Guard Model
2. Camfil Farr
3. American Air
4. Substitutions: Section 01 60 00 - Product Requirement.

B. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.
1. Nominal Size: 12 x 24 inches, 16 x 25 inches, 24 x 24 inches
2. Thickness: 2 inch.

C. Performance Rating:
1. Face Velocity: 500 fpm
2. Initial Resistance: 0.15 inch wg
3. Recommended Final Resistance: 0.50 inches wg.

D. Casing: Cardboard-frame with perforated metal retainer.

E. Holding Frames: 20 gage minimum galvanized steel frame with expanded metal grid on outlet side and steel rod grid on inlet side, hinged with pull and retaining handles.

2.3 EXTENDED SURFACE RETAINED MEDIA FILTERS

A. Manufacturers:
1. Air Guard Model
2. Camfil Farr
3. American Air
4. Substitutions: Section 01 60 00 - Product Requirements

B. Media: UL 900 Class 2 pleated, non-woven cotton fabric, scrim reinforced; supported by welded steel retainer; in 16 gage steel holding frame with corrosion resistant coating.
1. Effective Media Area: 20sq ft per 1000 cfm capacity rating.
2. Nominal Size: 24 x 24 x 12 inches x 2” deep.

C. Performance Rating: ASHRAE 52.1:
1. Percent Dust Spot Efficiency: 30
2. Percent Average Weight Arrestance: 92.
3. Initial Resistance at 500 fpm Face Velocity: 0.20 inch wg.
4. Recommended Final Resistance: 0.50 inch wg above initial resistance.

2.4 FILTER FRAMES AND HOUSINGS

A. Manufacturers:
1. Air Guard Model
2. Camfil Farr
3. American Air
4. Substitutions: Section 01 60 00 – Product Requirements.

B. General: Fabricate filter frames and supporting structures of 16 gage galvanized steel or extruded aluminum T-section construction with necessary gaskets between frames and walls.

C. Standard Sizes: For interchange ability of filter media of other manufacturers; for panel filters, size for 24 x 24 inches filter media, minimum 2 inches thick; for extended surface and high efficiency particulate air filters, provide for upstream mounting of panel filters.

D. Side Servicing Housings: Flanged for insertion into ductwork, of reinforced 16 gage galvanized steel; access doors with continuous gaskets and positive locking devices on both sides; extruded aluminum tracks or channels for primary filters with positive sealing gaskets.

2.5 FILTER GAGES

A. Manufacturers:
1. Dwyer Model
2. Matheson Model
3. General Filters Model
4. Substitutions: Section 01 60 00 - Product Requirements

B. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case. Furnish vent valves, black figures on white background, front calibration adjustment, range 0-2.0 inch wg, 3 percent of full scale accuracy.

C. Inclined Manometer: One piece molded plastic with epoxy coated aluminum scale, inclined-vertical indicating tube and built-in spirit level, range 0-3 inch wg, 3 percent of full scale accuracy.

D. Accessories: Static pressure tips with integral compression fittings, 1/4 inch aluminum plastic tubing, 2-way or 3-way vent valves.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install filters with felt, rubber, or neoprene gaskets to prevent passage of unfiltered air around filters.

B. Install filter gage static pressure tips upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level.

C. Do not operate fan system until temporary filters are in place. Replace temporary filters used during construction and testing, with clean set.

D. Install filter gages on filter banks with separate static pressure tips upstream and downstream of filters.

END OF SECTION 234000

SECTION 23 6213 - PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR AND CONDENSER UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Heat Pump condensing unit package.

B. Charge of refrigerant and oil.

C. Controls and control connections.

D. Refrigerant piping connections.

E. Motor starters.

F. Electrical power connections.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Section 23 0400 – General Conditions for Mechanical Trades.

C. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

D. Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment: Placement of vibration isolators.

E. Section 23 0993 - Sequence of Operations for HVAC Controls.

F. Section 23 2300 – Refrigerant Piping

G. Section 23 7223 – Packaged Air-to-Air Energy Recovery Units

H. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS(follow the most currently adopted amended version)

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

B. AHRI 365 I-P - Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units.

C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems.

D. ASHRAE Std 23.1 - Methods of Testing for Rating the Performance of Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant.

E. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.

F. ASHRAE Std 90.2 - Energy-Efficient Design of Low-Rise Residential Buildings.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

H. NEMA MG 1 - Motors and Generators.

I. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical.

1.4 DEFINITIONS

A. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

B. Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams. Include equipment served by condensing units in submittal, or submit at same time, to ensure capacities are complementary.

C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Include schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system.

D. Design Data: Indicate pipe and equipment sizing.

E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

F. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

G. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

H. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 - Requirements related to maintenance materials.
2. Extra Lubricating Oil: One complete change.

1.6 QUALITY ASSURANCE

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 WARRANTY

A. See Division 01 General Requirements.

B. Provide a five year warranty to include coverage for refrigerant compressors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Daikin.
B. Trane.
C. Carrier
D. Johnson/York.
E. Substitutions: See Division 01 – General Requirements.

2.2 MANUFACTURED UNITS

A. Units: Self-contained, packaged, factory assembled and pre-wired units suitable for outdoor use, consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, wind deflector, and screens.

B. Construction and Ratings: In accordance with AHRI 210/240. Test in accordance with

C. Performance Ratings: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1 I-P.

D. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.3 CASING

A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.

B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.

C. Provide removable access doors or panels with quick fasteners and piano hinges.

2.4 CONDENSER COILS

A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig, and vacuum dehydrate. Seal with holding charge of nitrogen.

B. Coil Guard: Expanded metal with lint screens.

2.5 FANS AND MOTORS

A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Equip with roller or ball bearings with grease fittings extended to outside of casing.

B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in current and thermal overload protection. Refer to Section 23 0513.

C. Horizontal discharge, double width, double inlet forward curved centrifugal type condenser fans, equipped with roller or ball bearings with grease fittings extended to outside of casing, V-belt drive with belt guard.

D. Motors as indicated, in compliance with Section 22 0513.

2.6 COMPRESSORS

A. Compressor: Hermetic receprocating or scroll type, or semi-hermetic reciprocating or screw type, unless otherwise indicated in the schedule.

B. Mounting: Statically and dynamically balance rotating parts and mount on spring vibration isolators.
1. Internally isolate units on springs.
2. Refer to Section 23 0548.

C. Lubrication System: Reversible, positive displacement oil pump with oil charging valve, oil level sight glass, and magnetic plug or strainer.

D. Motor: 1800 rpm (recriprocating) or 3600 rpm (scroll or screw) suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting. Furnish with starter.
1. Refer to Section 23 0513.

E. Capacity Reduction Equipment: Suction valve unloaders, with lifting mechanism operated by electrically actuated solenoid valve, with unloaded compressor start; controlled from suction pressure.

F. Sump Oil (crankcase) Heater for Reciprocating Compressors: Evaporates refrigerant returning to sump during shut down. Energize heater continuously when compressor is not operating.

2.7 REFRIGERANT CIRCUIT

A. Provide each unit with one refrigerant circuit, factory supplied and piped. Refer to Section 23 2300.

B. For each refrigerant circuit, provide:
1. Filter dryer replaceable core type.
2. Liquid line sight glass and moisture indicator.
3. Thermal expansion valve for maximum operating pressure.
4. Insulated suction line.
5. Suction and liquid line service valves and gage ports.
6. Liquid line solenoid valve.
7. Charging valve.
8. Discharge line check valve.
9. Compressor discharge service valve.
10. Condenser pressure relief valve.

C. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control utilizing thermistors.

2.8 CONTROLS

A. On unit, mount weatherproof steel control panel, NEMA 250, containing power and control wiring, molded case disconnect switch, factory wired with single point power connection. Factory mount disconnect switch on unit under provisions of Section 26 2717.

B. For each compressor, provide across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for controls power. Provide manual reset current overload protection. For each condenser fan, provide across-the-line starter with starter relay.

C. Provide safety controls arranged so any one will shut down machine:
1. High discharge pressure switch (manual reset) for each compressor.
2. Low suction pressure switch (automatic reset) for each compressor.
3. Oil Pressure switch (manual reset).

D. Provide the following operating controls:
1. Refer to Section 23 0993.
2. Compressor short cycle timer.
3. Periodic pump-out timer to pump down on high evaporator refrigerant pressure.
4. Lead-lag switch to alternate compressor operation.

E. Provide the following operating controls where indicated in the schedule(s).
1. Hot gas bypass sized for minimum compressor loading, bypasses hot refrigerant gas to evaporator.
2. Controls to permit operation down to 0°F ambient temperature.

a. Thermostat to cycle fan motors in response to outdoor ambient temperature.
b. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
c. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.
d. Electronic control consisting of mixing damper assembly, controlled to maintain constant refrigerant condensing pressure.

3. Low ambient thermostat to lock out compressor at low ambient temperatures.

F. Gages: Pre-piped for suction and discharge refrigerant pressures and oil pressure for each compressor.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's installation instructions.

B. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.

C. Provide for connection to electrical service. Refer to Section 26 2717.

D. Install units on vibration isolation. Refer to Section 23 0548.

E. Install units on concrete base as indicated. Refer to Division 03 - Requirements related to concrete..

F. Provide connection to refrigeration piping system and evaporators. Refer to Section 23 2300. Comply with ASHRAE Std 15.

3.2 SYSTEM STARTUP

A. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.

B. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.

C. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

D. Provide cooling season start-up, and winter season shut-down for first year of operation.

END OF SECTION

SECTION 236411 - PACKAGED WATER CHILLERS – SCROLL

PART 1 GENERAL

1.1 SUMMARY

A. Section includes chiller package, charge of refrigerant and oil, controls and control connections, chilled water connections, condenser water connections, refrigerant connections, auxiliary water connections, starters.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
5. Section 01 91 13 - Commissioning
6. Section 23 09 00 - Sequence of Operations for HVAC Controls: Sequences of operation for chillers specified in this section.
7. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and condenser water piping for placement by this section.
8. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for piping specialties for placement by this section.
9. Section 23 23 00 - Refrigerant Piping: Product requirements for refrigerant piping for placement by this section.
10. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection to chillers specified by this section.

1.2 REFERENCES (follow the most currently adopted amended version)

A. Air-Conditioning and Refrigeration Institute:
1. ARI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems

D. American Society of Mechanical Engineers:
1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

E. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. UL 984 - Hermetic Refrigerant Motor-Compressors.

G. UL 1995 - Heating and Cooling Equipment.

1.3 DEFINITIONS

A. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

B. Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

1.4 SUBMITTALS

A. Section 01 - Submittal Procedures.

B. Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate valves, strainers, and thermostatic valves required for complete system.

C. Product Data: Submit rated capacities, weights, specialties and accessories, electrical requirements, wiring diagrams, and control diagrams.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include startup instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements including those furnished but not produced by manufacturer.

F. Manufacturer’s Field Reports: Submit start-up report for each unit. Indicate results of leak test and refrigerant pressure test.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout procedures.

B. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

1.6 QUALITY ASSURANCE

A. Conform to ARI 550/590 code for testing and rating of screw water chillers.

B. Performance Ratings: Coefficient of Performance (COP) and Integrated Part-Load Value (IPLV) not less than prescribed by ASHRAE 90.1.

C. Perform Work in accordance with State of Connecticut standard.

D. Maintain two copies of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements.

B. Accept chillers on site in factory packaging. Inspect for damage.

C. Protect indoor chillers from weather by storing under roof.

1.10 WARRANTY

A. Section 01- Closeout Procedures.

B. Furnish five year manufacturer warranty to for compressors, all other pieces and parts shall be warranted by manufacturer for 18 months including but not limited to evaporator, condenser, complete assembly including materials and labor.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.11 MAINTENANCE SERVICE

A. Section 01- Closeout Procedures.

B. Furnish service and maintenance of chiller for 18 months from Date of Substantial Completion.

C. Examine unit components monthly. Clean, adjust, and lubricate equipment.

D. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's

operating and maintenance data. Use parts produced by manufacturer of original equipment.

E. Perform work without removing units from service during building normal occupied hours.

F. Provide emergency call back service at all hours for this maintenance period.

G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

H. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.12 MAINTENANCE MATERIALS

A. Section 01- Closeout Procedures.

B. Furnish two containers of lubricating oil.

PART 2 PRODUCTS

2.1 PACKAGED WATER CHILLERS

A. Manufacturers:
1. Trane
2. Daikin Applied
3. Carrier

B. Product Description: Factory assembled, single-piece chassis, air-cooled liquid chiller. Contained within the package shall be all factory wiring, piping, controls, and refrigerant charge (HFC-410A).

C. High efficiency/performance: This provides oversized heat exchangers for two purposes: It allows the unit to be more energy efficient, and the unit will have enhanced operation in high ambient conditions.

D. Factory Functional Test: The chiller shall be pressure tested, evacuated and fully charged with refrigerant and oil. In addition, a factory functional test shall be conducted to verify correct operation by cycling condenser fans and compressors and confirming operation of temperature and pressure sensors.

2.2 COMPRESSORS

A. Screw Compressors
1. Provide compressor with automatic capacity reduction equipment consisting of capacity control via variable speed drive and slide valve. Compressor must start unloaded for soft start on motors.

2.3 EVAPORATOR

A. 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.

B. Insulate the evaporator and water boxes with a minimum of 0.75 inch (K=0.28) UV rated insulation. If the insulation is field installed, the additional money to cover material and installation costs in the field should be included in the bid.

C. Evaporator heaters shall be factory installed and shall protect unit down to -20F (-29C). Contractor shall wire separate power to energize heat tape and protect cooler while chiller is disconnected from the main power.

D. 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.

E. Provide ability to remove evaporator tubes from either end of the heat exchanger.

F. Provide water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.

G. 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.

H. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired, at the factory of origin.

2.4 CONDENSER COILS, FANS AND MOTORS

A. Fans shall by dynamically balanced and direct driven.

B. All condenser fans shall have integrated drives to provide variable speed for optimized efficiency.

C. Chiller shall be able to start and operate in ambient conditions down to 14ºF (-10ºC) and up to 115ºF (46ºC).

D. Construct condenser coils of microchannel all aluminum brazed fin construction. The condenser coils shall have an integral sub-cooling circuit and shall be designed for at

least 350 psig working pressure. Leak tested at 1.5 times working pressure. Coils can be cleaned with high pressure water.

2.5 ENCLOSURES/STARTER

A. House components in a galvanized steel frame and mounted on a formed steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.

B. Unit panels, base rails 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.

C. Mount starters and Terminal Blocks in a UL 2014 rated weatherproof panel provided with full opening access doors. If a circuit breaker is chosen, it 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.

D. 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 1000 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.

E. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

2.6 LOW VOLTAGE VARIABLE SPEED DRIVE (VSD), UNIT MOUNTED

A. The water chiller shall be furnished with an air cooled variable speed drive (VSD) as shown on the drawings.

B. The VSD will be specifically designed to interface with the water chiller controls and allow for the operating ranges and specific characteristics of the chiller.

C. The VSD efficiency shall be 97% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.96 at all loads.

D. The VSD shall be solid state, microprocessor based pulse-width modulated (PWM) design. The VSD shall be voltage and current regulated. Output power devices shall be IGBTs.

E. Power semi-conductor and capacitor cooling shall be from a liquid or air cooled heatsink.

F. Warranties
1. The variable speed drive shall be warranted by the manufacturer for a period of twelve months from the date of installation. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory-authorized on-site service.

2.7 REFRIGERANT CIRCUIT

A. All units shall have 2 refrigeration circuits to provide redundancy, each with one or two (manifolded) compressor(s) on each circuit.

B. Provide for refrigerant circuit:
1. Liquid line shutoff valve.
2. Suction service valve
3. Discharge service valve
4. Filter (replaceable core type).
5. Liquid line sight glass.
6. Electronic expansion valve sized for maximum operating pressure.
7. Charging valve.
8. Discharge and oil line check valves.
9. High side pressure relief valve.
10. Full operating charge of R134a and oil.

C. Capacity Modulation: Provide capacity modulation by a variable speed drive. Unit shall be capable or operation down to 15%.

2.8 CONTROLS

A. 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.

B. The unit controller shall utilize the following components to automatically take action to prevent unit shutdown due to abnormal operating conditions which will perform as follows:
1. High pressure switch that is set 20 PSIG lower that factory pressure switch that will automatically unload the compressor to help prevent a high pressure condenser control trip. One switch is required for each compressor and indicating light shall also be provided.
2. Motor surge protector that is set at 95% of compressor RLA that will automatically unload the compressor to help prevent an over current trip. One protector is required for each compressor and indicating light shall also be provided.
3. Low pressure switch that is set at 5 PSIG above the factory low pressure switch that will automatically unload the compressor to help prevent a low evaporator temperature trip. One switch is required for each compressor and indicating light shall also be provided.

C. 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.

D. Provide the following safety controls with indicating lights or diagnostic readouts.
1. Low chilled water temperature protection.
2. High refrigerant pressure.
3. Low oil flow protection.
4. Loss of chilled water flow.
5. Contact for remote emergency shutdown.
6. Motor current overload.
7. Phase reversal/unbalance/single phasing.
8. Over/under voltage.
9. Failure of water temperature sensor used by controller.
10. Compressor status (on or off).

E. Provide the following operating controls:
1. A variable method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. 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.
2. Chilled water pump output relay that closes when the chiller is given a signal to start.
3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.
4. 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.
5. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance trip outs.
6. 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.
7. Low ambient lockout control with adjustable setpoint.
8. Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.

F. 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:
1. Leaving chilled water setpoint adjustment from LCD input
2. Entering and leaving chilled water temperature output
3. Percent RLA output for each compressor

4. Pressure output of condenser
5. Pressure output of evaporator
6. Ambient temperature output
7. Voltage output
8. Current limit setpoint adjustment from LCD input.

G. Digital Communications to BAS system shall consist of a BACnet MS/TP interface via a single twisted pair wiring.

H. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

2.9 CHILLER PERFORMANCE

A. Air Cooled Water Chillers
1. See Schedules

2.10 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Section 26.

B. Motors: In accordance with Section 23 05 13.

C. Disconnect Switch: Factory mount in control panel.

2.11 SOURCE QUALITY CONTROL (AND TESTS)

A. Section 01 - Quality Requirements: Testing, inspection and analysis requirements.

B. Furnish testing and analysis of package chillers.

C. Furnish shop inspection and testing for package chillers.

D. Make completed chillers available for inspection at manufacturer's factory prior to packaging for shipment. Furnish at least seven days notice before packaging is scheduled.

E. Allow witnessing of factory inspections and tests at manufacturers test facility. Furnish at least seven days notice before inspections and tests are scheduled.

2.12 SOUND

A. At full load chiller sound power shall not exceed 102 (dBA) A-weighted. Submitted sound data shall be in accordance with AHRI 370.
1. If manufacturer cannot meet this sound specification then sound attenuation devices and/or barrier walls must be field installed at the contractor expense to meet the specified level.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install packaged outdoor chiller on concrete foundation minimum 6 inches thick and 6 inches wider than equipment base on each side. Refer to Section 03.

B. Install units on vibration isolation. Refer to Section 23 05 48.

C. Install the following piping accessories on evaporator chilled water piping connections. Refer to Section 23 21 16 and Section 23 21 13.
   1. On inlet:
      a. Thermometer well for temperature controller.
      b. Thermometer.
      c. Strainer.
      d. Flow switch.
      e. Flexible pipe connection.
      f. Pressure gage.
      g. Shut-off valve.
   2. On outlet:
      a. Thermometer.
      b. Flexible pipe connection.
      c. Pressure gage.
      d. Shut-off valve.

D. Install auxiliary water piping for oil cooling units and purge condensers.

E. Install the following piping accessories on condenser water piping connections. Refer to Section 23 21 16 and Section 23 21 13.
   1. On inlet:
      a. Thermometer well for temperature limit controller.
      b. Thermometer well and thermometer.
      c. Strainer.
      d. Flow switch.
      e. Flexible pipe connection.
      f. Pressure gage.
      g. Shut-off valve.
   2. On outlet:
      a. Thermometer well and thermometer.
      b. Flexible pipe connection.
      c. Pressure gage.
      d. Shut-off valve.

F. Arrange piping for easy dismantling to permit tube cleaning.

G. Install refrigerant piping connections to air-cooled condensing units. Refer to Section 23 23 00.

H. Install piping from chiller safety relief valve to outdoors. Size as recommended by manufacturer.

I. Install chiller accessories furnished loose for field mounting.

J. Install electrical devices furnished loose for field mounting.

K. Install control wiring between chiller control panel and field mounted control devices.

L. Provide connection to electrical service. Refer to Section 26.

3.2 FIELD QUALITY CONTROL

A. Section 01 - Quality Requirements, 01 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Furnish cooling season start-up, winter season shutdown service, for first year of operation. When initial start-up and testing takes place in winter and machines are to remain inoperative, repeat start-up and testing operation at beginning of first cooling season.

3.3 MANUFACTURER'S FIELD SERVICES

A. Section 01 - Quality Requirements: Manufacturers' field services.

B. Furnish services of factory trained representative for minimum of two days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.

C. Furnish initial charge of refrigerant and oil.

3.4 ADJUSTING

A. Section 01- Closeout Procedures.

B. Provide cooling season start-up, winter season shutdown service, for first year of operation.

3.5 DEMONSTRATION AND TRAINING

A. Section 01- Closeout Procedures.

B. Demonstrate system operations and verify specified performance..

C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of unit. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.6 COMMISSIONING

A. Engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Division 01 Commissioning Requirements.

B. Verify that equipment is installed and commissioned as per requirements of Division 01 Commissioning Requirements and manufacturer's written instructions.

C. Complete installation and startup checks and functional tests according to Division 01 Commissioning Requirements and manufacturer's written instructions.

D. Operational Test: After electrical and control systems have been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the start up procedure.

E. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

F. Verify that equipment is installed and commissioned as per requirements of Section 01 19 13 and manufacturer's written instructions.

G. Complete installation and startup checks and functional tests according to Section 01 91 13 and manufacturer's written instructions.

END OF SECTION 236411

SECTION 23 7223 - PACKAGED AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Energy recovery units.

B. Casing.

C. Fans.

D. Total energy core.

E. Filters.

F. Vibration isolation.

G. Power and controls.

H. Accessories.

I. Service accessories.

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements

B. Division 07 - Thermal and Moisture Protection.

C. Division 09 - Finishes.

D. Section 23 0400 - General Requirements for Mechanical Trades.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.

B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.

C. AHRI 1060 I-P - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.

D. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

E. ASHRAE Std 84 - Method of Testing Air to Air Heat/Energy Exchangers.

F. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

G. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

J. NFPA 70 - National Electrical Code.

K. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

L. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

M. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. See Division 01 - General Requirements.

B. Product Data: Manufacturer's installation instruction, product data, and engineering calculations.

C. Shop Drawings: Show design and assembly of energy recovery unit and installation and connection details.

D. Samples: Submit sample showing custom paint colors.

E. Manufacturer's Qualification Statement.

F. Closeout Submittals: Submit manufacturer's operation and maintenance instructions.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 01 - General Requirements.
2. Spare Parts: One of each kind of filter.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Firm regularly engaged in manufacturing energy recovery units.
2. Manufactured and assembled in the United States of America.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in manufacturer's unopened packaging.

B. Store products to be installed indoors in dry, heated area.

1.7 WARRANTY

A. See Division 01 - General Requirements.

B. Warranty ventilator to be free from defects in material and workmanship and of all parts for period of 1-1/2 years from date of Substantial Completion.

C. Warranty energy recovery core to be free from defects in material and workmanship for 3 years under circumstances of normal use.

D. Warranty motor to be free from defects in material and workmanship for 7 years under circumstances of normal use.

E. Warranty dessicant core to be free from defects in material and workmanship for 5 years under circumstances of normal use.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Energy Recovery Ventilators:
1. Oxygen8 A16
2. Greenheck ERV MiniCore
3. RenewAire HE series
4. Substitutions: See Division 01 – General Requirements.

2.2 MINIMUM PERFORMANCE

1. Total Recovery Efficiency: 50 percent, at 95 degrees F (35 degrees C).
2. Apparent Sensible Effectiveness: 75 percent, at 32 degrees F (0 degrees C).
3. Draw through fan arrangement on both sides of the wheel.

2.3 ENERGY RECOVERY UNITS

A. Energy Recovery Units: Dessicant core type; prefabricated packaged system designed by manufacturer.
1. Access: Hinged and/or screwed access panels on front.
2. Lifting holes at the unit base.
3. Framing: Welded extruded aluminum tubular frame capable of supporting components and casings.
4. Permanent name plate listing manufacturer mounted inside door near electrical panel.

2.4 CASING

A. Wall, Floor, and Roof Panels:
1. Panels: Removable.
2. Construction: 1 inch thick, double wall box construction, with formed edges of exterior wall overlapping formed edges of interior wall.
3. Aluminum is standard. Factory-painted aluminized steel is an economic alternative when the higher corrosion resistance of aluminum is not required.
4. Exterior Wall: Galvanized steel sheet.
   a. 20 gage, 0.0359 inch galvanized steel.
   b. 0.040 inch thick aluminum.
   c. Color: Gray.

5. Interior Wall: Galvanized sheet metal.
   a. 20 gage, 0.0359 inch aluminized steel.
   b. 22 gage, 0.0299 inch galvanized sheet metal.
6. Insulation:
   a. 1/2 inc insulated fiberglass.
   b. Panel Cores: Mineral wool board.
   c. Include antimicrobial protection.
   d. Mold Resistance: "Pass" when tested according to ASTM C1338.
   e. Fungal Resistance: No growth when tested according to ASTM G21.
   f. Bacteria Resistance: No growth when tested according to UL 181.
   g. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.
   h. Smoke Developed Index (SDI): 50, maximum, when tested in accordance with ASTM E84 or UL 723.
   i. Secure insulation to unit with waterproof adhesive and permanent mechanical fasteners.
7. Roof Panel: Weatherproof.
8. Panel Joints: T-shaped standing seams with overlapping metal caps.
9. Fasteners: Stainless steel.
10. Isolation and Seal: Form continuous, thermally isolated, weather tight seal between inner wall of panels and structural framing with closed cell PVC foam gasketing.
11. Seams: Sealed, requiring no caulking at job site.
12. Coating: Polyurethane enamel.

B. Access Panels: Provide access to components through a large, tightly sealed and easily removable panel.

C. Doors:
1. Construct doors of same construction and thickness as wall panels.
2. Height: 80 inches or full height of unit.
3. Hardware:
   a. Hinges: Aluminum.
   b. Corrosion-resistant.
   c. Provide exterior handle and interior 3-point latching device.
   d. Prop Rod: Capable of propping doors in open position.
   e. Wind Restraint: Door chain with spring to absorb force of door swinging open.
   f. Gasket: P-shaped extruded neoprene.
   g. Label each door to identify equipment located within.

D. Trim: 0.08 inches aluminum, continuously welded.

E. Install panels on structural framing with self-tapping stainless steel screws with integral neoprene-backed stainless steel washers.

F. Duct Connection Collars: 0.08 inches (2 mm) aluminum, continuously welded.

2.5 FANS

A. Provide separate fans for exhaust and supply blowers.

B. Fans:
1. Individually driven with a dedicated motor.
2. Backward inclined.
3. Single width, single inlet.
4. Class 1 aluminum wheels.
5. AMCA-rated.
6. Provide with non-overloading characteristics.
7. Provide non-sparking integral spun steel venturi inlet cones.

C. Bearings:
1. Pillow block.
2. Bearings: Permanently lubricated sealed ball bearings.
3. Rated for not less than 200,000 hours of operation with accessible greased fittings.

D. Housings: 12 gage, 0.1046 inch aluminized steel with plenums integral to general housing and constructed to Class 1 fan standards.

E. Motors:
1. Motors: Open drip proof.
2. Efficiency: High.
3. Speed: Single.
4. Control: Constant Speed.
5. Motor Slide Bases: Removable and adjustable.
6. Fan Motor: Thermal overload protected.
7. Fan Motor: UL listed and labeled.

F. Drives:
1. Fans: Direct Drive.
2. Service Factor: 1.2 (capable).

2.6 TOTAL ENERGY CORE

A. Core: Transfer heat and humidity from one air stream to the other with minimum carryover of the exhaust air into the supply air stream.

B. Bypass around Energy Core for freeze protection is not allowed.

C. Energy Core Media: Cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery.

D. Core Effectiveness: Rated in accordance with ASHRAE Std 84 and AHRI 1060 I-P.

E. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.

F. Smoke Developed Index (SDI): 50 or less, when tested in accordance with ASTM E84 or UL 723.

G. Energy Recovery Core Media Face:
1. Conform to NFPA 90A.

2. Coating: Acid resistant coating.

H. Coat all corrugated surfaces with a thin non-migrating absorbent layer.

I. Core Cassette: Easily removable from the unit.

J. Desiccant:
1. Type: 3A.
2. Performance:
a. Desiccant: Non-dissolving, permanent, and resistant to damage from compressed air, low temperature steam, hot water or by vacuum cleaning.
3. Ventilation Factor: 1.00.

2.7 FILTERS

A. Final Filter on Fresh Air Stream: 13 MERV.

B. Return and Fresh Air Streams: MERV 8 filters constructed to meet ASHRAE Std 52.2.

C. Filter Removal Hooks: Provide means to remove filters that are not immediately accessible from exterior of unit

D. Provide spare set of filters.

2.8 POWER AND CONTROLS

A. Motor Control Panels: UL listed.

B. Include necessary motor starters, fuses, transformers and overload protection according to NFPA 70.

C. Provide single-point field connection to power supply.

D. Provide non fused main disconnect integral to control panel.

E. Install wiring in accordance with NFPA 70.

F. Wiring: Enclosed in flexible, liquid tight steel conduit.

2.9 ACCESSORIES

A. Airflow Monitor:
1. Include integral airflow monitoring station with ability to read both ventilation and exhaust airflow expressed in cu ft/min.
2. Mount monitor gage on unit exterior and make casing connection watertight.

B. DX Heat Pump Evaporator Coil:
1. Constructed of copper tubes expanded onto aluminum fins. Factory leak tested under water. Removable, PVC construction, double-sloped drain pan with piping connections on both sides.

2. Refrigeration System: Single refrigeration circuit controlled by externally installed thermal expansion valve kit provided by VRF system manufacturer.

2.10 SERVICE ACCESSORIES

A. Switch: 2 type.
1. Two Position Type: Service and operate.

B. Electrical Components: Factory wired for single point power connection.
1. 60 Hz power connection.
2. Isolate electrical box from the airflow.
3. Protect all integral wires and connections.
4. Electrical Components: UL Listed.
5. Electrical Panel: NEMA 3R mounted on the unit exterior for ease of access.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that structure is ready for installation of unit, that openings in deck for ductwork, if required, are correctly sized and located, and that mechanical and electrical utilities supplying unit are of correct capacities and are accessible.

3.2 INSTALLATION

A. Provide openings for suitable ductwork connection.

3.3 SYSTEM STARTUP

A. Provide services of manufacturer's authorized representative to provide start up of unit.

3.4 CLEANING

A. Clean filters, air plenums, interior and exposed-to-view surfaces prior to Substantial Completion.

B. See Division 01 - General Requirements.

END OF SECTION

SECTION 238127 – VARIABLE REFRIGERANT VOLUME SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes Inverter-based R-410A Mini-Split A. C. & Heat Pump Systems (Indoor Direct Expansion Fan Coil Units and Outdoor Air-cooled Condensing Units) with engineered piping/wiring for Variable Refrigerant Volume/Flow.
   1. System design includes All Heat-only or All Cool-only Operation.
   2. System design includes simultaneous Heat & Cool Operation (Heat Recovery).

B. Consideration of Alternate Manufacturers: For non-listed, but established manufacturers of Variable Refrigerant Volume/Flow Mini-split systems, provide the following documentation a minimum of ten (10) working days prior to the published bid date, in order to be properly evaluated by the engineering design team:
   1. Name of proposed manufacturer and company information/profile.
   2. Name of proposed support organization (representative, distributor, etc.)
   3. Product & Performance data (capacities, efficiencies, physical dimensions, acoustic ratings, etc.) of equipment proposed in the Variable Refrigerant Volume/Flow System:
      a. Indoor Fan Coils.
      b. Outdoor Condensing Units.
      c. Controls.
      d. Accessories.
      e. Pipe Sizing Layout.
      f. Electrical Wiring Sizing/Layout.
   4. Location of nearest full-technical-service organization with full training on the proposed Variable Refrigerant Volume/Flow Mini-split System.
   5. Disclosure of all known design, specification, installation and operational differences of proposed system from basis-of-design system.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
   2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
   3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
   4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
   2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASTM International:

1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

D. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

A. Product Data: For each mini-split system, include documentation for rated capacities, operating characteristics, acoustic performance, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Piping Diagrams: Manufacturer to layout and size Refrigerant piping between each component of system. Provide sizing diagrams for review prior to installation by factory-trained refrigerant piping technicians.

C. Wiring Diagrams: Manufacturer to layout and size power, signal & control wiring between each component of system. Provide sizing diagrams for review prior to installation by factory-trained refrigerant piping technicians/electrical contractor.

D. Piping Layouts: Provide Floor Plan layout of complete system including but not limited to location of all indoor units, branch boxes, piping, condensing units, etc.

E. Startup Personnel Certification: Provide evidence of factory training of each Refrigeration Technician scheduled to be utilized in installation/startup/commissioning of variable refrigerant volume mini-split systems.

F. Operation and Maintenance Data: For Mini-split system to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of mini-split systems and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

D. Performance Ratings: Certify published performance of Mini-split A. C. & Heat Pump units according to ARI Standard 210/240 covering Unitary Heat Pumps.

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

F. Fabricate and install refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."

1.5 QUALITY ASSURANCE

A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.

B. Cooling Capacity: Rate in accordance with ARI 210/240.

C. Sound Rating: Measure in accordance with ARI 270.

D. Insulation and adhesives: Meet requirements of NFPA 90A.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate installation of condensing units with concrete pad or roof structure.

C. Coordinate installation of air handling units with building structure.

D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

E. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

F. Coordinate location of piping and electrical rough-ins.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Unit warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of mini-split equipment that fails in materials or workmanship. Submit a written warranty signed by the mini-split system manufacturer and installer agreeing to furnish labor and parts for failures within a warranty period of one (1) year from the date of substantial completion/documented Start-up.

C. Compressor warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace compressor(s) that fail in materials or workmanship. Submit a written warranty signed by the mini-split system manufacturer and installer agreeing to furnish parts-only for compressor failures within a warranty period of five (5) years from the date of substantial completion.

D. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

PART 2 PRODUCTS

2.1 DUCTLESS SPLIT COOLING SYSTEM (1 outdoor units and 1 indoor units)

A. Manufacturers:
   1. Trane.
   2. Other acceptable manufacturers offering similar products include:
      a. Mitsubishi.
      b. Daikin.
      c. Substitutions: Not Acceptable

B. Provide piping in accessories for a complete and operational system from specification below.

2.2 REFRIGERANT MULTI-ZONE HEAT PUMP SYSTEMS (“VRV/VRF” System)

A. Manufacturers:
1. Trane.
2. Other acceptable manufacturers offering similar products include:
a. Mitsubishi.
b. Daikin.
c. Substitutions: Not Acceptable

2.3 GENERAL

A. The intent of the basis of design is for the VRV manufacturer is to provide return air sensors integral to the indoor VRV air handling unit, the VRV manufacturer is not intended to supply wall mount zone controllers/temperature sensors. As basis of design ATC is responsible to provide wall mount temperature sensors shown on plan which will not only control fin tube radiation valves but also provide room temperature readings which will be used to control VRV air handlers as stated in 230993. VRV Air Handlers are to be indexed into fan mode, heat mode, cool mode and off by the BMS, VRV Manufacturer zone sensors are not to be supplied as basis of design. If alternate VRV manufacturer is submitted ATC contractor, VRV manufacturer and Mechanical contractor are to provide all parts and accessories for a complete and operational system to operate as described below, if alternate sensors are required by deviating from basis of design ATC is to provide installation and communication wiring for these devices. The BMS shall control the individual VRV Air Handler units as follows.

2.4 REFRIGERANT MULTI-ZONE HEAT PUMP OUTDOOR UNITS

A. The unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.

B. The casing shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

C. The unit shall be equipped with multiple circuit boards that interface to the internal controls system and shall perform all functions necessary for operation.

D. The unit shall be run tested at the factory.

E. The unit shall have an accumulator with refrigerant level sensors and controls.

F. The unit shall be capable of operating in heating down to -4°F ambient temperature without additional low ambient controls.

G. The unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

H. Fan: The unit shall be furnished with one direct drive, variable speed propeller type fan. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed. The fan motor shall be mounted for quiet operation. The

fan shall be provided with a raised guard to prevent contact with moving parts. The unit shall have vertical discharge airflow.

I. Refrigerant: R-410A.

J. Coil: The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing. The coil shall be protected with an integral metal guard. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

K. Compressor: The compressor shall be a high performance, inverter driven, modulating capacity scroll compressor. A crankcase heater shall be factory mounted on the compressor. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable down to 16% of rated capacity. The compressor will be equipped with an internal thermal overload. The compressor shall be mounted to avoid the transmission of vibration.

L. Electrical: The outdoor unit shall be controlled by integral microprocessors. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 12VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system..

2.5 REFRIGERANT MULTI-ZONE HEAT PUMP CONTROLLERS

A. Cabinet: The casing shall be fabricated of galvanized steel. The cabinet shall house a liquid-gas separator and multiple refrigeration control valves. The unit shall house two tube-in-tube heat exchangers.

B. Refrigerant Valves: The unit shall be furnished with multiple two position refrigerant valves. Each circuit shall have one (54,000 Btu/h or smaller indoor unit section) two-position liquid line valve and a two-position suction line valve. When connecting a 54,000 Btu/h or larger indoor unit section, two branch circuits shall be joined together at the branch controller to deliver an appropriate amount of refrigerant. The two refrigerant valves shall operate simultaneously. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

C. Electrical: The Controller shall be controlled by integral microprocessors.

2.6 Ceiling Mounted 4-Way Cassette

A. General: The unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Cabinet: The cabinet shall be space-saving ceiling-recessed cassette. The cabinet panel shall have provisions for a field installed filtered outside air intake. Branch ducting shall

be allowed from cabinet. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space

C. Fan: The indoor fan shall be an assembly with one inline-flow fan(s) direct driven by a single motor. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings. The unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.

D. Filter: Return air shall be filtered by means of an easily removable, washable filter.

E. Coil: The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. Both refrigerant lines to the indoor units shall be insulated.

F. Controls: As required to perform functions necessary 230993.

2.7 Wall Mounted Refrigerant Multi-Zone Air Handler

A. General: The unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Cabinet: The casing shall have a white finish. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard. There shall be a separate back plate which secures the unit firmly to the wall.

C. Fan: The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

D. Filter: Return air shall be filtered by means of an easily removable, washable filter.

E. Coil: The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. Both refrigerant lines to the indoor units shall be insulated.

F. Controls: As required to perform functions necessary 230993.

2.8 HORIZONTAL REFRIGERANT MULTI-ZONE AIR HANDLER

A. General: The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Fan: The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of four (4) speeds, High, Mid1, Mid2, and Low, 2 of which are selectable on the room controller. The indoor unit shall have a ducted air outlet system and ducted return air system.

C. Filter: Return air filter shall be provided, refer to schedules for location(duct or in return filter grille).

D. Coil: The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. Both refrigerant lines to the indoor units shall be insulated.

E. Controls: As required to perform functions necessary 230993.

2.9 REFRIGERANT MULTI-ZONE HEAT PUMP CONTROLS

A. General: Controls shall consist of remote controllers, timers, and integrated system software communicating over a high-speed communication bus with interconnection and control via bacnet gateway. The controls shall support operation monitoring, scheduling, personal browsers, maintenance support, and integration with the Building Management Systems (BMS).

B. The room temperature sensors/thermostats shall be the same as the Building Management System room temperature sensors/thermostats; factory provided thermostats shall not be used.

C. Wiring: Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the controller and outdoor unit. Control wiring shall run from the indoor unit terminal block to the controller associated with that unit. Wiring shall be 2-conductor 16 AWG or 18 AWG stranded wire with a shield, and shall be in accordance to Division 16.

D. BACnet Gateway: The gateway shall provide open protocol communication between VRV system and building automation system installed under this project.

2.10 REFRIGERANT PIPING AND SPECIALTIES PIPING

A. Copper Tubing: ASTM B280, Type ACR hard drawn or annealed.

1. Fittings: ASME B16.22 wrought copper.
2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F (640 to 805 degrees C).

B. Copper Tubing to 7/8 inch OD: ASTM B88, Type K, annealed.
1. Fittings: ASME B16.26 cast copper.
2. Joints: Flared.

C. Pipe Supports and Anchors:
1. Conform to ASME B31.5, ASTM F708.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
10. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
11. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
12. Roof supports shall be Proof Products and Systems Corporation or approved equal. Supports shall include equipment rail of suitable length, steel slide chanel with mounting brackets, pipe roller assembly with continuous gavanized threaded rods. Supports shall be furnished under this division and installed under architectural sections.

2.11 REFRIGERANT

A. Refrigerant: 410A

2.12 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:
1. Henry Valve or approved equal.

B. Indicators: Double port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum working pressure of 500 psig, and maximum temperature of 200 degrees F.

2.13 VALVES

A. Diaphragm Packless Valves:

1. Manufacturers:
   a. Henry Valve or approved equal.
2. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psig and maximum temperature of 275 degrees F.

B. Packed Angle Valves:
1. Manufacturers:
   a. Henry Valve or approved equal.
2. Forged brass, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psig and maximum temperature of 275 degrees F.

C. Ball Valves:
1. Manufacturers:
   a. Henry Valve or approved equal.
2. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psig and maximum temperature of 325 degrees F.

D. Service Valves:
1. Manufacturers:
   a. Henry Valve or approved equal.
2. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psig.

2.14 STRAINERS

A. Straight Line or Angle Line Type:
1. Manufacturers:
   a. Henry Valve or approved equal.
2. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psig.

B. Straight Line, Non-Cleanable Type:
3. Manufacturers:
   a. Henry Valve or approved equal.
4. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of 430 psig.

2.15 CHECK VALVES

A. Globe Type:
1. Manufacturers:
   a. Henry Valve or approved equal.
2. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc;

for maximum working pressure of 500 psig and maximum temperature of 300 degrees F.

B. Straight Through Type:
1. Manufacturers:
a. Henry Valve or approved equal.
2. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psig and maximum temperature of 250 degrees F.

2.16 FILTER-DRIERS

A. Replaceable Cartridge Angle Type:
1. Manufacturers:
a. Henry Valve or approved equal.
2. Shell: ARI 710, UL listed, brass, steel, removable cap, for maximum working pressure of 500 psig.
3. Filter Cartridge: Pleated media with integral end rings, stainless steel support.
4. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina.
5. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets.

B. Permanent Straight Through Type:
1. Manufacturers:
a. Henry Valve or approved equal.
2. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 500 psig.

2.17 SOLENOID VALVES

A. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, integral strainer, with flared, solder or threaded ends; for maximum working pressure of 500 psig. Stem stall permit manual operation in case of coil failure.

B. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

C. Electrical Characteristics: 120 volts, single phase, 60 Hz.

1.2 RECEIVERS

D. Internal Diameter 6 inch and Smaller:
1. ARI 495, UL listed, steel, brazed; 400 psig maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

E. Internal Diameter Over 6 inch:

1. ARI 495, welded steel, tested and stamped in accordance with ASME SEC 8D; 400 psig with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.18 FLEXIBLE CONNECTORS

A. Corrugated stainless steel bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 500 psig.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Install roof-mounting units on equipment supports specified in Division 7.

C. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.2 CONNECTIONS

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

B. Provide service valves (as per section 2.13-D above) at both pipes (Suction and Hot Gas) at every unit so individual VRV unit can be removed from service for repair without affecting operation of the remaining units/ associated system.

C. Install piping adjacent to machine to allow service and maintenance.

D. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping."

E. Connect Power and Controls wiring according to manufacturer’s documented instructions and Division 26 specification means and methods.

3.3 STARTUP SERVICE

A. Perform Startup of Inverter-based R-410A Variable Refrigerant Volume/Flow mini-split systems using only manufacturer-trained refrigeration technicians.

B. Complete installation and startup checks according to manufacturer's written instructions.

C. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain Variable Refrigerant Volume/Flow mini-split systems.

B. Demonstrate operation and maintenance procedures.

C. Furnish services for manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of boilers. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer prior to training date.

END OF SECTION 238137

SECTION 238200 - CONVECTION HEATING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Finned tube radiation.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
3. Section 23 07 00 - HVAC Insulation: Execution requirements for insulation specified by this section.
4. Section 01 91 13 - Commissioning
5. Section 23 21 13 - Hydronic Piping: Execution requirements for connection of chilled water, hot water, and drain piping to units specified by this section.
6. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
7. Section 23 23 00 - Refrigerant Piping: Execution requirements for connection of refrigerant piping to units specified by this section.
8. Section 23 31 00 - HVAC Ducts and Casings: Execution requirements for ducts specified by this section.
9. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connection to units specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

B. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers.

C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.

D. Samples: Submit one sample of each radiation cabinet detailed.

E. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access to valves.

C. Operation and Maintenance Data: Submit manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of Connecticut standard.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept units on site in factory packing. Inspect for damage. Store under roof.

C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer’s warranty for unit heater, cabinet unit heater and unit ventilator motors.

C. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

1.11 EXTRA MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two sets of filters.

PART 2 PRODUCTS

2.1 FINNED TUBE RADIATION

A. Manufacturers:
1. Rittling
2. Other acceptable manufacturers offering equivalent products include:
a. Vulcan
b. Sterling

B. Heating Elements: Refer to Plans

C. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

D. Enclosures: Minimum 18 gage steel, with removable tamper-proof front panel, end panels, end caps, corners, and joiner pieces. Support rigidly, on wall or floor mounted brackets at least 3 feet on center maximum.

E. Finish: Factory applied baked finish, color selected by architect.

F. Damper: Where heating media is not thermostatically controlled, furnish knob-operated internal damper at enclosure air outlet.

G. Access Doors: For otherwise inaccessible valves, furnish factory-made permanently hinged access doors, 6 x 7 inch minimum size, integral with cabinet.

H. Capacity: As shown on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. For recessed units, verify recess dimensions are correct size.

C. Verify wall construction is ready for installation.

D. Verify ductwork is ready for installation.

E. Verify concealed blocking and supports are in place and connections are correctly located.

3.2 INSTALLATION

A. Install air coils in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible. Refer to Section 23 31 00.

B. Support air coil sections independent of piping on steel channel or double angle frames and secure to casings. Furnish frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Install with airtight seal between coil and duct or casing.

C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

D. Make connections to coils with unions and flanges.

E. On water coils locate water supply at bottom of supply header and return water connection at top. Install water coils to be drainable and install drain connection at low points. Refer to Section 23 21 13.

F. On water and glycol heating coils, and chilled water cooling coils, connect water supply piping to leaving airside of coil (counter flow arrangement). Refer to Section 23 21 13.

G. For cooling coils where air velocity exceeds 550 ft/min, install three break moisture eliminators of 24 gage galvanized steel.

H. Install insulation air coil casings. Refer to Section 23 07 00.

I. Install drain pan and drain piping connection for cooling coils. Fabricate drain pan from 20 gage galvanized steel. Extend 3 inches from face of coil entering air side, 6 inches from face of coil leaving air side. Pipe drain pans individually to floor drain with water seal trap. Refer to Section 23 21 13.

J. Insulate headers located outside airflow, insulate as specified for piping. Refer to Section 23 07 00.

K. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.

L. Protection: Install finished cabinet units with protective covers during remainder of construction.

M. Finned Tube Radiation: Locate on outside walls and run cover wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Install wall angles where units butt against walls.

N. Hydronic Units: Install with required accessories. All accessories shall be installed in accordance with drawing details. Refer to Section 23 21 13.

O. Units with Cooling Coils: Install drain piping to condensate drain. Refer to Section 23 21 13.

3.3 CLEANING

A. Division 01 – Closeout Procedures.

B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

D. Install new filters.

3.4 DEMONSTRATION

A. Demonstrate unit operation and maintenance.

B. Furnish services for manufacturer's technical representative for a 4 hour period to instruct Owner's personnel in operation and maintenance of boilers. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer prior to training date.

3.5 COMMISSIONING

A. Verify that equipment is installed and commissioned as per requirements of Section 01 91 13 and manufacturer's written instructions.

B. Complete installation and startup checks and functional tests according to Section 01 91 13 and manufacturer's written instructions.

END OF SECTION 238200

SECTION 238223 – UNIT VENTILATORS

PART 1 GENERAL

1.01 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Outside air intake box and louver.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Air Filters: Section 234100.

B. Wiring for Motors and Controllers: Section 260523.

C. Motors and Motor Controllers: Section 260221.

1.03 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for each unit ventilator.

B. Contract Closeout Submittals:
1. Operation and Maintenance Data: Deliver electronic copy, covering the installed products, to the Owner.

1.04 MAINTENANCE

A. Extra Material: Furnish 2 spare sets of filters for each unit ventilator. Box and label spare filters. Store at the site where directed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Galvanized Sheet Steel: Zinc coated carbon steel, commercial quality, ASTM A 653, coating designation G90.

B. Cold Rolled Steel: Carbon steel, commercial quality - ASTM A 366. Degrease, clean and phosphatize sheet steel in the factory of the unit manufacturer or use mill phosphatized.

2.02 UNIT VENTILATORS

A. General: Provide combination heating-cooling- ventilating units complete with an outlet air intake box. Furnish units complete with return and outlet air grilles, dampers and required duct connections.

B. Unit Casing: Fabricate casing from No. 14 gage sheet steel, formed, reinforced and braced for rigidity, with removable ends and front panel to allow access for installation and servicing. Provide fixed discharge air grilles integral with the casing and removable air grilles for access to filters. In addition, provide openings in the bottom and knockouts where required for piping and electrical connections. Provide security type heads (Allen head wrench type or equivalent as approved) on all exposed cabinet fasteners and leveling legs under both ends of the unit.

C. Fan Assembly:
1. Fan Board Assembly: Provide assembly of the blow through design, complete with multiple centrifugal fans with steel or non-ferrous wheels and acoustically treated fan scrolls, mounted on a solid steel shaft supported on lubricated type bearing assemblies, Vee belt connected to an electric motor located outside the air stream. Mount fan and shaft assembly on a formed No. 12 gage sheet steel fan board. Provide isolation devices between fan board and unit casing.
2. Electric Motor: Provide constant speed capacitor type motor with built-in thermal overload protection. Provide isolation devices between motor and support.

D. Coil: Provide heating and cooling coils of the plate fin type, designed for a working pressure of 200 psig and a 300 psig air pressure test underwater. Pitch coils at a minimum 30 degrees angle from the vertical to insure proper drainage of condensate from coil surface to drain pan. Provide minimum No. 18 gage galvanized steel drain pans, insulated on the inside surfaces with a corrosion resistant material and pitched for complete drainage to a drain opening. Provide an auxiliary drain pan under valving.

E. Filter Section: Provide a built-in filter frame installed in front of unit, allowing easy removal of disposable type filters without removal of front panel.

F. Dampers: Provide factory installed dual blade mixing dampers, with a continuous divider plate between the blades, to positively separate the fresh air compartment from the return air. In addition, provide tight sealing by-pass dampers.

G. Outside Air Intake Box: Furnish each unit complete with a louvered fresh air intake box, unless otherwise indicated. Fabricate from sheet steel, formed, reinforced and braced for rigidity, complete with a built-in birdscreen. Factory coat all surfaces of aluminum boxes in contact with masonry with a corrosion resistant material. Provide steel boxes with a factory applied baked enamel finish, of color as directed.

H. Factory Finish: Furnish all exposed surfaces of units with a factory applied two coat baked enamel finish, unless otherwise indicated. Select colors from the unit manufacturer’s standard color charts.

I. Accessories: Provide accessories as noted on the drawings, the products of the same manufacturer as the ventilators. Furnish accessories fabricated of the same materials and with a finish to match the ventilators.

PART 3 EXECUTION

3.01 INSTALLATION

A. Floor Mounted Units: Install, level and align units as required by the particular installation.

B. Air Intake Box: Deliver wall boxes to others for installation. Coordinate with installer in locating and sizing all openings. Provide complete detailed dimensional data to installer.

C. Accessories: Install accessories of type, quantity and in location indicated on drawing.

3.02 CONTROL

A. Provide with BACnet card for interface to Building Management System. Refer to Section 23 0993 for sequence of operation.

END OF SECTION

SECTION 23 8300 – RADIANT HEATING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Radiant heating hydronic piping.

1.2 RELATED REQUIREMENTS

A. Division 03 - Concrete.

B. Division 07 - Thermal and Moisture Protection

C. Division 08 - Openings.

D. Division 09 – Finishes.

E. Section 23 0716 - HVAC Equipment Insulation.

F. Section 23 0719 - HVAC Piping Insulation.

G. Section 23 0913 - Instrumentation and Control Devices for HVAC.

H. Section 23 0993 - Sequence of Operations for HVAC Controls.

I. Section 23 2113 - Hydronic Piping.

J. Section 23 2114 - Hydronic Specialties.

K. Section 26 0534 - Conduit.

L. Section 26 0537 - Boxes.

M. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections. Installation of room thermostats. Electrical supply to units.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

A. ASTM B75 - Standard Specification for Seamless Copper Tube.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

C. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.

D. ASTM F1281 - Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe.

E. ASTM F1807 - Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-Linked (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing.

F. ASTM F1974 - Standard Specification for Metal Insert Fittings for Polyethylene/Aluminum/ Polyethylene and Crosslinked Polyethylene/Aluminum/ Crosslinked Polyethylene Composite Pressure Pipe.

G. DIN EN 4726 - Warm Water Surface Heating Systems and Radiator Connecting Systems - Plastics Piping Systems and Multilayer Piping Systems.

H. NFPA 70 - National Electrical Code.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

A. See Division 01 - General Requirements.

B. Product Data: Provide data for Hydronic radiant units.

C. Shop Drawings: Indicate piping layout, electrical terminations, thermostats, controls, branch circuit connections._____.

D. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.

E. Field Quality Control Submittals: Indicate test reports, inspection reports, and pressure test reports.

F. Project Record Documents: Record actual locations of radiant tubing.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, installation instructions, maintenance and repair data, and parts listings.

H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

I. Maintenance Data:
1. Include repair methods and parts list of components.
2. See Division 01 - General Requirements.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7 WARRANTY

A. See Division 01 - General Requirements.

PART 2 PRODUCTS

2.1 RADIANT-HEATING HYDRONIC PIPING

A. Applications:
1. Provide the following types of hydronic, radiant heating piping for the applications described:
a. Piping in Exterior Concrete: EPDM.

B. EPDM Pipe and Fittings:
1. Manufacturers:
a. Watts Radiant Inc, a Watts Water Technologies Company
b. Viega.
c. Substitutions: See Division 01 - General Requirements and 23 04 00 General Conditions for Mechanical Trades.
2. Pipe Material: Crosslinked EPDM inner and outer tubes.
3. Wall Thickness: Minimum 1/8 inch.
4. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.0000436996 grains per cu ft/day at 104 degrees F according to DIN 4726.
5. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.
6. Fittings: ASTM F1807, copper with stainless-steel crimps or clamps.
7. Pressure/Temperature Rating: Minimum 100 psig and 210 degrees F .

C. Distribution Manifolds (Manufacturer's Standard):
1. Manifold: Minimum 1 inch, brass, copper, or stainless steel.
2. Main Shutoff Valves:
a. Factory installed on supply and return connections.
b. Two-piece brass, bronze body.
c. Ball: Chrome-plated bronze.
d. Seals: PTFE.
e. CWP Rating: 150 psig.
f. Maximum Operating Temperature: 225 degrees F .
3. Manual Air Vents:
a. Body to consist of bronze, or brass.

b. Internal Parts: Nonferrous.
c. Operator: Key furnished with valve or screwdriver bit.
d. Inlet Connection: 1/2 inch .
e. Discharge Connection: 1/8 inch .
f. CWP Rating: 150 psig .
g. Maximum Operating Temperature: 225 degrees F .

4. Balancing Valves:
   a. Body: Provide plastic, bronze plug, globe cartridge type.
   b. Plug: EPDM.
   c. Globe Cartridge and Washer: Brass with EPDM composition washer.
   d. Seat: PTFE.
   e. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
   f. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
   g. Handle Style: Knob, with memory stop to retain set position if used for shutoff.
   h. CWP Rating: Minimum 125 psig.
   i. Maximum Operating Temperature: 250 degrees F .
5. Zone Control Valves:
   a. Body: Provide brass, bronze plug, globe cartridge type.
   b. Plug: EPDM.
   c. Globe Cartridge and Washer: Brass with EPDM composition washer.
   d. Seat: PTFE.
   e. Actuator: Replaceable electric motor.
   f. CWP Rating: Minimum 125 psig.
   g. Maximum Operating Temperature: 250 degrees F .
6. Thermometers:
   a. Mounted on supply and return connections.
   b. Case: Dry type, metal or plastic, 2 inch diameter.
   c. Element: Bi-metallic coil.
   d. Movement: Mechanical, connecting element and pointer.
   e. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
   f. Pointer: Black metal.
   g. Window: Plastic.
   h. Connector: Rigid, back type.
   i. Thermal System: Bi-metallic coil.
   j. Accuracy: Plus or minus 1 percent of range, 1 scale division, to maximum of 1.5 percent of range.
7. Mounting Brackets: Provide copper, plastic, rubber-clad steel, where in contact with manifold.

D. Piping Specialties (Manufacturer's Standard):
1. Cable Ties:
   a. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
   b. Minimum Width: 1/8 inch.
   c. Minimum Tensile Strength: 20 lb .
   d. Temperature Range: Minus 40 degrees F to plus 185 degrees F .
2. Floor Mounting Staples:

a. Steel, with corrosion-resistant coating and smooth finish without sharp edges.
b. Minimum Thickness: 3/32 inch .
c. Width: Minimum, wider than tubing.

3. Floor Mounting Clamps:
   a. Two bolts, steel, with corrosion-resistant coating and smooth finish without sharp edges.
   b. Minimum Thickness: 3/32 inch .
   c. Width: Minimum, wider than tubing.
4. Floor Mounting Tracks:
   a. Aluminum or plastic channel track with smooth finish and no sharp edges.
   b. Minimum Thickness: 1/16 inch.
   c. Slot Width: Snap fit to hold tubing.
   d. Slot Spacing: 2 inch intervals.
5. Heat-Emission Plates:
   a. Formed aluminum suitable for radiant-heating piping.
   b. Minimum Thickness: 1/16 inch.
   c. Slot Width: Snap fit to maintain pressure fit on tubing.

E. Prepackaged Pumping Station:
1. Manufacturers:
   a. IPEX Inc.
   b. Oventrop Corporation
   c. Slantfin Corporation.
   d. Substitutions: See Division 01 - General Requirements and 23 04 00 General Conditions for Mechanical Trades.
2. Pump:
   a. Maximum Temperature: 230 degrees F .
   b. Maximum Pressure: 145 psig.
   c. High efficiency with ECM motor.
3. Mixing Valve: 3-way with adjustable bypass and 24-volt actuator.
4. Accessories:
   a. Ball valves with thermometers, temperature range of 30 to 250 degrees F .
      1) Body and Stem Material: Brass.
      2) Seal: Double-O-ring.
      3) Ball Material: Hard chrome plated brass.
      4) PTFE seats, brass collar nuts.
      5) Thermometers integrated in the handles, with indication of open and shut position.
   b. Check valve, minimum opening, differential pressure 0.30 psig .
   c. Tailpieces.
   d. Two station manifold.
   e. Differential pressure bypass.
   f. Wall mounting bracket.

PART 3 EXECUTION

3.1 EXAMINATION

A. Hydronic Radiant Heating Piping:
1. Examine surfaces and substrates to receive radiant heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
a. Ensure that surfaces and pipes in contact with radiant heating piping are free of burrs and sharp protrusions.
b. Ensure that surfaces and substrates are level and plumb.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean all surfaces prior to installation.

3.3 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Hydronic Radiant Heating Piping:
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
2. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
3. Install piping as indicated unless deviations to layout are approved on shop drawings or coordination drawings.
4. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
5. Connect radiant piping to manifold in a reverse-return arrangement.
6. Do not bend pipes in radius smaller than manufacturer's minimum bend radius dimension.
7. Install manifolds accessible locations, or install access panels to provide maintenance access as required in Section 08 3100.
8. Comply with requirements in Sections 23 2113 and 23 2114 for pipes and connections to hydronic systems and for glycol-solution fill requirements.
9. Fire and Smoke Barrier Penetrations:
a. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations.
b. Seal pipe penetrations with firestop materials according to Section 07 8400.
10. Piping in Exterior Concrete:
a. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
b. Space cable ties a maximum of 18 inches and at center of turns or bends.
c. Maintain 3 inch minimum cover.
d. Install a sleeve of 3/8 inch thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints.

1) Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.

e. Maintain minimum 40 psig pressure in piping during concrete placement and continue for 24 hours after placement.

11. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
12. After system balancing has been completed, mark balancing valves to permanently indicate final position.
13. Perform the following adjustments before operating the system:
    a. Open valves to fully open position.
    b. Check operation of automatic valves.
    c. Set temperature controls so all zones call for full flow.
    d. Purge air from piping.
14. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:
    a. Start system heating at a maximum of 10 degrees F above the ambient radiant panel temperature and increase 10 degrees F each following day until design temperature is achieved.
    b. For freeze protection, operate at a minimum of 60 degrees F supply-water temperature.

3.4 FIELD QUALITY CONTROL

A. See Division 01 - General Requirements.

B. Provide manufacturer's field representative to test, inspect, instruct, and observe.

C. Hydronic Radiant Heating Piping
1. Prepare radiant heating piping for testing as follows:
    a. Open all isolation valves and close bypass valves.
    b. Open and verify operation of zone control valves.
    c. Flush with clean water and clean strainers.
2. Perform the following tests and inspections with the assistance of a factory authorized service representative:
    a. Leak Test:
        1) After installation, charge system and test for leaks.
        2) Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig.
        3) Repair leaks and retest until no leaks exist.
    b. Test and adjust controls and safeties.
    c. Replace damaged and malfunctioning controls and equipment.
3. Radiant heating piping will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.
5. Protect hydronic piping system from damage during construction.

3.5 CLOSEOUT ACTIVITIES

A. See Division 01 - General Requirements.

3.6 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

B. Outdoor Equipment: Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 260400 - GENERAL CONDITIONS FOR ELECTRICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

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

B. This section applies to certain sections of Division 23 "Mechanical," and this section applies to all sections of Division 26, "Electrical" of this project specification unless specified otherwise in the individual sections.

C. The Drawings of other trades (Architectural, Landscape, Civil, Mechanical, Fire Protection and Plumbing) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

1.2 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

C. It is the intent of this Section of the Specifications to establish a standard of quality and performance characteristics for basic materials and installation methods used in building electrical systems.

1.3 COMMISSIONING

A. Engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of other trades commissioning requirements.

B. Complete installation and startup checks and functional tests according to Electrical systems commissioning and manufacturer's written instructions.

C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the start-up procedure.

D. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

E. Contractor is responsible for testing and shall participate in the electrical systems commissioning as indicated in Section 01 9113.

1.4 INTENT

A. This contract is for all labor, materials and equipment required for installation. The system shall be complete and finished in all respects, tested and ready for operation. Work shall include calibration of equipment with factory settings. All materials, equipment and apparatus shall be new and of first class quality.

B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.

C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.

D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

E. Location of all existing systems and equipment shown on floor plans is based on the best available information. The Contractor shall verify all dimensions and locations of existing systems and equipment in the field and adjust as necessary.

F. Certain items of existing equipment may be indicated for removal or relocation. Items noted for removal shall be disconnected and turned over to the Owner or disposed of by the Contractor if the Owner so requests. If instructed to dispose of items, the Contractor shall remove the items from the premises and dispose of them in a safe, legal and responsible manner and location. Items noted for relocation are intended for reuse in another location as designated on the Drawings. It shall be the responsibility of the Contractor to remove the material from its present location, store the material in a safe place and reinstall the material in its new location. Questions regarding the suitability of the material or equipment shall be brought to the attention of the Owner and Engineer in writing.

G. Wherever a particular piece of equipment, device or material is specifically indicated on the Drawings by model number, type, series or other means, that specification shall take precedence over equipment or materials specified herein. For example: If a particular switch is specified on the Drawings, its specification takes precedence over switch specified herein.

1.5 DEFINITIONS

A. Word “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.

B. Word “install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.

C. Words “furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, all ready to be installed including where appropriate all necessary interim storage and protection.

D. Word “provide” shall mean furnish (or supply) and install as necessary.

E. Word “finished” refers to all rooms and areas scheduled to be painted in Room Finish Schedule on the drawings. All rooms and areas not covered in Schedule, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

F. Words “approved equal” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

G. Word “wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system. Word “product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

H. Substitutions: Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the Contractor after award of the Contract are considered requests for "substitutions."

I. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

J. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

K. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.

L. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

M. Remove: The term “remove” means “to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”

N. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

O. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.6 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

C. The Owner may without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.

D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.7 SURVEYS AND MEASUREMENTS

A. Before submitting his Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which his work will be installed. This Contract includes all modifications of existing systems required for the installation of new equipment. This Contract includes all necessary offsets, transitions and modifications required to install all new equipment in existing spaces. All new and existing equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions he makes, any omissions or errors he makes as a result of his failure to become fully familiar with the existing conditions at the site and the Contract Documents.

B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

1.8 CODES AND STANDARDS

A. Reference Standard Compliance
1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
2. Independent Testing Organization Certificate: In lieu of the label or listing, indicated above submit a certificate from an independent testing organization, competent to perform testing, and approved by the engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

B. The Following Codes and Standards listed below apply to all electrical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
Connecticut State Building Code - Connecticut Supplement
The International Building Code
The International Mechanical Code
The International Plumbing Code
The BOCA National Code Supplement
The National Electrical Code
NFPA 101 Life Safety
Model Energy Code
ASHRAE 90.1 and International Energy Conservation Code

C. The following Standards shall be used where referenced by the following abbreviations:

AIA	American Institute of Architects
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
IEEE	Institute of Electrical and Electronics Engineers
NBS	National Bureau of Standards
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSC	National Safety Council
OSHA	Occupational Safety and Health Administration
UL	Underwriters’ Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.9 PERMITS AND FEES

A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.10 EQUIPMENT SUBSTITUTIONS

A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The contractor is required to submit any and all costs (including costs associated or required by all trades) along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.

B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.

C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.

D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the equipment or materials as hereinafter specified, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid

with manufacturer's equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.

F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.

G. Equipment, material or devices submitted for review as an "equivalent" shall meet the following requirements:
1. The equivalent shall have the same construction features such as, but not limited to:
   a. Material thickness, gauge, weight, density, etc.
   b. Welded, riveted, bolted, etc., construction
   c. Finish, undercoating, corrosion protection
2. The equivalent shall perform with the same or better operating efficiency.
3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.

H. Equipment, material or devices submitted for review as a "substitution" shall meet the following requirements:
1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
2. Submit three (3) copies of each request for substitution for consideration.
3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
   a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
   b. Samples, where applicable or requested.
   c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.

d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.

e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.

f. Cost information, including a proposal of the net change, if any in the Contract Sum.

g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.

h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.

i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.

    1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.

    2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

    3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.11 SUBMITTAL PROCEDURES

A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmitals.
1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
2. If an intermediate submittal is necessary, process the same as the initial submittal.
3. Allow two weeks for reprocessing each submittal.
4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
1. Include the following information on the label for processing and recording action taken.
    a. Project name.
    b. Date.
    c. Name and address of Engineer.
    d. Name and address of Contractor.
    e. Name and address of subcontractor.
    f. Name and address of supplier.
    g. Name of manufacturer.
    h. Number and title of appropriate Specification Section.
    i. Drawing number and detail references, as appropriate.

E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor

variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

F. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.

G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

1.12 SHOP DRAWINGS

A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Electrical Contract. Refer to the General Conditions and Supplementary General Conditions for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.

C. Provide shop drawings for all devices specified under equipment specifications for all systems including fire alarm, switchgear, clock, lighting, etc., or where called for elsewhere in the Specifications. Shop drawings shall include manufacturers’ names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures) of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

D. Submittals shall be marked with the trade involved, i.e., Electrical, HVAC, Plumbing, Fire Protection, etc. when the submittal could involve more than one trade.

E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

F. Failure to submit shop drawings in ample time for review shall not entitle the Contractor to an extension of Contract time. No claim for extension by reason of such default will be allowed, nor shall the Contractor be entitled to purchase, furnish and/or install equipment which has not been reviewed by the Engineer.

G. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.

H. Acceptance rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.

I. Acceptance of shop drawings shall not apply to quantity nor relieve Contractor of his responsibility to comply with intent of Drawings and Specifications.

J. Acceptance of shop drawings is final and no further changes will be allowed without the written consent of the Engineer.

K. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.

L. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.

M. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

1.13 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1 Section "PROJECT COORDINATION," to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. Indicate the proposed locations of light fixtures, panelboards, conduits, cabinets, etc. Include the following:
   2. Clearances for installing and maintaining insulation.
   3. Clearances for servicing and maintaining equipment, including NEC requirements and space for equipment disassembly required for periodic maintenance.
   4. Equipment connections and support details.
   5. Exterior wall and foundation penetrations.
   6. Fire-rated wall and floor penetrations.

7. Sizes and locations of required concrete pads and bases.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

E. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. The cost for these floor plans is a lump sum fee of $ 1,500.00. If the Contractor elects to obtain the Engineers electronic files a REVIT File Release Form must be submitted with payment. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the REVIT File Release Form, and payment, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the REVIT File Release Form is appended to the end of this specification section

1.14 COORDINATION WITH OTHER DIVISIONS

A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.

B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, heating, condenser, chilled water piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.

C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.

D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

E. If so directed in other Sections, the Contractor indicated shall prepare composite working drawings and sections clearly showing how the work is to be installed in relation to the work of other trades, at no extra charge to the Owner.

1.15 WORKMANSHIP

A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, journeymen, electricians, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

E. All labor for installation of electrical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.16 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.

B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.17 TEMPORARY UTILITIES

A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not

overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. First Aid Supplies: Comply with governing regulations.

D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.

E. Provide temporary lighting in all areas, throughout construction activities.
   1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
   2. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.
      a. Except where overhead service must be used, install electric power service underground.
      b. Power Distribution System: Install wiring overhead, and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, AC 20 ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.
   3. Temporary Telephones: Provide temporary telephone service for all personnel engaged in construction activities, throughout the construction period.

F. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

G. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.18 PROJECT PHASING

A. Work under each Section shall include all necessary temporary connections, equipment, conduit, wiring, fire alarm equipment and testing, lighting and emergency lighting, fire stopping, connection of necessary mechanical equipment, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems

that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain existing systems operational or to accommodate the construction phasing of the project.

1.19 PROTECTION OF MATERIALS AND EQUIPMENT

A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.

B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.20 ADJUSTING AND TESTING

A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.

B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct the personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing, that the equipment was installed according to manufacturers recommendations and is operating as intended by the manufacturer.

1.21 CLEANING

A. The Contractor shall thoroughly clean all equipment of all foreign substances, oils, dust, dirt, etc., inside and out before final acceptance by the Engineer.

B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of

removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

C. During the course of construction, all conduits shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.

D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work.

E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
1. Remove labels that are not permanent labels.
2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces and panelboard interiors.
4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean light fixtures and lamps.

F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.

G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.22 OPERATING AND MAINTENANCE

A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner’s representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

D. An authorized manufacturer’s representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: emergency generator, fire alarm system, nurse call system,

paging systems, etc. These letters will be bound into the operating and maintenance books.

E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

F. Demonstration shall be recorded on VHS audio/video tape with two (2) tapes turned over to the Owner.

1.23 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty, 3-ring, vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.

B. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Emergency instructions.
6. Spare parts list.
7. Copies of warranties.
8. Wiring diagrams.
9. Recommended "turn around" cycles.
10. Inspection procedures.
11. Shop Drawings and Product Data.
12. Equipment start-up reports.

C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.

D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.24 ACCEPTANCES

A. The equipment, materials, workmanship, design and arrangement of all work installed under the Electrical Sections shall be subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, the Electrical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Electrical Sections. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.

C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of the awarding of the Contract. In such instances, deviations may be made pending acceptance by the Engineer or the Owner’s representative.

D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Electrical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.

F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.25 RECORD DRAWINGS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
   1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
   2. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
   3. Note related Change Order numbers where applicable.

4. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.These shall be clearly marked for Record Drawings on a clean set of reproducible mylar sepias at the completion of the work and turned over to the Owner.

1.26 WARRANTIES AND BONDS

A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
   1. General close-out requirements included in Section "Project Close-out."
   2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of each division.
   3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.27 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
   1. Refer to individual Sections of Divisions 2 through 16 for specific content requirements, and particular requirements for submittal of special warranties.

J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
   1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
   2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
   3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.28 GUARANTEES

A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineers satisfaction.

B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided

1.29 PROJECT CLOSE-OUT

A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.

B. Deliver tools, spare parts, extra stock, and similar items.

C. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

D. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

E. Inspection Procedures: On receipt of a request for inspection, the Engineer will either proceed with inspection or advise the Contractor of unfilled requirements. The Engineer will prepare the Certificate of Substantial Completion following inspection, or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
1. The Engineer will repeat inspection when requested and assured that the Work has been substantially completed.
2. Results of the completed inspection will form the basis of requirements for final acceptance.

END OF SECTION 260400

REVIT File Release Form
DELIVERY OF REVIT FILES FOR: _____
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ _____
Client's Signature Date

_____
Company - Title

_____ _____
Architects' Signature Date

_____
Firm - Title

_____ _____
Owner's Signature Date

_____
Company - Title

SECTION 260503 - EQUIPMENT WIRING CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes electrical connections to equipment.

B. Related Sections:
1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Requirements: Submittal procedures.

B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.5 COORDINATION

A. Section 01 – Project Management and Coordination: Coordination and project conditions.

B. Obtain and review shop drawings, product data, manufacturer’s wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

C. Determine connection locations and requirements.

D. Sequence rough-in of electrical connections to coordinate with installation of equipment.

E. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 CORD AND PLUGS

A. Manufacturers:
   1. Hubbell.
   2. Leviton.
   3. Bryant.
   4. Substitutions: Section 01 – Substitution Procedures.

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.

D. Cord Construction: Type SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

F. Refer to drawings for specific NEMA receptacle, plug, connector body configurations.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 - Project Management and Coordination: Coordination and project conditions.

B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.2 INSTALLATION

A. Make electrical connections.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Install receptacle outlet to accommodate connection with attachment plug.

E. Install cord and cap for field-supplied attachment plug.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

3.3 ADJUSTING

A. Section 01 - Closeout Procedures: Testing, adjusting, and balancing.

B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION 260503

SECTION 260519 - ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes building wire and cable; metal clad cable; and wiring connectors and connections.

B. Related Sections:
1. Section 26 05 53 - Identification for Electrical Systems: Product requirements for wire identification.
2. Section 31 23 33 – Trenching and Backfilling: Execution requirements for trenching required by this section.
3. Section 31 23 33 - Trenching and Backfilling: Requirements for backfill to be placed by this section.

1.2 REFERENCES

A. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.
2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

1.3 SYSTEM DESCRIPTION

A. Product Requirements: Provide products as follows:

1. Solid conductor for feeders and branch circuits 10 AWG and smaller.
2. Stranded conductors for control circuits.
3. Conductor not smaller than 12 AWG for power and lighting circuits.
4. Conductor not smaller than 16 AWG for control circuits.
5. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet feet.
6. 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

B. Wiring Methods: Provide the following wiring methods:

1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway, or metal clad cable.
2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN insulation, in raceway, or metal clad cable.

4. Wet or Damp Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
5. Exterior Locations: Use only building wire, Type XHHW insulation, in raceway.
6. Underground Locations: Use only building wire, Type XHHW insulation in raceway.

C. Conductor sizes are based on copper unless indicated as aluminum or "AL".

D. When aluminum conductor is substituted for copper conductor, size to match circuit requirements for conductor ampacity and voltage drop.

1.4 SUBMITTALS

A. Section 01 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit for building wire and each cable assembly type.

C. Test Reports: Indicate procedures and values obtained.

D. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations of components and circuits.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with the current issue of the State of Connecticut Building and Fire Safety Code.

B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.8 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on Drawings.

1.9 COORDINATION

A. Section 01 – Project Management and Coordination: Requirements for coordination.

B. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

C. Wire and cable routing indicated is approximate unless dimensioned. Include wire and cable lengths within 10 ft of length shown.

PART 2 PRODUCTS

2.1 BUILDING WIRE

A. Manufacturers:
1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Substitutions: Section 01 – Substitution Procedures.

B. Product Description: Single conductor insulated wire.

Conductor: Copper for sizes smaller than 4 AWG; copper or aluminum for sizes 4 AWG and larger.

A. Insulation: NFPA 70; Type THHN/THWN insulation for feeders and branch circuits, rated 75 degrees C.

2.2 METAL CLAD CABLE

A. Manufacturers:
1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Substitutions: Section 01 - Substitution Procedures.

B. Conductor: Copper for sizes smaller than 4 AWG; copper or aluminum for sizes 4 AWG and larger.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 90 degrees C.

E. Insulation Material: Thermoplastic.

F. Armor Material: Steel.

G. Jacket: Where required.

H. Provide separate ground conductor within cable do not use armor material for ground path.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Project Management and Coordination: Coordination and project conditions.

B. Verify interior of building has been protected from weather.

C. Verify mechanical work likely to damage wire and cable has been completed.

D. Verify raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

A. Route wire and cable to meet Project conditions.

B. Neatly train and lace wiring inside boxes, equipment, and panelboards.

C. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

D. Special Techniques--Building Wire in Raceway:
1. Pull conductors into raceway at same time.
2. Install building wire 4 AWG and larger with pulling equipment.

E. Special Techniques - Cable:
1. Protect exposed cable from damage.
2. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure or ceiling suspension system. Do not rest cable on ceiling panels.
3. Use suitable cable fittings and connectors.

F. Special Techniques - Wiring Connections:
1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
7. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

8. Terminate aluminum conductors with tin-plated aluminum-bodied compression connectors only. Fill with anti-oxidant compound before installing conductors.

G. Install solid conductor for feeders and branch circuits 10 AWG and smaller.

H. Install stranded conductors for branch circuits 10 AWG and smaller. However, when stranded conductors are used in lieu of solid, then install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.

I. Adhere to manufacturers requirements for all Mineral Insulated cable installation requirements and as outlined in NEC Article 332.0.

3.4 WIRE COLOR

A. General:
1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
   a. Black, red, and blue for circuits at 120/208 volts single or three phase.
   b. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
   a. Black, red, and blue for circuits at 120/208 volts single or three phase.
   b. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.

B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.

D. Feeder Circuit Conductors: Uniquely color code each phase.

E. Ground Conductors:
1. For 6 AWG and smaller: Green.
2. For 4 AWG and larger:Identify with green tape at both ends and visible points including junction boxes.

3.5 FIELD QUALITY CONTROL

A. Section 01 - Closeout Procedures: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rod electrodes.
2. Wire.
3. Grounding well components.
4. Mechanical connectors.
5. Exothermic connections.
6. Building ground ring.

B. Related Sections:
1. Section 03 - Concrete Reinforcing: Bonding or welding bars when reinforcing steel is used for electrodes.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:
1. Metal underground water pipe.
2. Metal building frame.
3. Rebar in column base.
4. Copper Clad Steel Rod electrode.

1.4 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 10 ohms maximum.

1.5 SUBMITTALS

A. Section 01 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.7 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

B. Perform Work in accordance with State of Connecticut Codes and Standards.

C. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum 3 years experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.10 COORDINATION

A. Section 01 – Project Management and Coordination: Requirements for coordination.

B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

C. Verify existing building steel is properly grounded per National Electrical Code. Provide connections, jumpers, etc as required to meet code.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers:
1. Copperweld, Inc.
2. Erico, Inc.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical
5. Substitutions: Section 01 - Substitution Procedures

B. Product Description:
1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.
3. Length: 10 feet.

C. Connector: U-bolt clamp.

2.2 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: 2 AWG.

C. Grounding Electrode Conductor: Copper conductor insulated as per plans.

D. Bonding Conductor: Copper conductor bare or insulated #6 AWG minimum.

2.3 MECHANICAL CONNECTORS

A. Manufacturers:
1. Copperweld, Inc.
2. Erico, Inc.
3. ILSCO Corporation
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical.
6. Substitutions: Section 01 - Substitution Procedures

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Cadweld, Erico, Inc.
2. Copperweld, Inc.
3. ILSCO Corporation.
4. O-Z Gedney Co.

5. Thomas & Betts, Electrical.
6. Substitutions: Section 01- Substitution Procedures

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 – Project Management and Coordination: Verification of existing conditions before starting work.

B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.3 INSTALLATION

A. Install in accordance with IEEE Standards.

B. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.

C. Install grounding electrode conductor and connect to reinforcing steel in foundation footing per NEC.

D. Bond together metal siding not attached to grounded structure; bond to ground.

E. Install grounding and bonding in patient care areas to meet requirements of NFPA 99.

F. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

G. Install continuous grounding using underground cold water system, driven rods, foundation electrode and building steel as grounding electrode.

H. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

I. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.

J. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to

ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

K. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.

L. Permanently attach equipment and grounding conductors prior to energizing equipment.

M. Connections to Lightning Protection System: Bond grounding conductors, including grounding-conductor conduits, to lightning protection down conductors or lightning protection grounding conductors in compliance with NFPA 780.

N. Common Ground Bonding with Lightning Protection System: Bond electric power system, grounding electrode system directly to lightning protection system earth connection at closest point to electric service grounding electrode. Use bonding conductor sized the same as system grounding conductor and install in conduit.

3.4 COUNTERPOISE

A. Provide a ground ring conductor (counterpoise) extending around perimeter of the building. Bury counterpoise not less than 30 inches below grade and 5 feet from the building foundation. Use #4/0 conductor and for taps to building steel. Fill trench with ground enhancement material a minimum of 1” above and below the conductor.

B. Ground the steel frame of the building with a ground rod at every corner column and at every other exterior column. Locate ground rods at counterpoise trench and attach to the counterpoise conductor. The top of the ground rod shall be not less than 24” below grade.

3.5 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.

C. Perform ground resistance testing in accordance with IEEE 142.

D. Perform leakage current tests in accordance with NFPA 99.

E. Perform continuity testing in accordance with IEEE 142.

F. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION 262526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Equipment Bases and Supports

1.2 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

B. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.

E. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.5 PRE-INSTALLATION MEETINGS

A. Section 01 – Project Management and Coordination: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 - Product Requirements: Environmental conditions affecting products on site.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. Electroline Manufacturing Company.
3. O-Z Gedney Co.
4. Thomas and Betts
5. Substitutions: Section 01 - Substitution Procedures.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

A. Sleeves for conduit, raceway, cable tray, or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for conduit, raceway, cable tray, or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for conduit, raceway, cable tray, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. PSI Link-Seal.
4. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 – Project Management and Coordination: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of fire stopping material.

B. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
1. Concrete Structural Elements: Provide precast inserts, expansion anchors.
2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 – Cast In Place Concrete.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

3.5 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 6 inch above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with stuffing fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

3.6 FIELD QUALITY CONTROL

A. Section 01 - Quality Requirements; 01 - Closeout Procedures: Field inspecting, testing, adjusting, and balancing.

3.7 PROTECTION OF FINISHED WORK

A. Section 01- Closeout Procedures: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:
1. Section 26 05 03 - Equipment Wiring Connections.
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
4. Section 26 05 34 - Floor Boxes for Electrical Systems.
5. Section 26 05 53 - Identification for Electrical Systems.
6. Section 26 27 26 - Wiring Devices.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.

B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than 5feet outside Foundation Wall: Provide PVC Conduit.

C. Underground Within 5 feet from Foundation Wall: Provide rigid steel conduit.

D. In or Under Slab on Grade: Provide PVC conduit with PVC coated rigid sweeps.

E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.

F. Wet and Damp Locations: Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.

G. Concealed Dry Locations: Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

H. Exposed Dry Locations: Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.4 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.5 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit for the following:
1. Flexible metal conduit.
2. Liquidtight flexible metal conduit.
3. PVC conduit.
4. Flexible nonmetallic conduit.
5. Nonmetallic tubing.
6. Raceway fittings.
7. Conduit bodies.
8. Surface raceway.
9. Wireway.
10. Pull and junction boxes.
11. Handholes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Closeout procedures.

B. Project Record Documents:
1. Record actual routing of conduits larger than 2 inch.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements: Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.8 COORDINATION

A. Section 01 – Project Management and Coordination: Coordination and project conditions.

B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 - Substitution Procedures.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 -Substitution Procedures.
5. Fittings: NEMA FB 1.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Anamet Electrical.
3. Allied Tube and Conduit.
4. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Interlocked steel construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.4 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 - Substitution Procedures.
5. Fittings and Conduit Bodies: NEMA FB 1; steel type.

2.5 NONMETALLIC CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Allied Tube and Conduit.
4. Substitutions: Section 01- Substitution Procedures.

B. Product Description: NEMA TC 2; Schedule 40 PVC.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.6 NONMETALLIC TUBING

A. Manufacturers:
1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Allied Tube and Conduit.
4. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: NEMA TC 2.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.7 SURFACE METAL RACEWAY

A. Manufacturers:
1. Hubbell Wiring Devices.
2. Thomas & Betts Corp.
3. The Wiremold Co.
4. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway. Provide separated channels for power and telecommunications wiring where combined runs are required.

C. Finish: Architect to select from manufacturers standard color palette.

D. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.8 WIREWAY

A. Manufacturers:
   1. Carlon Electrical Products.
   2. Thomas & Betts Corp.
   3. Hoffman.
   4. Substitutions: Section 01 - Substitution Procedures.

B. Knockouts: Manufacturer's standard.

C. Cover: Screw cover.

D. Finish: Rust inhibiting primer coating with gray enamel finish.

2.9 OUTLET BOXES

A. Manufacturers:
   1. Erico Products.
   2. Raco.
   3. Thomas & Betts Corp.
   4. Substitutions: Section 01 - Substitution Procedures.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
   2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic Outlet Boxes: NEMA OS 2.

D. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer.

E. Wall Plates for Finished Areas: As specified in Section 26 27 26.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.10 PULL AND JUNCTION BOXES

A. Manufacturers:
   1. Carlon Electrical Products.
   2. Hubbell Wiring Devices.
   3. Thomas & Betts Corp.
   4. Substitutions: Section 01 - Substitution Procedures.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Surface Mounted Cast Metal Box: NEMA 250, flat-flanged, surface mounted junction box:
   1. Material: Cast aluminum.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

D. In-Ground Handholes: Stackable 18”x16”x12”, open bottom as manufactured by Qauzite Co.:
   1. Material: Precast concrete.
   2. Cover: Traffic rated precast concrete.
   3. Cover Legend: "ELECTRIC" or “TELEPHONE”.
   4. Provide size as required for primary electrical and telco circuits.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 – Project Management and Coordination: Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 26 05 26.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.

C. Identify raceway and boxes in accordance with Section 26 05 53.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Route exposed raceway parallel and perpendicular to walls.

H. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

I. Route conduit in and under slab from point-to-point.

J. Maintain clearance between raceway and piping for maintenance purposes.

K. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

L. Cut conduit square using saw or pipe cutter; de-burr cut ends.

M. Bring conduit to shoulder of fittings; fasten securely.

N. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

O. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.

P. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

Q. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

R. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

S. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

T. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

U. Close ends and unused openings in wireway.

3.4 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings. Adjust box location prior to rough-in to accommodate intended purpose.

B. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

D. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

E. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

F. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

G. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

H. Install stamped steel bridges to fasten flush mounting outlet box between studs.

I. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

J. Install adjustable steel channel fasteners for hung ceiling outlet box.

K. Do not fasten boxes to ceiling support wires or other piping systems.

L. Support boxes independently of conduit.

M. Install gang box where more than one device is mounted together. Do not use sectional box.

N. Install gang box with plaster ring for single device outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.

C. Locate outlet boxes to allow luminaires positioned as indicated on Electrical Lighting Drawings.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.6 ADJUSTING

A. Section 01 Closeout Procedures: Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.7 CLEANING

A. Section 01 - Closeout Procedures: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION 260533

SECTION 260534 - FLOOR BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes floor boxes; floor box service fittings; poke-through fittings; and access floor boxes.

B. Related Sections:
1. Section 07 84 13 –Penetration Firestopping.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 27 26 - Wiring Devices: Receptacles for installation in floor boxes.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog data for floor boxes service fittings.

C. Samples: Submit two of each service fitting illustrating size, material, configuration, and finish.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Closeout procedures.

B. Project Record Documents: Record actual locations of each floor box and poke-through fitting.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.6 EXTRA MATERIALS

A. Section 01 - Closeout Procedures: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 FLOOR BOXES

A. Manufacturers:
1. Legrand/Wiremold
2. Leviton.
3. Bryant.
4. Hubbell.
5. Substitutions: Division 01 - Product Requirements.

B. Basis of design models:
1. Legrand EFB45S series with EFB45CTC cover for power, data, and AV input devices.
2. Legrand RFSB-OG series with RP4CT cover for power-only devices.

C. Floor Boxes: NEMA OS 1.

D. For high capacity devices, power, data and AV outlets (as specified on drawings) shall be completely concealed and mounted on the side wall of floor box interior. Floor box shall utilize integral cable management with NO jacks being located on the top of the cover plate.

E. Floor boxes shall use sliding or flip-up covers.

F. Floor box shall be furnished with die cast aluminum cover assembly, with finish to be determined by architect.

G. Conduits: Provide device capable of accepting the following conduit terminations:

1. 3/4" for power.
2. 1-1/4” for data/telecommunications.
3. 2” for audiovisual.

H. Furnish with necessary furniture feed accessories when connecting to modular furniture.

I. Provide empty cover plates for sections without power/communication devices installed.

J. Finish: Cover color shall be gray or as selected by the Architect.

K. Installation: Contractor is responsible of trenching from floor mounted fitting location to nearest wall.

L. Provide final connections to furniture from furniture-feed devices as required by manufacturer.

2.2 POKE-THROUGH DEVICES

A. Manufacturers:
1. Legrand/Wiremold
2. Leviton.
3. Bryant.

4. Hubbell.
5. Substitutions: Division 01 - Product Requirements.

B. Basis of design models:
1. Legrand 6AT for power, data, and AV input devices.
2. Legrand RC9 for power-only devices.

C. Product Description: Assembly comprising of service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.

D. Provide connectors with sliding covers, flip-up covers are not acceptable.

E. Fire rating to match that of floor.

F. Service fitting type: Flushed.

G. Conduits: Provide device capable of accepting the following conduit terminations:

1. 3/4" for power.
2. 1-1/4” for data/telecommunications.
3. 2” for audiovisual.

H. Provide empty cover plates for sections without power/communication devices installed.

I. Core Drills: Contractor is responsible of providing 4” core drill for the installation of the assemblies described herein.

J. Finish: Cover color shall be gray or as selected by the Architect.

K. Provide final connections to furniture from furniture-feed devices as required by manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 – Project Management and Coordination: Coordination and project conditions.

B. Where use for a device is not specified, consult with Architect and Engineer prior to rough-in.

C. Verify locations of floor boxes and outlets in work areas prior to rough-in.

D. Verify openings in access floor are in proper locations.

3.2 INSTALLATION

A. Poke-thru fittings are indicated on Drawings in approximate locations unless dimensioned. Adjust poke-thru fitting location to accommodate intended purpose.

B. Install fittings to preserve fire resistance rating of slabs and other elements, using materials and methods specified in Section 07 84 00.

C. Confirm quantity of devices and cables intended for each box, and cable types before purchasing or setting devices.

3.3 ADJUSTING

A. Section 01- Closeout Procedures: Testing, adjusting, and balancing.

B. Adjust floor box flush with finish flooring material.

3.4 CLEANING

A. Section 01 - Closeout procedures: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

END OF SECTION 260534

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Stencils.
6. Underground Warning Tape.
7. Lockout Devices.

B. Related Sections:
1. Section 09 – Interior Painting: Execution requirements for painting specified by this section.
2. Section 27 - Identification for Communications Systems.

1.2 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Product Data:
1. Submit manufacturer’s catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with State of Connecticut Public Work's standard.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 - Product Requirements: Environmental conditions affecting products on site.

B. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

1.8 EXTRA MATERIALS

A. Section 01 - Closeout Procedures: Requirements for extra materials.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
1. Seton
2. Brady
3. Ideal Industries
4. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.

C. Letter Size:
1. 1/8 inch high letters for identifying individual equipment and loads.
2. 1/4 inch high letters for identifying grouped equipment and loads.

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Manufacturers:
1. Seton
2. Brady
3. Ideal Industries
4. Substitutions: Section 01 - Substitution Procedures.

B. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background.

2.3 WIRE MARKERS

A. Manufacturers:
1. Seton
2. Brady
3. Ideal Industries
4. Substitutions: Section 01 - Substitution Procedures.

B. Legend:
1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
2. Control Circuits: Control wire number as indicated on Drawings.

2.4 CONDUIT AND RACEWAY MARKERS

A. Manufacturers:
1. Seton
2. Brady
3. Ideal Industries
4. Substitutions: Section 01 - Substitution Procedures.

B. Color:
1. Medium Voltage System: Black lettering on white background.
2. 480 Volt System: Black lettering on white background.
3. 208 Volt System: Black lettering on white background.

C. Legend:
1. Medium Voltage System: HIGH VOLTAGE.
2. 480 Volt System: 480 VOLTS. HIGH VOLTAGE.
3. 208 Volt System: 208 VOLTS.
1. Emergency Power Systems: Emergency (with voltage following “Emergency”)
2. Telephone System: Telephone
3. Voice/Data Systems: Voice/Data
4. Security System: Security

2.5 UNDERGROUND WARNING TAPE

A. Manufacturers:
1. Seton
2. Brady
3. Ideal Industries
4. Substitutions: Section 01 - Substitution Procedures.

B. Description: 4 inch wide plastic tape, detectable type, colored red yellow with suitable warning legend describing buried electrical lines.

2.6 LOCKOUT DEVICES

A. Lockout Hasps:
1. Manufacturers:
a. Seton
b. Brady
c. Ideal Industries
d. Substitutions: Section 01 - Substitution Procedures.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 for stencil painting.

3.2 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:
1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
4. Secure nameplate to equipment front using rivets.
5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
6. Install nameplates for the following:
a. Switchboards.
b. Panelboards.
c. Transformers.
d. Disconnects.

C. Label Installation:
1. Install label parallel to equipment lines.
2. Install label for identification of individual control device stations.
3. Install labels for permanent adhesion and seal with clear lacquer.

D. Wire Marker Installation:
1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.

E. Underground Warning Tape Installation:
1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION 260553

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Contactors.
2. Switches.
3. Occupancy sensors.
4. Photocells.
5. Distributed Lighting Control Systems

B. Related Sections:
1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.
2. Section 26 05 19 - Electrical Power Conductors and Cables.
3. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Product requirements for raceway and boxes for placement by this section.
4. Section 26 05 53 - Identification for Electrical Systems: Product requirements for electrical identification items for placement by this section.
5. Section 26 24 16 - Panelboards.
6. Section 26 27 26 - Wiring Devices: Product requirements for wiring devices for placement by this section.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contractors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks.
5. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
6. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
7. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

1.3 SYSTEM DESCRIPTION

A. Distributed switching control using self contained individually mounted lighting relays.

B. Where indicated on drawings or required by applicable code, provide automatic shutoff for lighting inside building larger than 5000 square feet. Control shutoff by method conforming to ICC IECC.

C. Where indicated on drawings or required by applicable code, provide automatic shutoff for lighting outside building. Control shutoff by method conforming to ICC IECC.

1.4 SUBMITTALS

A. Section 01 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate dimensioned drawings of lighting control system components and accessories.
1. One Line Diagram: Indicating system configuration indicating panels, number and type of switches or devices.
2. Include typical wiring diagrams for each component.

C. Product Data: Submit manufacturer’s standard product data for each system component.

D. Manufacturer's Installation Instructions: Submit for each system component.

E. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:
1. Product Data for Credit 4(b)9: Individual Lighting Control.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record the following information:
1. Actual locations of components and record circuiting and switching arrangements.
2. Wiring diagrams reflecting field installed conditions with identified and numbered, system components and devices.

C. Operation and Maintenance Data:
1. Submit replacement parts numbers.
2. Submit manufacturer’s published installation instructions and operating instructions.
3. Recommended renewal parts list.

1.6 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept components on site in manufacturer's packaging. Inspect for damage.

C. Protect components by storing in manufacturer's containers indoor protected from weather.

1.9 WARRANTY

A. Section 01 - Closeout Procedures: Requirements for warranties.

B. Furnish five year manufacturer warranty for components.

1.10 EXTRA MATERIALS

A. Section 01 - Closeout Procedures: Requirements for extra materials.

B. Furnish two of each switch type.

C. Furnish six of each occupancy sensor type.

D. Furnish two of each photocell type.

PART 2 PRODUCTS

2.1 SWITCHES

A. Manufacturers:
1. Douglass Controls, and as reference in drawings.
2. Hubbell Incorporated
3. Leviton Manufacturing Co., Inc.
4. Pass and Seymour/Legrand
5. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Specification Grade, toggle switch rated 120/277V 20A minimum.
1. Material: Plastic.
2. Color: By Architect.

2.2 SWITCH PLATES

A. Manufacturers:
1. Douglass Controls, and as reference in drawings.
2. Hubbell Incorporated.
3. Leviton Manufacturing Co., Inc.
4. Pass and Seymour/Legrand.
5. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Specification Grade.
1. Material: Stainless steel.
2. Color: by architect.

2.3 OCCUPANCY SENSOR

A. Manufacturers:
1. As indicated on symbol list and in plan details.
2. Substitutions: Section 01 - Substitution Procedures.

B. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 12 minutes.

C. Furnish with manual override.

D. Operation: Silent.

E. Room Sensors: As indicated on Drawings.

2.4 PHOTOCELLS

A. Manufacturers:
1. As indicated on symbol list and in plan details.
2. Substitutions: Section 01 - Substitution Procedures.

B. Furnish with manual override.

C. Operation: Silent.

D. Room Sensors: As indicated on Drawings.

2.5 EMERGENCY LIGHTING INTERFACE

A. Lighting inverter as scheduled on drawings.

B. Where emergency lighting is to be controlled by the lighting control system, provide UL924 listed load control relays as necessary to insure that emergency lights are automatically turned full on upon loss of normal power to the area.

C. Refer to the drawings for applications of emergency shunt relays incorporated into the lighting control system for specific applications.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mount switches, occupancy sensors, and photocells as indicated on Drawings.

B. Install wiring in accordance with Section 26 05 19.

C. Use only properly color coded, stranded wire. Install wire sizes as indicated on Drawings. Install wire in conduit in accordance with Section 26 05 33.

D. Label each low voltage wire clearly indicating connecting relay panel. Refer to Section 26 05 53.

E. Mount relay as indicated on Drawings. Wire numbered relays in panel to control power to each load. Install relays to be accessible. Allow space around relays for ventilation and circulation of air.

F. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.

G. Label each low voltage wire with relay number at each switch or sensor.

H. Install all equipment in accordance with manufacturer’s installation instructions.

I. The lighting controls shall be installed in accordance with specific guidelines and submittal documents provided by the lighting control manufacturer.
Where variations from the general specifications or drawings exist, the contractor shall request a clarification prior to rough in or installation.

J. The contractor shall verify all wire type and routing requirements with the lighting controls manufacturer prior to installation. Not part of this section are requirements for work including, but not limited to, raceways, electrical boxes, junction boxes, circuit protection, wiring, and fittings required for installation of the lighting control equipment.

3.2 MANUFACTURER'S FIELD SERVICES

A. Section 01 - Quality Requirements: Requirements for manufacturer’s field services.

B. Furnish services for minimum of one day days for check, test, and start-up. Perform the following services:
1. Check installation of panelboards.
2. Test operation of remote controlled devices.
3. Repair or replace defective components.

C. The lighting controls manufacturer shall provide reasonable access to factory direct telephone technical support during normal business hours.

3.3 STARTUP AND PROGRAMMING

A. Test relays, contactors, and switches after installation to confirm proper operation.

B. Confirm correct loads are recorded on directory card in each panel.

C. The system manufacturer shall provide a factory authorized field engineer to the project site after installation has been completed and prior to system energization for the purpose of testing and adjustment of the system. Factory field engineer shall test and verify all system functions and ensure proper operation of the system components in accordance

with the specifications and on-site conditions. The installing contractor shall notify the system manufacturer in writing that the system is completely wired and ready to be energized and tested 2 weeks prior to scheduling a field engineer for start-up of the system. Should the field engineer arrive on the job site and find the installation incomplete, the installing contractor shall pay the cost of any future visits by the field engineer required to complete the system start-up.

D. During the start-up procedure, the factory field engineer shall provide programming assistance and guidance to the building operating personnel in order to program the systems for initial operation.

E. Allow for up to 4 hours of on-site training on the use and maintenance of the lighting control system to be scheduled at the completion of startup and programming of the system.

3.4 ADJUSTING

A. Section 01 - Closeout Procedures: Requirements for starting and adjusting.

B. Test each system component after installation to verify proper operation.

C. Test relays, contactors, and switches after installation to confirm proper operation.

D. Confirm correct loads are recorded on directory card in each panel.

3.5 DEMONSTRATION

A. Section 01 - Closeout Procedures: Requirements for demonstration and training.

B. Demonstrate operation of the following system components:
1. Operation of switches.
2. Operation of each type of occupancy sensors and daylight controls.
3. Operation of each type of photocell.

C. Furnish 4 hours to instruct Owner's personnel in operation and maintenance of system. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION 260923

SECTION 262416 – PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes distribution and branch circuit panelboards, fusible branch circuit panelboards, electronic grade branch circuit panelboards.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 53 - Identification for Electrical Systems.
3. Section 26 28 13 - Fuses.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:

1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
6. NEMA PB 1 - Panelboards.
7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories Inc.:
1. UL 67 - Safety for Panelboards.
2. UL 1283 - Electromagnetic Interference Filters.
3. UL 1449 - Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Product Data: Submit catalog data showing specified features of standard products.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

C. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 MAINTENANCE MATERIALS

A. Section 01 - Closeout Procedures: Requirements for maintenance products.

B. Furnish two of each panelboard key.

1.7 WARRANTY

A. Provide an 18 month manufacturer warranty for panelboards.

PART 2 PRODUCTS

A. enamel.

2.2 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. Square D
2. General Electric
3. Eaton.
4. Substitutions: Not permitted

B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus: Copper, current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard; furnish insulated ground bus as indicated on Drawings.

D. Minimum Integrated Short Circuit Rating: Calculated based on primary transformer available SCR and as indicated on plans.

E. TVSS Devices: Provide integral panel mounted TVSS modules within all branch power panelboards. Coordinate with surge capacity rating of main switchboard TVSS device.

F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.

G. Enclosure: NEMA PB 1, Type 1.

H. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards.

I. Cabinet Front: Surface cabinet front with concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard gray enamel.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards and load centers in accordance with NEMA PB 1.1.

B. Install panelboards and load centers plumb.

C. Install recessed panelboards and load centers flush with wall finishes.

D. Height: 6 feet to top of panelboard and load center; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

E. Install filler plates for unused spaces in panelboards.

F. Provide typed or neatly handwritten circuit directory for each branch circuit panelboard and load center. Revise directory to reflect circuiting changes to balance phase loads.

G. Install engraved plastic nameplates in accordance with Section 26 05 53.

H. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels in accordance with NFPA 70.

3.2 FIELD QUALITY CONTROL

A. Section 01 - Closeout Procedures Field inspecting.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

D. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

E. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

F. Above testing shall be documented in writing and furnished as a part of O&M manuals, and provided to CX agent prior to closeout.

3.3 ADJUSTING

A. Section 01 - Closeout Procedures: Requirements for starting and adjusting.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION 262416

SECTION 262726 – WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes wall switches; wall dimmers; receptacles; multioutlet assembly; and device plates and decorative box covers.

B. Related Sections:
1. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Outlet boxes for wiring devices.
2. Section 26 05 34 - Floor Boxes for Electrical Systems: Service fittings for receptacles installed on floor boxes.
3. Section 26 05 34 - Floor Boxes for Electrical Systems: Poke-through receptacles.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.5 EXTRA MATERIALS

A. Section 01 - Closeout Procedures: Spare parts and maintenance products.

B. Furnish five of each style, size, and finish wall plate.

PART 2 PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
1. Hubbell Wiring Products.
2. Leviton.
3. Bryant.

4. Pass and Seymour.
5. Substitutions: Section 01 - Substitution Procedures.

B. Body and Handle: Color by architect.

C. Ratings:
1. Voltage: 120-277 volts, AC.

D. Ratings: Match branch circuit and load characteristics.

E. Specification grade device.

2.2 RECEPTACLES

A. Manufacturers:
1. Hubbell Wiring Products.
2. Leviton.
3. Bryant.
4. Pass and Seymour.
5. Substitutions: Section 01- Substitution Procedures.

B. Product Description: Specification grade device.

C. Device Body: Color by architect.

D. Configuration: NEMA WD 6, type as indicated on Drawings.

E. Convenience Receptacle: Type 5-20.

F. GFCI Receptacle: Convenience receptacle with integral self testing ground fault circuit interrupter to meet regulatory requirements.

2.3 WALL PLATES

A. Manufacturers:
1. Hubbell Wiring Products.
2. Leviton.
3. Bryant.
4. Pass and Seymour.
5. Substitutions: Section 01 - Substitution Procedures.

B. Decorative Cover Plate: stainless steel natural brushed finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 – Project Management and Coordination: Coordination and project conditions.

B. Verify outlet boxes are installed at proper height.

C. Verify wall openings are neatly cut and completely covered by wall plates.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install devices plumb and level.

B. Install switches with OFF position down.

C. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Install receptacles with grounding pole on top.

F. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

G. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

H. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.

I. Use jumbo size plates for outlets installed in masonry walls.

J. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

K. Install tamper resistant type duplex receptacles in all child care areas.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 26 05 33 to obtain mounting heights as specified and as indicated on drawings.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle 18 inches above finished floor.

D. Install convenience receptacle 6 inches above counter back splash of counter.

3.5 FIELD QUALITY CONTROL

A. Section 01 – Quality Requirements: Field inspecting.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify each receptacle device is energized.

E. Test each receptacle device for proper polarity.

F. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

A. Section 01 - Closeout Procedures: Testing, adjusting, and balancing.

B. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Section 01 - Closeout Procedures: Final cleaning.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fuses.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.3 DESIGN REQUIREMENTS

A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for the following components: wire, cable, bus structures, and other equipment. Design system to maintain component damage within acceptable levels during faults.

B. Select fuses to coordinate with time current characteristics of other overcurrent protective elements, including other fuses, circuit breakers, and protective relays. Design system to maintain operation of device closest to fault operates.

1.4 FUSE PERFORMANCE REQUIREMENTS

A. General Purpose Branch Circuits: Class RK1 (time delay).

B. Motor Branch Circuits: Class RK1 (time delay).

1.5 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Closeout procedures.

B. Project Record Documents: Record actual sizes, ratings, and locations of fuses.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.8 MAINTENANCE MATERIALS

A. Section 01 - Closeout Procedures: Spare parts and maintenance products.

B. Furnish two fuse pullers.

1.9 EXTRA MATERIALS

A. Section 01 - Closeout Procedures: Requirements for extra materials.

B. Furnish three spare fuses of each Class, size, and rating installed.

PART 2 PRODUCTS

2.1 FUSES

A. Manufacturers:
1. Bussman.
2. Gould Shawmut.
3. Little Fuse.
4. Substitutions: Section 01 - Substitution Procedures.

B. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.

C. Voltage: Rating suitable for circuit phase-to-phase voltage.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install fuse with label oriented so manufacturer, type, and size are easily read.

END OF SECTION 262813

SECTION 262819 – ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fusible and nonfusible switches.

B. Related Sections:
   1. Section 26 28 13 - Fuses.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.
   2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Closeout procedures.

B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
   1. General Electric.
   2. Square D.
   3. Siemens.

4. Eaton/Cutler Hammer.
5. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: NEMA KS 1, enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Fuse clips: Designed to accommodate NEMA FU 1 fuses.

D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

E. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

F. Furnish switches with entirely copper current carrying parts.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.
5. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: NEMA KS 1, enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

D. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

E. Furnish switches with entirely copper current carrying parts.

2.3 SWITCH RATINGS

A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install enclosed switches plumb. Provide supports in accordance with Section 26 05 29.

B. Height:5 feet to operating handle.

C. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.

D. Install engraved plastic nameplates in accordance with Section 26 05 53.

E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

F. For switches feeding mechanical equipment, install switch within sight of the equipment.

3.2 FIELD QUALITY CONTROL

A. Section 01 – Quality Requirements: Field inspecting.

B. Section 01 - Closeout Procedures: testing, adjusting, and balancing.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION 232819

SECTION 262826 – ENCLOSED TRANSFER SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes manual transfer switch and generator connection cabinet in individual enclosures.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. Underwriters Laboratories Inc.:
   1. UL 1008 - Transfer Switch Equipment.

1.3 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 - Closeout Procedures: Closeout procedures.

B. Project Record Documents: Record actual locations of enclosed transfer switches.

C. Operation and Maintenance Data: Submit routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Supplier: Authorized distributor of specified manufacturer with minimum three years experience.

1.6 MAINTENANCE SERVICE

A. Furnish service and maintenance of transfer switch and connection cabinets for one year from Date of Substantial Completion.

1.7 WARRANTY

A. Provide an 18 month manufacturer warranty for transfer switches.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH

A. Manufacturers:
1. Foxfab (basis of design)
2. Asco
3. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Manual transfer switch. Model FFTS-M2F-V3-CRS-LA.

C. Configuration: Manually operated, mechanically held transfer switch.

D. Rating: “as indicated on drawings”.

E. Interrupting Capacity: 100 percent of continuous rating.

F. Product Features:
1. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, switch position.
2. Weatherproof Type NEMA 3R enclosure.
3. Steel Construction with ANSI 61 Grey powder coat finish.
4. Free-standing design.
5. Hinged Single Door with gaskets and pad-lockable handle.
6. Fused manual transfer switch (3-pole).
7. Pad-lockable operating handle.
8. Mechanical line and load lugs.
9. Three-phase, 208V/120V, 1600Amp rating.

G. Enclosure:
1. Enclosure: Type 3R.
2. Finish: Grey powder coat finish.

2.2 GENERATOR CONNECTION CABINET

A. Manufacturers:
1. Foxfab (basis of design)
2. Asco
3. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Connection cabinet for a portable/mobile generator. Model FFCC-A1-1200-U3-G-CRS-LA-AD.

C. Configuration: Manually operated by direct cam connections.

D. Rating: “as indicated on drawings”.

E. Interrupting Capacity: 100 percent of continuous rating.

F. Product Features:
1. Dead-front cover
2. Color coded camlock receptacles
3. Angled camlock plate for secure connection
4. Bottom cable access door
5. Three-phase, 208V/120V, 1200Amp rating.

G. Enclosure:
1. Enclosure: Type 3R.
2. Finish: Grey powder coat finish.

2.3 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing of the manual transfer switch and generator connection cabinet. Furnish a temporary generator to perform such test. The EC shall be responsible of all costs associated with the temporary generator.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install engraved plastic nameplates in accordance with Section 26 05 53.

3.2 FIELD QUALITY CONTROL

A. Section 01 - Quality Requirements: Field inspecting.

B. Inspect and test in accordance with NETA ATS, except Section 4. (Variation for manual transfer)

C. Perform inspections and tests listed in NETA ATS, Section 7.22.3.

3.3 MANUFACTURER'S FIELD SERVICES

A. Section 01 - Quality Requirements: Manufacturers’ field services.

B. Check out transfer switch connections and operations and place in service.

3.4 ADJUSTING

A. Section 01 - Closeout Procedures: Testing, adjusting, and balancing.

B. Adjust control and sensing devices to achieve specified sequence of operation.

3.5 DEMONSTRATION AND TRAINING

A. Demonstrate operation of transfer switch under load.

B. Provide minimum of 4 hours instruction to Owner & personnel by manufacturers' authorized representative.

END OF SECTION 262826

SECTION 265100 – INTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes interior luminaires, lamps, ballasts, and accessories.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 56 00 - Exterior Lighting.

1.2 REFERENCES

A. International Engineering Society of North America:
1. IESNA LM-79: Approved Method- Electrical and Photometric Measurements of Solid-State Lighting Products.
2. IESNA LM-80: Approved Method for Measuring Lumen Maintenance of LED light Sources.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.

C. Product Data: Submit dimensions, ratings, and performance data:
1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA LM-79 and IESNA LM-80.
   a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   b. Testing Agency Certified Data: Photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   c. TM-21 report for L70 rating at color temperature specified.

D. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

E. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

F. Qualification Data: For testing laboratory providing photometric data for luminaires.
1. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
3. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.
4. Sample warranty.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 MAINTENANCE MATERIALS

A. Furnish two of each plastic lens type.

B. Furnish ten replacement LED retrofit kits for each retrofit fixture type.

C. Furnish two of each ballast and LED driver type.

PART 2 PRODUCTS

2.1 INTERIOR LUMINAIRES

A. Manufacturers:
1. Manufacturers represented by Apex Lighting. (Basis of Design)
2. Manufacturers represented by Illuminate Lighting.
3. Manufacturers represented by Reflex Lighting.
4. Manufacturers represented by Lighting Affiliates.

B. Substitutions:
1. Substitutions: Section 26 04 00 - Product Requirements and as follows:

a. Approved equals to the basis of design fixture shall be accepted for review with the proposed substitute fixture meeting the following minimum requirements:
   1) Be of the same general size, style and shape, including but not limited to lens construction and shading.
   2) Be of equal or better quality and construction.
   3) Be supplied with all required accessories to match the specified fixture.
   4) Be supplied with all remote drivers, power supplies and cabling lengths to meet specified performance and control.
   5) Provide the same or better distribution, efficiency, source lumen output, and L70 lumen depreciation metric.
b. Provide point-by point photometric calculations at the request of the Engineer for evaluation.
c. The basis of design fixture listed in the Lighting Fixture Schedule lists part numbers, specifications, options, accessories and source output available at the time of design. Substitutions shall meet these requirements as scheduled.
d. The evaluation of an approved equal shall be at the sole discretion of the Architect and Engineer.

C. Product Description: Complete interior luminaire assemblies, with features, options, and accessories as scheduled.

D. Performance requirements:
1. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
2. Luminaire requirements
   a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   b. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
   c. Recessed Fixtures: Comply with NEMA LE 4.
   d. Bulb shape complying with ANSI C79.1.
   e. Lamp base complying with ANSI C81.61.
   f. CRI of minimum 80.
   g. LED lamp life, minimum of 70,000 hours.
   h. TM-21 L70 lumen depreciation metric calculated at color temperature listed.
   i. Internal ballast/driver.
   j. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.2 MATERIALS

A. Metal Parts:
1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

4. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
5. Diffusers and Globes:
   a. Refer to Interior Light Fixture Schedule for types.
   b. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   c. Glass: Annealed crystal glass unless otherwise indicated.
   d. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

6. Housings:
   a. Extruded-aluminum housing and heat sink unless otherwise indicated.
   b. Powder-coat finish unless otherwise indicated, color selection by Architect.

7. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   a. Label shall include the following characteristics:
      1) CCT and CRI for all luminaires.

B. METAL FINISHES
1. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.3 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage minimum.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

F. Product Description: Electronic ballast instant start (program start where controlled by occupancy sensors) by Certified Ballast Manufacturers, Inc. to comply with ANSI C82.1, suitable for lamps specified, with voltage to match luminaire voltage.

2.4 LED DRIVERS

A. Manufacturers:
1. eldoLED
2. Lutron.
3. General Electric Co.
4. Philips Electronics North America.
5. Osram/Sylvania.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: LED dimming driver.
1. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers

C. General:
1. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
3. Driver must limit inrush current.
   a. Base specification: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 $Amps^2$ – seconds.
   b. Preferred Specification: Meet or exceed $30mA^2s$ at 277VAC for up to 50 watts of load and 75A at 240us at 277VAC for 100 watts of load.
4. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
5. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
6. Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
7. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
   a. Adjustment of forward LED voltage, supporting 3V through 55V.
   b. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
   c. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
8. Driver must be able to operate for a (+/- 10%) supply voltage of 120V through 277VAC at 60Hz.
9. Driver should be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
10. Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be

extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.

D. Light Quality
1. Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 1 percent and 10% relative light output where indicated, or 100 – 10% light standard. Driver shall respond similarly when raising from 1% to 100%
a. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
2. Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
3. Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-1 percent luminaire shall have:
a. LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
b. Base specification: Flicker index shall be less than 5% at all frequencies below
c. 1000 Hz.
d. Preferred specification: Flicker index shall be equal to incandescent and less than 1% at all frequencies below 1000 Hz.

E. Control Input
1. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
a. Must meet IEC 60929 Annex E for General White Lighting LED drivers
b. Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
c. Must meet ESTA E1.3 for RGBW LED drivers

F. Driver: Selected by dimming system manufacturer as suitable for operation with control unit and suitable for LED source type and quantity specified for luminaire.

2.5 LED FIXTURES

A. Refer to light fixture schedule.

B. Minimum allowable efficacy of 130 lumens per watt to satisfy DLC qualification criteria.

C. Integral junction box with conduit fittings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install suspended luminaires using pendants supports. Install pendant length required to suspend luminaire at indicated height.
   1. Suspended Luminaire Support:
      a. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
      b. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box, heavy-duty swivel hangers and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
      c. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
      d. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

B. Support luminaires independent of ceiling framing.

C. Where remote ballasts are required, mount ballasts in remote locations as per the manufacturers' recommendations and per ballast requirements, at no additional cost.

D. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

E. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

F. Exposed Grid Ceilings: Support surface-mounted luminaires on grid ceiling directly from building structure.

G. Install recessed luminaires to permit removal from below.

H. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

I. Install clips to secure recessed grid-supported luminaires in place.

J. Install wall-mounted luminaires at height as indicated on Drawings and as scheduled.

K. Install accessories furnished with each luminaire.

L. Connect luminaires to branch circuit using flexible conduit, except for emergency lighting which shall be in conduit completely.

M. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

N. Install specified lamps in each luminaire.

O. Ground and bond interior luminaires in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Aim and adjust luminaires as indicated on Drawings.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Remove dirt and debris from enclosures.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

B. Relamp luminaires having failed lamps at Substantial Completion.

3.6 SCHEDULES

A. Refer to Drawings.

END OF SECTION 265100

SECTION 265200 – EMERGENCY LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes emergency lighting units and exit signs.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 51 00 - Interior Lighting: Exit signs.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SYSTEM DESCRIPTION

A. Emergency lighting to comply with requirements.

1.4 SUBMITTALS

A. Section 01 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit dimensions, ratings, and performance data.

C. Samples: Submit two color chips 3 x 3 inch in size illustrating unit finish color.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 EXTRA PRODUCTS

A. Provide (2) emergency lighting units complete with all labor and materials required for installation as directed by the Local Authority Having Jurisdiction.

B. Provide (5) universal exit signs complete with all labor and materials required for installation as directed by the Local Authority Having Jurisdiction.

1.7 MAINTENANCE MATERIALS

A. Section 01 - Closeout Procedures: Spare parts and maintenance products.

B. Furnish one replacement lamps for each lamp installed.

C. Furnish one replacement battery for each battery type and size.

PART 2 PRODUCTS

2.1 EXIT SIGNS

A. Manufacturers:
1. Manufacturers represented by Apex Lighting. (Basis of Design)
2. Manufacturers represented by Illuminate Lighting.
3. Manufacturers represented by Reflex Lighting.
4. Manufacturers represented by Lighting Affiliates.

B. Product Description: Exit sign fixture.

C. Housing: as Scheduled.

D. Face: as scheduled.

E. Letters and Directional Arrows: As indicated on Drawings.

F. Mounting: As indicated on Drawings.

G. Fixtures shall be provided to suit the Connecticut approved Symbol of Accessibility.

H. Fixtures shall be provided to suit a combination EXIT sign and Symbol of Accessibility.

I. Lamps: LED

J. Input Voltage: 120 volts.

2.2 EMERGENCY LIGHTING SHUNT/BYPASS RELAYS

A. Manufacturers:
1. Douglas Lighting Controls
2. Hubbell Control Solutions
3. WattStopper
4. Substitutions: Section 01 - Substitution Procedures.

B. Product Description: Relay unit capable of switching lights on in event of power failure. Input Voltage: 120 volts.

C. Products must be capable of 0-10 volt dimming signal override. Refer to the lighting control details for specific applications.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install suspended exit signs using pendants supported from swivel hangers. Install pendant length required to suspend sign at indicated height.

B. Install surface-mounted exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install wall-mounted exit signs at height as indicated on Drawings.

D. Install accessories furnished with each exit sign.

E. Connect exit signs to branch circuit outlets provided in Section 26 05 33 as indicated on Drawings.

F. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within unit.

G. Install specified lamps in each exit sign.

H. Ground and bond exit signs in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Section 01 – Quality Requirements: Field inspecting.

B. Operate each unit after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Section 01 - Closeout Procedures: Testing, adjusting, and balancing.

B. Aim and adjust lamp fixtures as indicated on Drawings.

C. Position exit sign directional arrows as indicated on Drawings.

3.4 PROTECTION OF FINISHED WORK

A. Section 01 - Closeout Procedures: Protecting finished work.

B. Replace any units that are not fully functional at Substantial Completion.

3.5 SCHEDULES

A. See Drawings.

END OF SECTION 265200

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Section Includes:
1. Wire.
2. Mechanical connectors.

B. Related Sections:
1. Section 07 8413 - Firestopping: Product requirements for firestopping for placement by this section
2. Section 26 0526 - Grounding and Bonding for Electrical Systems.

1.3 REFERENCES

A. Building Industry Consulting Service International, Inc.
1. BICSI TDM Manual - Telecommunications Distribution Methods Manual.

B. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

C. Telecommunication Industry Association/Electronic Industries Alliance:
1. TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.4 SYSTEM DESCRIPTION

A. Communications grounding systems use the following elements as grounding electrodes:
1. Building grounding electrode.

B. Do not use the following elements as grounding electrodes:
1. Building plumbing system.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 25 ohms maximum.

1.6 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

D. Manufacturer's Installation Instructions: Submit for active electrodes.

1.7 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.8 QUALITY ASSURANCE

A. Provide grounding, surge protection and lightning protection of telecommunications system in accordance with latest version of Grounding, Bonding and Electrical Protection chapter of the BICSI TDM Manual, TIA/EIA 607, and NFPA 70.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.11 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 WIRE

A. Material: Stranded copper, size as indicated in telecom grounding riser.

B. Grounding Conductor: Copper conductor bare or insulated.

C. Bonding Conductor: Copper conductor bare.

2.2 MECHANICAL CONNECTORS

A. Manufacturers:
1. Copperweld, Inc.
2. Erico, Inc.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical
5. Substitutions: Section 01 60 00 - Product Requirements

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.2 INSTALLATION

A. Install grounding and bonding conductors concealed from view.

B. Install grounding for racks and equipment using 6 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor to copper communication grounding bus bar located in MDF.

C. Bond main telecommunications grounding system to building grounding electrode system at main electrical service entrance location with 6 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor.

D. Install routing for grounding conductor as short and direct as practical.

E. Install routing of bonding conductors with minimum number of bends and splices. Use sweeping bends.

F. Install bonding connections with listed bolts, crimp pressure connectors, clamps, or lugs.

G. Position busbars near associated equipment and insulate from supports.

H. Construct busbars of copper, 4 inches x 8 inches by 1/4 inch thick with pilot holes for ground lug.

I. Bond backbone cabling at each sheath opening.

J. Ground data cabinets, racks, cable trays, and mounting hardware located MDF and IDFs.

K. Install ground from each piece of equipment to MDF Room grounding bar via an insulated cable no smaller than 6 AWG stranded copper wire. Install proper grounding lug on cable where connecting to racks and grounding bar.

L. Label grounding conductors and grounding bus bars in accordance with Section 27 05 53.

M. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Visually inspect from each bus bar to main grounding electrode service location.

C. Test in accordance with BICSI TDM Manual, TIA/EIA 607, and NFPA 70.

D. When improper grounding is found, check entire project and correct. Perform retest.

END OF SECTION 270526

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications

1.2 SUMMARY

A. Section Includes:
1. Conduit supports.
2. Spring steel clips.
3. Sleeves & Seals

1.3 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
1. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
2. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

D. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of hangers and supports.

E. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience, approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. Electroline Manufacturing Company.
3. O-Z Gedney Co.
4. Thomas and Betts
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 SPRING STEEL CLIPS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Mounting hole and screw closure.

2.3 SLEEVES

A. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for conduit, cable tray, raceway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

2.4 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. PSI Link-Seal.
4. Substitutions: Section 01 60 00 – Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

3.2 PREPARATION

A. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
   1. Concrete Structural Elements: Provide, expansion anchors, and preset inserts.
   2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners.
   3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
   4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
   5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
   6. Sheet Metal: Provide sheet metal screws.
   7. Wood Elements: Provide wood screws.

B. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:
   1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
   2. Install surface mounted cabinets and panelboards with minimum of four anchors.
   3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
   4. Support vertical conduit at every floor.

3.4 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

3.5 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements:Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION 270529

SECTION 270533 - CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:
1. Section 07 8413 - Firestopping: Product requirements for firestopping for placement by this section
2. Section 26 0503 - Equipment Wiring Connections.
3. Section 26 0533 - Raceway and Boxes for Electrical Systems.
4. Section 26 0534 - Floor Boxes for Electrical Systems.
5. Section 26 2726 - Wiring Devices.
6. Section 27 0526 - Grounding and Bonding for Communications Systems.
7. Section 27 0529 - Hangers and Supports for Communications Systems.

C. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.

D. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
5. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
6. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

E. Allowances: Refer to Division 01 Section “Allowances” for lump-sum allowance for additional conduit and backboxes.

F. Unit Prices: Administrative and procedural requirement for unit prices for conduit and backboxes are specified in Division 1 Section “Unit Prices”.

1.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

1.4 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit for the following:
1. Metallic conduit
2. Liquidtight flexible metal conduit.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:
1. Record actual routing of conduits larger than 2 inch.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 6000 - Product Requirements: Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.8 COORDINATION

A. Section 01 3000 - Administrative Requirements: Coordination and project conditions.

B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.Rigid Steel Conduit: ANSI C80.1.

B. Rigid Aluminum Conduit: ANSI C80.5.

C. Intermediate Metal Conduit (IMC): Rigid steel.

D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Anamet Electrical.
3. Allied Tube and Conduit.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Interlocked steel aluminum construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel

2.4 OUTLET BOXES

A. Manufacturers:
1. Erico Products.
2. Raco.
3. Thomas & Betts Corp.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
   2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic Outlet Boxes: NEMA OS 2.

D. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer.

E. Wall Plates for Finished Areas: As specified in Section 26 27 26.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.5 PULL AND JUNCTION BOXES

A. Manufacturers:
   1. Carlon Electrical Products.
   2. Hubbell Wiring Devices.
   3. Thomas & Betts Corp.
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 26 27 16.

D. Surface Mounted Cast Metal Box: NEMA 250; flat-flanged, surface mounted junction box:
   1. Material: Galvanized cast iron Cast aluminum.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 26 05 26.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.

C. Identify raceway and boxes in accordance with Section 26 05 53.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 26 05 29.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit in and under slab from point-to-point.

K. Maximum Size Conduit in Slab Above Grade: 3/4 inch. Do not cross conduits in slab larger than 1/2 inch.

L. Maintain clearance between raceway and piping for maintenance purposes.

M. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

N. Cut conduit square using saw or pipe cutter; de-burr cut ends.

O. Bring conduit to shoulder of fittings; fasten securely.

P. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

Q. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

R. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install hydraulic one-shot bender to fabricate factory elbows for bends in metal conduit larger than 2 inch size.

S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

W. Close ends and unused openings in wireway.

3.4 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings. specified in section for outlet device.

B. Adjust box location prior to rough-in to accommodate intended purpose.

C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

I. Install stamped steel bridges to fasten flush mounting outlet box between studs.

J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

K. Install adjustable steel channel fasteners for hung ceiling outlet box.

L. Do not fasten boxes to ceiling support wires or other piping systems.

M. Support boxes independently of conduit.

N. Install gang box where more than one device is mounted together. Do not use sectional box.

O. Install gang box with plaster ring for single device outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements.

B. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.6 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.7 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION 270533

SECTION 271300 - TELECOMMUNICATIONS AND DATA WIRING SYSTEM

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SECTION INCLUDES

A. Horizontal data/VOIP cabling and infrastructure.

B. IT rack hardware.

C. Patch panels.

1.3 RELATED SECTIONS

A. Carefully examine all of the Contract Documents for requirements that affect the work of this section. Other specification sections that directly relate to the work of this section include, but are not limited to the following:
1. Section 27 0526 – Grounding and Bonding for Communication Systems
2. Section 27 0529 – Hangers and Supports for Communication Systems
3. Section 27 0533 – Conduits and Backboxes for Communication Systems
4. Section 27 0536 – Cable Trays

1.4 REFERENCES

A. All wire and components supplied and installed shall meet the requirements of the following and all sub-referenced documents:
1. The National Electrical Code, Article 800.
2. Underwriters Laboratories (UL).
3. EIA/TIA 568-B.
4. EIA/TIA 569.
5. BICSI TDMM

1.5 SYSTEM DESCRIPTION

A. Service entrance from Telecommunications Utility Company.

B. Service entrance pathway: Empty raceway, boxes, etc. from utility pole to telecommunications demarcation point.

C. WAN fiber optic pathway: Empty raceway, boxes, etc. from telecommunications demarcation point to main server rack in MDF. Entrance wiring by utility company.

D. Backbone pathway: Conform to TIA/EIA 569 using conduit, sleeves, J-Hooks, and other methods indicated on drawings.

E. Horizontal pathway: Conform to TIA/EIA 569 using conduit, sleeves, J-Hooks, and other methods indicated on drawings.

F. Backbone wiring: Complete from point of utility Co. termination in MDF to each IDF using unshielded voice backbone and optical fiber communications backbone cables.

G. Horizontal wiring: Complete from rack in MDF or IDF to each outlet using unshielded horizontal cables as indicated on drawings.

H. Network equipment racks, cabinets, and accessories.

I. Fireproofing of penetrations, grout, sleeve seals and openings for pathways.

J. Testing, certification, and warranty for all cabling.

K. Record drawings and documentation.

L. Operation and Maintenance Instruction Manuals.

M. Training for work and equipment of this section.

1.6 SUBMITTALS

A. Section 01 3300 – Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturer’s product data, installation instructions, use limitations and recommendations for each material used.

C. Authorizations: The vendor must submit, with this bid, proof of any manufacturer's authorizations that may be required to sell, install and configure proposed cable and hardware.

D. Warranty Information: The vendor is required to submit, with this bid, specifications describing the standard warranty for all proposed cable and hardware. Minimum warranty accepted shall be 2 years.

E. Field Quality Control Reports.

1.7 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations and sizes of pathways and outlets.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum THREE YEARS documented experience.

B. UL Compliance: The communication system supplied shall be listed by Underwiters' Laboratories under the UL Standard 1459 for Telephone Appliances and Equipment. A copy of the UL listing card for the proposed system shall be included with the contractor's submittal.

C. FCC Approval: The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Systems that are not FCC approved or that utilize intermediary devices for connection, shall not be considered. Provide FCC registration number of the system being proposed as part of the submittal process.

D. Installer: Company specializing in installing products specified in this section with minimum three years documented experience, and with service facilities within 50 miles of project.
   1. Evidence of ability: Furnish training certifications. Certified training shall be industry recognized at least equal to:
      a. Building Industry Consulting Service international, Inc (BICSI).
      b. Ortronics Certified installer.
      c. Hubbell Certified installer.
      d. Leviton Certified Installer.
      e. Siemon Cabling System Certified Installer.

E. Provide a full time, on-site Project manager to supervise the project.

F. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.9 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 – Administrative Requirements: pre-installation meeting.

B. Convene minimum THREE WEEKS prior to commencing work of this section.

1.10 EXTRA MATERIALS

A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish ten single gang 4-port face plates.

C. Furnish ten communications outlet jacks of each type.

D. Furnish 2-48 port patch panels.

E. Furnish 2-horizontal wire managers.

F. Furnish five of each length and type of patch cords.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.12 COORDINATION

A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.

B. Pre-installation Conference: Conduct conference at project site to comply with requirements in Section 01 1100.

C. Coordinate with utility company, relocation of overhead of underground lines interfering with construction.

D. Contact utility company regarding charges related to service installation. Include utility charges in this contract.

E. Utility charges for service installation paid by Owner and are not part of this contract.

1.13 MOCKUP

A. Provide a complete Classroom mock-up (one typical classroom) for coordination and review by owner and engineer prior to installing systems throughout the building. Refer to section 01 4000 Quality Requirements and Section 26 0400 – General Conditions for Electrical Trades.

1.14 WARRANTY

A. Provide a warranty for one (1) year against defects in material and workmanship on al components, equipment, software, systems, cabling, etc. as specified herein. Warranty shall start at time of substantial completion or beneficial use, whichever comes sooner. Any failure due to defective material, equipment, installation, or workmanship that may develop over the course of the warranty period shall be corrected at no expense to the Owner, including all materials, labor, travel and expenses.

B. Data Cabling Warranty: provide a manufacturer's data cabling twenty-five (25) year mission critical warranty for voice and data structured cabling system.
   1. The Contractor shall provide documented proof that he/she is authorized and certified and in good standing with the manufactures to provide this warranty.
   2. The contractor shall provide a written 25-year warranty from the manufacturer at substantial completion of the project.
   3. The warranty shall include connecting hardware products and installed cable as part of the data cabling system warranty.
   4. The data cabling system shall include:
      a. Work area outlets.
      b. Horizontal cable.
      c. Backbone cable.
      d. The connecting hardware in the horizontal cross-connect.

e. The equipment patch cord at the work area outlet.
f. The patch cord at the horizontal cross-connect.

5. The manufacturer's warranty shall guarantee that the data cabling system shall be free from defects in materials and workmanship for the duration of the warranty.

PART 2 PRODUCTS

2.1 HORIZONTAL CABLE

A. Manufacturers:
1. General Cable
2. Belden
3. Mohawk
4. Allied Wire & Cable
5. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Unshielded, twisted pair 23AWG wire (UTP) with suitable insulation and sheath material to meet or exceed EIA /TIA 568C.0 or equivalent. The wire shall be type communications riser cable (CMR). Cables shall adhere to the EIA/TIA Category 6 specifications.

C. Provide 9" of slack on outlet boxes behind each faceplate.

D. Pulling tension: The cable pulling tension shall not exceed 25 ft/lbs as indicated in TIA/EIA-568-A.

E. Supports: Horizontal cabling shall be supported via cable trays where indicated in drawings. Refer to Section 27 05 36. Cabling between cable tray and work station conduit shall be supported via J-Hooks as indicated in drawings. J-Hooks shall be manufactured by:
1. Cooper B-Line
2. Caddy
3. Chatsworth

F. Copper Telephone: Provide a copper telephone system (POTS) as follows:
1. Provide and terminate copper pair backbone cabling at each IDF/MDF for emergency telephone/fax backup. Quantity of copper pairs as indicated on drawings.
2. Terminate copper pairs in 110 type blocks.
3. Provide cable jacket. Provide CMR or CMP rated cable for riser applications.
4. Provide EIA/TIA Cat. 3 UTP cabling from 110 blocks to "analog" work stations, as indicated on drawings.

2.2 COPPER PATCH PANELS AND TERMINATIONS

A. Manufacturers:
1. Hubbell
2. Ortronics
3. Panduit
4. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: TIA/EIA 568 19 inch, Cat. 6 rated, rack-mounted panels with 110-type terminations.

C. Panels shall be 48 port, 2U, UL Cat. 6 type with integral printed circuit board, color coding, 110-type IDC terminations, and 8-position jacks.

D. Each port shall include a color coded identification label.

E. Provide horizontal wire management above and below each patch panel. Provide rear cable management bar with strain-relief brackets behind each patch panel.

F. Patch Cords: Supply patch cords which meet the following specification and are of the same TIA/EIA category rating and manufacturer as the workstation cabling:
1. 4- unshielded twisted pairs
2. 24 AWG stranded conductors
3. Thermoplastic Dielectric
4. EIA/TIA 568B Category 6
5. Quantity: (48) per each Patch Panel provided for the project, plus 10% spare capacity
6. Length: Coordinate length with owner.

2.3 RACK HARDWARE

A. Manufacturers:
1. Hubbell
2. Chatsworth
3. Middle Atlantic
4. Great Lakes
5. Ortronics/Legrand
6. Substitutions: NOT ACCEPTED.

B. Equipment Racks: Free standing equipment racks shall be seven feet high, EIA 19” wide, open bay as indicated on drawings. Racks shall include the following features:
1. Universal, 10-32 threaded hole pattern on the front and rear flanges, and mounting holes on both sides of the rack for wire management.
2. Shelves for electronic equipment rated load carrying capacity of 125% of each piece of equipment.
3. Mounting brackets to support equipment installed in the racks.
4. Hook and loop Velcro cable strain-relief system on rear of rack to support horizontal and backbone cable.
5. Hook and loop Velcro cable strain-relief system on front of rack for dressing patch cables and cross-connect wiring.
6. Bonding and grounding cables for all equipment not directly bolted to equipment rack.
7. Grounding bus bar with terminals for #6 copper minimum bonding cables.
8. Provide all hardware and accessories required to properly support rack from the top and bottom and assemble rack in place.

C. Equipment Cabinets: Cabinets shall be seven feet high, 24 inches wide and 31.5 inches deep. Cabinets shall include the following features:
1. Welded construction (steel or aluminum) with full hinge doors and keyed locks (all cabinets keyed alike). Color as approved by Architect. Front door shall include vision panel, rear-door shall include louvers for ventilation.
2. Integral EIA four (4) post equipment rack with, 10-32 threaded hole pattern for mounting of equipment.
3. Adjustable front and rear mounting rails specifically designed to support equipment installed in the rack.
4. Hook and loop Velcro cable strain-relief system on rear of rack to support horizontal and backbone cable.
5. Hook and loop Velcro cable strain-relief system on front of rack for dressing patch cables and cross-connect wiring.
6. Integral fans and louvers to adequately ventilate the equipment within the cabinets. Maintain to be no greater the 88 degrees F in warmer months.
7. Bonding and grounding cables for all equipment not directly bolted to equipment rack.
8. Grounding bus bar with terminals for #6 copper minimum bonding cables.
9. Surge protected power strip.
10. Provide all hardware and accessories required to properly support rack from the top and bottom and assemble rack in place.

D. Cable Management:
1. Provide horizontal cable management above and below each patch panel, and in locations shown on drawings. Horizontal management shall be sized no smaller than 1U.
2. Provide 6” rear cable management bar located behind each patch panel, and in locations shown on drawings.
3. Provide vertical cable management on both sides of each rack, and in locations shown on drawings. Vertical management shall be sized no smaller than 6”. When mounted between racks, size no smaller than 12”.

2.4 BACKBOARDS

A. Material: Class “A” fire retardant plywood.

B. Size: 3/4" thick. Width and Height as indicated on drawings.

C. Paint with two(2) coats of grey paint.

2.5 POWER DISTRIBUTION

A. MANUFACTURER:
1. Tripp-Lite (basis of design)
2. APC
3. Substitutions: See division 1 – Product Requirements.

B. PRODUCT DESCRIPTION:
1. Provide rack mounted vertical and horizontal power distribution units as indicated on drawings.
2. All PDU's shall be powered via owner-provided UPS at bottom of rack, unless otherwise noted.

C. VERTICAL PDU:
1. All vertical power distribution units shall meet or exceed the following general requirements:
a. L5-20P input plug. Contractor shall provide all necessary adapters to convert input plug to 5-20P if no L5-20R outlets are available in owner-provided UPS. Input plug shall be at least 10 feet long.
b. 120VAC input.
c. 2.4KW nominal load capacity.
d. Twenty-eight(28) NEMA 5-20R outlets.
e. 60" height.
f. Unit shall be metered, using a Digital LED display to show the total current draw of connected equipment in amps.
g. PDU's shall be surge protected.
2. Vertical power distribution units shall be mounted directly to each side of rack, as indicated in drawings. Provide all necessary mounting hardware.
3. Vertical power distribution units shall be Tripp-Lite model PDUMV20 or equal.

D. HORIZONTAL PDU:
1. All horizontal power distribution units shall meet or exceed the following general requirements:
a. L5-20P input plug. Contractor shall provide all necessary adapters to convert input plug to 5-20P if no L5-20R outlets are available in owner-provided UPS. Input plug shall be at least 10 feet long.
b. 120VAC input.
c. 2.4KW nominal load capacity.
d. Twelve(12) NEMA 5-20R outlets.
e. 1U width.
f. Unit shall be metered, using a Digital LED display to show the total current draw of connected equipment in amps.
g. PDU's shall be surge protected.
2. Horizontal power distribution units shall be mounted within rack, as indicated in drawings. Provide all necessary mounting hardware.
3. Horizontal power distribution units shall be Tripp-Lite model PDUMH20 or equal.

2.6 UNINTERRUPTIBLE POWER SUPPLIES

A. Manufacturer:
1. Tripp-Lite (basis of design)
2. APC
3. Eaton
4. Substitutions: See Division 1 – Product Requirements.

B. Product Description:
1. Provide uninterruptible power supplies in locations indicated on drawings. VA, voltage, and phase ratings as indicated on drawings. The below specifications apply to UPS units of various voltage/amperage combinations.

C. 3000VA units shall meet the following specifications:
1. Outputs:
a. Output capacity: 3000VA / 3.0kVA / 2880W.
b. Power factor: 0.96
c. Frequency: 60 Hz
d. Output voltage regulation (line mode): -14%, +6%
e. Output voltage regulation (battery mode): -5%, +5%
f. Output receptacles: Eight(8) 5-15/20R; One(1) L5-30R.
g. Output circuit breakers: Two 20A output breakers protect four 5-15/20R outlets each.
h. Two(2) switched single outlet load banks: (2) 5-15/20R.
i. Output waveform (line mode): Pure sine wave
j. Output waveform (battery mode): Pure sine wave
2. Inputs:
a. Rated input current: 24A
b. Nominal input voltage: 120VAC
c. Input connection type: L5-30P
d. Input cord length: 10 ft.
e. Input phase: Single
3. Battery:
a. Full load runtime: 3 min. @ 2880W
b. Half load runtime: 10 min. @ 1440W
c. DC system voltage: 48VDC
d. Recharge rate: Less than 5 hours from 10% to 90%.
e. Battery Access: Front panel battery access door
f. Transfer time: 5 milliseconds (line to battery mode)
4. Input Voltage Regulation:
a. Automatic voltage regulation (AVR) maintain line power operation with an input voltage range of 83 to 145 VAC.
b. Voltage reduction of 12% applies when input is between 127 and 145.
c. Voltage boost of 12% applies when input is between 96 and 108.
d. Voltage boost of 24% applies when input is between 83 and 95.
5. User Interface:
a. Unit is equipped with LCD information screen.
b. Front panel LCD information and configuration screen offers details UPS and site power status and operating data, plug configuration of voltage, operating mode, alarm function and a variety of additional options.
c. 3 pushbutton switches control OFF/ON power status, MODE selection and MUTE/ENTER control functions.
d. Power-fail alarm can be temporarily silenced using alarm-cancel switch; silent mode alarm configuration option available.
e. Audible alarm indicates UPS startup, power-failure, low-battery, overload, UPS fault and remote shutdown conditions.

6. Physical:
   a. Rack- mountable in both 2 and 4 post racks.
   b. 2U rack height.
   c. Steel housing.
7. Environmental:
   a. 32 to 104º(F) operating temperature
   b. 5 to 122º(F) storage temperature
   c. 0 to 95% relative humidity; non-condensing.
   d. Heat output: 409 BTU / hr.
8. Certifications and Warranty:
   a. UL1778 certified.
   b. 2-year warranty.
9. 120VAC, 30A UPS shall be Tripp-Lite SMART3000RMXL2U or approved equal.

D. 5000VA units shall meet the following specifications:
1. Outputs:
   a. Output capacity: 5000VA / 5.0kVA / 3750W.
   b. Power factor: 0.75
   c. Frequency: 60 Hz
   d. Output voltage regulation (line mode): -10%, +10%
   e. Output voltage regulation (battery mode): -5%, +5%
   f. Output receptacles: Eight (8) 5-15/20R; Two(2) L6-20R; One(1) L6-30R.
   g. Output circuit breakers: 20A double pole breaker supports L6-20R outlets, 20A branch rated breaker (x2) supports four 5-15/20R outlets each, L6-30R outlet is unbreakered.
   h. Output waveform (line mode): Sine wave
   i. Output waveform (battery mode): Pure sine wave
2. Inputs:
   a. Rated input current: 24A
   b. Nominal input voltage: 208VAC
   c. Input connection type: L6-30P
   d. Input cord length: 10 ft.
   e. Input phase: Single
3. Battery:
   a. Full load runtime: 8.5 min. @ 3750W
   b. Half load runtime: 20 min. @ 1875W
   c. DC system voltage: 48VDC
   d. Recharge rate: Less than 4 hours from 10% to 90%.
   e. Battery Access: Front panel battery access door
   f. Transfer time: 7 milliseconds (line to battery mode)
4. Input Voltage Regulation:
   a. Automatic voltage regulation (AVR) maintain line power operation with an input voltage range of 167 to 260 VAC.
   b. Voltage reduction of 12% applies when input is between 228 and 260.
   c. Voltage boost of 12% applies when input is between 167 and 194.

5. User Interface:
   a. 2 pushbutton switches control OFF/ON power status and alarm-cancel/ self-test operation.
   b. Power-fail alarm can be temporarily silenced using alarm-cancel switch; once silenced, alarm will re-sound to indicate low battery status.
   c. Audible alarm indicates power failure, overload, and low battery conditions.
   d. 5 LEDs indicate line power, battery power, overload, voltage regulation, and battery low/replace status.
6. Physical:
   a. Rack- mountable in both 2 and 4 post racks.
   b. 3U rack height.
   c. Steel housing.
7. Environmental:
   a. 32 to 104º(F) operating temperature
   b. 5 to 122º(F) storage temperature
   c. 0 to 95% relative humidity; non-condensing.
   d. Heat output: 671 BTU / hr.
8. Certifications and Warranty:
   a. UL1778 certified.
   b. 2-year warranty.
9. 208VAC, 30A UPS shall be Tripp-Lite SMART5000XFMRXL or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Rated Stairs: Penetrations into stairs are NOT permitted except for items serving that stair.

B. Wiring Method:
   1. Install all required telecommunications conduits, sleeves, and back boxes. Conduits, sleeves and boxes shall be installed in accordance with Section 270533.
   2. Install cables in raceways, conduits and interstitial spaces above suspended ceilings.
   3. Conceal wiring except in unfinished spaces.
   4. Wire shall not be subjected to pulling tensions greater the maximum specified by the manufacturer
   5. Wire bend radius shall not be less than the manufacturer’s minimum of one (1) inch.
   6. Support cables that are not in raceway or conduit at intervals no greater than 60 inches with supports designed for high-speed twisted pair wire (“J “ hooks)

C. Riser Cables:
   1. Install multimode and single mode fiber optic cable through the ceilings and riser conduit as indicated on the attached cable plates. The fiber shall be run in innerduct for its entire length. Cables shall be terminated as follows:

2. Multi/Single Mode Fiber: Mount SC type terminators in a 19" rack mounted enclosure at both ends.

D. Horizontal Cables:
1. Mount new station jacks on the specified plate, flush or surface mounted, as construction requires.
2. STATION IDENTIFICATION: Label connectors at station faceplates using the following system:
   a. Data Jacks: "D–", followed by the room number, followed by "–#" (where # is the number in sequence.)
   b. VOIP Jacks: "V–", followed by the room number, followed by "–#" (where # is the number in sequence.)
   c. Wireless Access Points: "W–", followed by the room number, followed by "–#" (where # is the number in sequence.)
   d. Security cameras: "S–", followed by the room number, followed by "–#" (where # is the number in sequence.)
   e. Devices located outside shall use "OUT" in place of room number.
   f. Example: If there are (4) data jacks and (2) VOIP jacks in room 133, they shall be labeled as:
      1) D—133—1
      2) D—133—2
      3) D—133—3
      4) D—133—4
      5) V—133—1
      6) V—133—2
3. Mark the plate with standard nomenclature as required by the configuration. Mark the outlet plainly and neatly with its station identification, as indicated in above paragraph. The station identification shall also be marked inside the outlet plate on the backing plate of the outlet, and shall match the ID used at the patch panel port. Make the outlet marking using the Panduit system or equal, except for the inside marking which may be by indelible marker. Place exposed marking on outlet plates under a transparent window for protection. Label cable with permanent marker compliant with EIA/TIA 606, six (6) inches back from the termination at both ends.
4. At the station end, terminate 4-pair UTP cables on 8-pin modular jacks according to TIA/EIA 568B terminating specifications.
5. At the telecom room, terminate all 4-pair UTP cables (voice & data) onto panel mounted 8-pin modular connectors that meet the TIA/EIA Category 6 specification. Provide sufficient patch jacks (ports) at each telecom closet to terminate the cables from all of the stations served by that closet. Mark the voice and data patch terminating jacks with its associated station identification in ascending sequential order. Mark patch panel using the Panduit system or equal. Match the patch panels into the supplied equipment racks.
6. Analog Line (Emergency Line) Connection:
   a. Coordinate with Telephone provider. Telephone provider shall terminate phone service at DEMARC. Contractor shall extend, punch down and make final connections to the specific locations listed below for complete service.
   b. Provide 110 type blocks as indicated in above PART 2. Terminate all cables within these blocks.

c. The Contractor is responsible for establishing an analog metallic connection to each “ANALOG” line, locations shown on drawings.

7. Provide coaxial cabling from work stations back to cable company demarcation equipment.

3.2 TESTING, HORIZONTAL CABLING

A. Horizontal cabling testing shall be conducted from the jack at the outlet in the Work Area to the Patch Panel on which the cables are terminated.

B. Baseline accuracy of the test equipment must exceed TIA Level III, as indicated by independent laboratory testing. Test adapter cable must be approved by the manufacturer of the test equipment.

C. All horizontal cables must be tested with a Level 3 Fluke DTX Networks Cable Tester.

D. Testing of the Permanent Link shall be performed. However, contractor shall warrant performance based on channel performance and provide patch cords that meet channel performance criteria. All cabling not tested strictly in accordance with these procedures shall be retested at no cost to the Owner.

E. Horizontal station cables shall be free of shorts within the pairs, and be verified for continuity, pair validity, and polarity, and Wire Map (Conductor Position on the Modular Jack). Any defective, split or miss-positioned pairs must be identified and corrected.

F. Testing of the Cabling Systems rated at TIA Category 6 and above shall be performed to confirm proper functioning and performance.

G. Testing of the Transmission Performance of station cables (Category 6 shall include):
1. Length
2. Attenuation
3. Pair to Pair NEXT
4. ACR
5. PSNEXT Loss
6. Return Loss
7. Pair to Pair ELFEXT Loss (Equal Level Far End Cross-Talk)
8. PSEFEXT Loss
9. Propagation Delay
10. Delay Skew
11. Return Loss

H. The maximum length of horizontal cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables.

I. Cables shall be tested to the maximum frequency defined by the EIA/TIA 568B standards covering that performance category. Test records shall verify a “PASS” on each cable and display the specified parameters – comparing test values with standards based “templates” integral to the unit.

J. Any “Pass*” or “Warning” test results shall be considered a “FAIL” for the channel or permanent link under test. In order to achieve an overall “Pass Condition”, the test result for each individual test parameter shall be “PASS”.

K. All data shall indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1MHz to the highest relevant frequency, using a swept frequency interval consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations. And in both directions when required by the appropriate standards.

3.3 TESTING, FIBER OPTIC CABLING

A. Tests after Installation
1. Upon completion of a cable installation and termination, the Fiber Optic cabling shall be tested to include Optical Attenuation (“Insertion Loss” Method).

B. Optical Attenuation Testing
1. Optical Attenuation shall be measured on all terminated optical fibers, in both directions of transmission, using the “Insertion Loss” method. Measurement shall be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both transmit and receive ends to ensure an accurate measurement of connector losses.
2. Field test instruments for fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-14A. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50-B.3, Method A. This launch condition shall be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-B.1) with Category 1 light source.
3. Field test instruments for single mode fiber cabling shall meet the requirements of ANSI/EIA/TIA-526-7.
4. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
5. The fiber optic launch cables and adapters must be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.
6. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests detailed in the following section.
   a. Performance Test Parameters
      1) The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA standard 568-B.1
      2) Link Attenuation = Cable_Attn + Connector_Attn + Splice_Attn
      3) Cable Attn (dB) = Attenuation Coefficient (dB/km) * Length (Km)
      4) The values for Attenuation_Coefficient are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation_Coefficient (dB/Km)
Single-mode outside plant	1310	0.5
	1550	0.5
Single-mode inside plant	1310	1.0
	1550	1.0

5) Connector_Attn (dB) = number_of_connector_pairs * connector_loss (dB)
6) Maximum allowable mated connector_loss = 0.70 DB
7) Splice_Attn (dB) = number of splices (S) * splice_loss (dB)
8) Maximum allowable splice_loss = 0.2dB
9) Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters , or optical amplifiers.
10) Test equipment shall measure the link lenth and automatically calculates the link loss based on the above formulas is preferred.
11) The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.
12) The backbone link shall be tested in two directions at both operating wavelengths to account for attenuation deltas associated with wavelength.
13) Backbone links shall be tested in accordance with ANSI/EIA/TIA-526-14A.
14) Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.
15) Single mode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7. All single mode links shall be certified with test tools using laser light sources.

3.4 DOCUMENTATION

A. At the completion of the project and prior to system acceptance provide the following documentation:
   1. As-built floor plans that show the final location and identification of the telecom outlets. Submit the floor plans in printed form and as AutoCAD 2000 files (Original AutoCAD files will be made available).
   2. Test results for each strand of fiber optic cable installed. This should be supplied in a page per strand printed format and in machine-readable (computer file) format. If the machine-readable file requires special software for reading, a single-user version of that software shall be provided as well.

3. Test results for each pair of copper riser cabling installed and the installed cable length.
4. Test results for each UTP station cable installed. This should be supplied in a page per cable printed format and in machine-readable (computer file) format. If the machine-readable file requires special software for reading, a single-user version of that software will be provided as well.
5. Test results for each coaxial riser and horizontal cable installed. Documentation indicating successful testing and length for each cable shall be bound and provided by the vendor.
6. Cross connection documentation for the voice station cable (cut sheets) which detail the station number, telecom room, and riser pair number for each installed cross connection.

END OF SECTION 271300

SECTION 274100 – AUDIO AND VIDEO SYSTEMS

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specification

1.2 SUMMARY

A. Section Includes:
1. AV Cabling, connectors, and faceplates.
2. Ceiling Projector
3. Projection Screen.

B. Carefully examine all of the Contract Documents for requirements that affect the work of this section. Other specification sections that directly relate to the work of this section include, but are not limited to, the following:
1. Section 27 0529 – Hangers and Supports for Communications Systems.
2. Section 27 0533 – Conduit and Backboxes for Communications Systems.
3. Section 27 0553 – Identification for Communications Systems.
4. Section 27 1000 – Structured Cabling (for Ethernet cable requirements).

1.3 REFERENCES

A. All wire and components supplied shall meet the requirements of the following and all sub-referenced documents:
1. The National Electrical Code, Article 800.
2. Underwriters Laboratories (UL).
3. EIA/TIA 568-B.

1.4 SYSTEM DESCRIPTION

A. This Specification establishes the requirements necessary to achieve the intended performance and function of the Audio-Video System(s) described herein. Therefore, all materials and labor that are specified are necessary to meet these requirements. It includes materials and labor required to provide a complete and operable system(s) as specified herein and shown with the Audio-Video Systems drawings.

B. It is understood and agreed by the project contractor that the systems described herein shall be completed in every detail necessary to supply a complete, working system(s) implemented in a professional manner.

C. This text as well as the provided drawings are only necessary to define the design intent and anticipated performance requirements. Equipment not discreetly mentioned or outlined in these documents shall be provided without claim for additional payment.

D. Drawings included with this document shall be considered part of this specification. The Contractor will provide complete and operating system(s) including all labor and materials for all assemblies and sub-assemblies either specified or implied within this project document.
   1. Equipment function and features are to be provided by the Contractor. Where a specific item is listed by manufacturer's name and product number it identifies a minimum requirement for performance parameters and functionally defined by the product. This is not only limited to the device specified but also by the manufacturer's warranties.
   2. If a Contractor intends to provide goods other than those specified, such as "an equivalent" device it must clearly be documented within the bid response. Proposed "equivalent" items must include a written certification from the manufacturer of the replaced item stating the equivalency of each item in regard to features, function, performance, and future system capabilities.
   3. A contractor wishing to substitute items with an equivalent product must be willing to demonstrate the equivalency of said item to the owner and owner's representative at the contractor's expense. This proof of equivalency, in addition to the manufacturer's letter may include the following.
      a. "On-Site" side by side demonstration of both the specified unit and the proposed equivalent item.
      b. Independent laboratory test report. This is to include spreadsheet comparison of all critical distortion, frequency response, dynamic range, and power requirements. All tests based upon current AES standards.
      c. Equipment costs for proposed substitution items shall be listed showing the owner or owner's representative a cost savings incurred with the use of said proposed item.
      d. Contactor costs incurred, travel expenses, and other related costs shall be incurred by the contractor.
      e. Any professional services, service fees of engineers, consultants, or architects as a result of time being expended during this review, charged to the owner ,shall be reimbursed to the owner by the contractor and/or his sub-contractor.

E. Provide all audiovisual patch cables to establish complete systems to the end-user level.

F. The audiovisual cable raceway systems consist of the following:
   1. The Metallic Conduit System is a network of empty conduits into which the Audiovisual Contractor shall install the cables for the audiovisual system.

G. Unless specifically called out otherwise, all audiovisual system wiring listed in the audiovisual schedule of terminations shall be run in metallic conduit.

1.5 SUBMITTALS:

A. Submit under provisions of Division 1.

B. Submittals shall include a complete "Bill of Material" by each sound system area. This shall include all components required to complete an operational system. Each item shall include the following:
   1. Quantity of device(s)
   2. Manufacturer's current model number
   3. Manufacturer's name

4. Item description

C. CAD produced drawings shall be included with package. These shall include, but not be limited to, the following:
1. All systems showing general wiring.
2. All System(s) signal path, as a one line riser.
3. Any and all custom manufactured panel assemblies.
4. Equipment Cabinet Risers

D. List a minimum of four completed project references similar to the scope of this project. Include project name, location, and contact names of references.

E. Provide a statement from the major manufactures showing the sound contractor is an authorized representative of that product. This is to insure products are current, recall notices are acknowledged, and correct programming/installation methods are employed as recommended by the manufacture.

F. Include a list of testing equipment owned by the Audio-Video contractor.

G. Warranty Information: The vendor is required to submit, with this bid, specifications describing the standard warranty for all proposed cable and hardware.

H. The Electrical Contractor shall submit a conduit riser diagram for all audiovisual system wiring.

1.6 CLOSEOUT SUBMITTALS

A. Division 01 – Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of all input and output stations for display devices.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum THREE YEARS documented experience.

B. Installer: Company specializing in installing products specified in this section with minimum three years documented experience.

C. Provide a full time, on-site Project manager to supervise the project.

D. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

E. Pre-approved audiovisual integrators/installers are as follows:
1. RnB Enterprises, Inc.; Newtown, CT
2. HB Communciations; North Haven, CT
3. Integrated Technical Systems, Inc.; Wallingford, CT
4. Environmental Systems Corporation; West Hartford, CT
5. ATC Audio; Springfield, MA

1.8 PRE-INSTALLATION MEETINGS

A. A minimum of one contractor meeting will be required with the owner or owner's representative to review the scope of project. The intent of this is to review submittals, proposed construction, proposed installation, and to coordinate sound system(s) installation with other trades.

1.9 EXTRA MATERIALS

A. Provide FIVE (5) of each patch cable type.

B. Provide FIVE (5) of each audiovisual connector type (HDMI, USB, 3.5mm, etc.)

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and product in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.11 COORDINATION

A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.

1.12 WARRANTY

A. Contractor's Warranty: Warranty the installation to be free of defect for a period of two (2) years.

B. Equipment Warranty: Each piece of equipment shall carry a two (2) year manufacturer's warranty.

1.13 MOCKUP

A. Given the single location where the system is to be installed, a mockup is not required; however, the contractor shall make extensive coordination with other trades and items in the vicinity to prevent obstructions and other site issues that could affect proper operability and functionality of the system. Refer to Division 01 Quality Requirements and Section 26 0400 – General Conditions for Electrical Trades.

PART 2 PRODUCTS

2.1 AUDIOVISUAL CABLING

A. Manufacturers:
1. Tripp-Lite
2. C2G
3. Extron
4. FSR
5. Belden
6. Crestron

B. HDMI cabling shall meet or exceed the following specifications:
   1. Provide interconnection for the transmission of HDMI digital video and audio signals over a copper cable assembly.
   2. Cable shall conform to the Premium High Speed HDMI Cable specification established by the HDMI organization
      a. Shall support resolutions up to 4096x2160 @ 60 Hz with 4:4:4 chroma sampling and 8-bit color depth
      b. Shall support data rates up to 18.0 Gbps.
   3. Shall meet the following cable construction requirements:
      a. 22 AWG copper wire minimum.
      b. HDMI type A male connectors with gold-plated contacts
      c. Bend radius of 4.10" (104.1 mm)
      d. Cable outer diameter of 0.47" (12.0 mm)
   4. Cable shall provide protection from outside electrical interference
   5. Cables shall comply with UL CM and CSA FT-1 standards
   6. Cable shall have a minimum temperature of -25 °C and a maximum of 75 °C
   7. Maximum length of HDMI cabling shall be 25 feet. Where a longer distance is required for in-wall purposes, provide HDMI optical runner system as specified herein.

C. USB cables shall meet or exceed the following specifications:
   1. Version “3.0” or higher.
   2. A-A or A-B type, as indicated on drawings.
   3. 24 / 28 AWG copper conductors.
   4. Up to 4.8 Gbps bandwidth.

D. Stereo audio cables shall meet or exceed the following specifications:
   1. 3.5mm type
   2. Shielded
   3. Tip-ring-sleeve
   4. Fully molded connector with strain relief

E. VGA cables shall meet or exceed the following specifications:
   1. Supports up to 2048x1536 resolution.
   2. 15-pin type.
   3. 26 / 28 AWG copper conductors.
   4. Minimum bend radius: 51 mm.
   5. Voltage Rating: 30V.
   6. Nominal Impedance: 75 ohm, +/- 5 ohm.

F. All cables shall be factory-supplied with connectors as indicated on drawings.

G. All cables shall be rated for in-wall applications.

2.2 AUDIOVISUAL CONNECTORS AND HDBASE-T EQUIPMENT

A. Manufacturers (basis of design):
   1. Extron, as shown on drawings.
   2. Substitutions: Section 01 6000 – Product Requirements.

B. System description: Audio-video equipment for the purpose of extending multiple signals over a single Cat.X cable.

C. Refer to drawings for model numbers and additional product requirements.

D. At a minimum, all extenders shall meet the following general specifications:
1. Support 4K and 1080p video signal.
2. Support USB 2.0 capability or higher.
3. Support stereo audio signal.

E. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees. Said modifications shall include, but not be limited to, changes to 120VAC power outlets, conduits, backboxes, data cabling, infrastructure and other required pathways.

2.3 CEILING MOUNTED PROJECTOR

A. Manufacturers:
1. BASIS OF DESIGN: Epson Pro L1075U.
2. Acceptable Alternates: Dukane, Panasonic.
3. Substitutions: Section 01 6000 – Product Requirements.

B. General specifications:
1. Provide ceiling hung projectors from drop stem/pole to align with projector screen.
2. Projectors shall have the following characteristics:
   a. 7000 lumens
   b. WUXGA resolution with 4K Enhancement Technology (1920x 1200 x 2)
   c. HDMI, HDBaseT, LAN, and USB Connections
   d. RCA and 3.5mm audio connections.
3. All devices associated with the ceiling mounted projector shall be mounted inside the polevault ceiling mounting system enclosure as provided under section 2.2.
4. Provide software management interface by EPSON.

C. Lens:
1. Provide (1) projector lens Epson ELPLW05 plus (1) additional spare.

D. Provide ceiling mounting system consisting via the polevault ceiling mounting system specified under section 2.2.

2.4 PROJECTION SCREEN

A. Manufacturers:
1. Milestone AV Technologies. Da-Lite is a registered trademarks of Milestone AV Technologies
   a. Product: Advantage Projector Screen
2. Substitutions: Section 01 6000 – Product Requirements.

B. Product information:
1. 90”(H) x160” (W), electrically operated 120 volt (60Hz), not more than 2.4 amp with a quick connect male plug-in connector on the motor. Shall have specially designed motor mounted inside the roller, to be three wire with ground, quick

reversal type, oiled for life, with automatic thermal overload cutout, integral gears, capacitor and an electric brake to prevent coasting. To have preset but adjustable limit switches to automatically stop picture surface in the "up" and "down" positions. Junction box shall be externally integrated into the housing making it possible to install the housing and wire to the building's electrical system during construction. The junction box shall contain a quick connector that is mounted in the housing for easy plug-in connection to the motorized fabric and roller assembly. The roller to be of rigid metal. The motorized fabric and roller assembly to be installed in the case at the factory or at a later time at the job site. Roller mounting brackets to be adjustable to allow centering or offsetting of the screen within the case. Screen to be designed for left or right-hand motor installation. Screen fabric to be flame retardant and mildew resistant fiberglass with black masking borders standard. Bottom of fabric shall be formed into a pocket holding a metal rod. Heavy duty plastic caps shall protect the ends of the rod. Top, front and back of case to be made of extruded aluminum powder coated white. End caps to be of heavy gauge steel, powder coated white. Bottom of case to have a removable access door. Door to be of extruded aluminum powder coated white. Bottom of case to be self-trimming, with a built-in flange around the bottom of the case. To be complete with integrated low voltage control unit and three position control switch and cover plate. Suitable for use in environmental air space in accordance with section 300-22 (c) of the National Electric Code, and sections 2-128, 12-010 (3) and 12-100 of the Canadian Electrical Code, part 1, CSA C22.1. Screen to be listed by Underwriters' Laboratories.

a. Projection Viewing Surface:
   1) High Contrast Matte White (GREENGUARD GOLD Certified)
b. Viewing Area H x W.
   1) HDTV Format (16:9). Black masking borders standard.
      a) 184 inch (4674 mm) diagonal, 90 inches x 160 inches (2286 mm x 4064 mm).

2. Controls:
   a. Wireless Remote for LVC.

2.5 PROJECTION SCREEN CONTROLS

A. General: All controls are UL Certified.
   1. Single station control rated 115V AC, 60 Hz with 3-position rocker switch with cover plate to stop or reverse screen at any point.
   2. Locking switch cover plate for limited access to three position switch. Provide with 2-sets of keys.
   3. Motor shall be left mounted.

PART 3 EXECUTION

3.1 INSTALLATION – GENERAL

A. Prior to installation, the Electrical Contractor shall submit a riser diagram for all audiovisual system conduits.

B. No installation work shall proceed until the conduit riser has been approved, in writing, by the Electrical Engineer.

C. All lines installed in conduits shall be splice free. Cabling shall be free from installation damage.

D. All connector wiring shall be by rosin core solder joints. No push on type connectors shall be accepted.

E. All cables to be numbered and identified in “As Built Documents”. Provide permanent cable identification.

F. Project shall be adequately staffed at all times. Coordination with other trades and cooperation is mandatory.

3.2 INSTALLATION – EQUIPMENT

A. All material and equipment to be new and unused.

B. Provide adequate ventilation for all active electronic equipment.

C. All equipment shall be installed without dents, scratches, free of marks and blemishes.

D. The contractor is responsible for all tuning, programming, setup and configuration of all audiovisual systems.

3.3 INSTALLATION - WIRE GROUPS IN CONDUIT

A. All audiovisual wiring shall be installed in conduit.

B. Minimum conduit diameters and diagrammatic routing of audiovisual conduits are indicated on drawings.

C. The actual diameter and path of each conduit run shall be determined by the Electrical Contractor in accordance with field conditions.

D. Should the Electrical Contractor choose to combine cable runs from individual terminations into a common conduit, then they must conform to the wire grouping, conduit fill, and conduit separation requirements listed in this Section.

E. To prepare the required conduit riser diagram, the Electrical Contractor must group cables by wiring type; determine the total number of cables in each conduit run; determine the diameter of each conduit run; determine the actual routing of each conduit run.

F. Refer to Paragraph 3.4 of this Section for wiring group and conduit separation requirements.

G. Refer to Table 5 at the end of this Section for audiovisual cable specifications and conduit capacities.

3.4 INSTALLATION - CONDUIT SEPARATION

A. Audiovisual system wiring is divided into separate groups according to their nominal voltage levels. These wiring groups must never be intermixed within a given conduit run. See Table 2 at the end of this Section for wire type information.

B. Conduits carrying audiovisual wiring must maintain a minimum separation from conduits carrying other types of audiovisual wiring. When necessary, ninety degree crossings in close proximity are acceptable. See Table 3 at the end of this Section for audiovisual conduit separation requirements.

C. Conduits carrying audiovisual wiring must maintain a minimum separation from conduits carrying other types of electrical wiring. Unusually heavy current demands in; or long parallel runs with; electrical services may dictate greater separations to avoid interference with the audiovisual system. See Table 4 at the end of this Section for electrical conduit separation requirements.

3.5 INSTALLATION - METALLIC CONDUIT SYSTEM

A. The metallic conduit system is specified by information called out in the large-format audiovisual system drawings:
   1. The location drawings indicate the position of each audiovisual device and the method of mounting each device.
      a. The schedule of terminations lists each audiovisual device; indicates the quantities, types, and groupings of all cables connected to each device; and lists the destination for all cables exiting each device.

B. Refer to Table 5 at the end of this Section for audio cable specifications and conduit sizing requirements.

C. In most cases, each run of this conduit system shall be bonded to the audio termination back boxes which are provided by the Audiovisual Contractor. The only exception is conduit which is routed to the audio equipment racks. Conduit runs entering or exiting the audio equipment racks shall be electrically isolated from the racks. PVC or other non-conductive fittings shall be used to isolate the conduit from the audiovisual equipment racks.

D. Provide all empty conduits with pull lines.

3.6 INSTALLATION - CABLE SLEEVES

A. Install per architectural detail drawings with threaded cap at each end of sleeve. These caps shall be lubricated for easy removal and held captive by a chain.

3.7 TESTING

A. Each cable and equipment manufacturer shall factory-test their respective products being installed on this project and provide test reports at time of delivery. Provide separate, respective test reports, indicating that products meet or exceed the latest applicable TIA/EIA Standards and technical bulletins.

B. All other products relative to this specification shall be tested to their respective industry’s strictest standards.

C. Each manufacturer shall factory-test their respective cable or equipment provided to this project at several lower frequency levels, including the minimum and maximum frequency level indicated herein. The test reports shall indicate test results for at least five equal incremental frequency levels, including the maximum required.

D. Presentation Systems: Verify the functionality of each installed system. Verify that connectors are properly installed and where appropriate, screwed down. Cable shall be neatly dressed and tied back. Tag cable with permanent markers indicating the function of each cable. Adjust and balance audio systems to provide a minimum of 85db/spl at the average listening position. System testing shall be coordinated with the Owner's representative.

3.8 DOCUMENTATION

A. Provide copies of all manuals and two (2) sets of as-built documents, in hard copy and electronic format. As-built documentation shall include location and types of hardware provided and installed as well as the interconnection of each device.

3.9 TRAINING:

A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.

B. Provide training to personnel selected by the Owner on operation and basic maintenance of all systems and equipment.

C. Include 8 hours of training Owner's staff.

3.10 REFERENCE TABLES

TABLE 1 - PROJECT WORK SCOPE

ITEMS TO BE PROVIDED AND INSTALLED	Electrical Contractor		Audiovisual Contractor	
	Provides	Installs	Provides	Installs
Audiovisual Equipment Racks and Devices			x	x
1.Metallic Conduit between Audiovisual Devices and Audiovisual Equipment Racks	x	x◊		
2. Conduit Insulation Bushings between Metallic Conduit and Audiovisual Equipment Racks	x	x◊		
3. Audiovisual Equipment Rack Cabling			x	x
4. Audiovisual Equipment Rack Terminations				x
5. Audiovisual Device Back Boxes and Floor Boxes		x◊	x	
6. Audiovisual Device Metallic Conduit	x	x◊		
7. Audiovisual Device Cabling			x	x
8. Audiovisual Device Termination				x
Audiovisual Cable Sleeves	x	x		
Audiovisual Pull Boxes	x	x		
Conduit Riser Diagram	x			

◊ Installation criteria to be provided by Audiovisual Contractor

TABLE 2 - AUDIOVISUAL WIRING TYPES

Audiovisual system wiring is divided into wiring groups according to their nominal voltage levels:

	Wiring Type
Group A	Microphones and other sensitive wiring (0 mV to 100 mV)
Group B	Line level wiring (100 mV to 10 V)
Group C	Loudspeaker and control wiring (10 V to 70 V)
Group D	Telephone, video, control and digital circuits (including Category Structured cabling for data)
Group E	Fiber optic cable

Note: These wiring groups must never be intermixed within a given conduit run!

TABLE 3 - AUDIO CONDUIT SEPARATION

Minimum conduit separation between conduits carrying wiring of different audiovisual groups is as follows:

	Group A	Group B	Group C	Group D	Group E
Group A	adjacent	6"	12"	12"	adjacent
Group B	-	adjacent	12"	6"	adjacent
Group C	-	-	adjacent	6"	adjacent
Group D	-	-	-	adjacent	adjacent
Group E	-	-	-	-	adjacent

Note: Ninety degree crossings in close proximity are acceptable.

TABLE 4 - ELECTRICAL CONDUIT SEPARATION

Minimum conduit separation between conduits carrying audiovisual wiring and other electrical service conduit is as follows:

	Group A	Group B	Group C	Group D	Group E
Dimmer controlled lighting	24"	12"	6"	12"	adjacent
SCR controlled services	24"	12"	6"	12"	adjacent
220/440VAC circuits	6"	6"	adjacent	adjacent	adjacent
All other services	6"	6"	adjacent	adjacent	adjacent

Note: Heavy current demands in or long parallel runs with the above services may dictate greater separations to avoid interference with the audiovisual systems.

TABLE 5 - CONDUIT SIZING FOR AUDIO CABLES

Audio Cable (dimensions in inches)				Maximum number of audio cables allowed in each conduit size (Based on 40% fill of EMT)						
Mfr	Type	OD	Area	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"
Belden	1351A	0.290	0.066	3	5	9	12	20	35	53
Belden	1502R	0.250	0.049	4	7	12	17	27	48	72
Belden	1694A	0.274	0.059	4	6	10	14	23	40	60
Belden	1696A	0.234	0.043	5	8	14	19	31	54	82
Belden	1700A	0.200	0.031	7	11	19	26	43	75	113
Belden	2412	0.220	0.038	5	9	15	21	35	61	93
Belden	7710A	0.770	0.466	0	1	1	2	3	5	8
Belden	7712A	0.970	0.739	0	0	1	1	2	3	5
Belden	7810A	0.405	0.129	2	3	5	6	10	18	27
Belden	8240	0.193	0.029	7	12	20	28	46	80	121
Belden	8281	0.305	0.073	3	5	8	11	18	32	48
Belden	8444	0.185	0.027	8	13	22	30	50	87	132
Belden	8451	0.138	0.015	14	23	40	54	90	157	237
Belden	8465	0.282	0.062	3	6	10	13	21	38	57
Belden	8467	0.314	0.077	3	4	8	11	17	30	46
Belden	8471	0.274	0.059	4	6	10	14	23	40	60
Belden	8473	0.340	0.091	2	4	7	9	15	26	39
Belden	8477	0.386	0.117	2	3	5	7	11	20	30
Belden	8489	0.257	0.052	4	7	12	16	26	45	68
Belden	8620	0.376	0.111	2	3	5	7	12	21	32
Belden	8734	0.194	0.030	7	12	20	28	45	79	120
Belden	8760	0.222	0.039	6	9	15	21	35	61	91
Belden	9451	0.135	0.014	15	24	42	57	94	164	247
Belden	9460	0.230	0.042	5	8	14	20	32	56	85
Belden	9831	0.330	0.086	2	4	7	9	15	27	41
Belden	9844	0.390	0.119	2	3	5	7	11	20	30
Belden	9941	0.230	0.042	5	8	14	20	32	56	85
Crestron	DM-CBL-NP	0.580	0.264	0	1	2	3	4	8	13
Crestron	DM-CBL-8G-NP	0.244	0.047	4	7	12	17	28	50	75
Trade	#08 THHN	0.216	0.037	6	9	16	22	37	64	97
Trade	#10 THHN	0.164	0.021	10	16	28	39	64	111	168
Trade	#12 THHN	0.130	0.013	16	26	45	61	101	177	267
Trade	#14 THHN	0.111	0.010	22	36	62	84	139	242	366

Note: Minimum conduit size allowed for audio cables is 3/4 inch.

END OF SECTION 274100

SECTION 281316 – ACCESS CONTROL SYSTEM

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 RELATED SECTIONS

A. Carefully examine all of the Contract Documents for requirements that affect the work of this section. Other specification sections that directly relate to the work of this section include, but are not limited to, the following:
1. Section 08 1113 – Hollow Metal Doors and Frames
2. Section 08 1416 – Flush Wood Doors
3. Section 08 8323 – Overhead Coiling Doors
4. Section 08 7100 – Finish Hardware
5. Section 27 1000 – Telecom and Data Wiring
6. Section 27 0526 – Telecom Grounding & Bonding
7. Section 27 0529 – Hangers & Supports for Telecom Wiring
8. Section 28 1600 – Intrusion Detection

1.3 REFERENCES

A. Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the Work of this Section:
1. Underwriters Laboratories Inc. (UL):
   a. UL 365: Police Station Connected Burglar Alarm Units and Systems.
   b. UL 609: Local Burglar Alarm Units and Systems.
   c. UL 611: Central Station Burglar-Alarm Units.
   d. UL 636: Holdup Alarm Units and Systems.
   e. UL 684: Local, Central Station, and Remote Station.
   f. UL 1023: Household Burglar-Alarm System Units.
   g. UL 1076: Proprietary Burglar-Alarm Units and Systems.
   h. UL 1610: Central-Station Burglar-Alarm Units.
2. Federal Communications Commission (FCC):
   a. Code of Federal Regulations Title 47: Part 15: Radio Frequency Devices.
   b. Code of Federal Regulations Title 47: Part 68: Connection of Terminal Equipment to the Telephone Network.

B. DEFINITIONS

1. HD (High-definition) – refers to video having resolution substantially higher than traditional television systems. HD has one or two million pixels per frame.
2. CIF (Common Intermediate Format) – refers to a standard video format, which is categorized based on the resolution.
3. IR (Infrared) – refers to a visual range requiring little to no light to visualize.
4. IP (Internet Protocol) – refers to a device that operates over the building's network.
5. VMS (Video Management System) – The software that operates all video surveillance cameras.
6. NVR (Network Video Recorder) – Server that configures and stores recorded data from the cameras.
7. SMS (Security Management System) – The software that operates all access control devices.
8. VADS (Video, Access, Digital Monitoring System) – The integrated software suite that integrates the VMS and the SMS, and allows for end user control of the system.

1.4 SYSTEM DESCRIPTION

A. Access Control Systems:
1. Structure comprised of many sub-systems capable of sharing information among each other and displaying information and events in an integrated manner displayed in assigned monitoring stations, local or remote. Each sub-system shall meet the following objectives:
a. Access Control System: Control access to and within the building using encoded key cards or fobs.

B. Integration: Contractor is responsible of integrating new security and access control devices to the existing access control system in the building to form a complete, unified system. Integration of door contacts and/or similar devices shall also be provided between the access control and intrusion detection systems.

C. Section includes components associated with the expansion of the existing access control system for the building, including but not limited to door controllers, door contacts, request to exit devices, and card readers.

D. Integration to the existing Security Management System software (SMS) shall be included as part of the responsibilities of the awarded contractor.

1.5 SUBMITTALS

A. Submit under provisions of section 01 3300.

B. Product Data: Provide details and technical specifications for each product indicated. Include physical dimensions, features, performance, electrical characteristics, ratings, software versions, and operating system details.

C. Shop Drawings: Include system line diagrams, equipment locations, installation details, and system integration plans.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types, quantities, and sizes.
   3. Plans and Elevations: Dimensioned plans and elevations of equipment racks, enclosures, and conduit interconnections, including access and workspace requirements.
   4. Data Calculations: Provide data bandwidth and storage calculations, including data backup and archive configuration details meeting the minimum project requirements as described herein.
   5. Wiring Diagrams: For power and signal wiring.

D. Equipment and Software License List: Include every piece of equipment and software license as applicable by product/model name and/or number, manufacturer, serial number, revision number, location, and date of original installation. If factory and/or bench testing regimens are required by the project plan, add pretesting record of each piece of equipment and software, listing name of person testing, date of test, and adjustments made.

E. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.

F. Field Tests: Submit results of field testing of every device including date, testing personnel, retesting date if applicable, and confirmation that every device passed field testing.

G. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one year period for Owner's review. Maintenance shall include, but not be limited to; labor and materials to repair the system. Provide test and adjustments, and regular inspections.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of all interactive whiteboards and projectors.

1.7 QUALIFICATIONS

A. All work, equipment, materials, construction, and installation provided under the Contract shall comply with the current applicable rules, regulations, standards, and ordinances of the local Authorities Having Jurisdiction (AHJ).

B. Electrical Components, Devices, Accessories, and Installation shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1. Comply with NECA 1.
2. Comply with NFPA 70.

C. Software integration between the VMS, access-control system, cameras, and all other integrated system components shall be tested and certified for interoperability by the manufacturers of each system.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 – Administrative Requirements: pre-installation meeting.

B. Convene minimum THREE WEEKS prior to commencing work of this section.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and product in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.10 COORDINATION

A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.

1.11 WARRANTY

A. All components shall be provided with an explicit manufacturer warranty of one year for software and two years for hardware.

B. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Basis of Design: Keri Systems

B. Acceptable Alternates: Not allowed. Expansion to existing system.

C. Substitutions: Not allowed. Expansion to existing system.

2.2 DOOR / CARD READER INPUT CONTROLLER INTERFACE

A. MANUFACTURERS

1. NXT-2D/4D, 2-4 Door/ Reader Interface
2. Substitutions: Not allowed

B. PRODUCT DESCRIPTION
1. Product provides a complete and fully featured hardware/firmware infrastructure for access controls software host systems.
2. Connects two access control card readers via Wiegand or Clockand-Data interface, controlling either one or two doors.
3. On-board flash memory, enabling program updates to be downloaded via the network.
4. Easily interfaced
   - Quick-disconnect screw terminal connectors
   - Rotary address switch (0–15)
   - Inputs for:
     i. 2 Readers
     ii. 2 Door monitor switches
     iii. 2 Request-to-Exit switches
   - Non-latching relay outputs (Rated 2A @ 30 VDC):
     i. 2 door strikes (configurable)
     ii. 2 auxiliary devices: door held/forced alarm, alarm shunt, host offline (comms down), or general purpose
5. Provide NXT door interface modules in existing access control cabinet. Field verify physical internal capacity of existing cabinet along with power supply and battery capacity for the support of newly added door(s). Refer to Section 2.4 of this specification for additional information regarding the provision of devices in case of physical or system capacity shortage.

C. MOUNTING
1. Mount inside a locking NEMA-4 rated enclosure with:
   - DC supply with battery back-up
   - Enclosure tamper switch
   - All connections made through conduit

   The unit should be installed indoors, inside a secure area, such as in an IT or telecommunications room, utility closet, or on a wall above a suspended ceiling. Location shall be coordinated with the IT staff and/or the owner prior to roguh-in.

2.3 CARD READERS

A. MANUFACTURERS
1. HID multiCLASS SE Reader
2. Substitutions: Not allowed

B. PRODUCT DESCRIPTION
1. Provide contactless smart card readers at locations shown on the drawings.
2. The reader shall have a Weigand output.
3. The reader shall have both an audio and visual notification for access granted and access denied.
4. The reader shall be suitable for both outdoor and indoor applications.

5. The reader shall be able to communicate with any proximity card by same manufacturer.
6. The reader shall operate up to 500ft away from door controller.

C. Models:
1. Base part numbers shall be selected for the proper application installation, and to match card reader devices currently deployed:
   a. RP10 (900P)
   b. RP40 (920P)

D. MOUNTING
1. Card readers shall have the ability to be mounted on glass, using kit by same manufacturer, if necessary.
2. Exact card reader locations shall be coordinated with door hardware installation.
3. All card reader wiring shall be run in conduit.

2.4 PROXIMITY CARDS

A. Provide and program (100) compatible proximity cards or fobs. Type of device shall be coordinated with the owner prior to purchase.

2.5 UNIFIED POWER SYSTEM ENCLOSURE

A. MANUFACTURERS
1. LifeSafety Power FlexPower VClass
2. Substitutions: Altronix

B. PRODUCT DESCRIPTION
1. VCLASS unified power systems are engineered to house FlexPower® power modules alongside NXT access hardware in one compact, secure system.
2. Unit is a 325W dual voltage 12V and 24V DC access power system.
3. C8 lock control module provide sixteen access control inputs capable of voltage or dry contact activation, and sixteen outputs programmable for failsafe / failsecure operation at either 12 or 24 VDC and controlled by the integrated fire alarm interface circuit on the FPO. D8 module provides sixteen fused outputs and each output is configurable for 12 or 24VDC operation.
4. VCLASS enclosures are painted steel with removable backplate and include lock, two (2) keys and tamper switch.
5. Provide additional cabinet units, complete including NXT access hardware, fire alarm modules, and batteries (12VDC) as required in the event of shortage in existing cabinet capacity. Coordinate and provide 120VAC connection via 2#12+1#12G,3/4”C from nearest available source along with connection to nearest fire alarm loop via manufacturer approved fire alarm wiring. Fire alarm wiring shall be routed via 3/4” conduit.

C. MOUNTING
1. The unit should be installed indoors, inside a secure area, such as in an IT or telecommunications room.

2.6 DOOR CONTACTS

A. MANUFACTURERS
1. Bosch ISN-CSD70 and ISN-CSD80 Compact Contacts or ISN-CMET-4418 Overhead Door Contact
2. Type of door contact device shall be selected for the proper application installation and to function with type of door and/or frame being specified.
3. Substitutions: Not allowed

B. PRODUCT DESCRIPTION
1. Bosch ISN-CSD70 and ISN-CSD80 Compact Contacts
a. Rugged, one-piece construction that eliminates the need for extra donut adapters. The compact (stubby) design allows you to use the contact in smaller spaces, without paying for a miniature design. Use on steel doors in eliminates the need for extra donut adapters.
2. Bosch ISN-CMET-4418 Overhead Door Contact
a. The contact is available in a metal finish. It uses epoxy and a special push-pin to hold the armored cable firmly in place.

2.7 REQUEST TO EXIT DETECTION

A. MANUFACTURERS
1. Bosch DS150i Series Request-to-exit Detectors
2. Substitutions: Not allowed

B. PRODUCT DESCRIPTION
1. Designed for Request-to-exit (REX) applications.
2. The DS150i detect motion in their coverage area and signal an access control system or door control device.
3. Single or double door use
4. Wall or ceiling mountable
5. Provide a TP160 Trim Plate - A light gray trim plate used when mounting the detector over a standard single-gang box.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine cable pathways including conduit, raceways, cable trays, and other pathway elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine rough-in for control cable and conduit systems to controllers, card readers, and other EACS components to verify conduit and back-box locations prior to installation of EACS devices

C. Examine available network capacity and support infrastructure. Consult with network administrator for compliance with network standards and capacity.

D. Examine install location for compliance with space allocations, installation tolerance, hazards to safe system operation, and other conditions affecting installation.

E. Examine roughing-in for LAN, WAN, and IP network before device installation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with SIA CP-01 Control Panel Standard.

B. Comply with ANSI/TIA-606-B Labelling Standard.

C. Prepare detailed project planning forms for programming and configuration with existing SMS. Fill in all data available from project plans and specifications and publish as project planning documents for review and approval. These may include (but are not limited to):

1. Define SMS Partitions.
2. For each Location, record setup of controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, software triggers, and list inputs and outputs for each controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish trigger actions between events and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Discuss badge layout options; design badges.
11. Complete system diagnostics and operation verification.
12. Prepare a specific plan for system testing, startup, and demonstration.
13. Develop acceptance test concept and, on approval, develop specifics of the test.
14. Develop cable and asset-management system details; input data from construction documents. Include system schematics and technical drawings in electronic format.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final programming and configuration documents. Use final documents to program and configure SMS software.

3.3 INSTALLATION

A. Rated Stairs: Penetrations into stairs are NOT permitted except for items serving that stair.

B. Make all connections to built-in door wiring in junction boxes.

C. Test all components before shipping to the project location.

D. Access control system shall be installed, programmed, and tested in accordance with manufacturer's installation instructions.
   1. Coordinate interfaces with Owner's representative where appropriate.
   2. Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.
   3. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent fill in conduits. Gather wires and tie to create an orderly installation.
   4. Coordinate with other trades to provide proper sequencing of installation.

E. Comply with TIA 569-C, "Commercial Building Standard for Telecommunications Pathways and Spaces."

F. Card Readers and Keypads and Peripheral Devices:
   1. Install number of conductor pairs recommended by device manufacturer for the functions specified.
   2. Follow device manufacturer's installation requirements for maximum cable distances and sizes.

3.4 INTEGRATION

A. Contractor is responsible for integration of access control and video management components, such that all features of each system can be operated from one user interface.

3.5 FIELD COMMISSIONING AND CERTIFICATION

A. Field Commissioning: Test system as recommended by manufacturer, including the following:
   1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
   2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction as applicable.
   3. Correct deficiencies until satisfactory results are obtained.
   4. Submit written copies of test results.

B. Tests and Inspections:
   1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-C, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-C.
   2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.

3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

3.6 TRAINING

A. Conduct on-site system administrator and security/surveillance operator training, with the number of sessions and length of sessions as recommended by the system manufacturer. Training shall include administration, provisioning, configuration, operation, and diagnostics.

END OF SECTION 281316

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

A. Provide new video surveillance cameras per contract documents and drawings, including engineering, components, installation and commissioning.

B. Successful bidder is responsible for integrating the new video surveillance cameras added under this project to the existing Exacqvision Enterprise CCTV system used in the building, and existing town-wide global networks as required and to meet client standards. Contractor shall contact town representatives and existing system's manufacturer support as required in order to provide a fully integrated system. The contractor shall include licensing and additional software to achieve remote monitoring.

1.3 RELATED SECTIONS

A. Carefully examine all of the Contract Documents for requirements that affect the work of this section.

1.4 REFERENCES

A. Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the Work of this Section:
   1. Canadian ICES-003
   2. Consultative Committee for International Radio (CCIR)
   3. Conformity for Europe (CE)
   4. Electronic Industry Association (EIA)
   5. Federal Communications Commission (FCC)
   6. Joint Photographic Experts Group (JPEG)
   7. Moving Pictures Experts Group (MPEG)
   8. Motion Joint Photographic Experts Group (MJPEG)
   9. National Television Systems Committee (NTSC)
   10. Phase Alternating by Line (PAL)
   11. Underwriters Laboratories Inc. (UL)
   12. Institute for Electrical and Electronics Engineers (IEEE)
   13. Physical Security Interoperability Alliance (PSIA)
   14. Open Network Video Interface Forum (ONVIF)

15. Real Time Streaming Protocol (RTSP)

1.5 DEFINITIONS

A. HD (High-definition) – refers to video having resolution substantially higher than traditional television systems. HD has one or two million pixels per frame.

B. CIF (Common Intermediate Format) – refers to a standard video format, which is categorized based on the resolution.

1.6 SUBMITTALS

A. Submit under provisions of section 01 3300.

B. Manufacturer's Product Data: Submit manufacturer's data sheets indicating systems and components proposed for use, including instruction manuals.

C. Shop Drawings: Submit complete shop drawings including connection diagrams for interfacing equipment, list of connected equipment, and locations for major equipment components.

D. Riser Diagram: Submit project-specific riser diagram showing all system components and all interconnects.

E. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings not later than Substantial Completion of the project.

F. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.

G. Field Tests: Submit results of field testing of every device including date, testing personnel, retesting date if applicable, and confirmation that every device passed field testing.

H. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one year period for Owner's review. Maintenance shall include, but not be limited to; labor and materials to repair the system, provide test and adjustments, and regular inspections.

1.7 QUALITY ASSURANCE

A. Manufacturer: Minimum ten years experience in manufacturing and maintaining video recording systems. Manufacturer shall provide toll-free technical assistance and support available 24/7.

B. Installer: Minimum two years experience installing similar systems, and acceptable to the manufacturer of the video recording system.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's labeled packages. Store and handle in accordance with manufacturer's requirements, in a facility with environmental conditions within recommended limits.

1.9 WARRANTY

A. Manufacturer's Warranty: The warranty period shall be twelve (12) months from the delivery date of the system under normal use and service.

PART 2 PRODUCTS

2.1 DIGITAL VIDEO RECORDER / VIDEO STORAGE SERVER

A. MANUFACTURER (EXISTING SYSTEM)
1. The Town currently utilizes ExacqVision Enteprise, with servers installed at a remote location. Intent is for the awarded contractor to add cameras to the existing building network and interface to the existing NVR and CCTV system with remote storage and monitoring capabilities.
2. Alternate manufacturers: Existing, not applicable.
3. Substitutions: Existing, not applicable.

2.2 IP/POE CAMERAS

A. MANUFACTURER
1. The selected manufacturer shall be Axis Communications.

B. Camera Model Numbers:
1. INTERIOR CAMERAS
a. AXIS #P3367-V, 5MP, Vandal Resistant Camera
2. EXTERIOR CAMERAS
a. AXIS #P3367-VE, 5MP, Light-Sensitive Camera with Remote Focus and Zoom

C. Alternate manufacturers:
1. Panasonic
2. Hanwha

D. All associated devices and/or licensing is required to obtain a fully functional system, as mandated by this bid specification, shall be included as part this bid specification.

E. Licensing
1. All required Exacqvision Enterprise licensing shall be included as part of this specification, including all required site licenses, and licensing for remote capabilities.
2. Integration licensing shall also be included for each camera to the existing Security Management System. Each camera shall be capable of being viewed and accessed via the existing SMS.

F. Camera Locations:
1. All camera locations MUST to be field verified with the Owner prior to start of project. Architectural drawings are for approximation purposes only. Additional charges will not be allowed for installation in areas not reviewed or approved by the Owner.

G. General Requirements:
1. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
2. All systems and components shall have been thoroughly tested and proven in actual use in the presence of the Owner or technology consultant.
3. All systems and components shall be provided with the availability of a toll-free (U.S.), 24-hour technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.
4. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and non-warranty items.

H. Camera Certifications:
1. CE, Class B.
2. FCC, Class B.
3. UL/cUL Listed.
4. C-Tick.

I. Camera Warranty
1. Three (3) years, parts and labor.

2.3 VIDEO SURVEILLANCE MANAGEMENT PLATFORM (EXISTING)

A. All components associated with this specification shall be interfaced with the existing VMS. All functionality shall be verified with the Owner and/or Security consultant prior to closeout.

B. All required licenses, including site licenses, integration licenses, and camera licenses for all cameras included in this project to provide a fully functional system, is required as part of this contract

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.

3.2 INSTALLATION

A. Test all components before shipping to the project location.

B. DVR and Camera system shall be installed, programmed, and tested in accordance with manufacturer's installation instructions.
   1. Coordinate interfaces with Owner's representative where appropriate.
   2. Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.
   3. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent fill in conduits. Gather wires and tie to create an orderly installation.
   4. Coordinate with other trades to provide proper sequencing of installation.

3.3 FIELD COMMISSIONING AND CERTIFICATION

A. Field Commissioning: Testing the Video Recording system as recommended by manufacturer, including the following:
   1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
   2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction as applicable.
   3. Correct deficiencies until satisfactory results are obtained.
   4. Submit written copies of test results.

3.4 TRAINING

A. Conduct on-site system administrator and security/surveillance operator training, with the number of sessions and length of sessions as recommended by the DVR system manufacturer. Training shall include administration, provisioning, configuration, operation, and diagnostics.

B. Furnish eight (8) hours of training.

END OF SECTION 282300

SECTION 310000 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 312319 – Dewatering

C. Section 312333 – Trench Excavation and Backfill for Utilities

D. Section 312500 – Soil Erosion and Sediment Control

1.2 SCOPE OF WORK

A. General: Perform in accordance with the Contract Documents.

B. Work Included: Work of this Section includes all labor, materials, equipment, and services necessary to complete the excavation, foundations, subgrade preparation, filling and grading as shown on the Drawings and specified herein including, but not limited to the following:

1. All earth and rock excavation to the bottom of foundations, walls, pits, slabs, manholes, etc. as required and indicated on the Contract Drawings or to a lower elevation to achieve required bearing capacity, as directed by the Geotechnical Engineer.
2. Excavation, filling and rough grading of site area at adjacent structures and roadways as required and within the project limit.
3. Excavation, filling, grading and compacting to required elevations for all foundations, slabs, walls, slopes, and cuts.
4. Legal disposing off the site, of surplus excavated materials unsuitable for filling or backfilling.
5. Pumping and dewatering as required for work of this section.
6. Subgrade preparation for foundations.
7. Protection and monitoring of adjacent structures, utilities and pavements.
8. Other labor and materials as may be reasonably inferred to be required to make the work under this Section complete.
9. Earthwork associated with demolition of existing structures.

1.3 REFERENCES

A. General: All work and materials under this section shall conform to the latest revision of the following standard specifications, where not otherwise required by the Contract Documents:

B. American Society for Testing and Materials (ASTM) – latest edition.

1. C 136 Test for Sieve Analysis of Fine and Coarse Aggregates
2. D 422 Method for Particle Size Analysis of Soils
3. D 698 Test for Moisture - Density Relations of Soils - Standard Proctor Method
4. D 1140 Test for Amount of Material in Soils Finer than No. 200 (75 mm) Sieve
5. D 1556 Test for Density and Unit Weight of Soil in Place by the Sand-Cone Method
6. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Hammer and 18-inch (457 mm) Drop (Modified Proctor)
7. D 2216 Laboratory Determination of Moisture content of Soil
8. D 2487 Classification of Soils for Engineering Purposes
9. D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
10. D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
11. D 4253 Test Method of Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
12. D 4254 Test Methods for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density
13. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils

C. American Association of State Highway and Transportation Officials (AASHTO) – Latest edition.

1. T 88 Mechanical Analysis of Soils

D. All work shall comply with the requirements of the Connecticut State Building Code (latest edition), and the requirements and regulations of any other Federal, State, or Local ordinances having jurisdiction.

E. Previous Reports: Geotechnical Study prepared by Clarence Welti P.C., dated February 1997

F. Geotechnical Report prepared by GEI Consultants, Inc., dated August 23, 2019

1.4 SUBMITTALS

A. Within ten days after award of the contract, the Contractor shall submit to the Architect a schedule detailing the sequence, and time of completion of all phases of work under this section.

B. At least two weeks in advance of imported fill use, the Contractor shall submit the following laboratory test data to the Geotechnical Engineer for each type of imported soil/gravel material to be used as compacted fill.

1. Test reports on borrow material as follows:
   a. Moisture and Density Relationship: ASTM D1557.
   b. Mechanical Analysis: AASHTO T-88.
   c. Moisture content in accordance with ASTM D 2216.
   d. Relative Density: ASTM D2049.
   e. California Bearing Ratio (CBR): ASTM D1883.
   f. Plasticity Index: ASTM 4318.

2. Include data for all samples indicating the exact location and methods of transportation and placement of all materials.
3. Certification indicating material is 'clean fill'.

C. Submit the name of each material supplier and specific type and source of each material. Any change in source or soil type throughout the job requires approval of the Builder and the Geotechnical Engineer.

D. Samples: Submit a 12 inch by 12 inch sample of filter fabric.

E. Shop Drawings:

1. Submit detailed shop drawings and calculations, to be reviewed by the Owner's Geotechnical Engineer, of earthwork procedures and sequences including temporary excavation support systems.
2. The drawings shall bear the signature and seal of a Professional Engineer registered in the State of Connecticut.

F. Pre-Construction Conditions Survey: The Contractor will perform a pre-construction conditions survey of all immediate adjacent structures, the results of which will be made available to the Owner and Design Team upon completion of the survey.

G. Certification for Examination of Site and Records: Before proceeding with the Work, submit certification in an acceptable form, signed by the Contractor, stating that careful examination has been made of the site, existing structures, records of utility lines, test boring records, test pit records, and subsurface exploration reports by the Geotechnical Engineer, the Drawings, and all other Contract Documents.

H. Submit approvals and permits to the General Contractor a minimum of 15 days prior to commencement of construction.

1.5 ENVIRONMENTAL CONSIDERATIONS, SOIL EROSION AND SEDIMENT CONTROL

A. Install erosion control measures in the sequence shown of the plans or as directed by the civil engineer or regulatory agencies to protect adjacent properties and water resources from erosion and sediment damage.

B. Any off-site soil disposal requirement shall be performed in accordance with all applicable Local, State, and Federal regulations governing soil movement and disposal.

C. Dust and Erosion Control: The Contractor shall take all necessary measures and provide equipment and/or materials to minimize dust from rising and blowing across the site and also to control surface water throughout the operation so that it does not run onto paved ways without being filtered. In addition, the Contractor shall control all dust created by construction operation and movement of construction vehicles, both on site and on paved ways. Comply with 2002 Connecticut Sediment and Erosion Control Guidelines.

1.6 PROJECT CONDITIONS

A. The subsurface conditions generally consist of a surficial layer of pavement underlain by about 5 feet of fill and then about 20 feet of sand. Groundwater was encountered during the subsurface exploration from about 6.5 feet below existing site grades. See the Geotechnical Report prepared by GEI Consultants and referenced herein for complete subsurface information.

B. The Contractor, by careful examination, shall inform himself as to the nature and location of the work; the conformation of the ground, the nature of the subsurface conditions; the locations of the groundwater table; the character, quality and quantity of the materials to be encountered; the character of the equipment and facilities needed preliminary to and during the execution of the work; the conditions of adjacent structures and utilities and all other matters which can in any way effect the work.

C. The Contractor shall be held to have visited the site and to have familiarized himself with the existing conditions of adjoining utilities and structures.

D. The Contractor shall make his own deductions of the subsurface conditions which may affect the methods or cost of construction of the work hereunder, and he agrees that he will make no claims for damages or compensations, except as are provided under the agreement, should he find conditions during the progress of the work different from those as calculated and/or anticipated by him. Additional borings and other exploratory operations may be performed by Contractor, at the Contractor's option and following the Owner's approval. No change in the Contract Sum will be authorized for such additional exploration undertaken by the Contractor.

E. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of the site of the work. The Contractor shall conform to all Town and State, and Federal regulations concerning the transportation of materials to and from and at the job site and shall secure in advance such permits as may be required.

1.7 PROTECTION

A. Protection of Adjacent Structures, Utilities and Pavements

1. Prior to commencement of any work, consult the records for existing utilities, and note all conditions and limitations, which might affect the work required under this section.
2. The Contractor shall become acquainted with the existence and location of all surface and subsurface structures and utilities within the project area. Contractor shall not damage any of those that are to remain and shall leave them accessible.
3. The work shall be executed so that no damage or injury will occur to existing public and adjoining or adjacent structures, streets, paving, sewers, gas, water, electric or any other pipes. Should any damage or injury caused by the contractor, or anyone in Contractor's employ, or by the work under this Contract occur, the Contractor shall, at his own expense, make good such damage and assume all responsibility for such injury.
4. Provide barricades and warning lights, barriers, etc, to prevent accidents, to avoid all necessary hazards and protect the public, the work, and property at all times, including Saturdays, Sundays, and holidays.

5. The above shall also include the protection of all existing utilities (including sewers, electrical lines and telecommunication lines) to remain in use within and adjacent to the area affected by the work of this project.
6. Monuments, bench marks and other reference features on streets bounding this project, shall be protected. Should these be disturbed in any manner, the Contractor shall have them replaced at own expense.
7. Excavation work shall be restricted to hours indicated in the Contract Documents.
8. The Contractor's surveyor shall install control points on the adjacent structures and pavement for vertical and horizontal monitoring (to the nearest 0.005 ft.). Control points shall be monitored weekly during excavation and foundation construction work.

B. Protection of Excavation Bottoms

1. Facilities and materials needed to prevent earth at bottom of excavation from becoming frozen or unsuitable to receive the foundations shall be furnished.
2. The excavation shall not be carried to final grades during freezing weather without providing complete protection against freezing of the subgrades as specified hereinafter. Complete protection against freezing shall also be provided if freezing weather sets in after completion of the excavation to final subgrade. This protection shall include adequate heating and coverage of the area to maintain temperatures above freezing until foundations have been concreted and backfilled.
3. Where excavations have been brought to the bottom elevations called for on the drawings, and the bottom of these excavations become unsuitable in the opinion of the Owner's Geotechnical Engineer because of inadequate protection by the Contractor, these excavations shall be carried to lower depths sufficient to provide stable bearing as determined by the Owner's Geotechnical Engineer.

1.8 ERRORS IN DEPTH

A. In the event that any part of the excavation is carried, through error, beyond the depth and the dimensions indicated on the drawings of called for in the specifications, then the Contractor, at his own expense, shall furnish and install gravel or stone with which to fill to the required level, in all locations except beneath footings and piers. At these locations, Contractor shall be required to fill to level of bottom footing with concrete mixed in the proportion of the foundations bearing on them. Where established bottoms as shown on drawings have not been maintained or have been disturbed by operations under this contract, they shall be cleaned out and filled with concrete mixed in the proportion of the footings bearing upon them, without additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Fill: Well-graded sand and gravel having no more than 10% by dry weight passing the No. 200 sieve, free of organic material, clay, excessive silt, other deleterious or compressible materials, cinders, frozen material, trash, masonry or rubble and free of particle having dimensions greater than 3-inches in all directions. The allowable bearing pressure of structural fill shall be 2.0 tons per square foot. The existing fill on-site is not suitable for direct structural support for

foundations or slab on grade. Imported structural fill should be well graded sand and gravel having a maximum particle size of 3 inches and no more than 10% passing the No. 200 sieve. Any approved imported fill should be "certified clean fill" free of hazardous substances and meeting all site, local and federal regulations. Structural fill shall be used as backfilling material within 3 feet of any structure, including footings, below-grade walls, utilities, manholes and catch basins. Structural fill shall also be used in areas from 2 feet below up to 6" below slabs and areas greater than 2 feet below pavement subgrade, if acceptable with the project Civil Engineer. Structural fill shall meet the following gradation:

1.	Sieve Size		Percent Passing by Weight
	a.	3 in	100
	b.	1-1/2 in.	55-100
	c.	No. 4	35-85
	d.	No. 16	20-65
	e.	No. 50	5-40
	f.	No. 200	0-10

B. Ordinary Fill: Well-graded sand and gravel having no more than 20% by dry weight passing the No. 200 sieve, free of organic material, clay, excessive silt, other deleterious or compressible material, cinders, frozen material, trash, masonry or rubble and free of particles having dimensions greater than 6-inch in all directions. The on-site fill and natural sand conforming to the above gradation criteria and material that is not regulated as waste that requires off-site disposal can be reused as ordinary fill. Ordinary fill shall be used as backfilling material in non-finished areas (i.e. landscaped areas) or in areas greater than 2 feet below pavement subgrades, if acceptable with the project Civil Engineer.

1.	Sieve Size		Percent Passing by Weight
	a.	6 in	100
	b.	3 in.	80-100
	c.	No. 4	20-100
	d.	No. 200	0-20

C. Imported Fill: Well-graded sand and gravel having no more than 10% by dry weight passing the No. 200 sieve, free of organic material, clay, excessive silt, other deleterious or compressible materials, cinders, frozen material, trash, masonry or rubble and free of particle having dimensions greater than 3-inches in all directions. Any approved imported fill should be "certified clean fill" free of hazardous substances and meeting all site, local and federal regulations. Imported fill shall meet the same gradation requirements as structural fill.

D. Crushed Stone: Free draining natural crushed stone free of deleterious materials and conforming to the gradation requirements commercially known as clean, durable, ¾-inch crushed stone. Recycled concrete shall not be acceptable. Material shall conform to the requirements of the ConnDOT Form 817, Section M.01.01, for No. 6 crushed stone.

E. The use of recycled concrete aggregate (RCA) is not permitted as backfill material behind permanent below grade walls or in the vicinity of drainage structures.

F. Filter Fabric: Mirafi 140N manufactured by TC Mirafi or approved equivalent non-woven geotextile filter fabric where specified.

PART 3 - EXECUTION

3.1 CODES, PERMITS AND REGULATIONS

A. Comply with all applicable laws, rules, and ordinances and regulations of the Federal Government, Connecticut, and other jurisdictions.

B. Obtain and pay for all permits and licenses required to execute and complete the work.

C. In case of conflict between regulations and specifications, the Contractor shall comply with the most stringent applicable codes, regulations or specifications.

3.2 PUMPING AND DEWATERING

A. Pumping and dewatering is anticipated. All pumping and dewatering work shall be conducted in accordance with the Dewatering Specification 312319 and the Geotechnical Report prepared by GEI Consultants.

B. Provide adequate pumps, or other equipment, appurtenances, power, drains, materials and labor necessary to excavation continuously dry during excavation, foundation construction, and backfilling and at such other times as the progress of the work may demand or as necessary to insure safety to the structure shall be provided.

C. All pumping both inside and outside the areas of the building shall be performed, continued and maintained as required for the completion of all work, including the work of the mechanical trades, throughout the period of the contract.

D. Contractor shall manage runoff to limit impact on construction.

E. The dewatering system or systems shall be installed and operated in such a manner as to avoid the movement of fines or loss of ground from below the bearing level and shall not influence the stability of surrounding areas. The facilities needed to eliminate loss of ground shall be included.

F. The Contractor shall not use any portion of the building foundation units or any part thereof as a sump for drainage resulting from pumping in any other area. The Contractor shall not conduct water to privately owned properties.

G. Any pumped groundwater which will require off-site disposal shall comply with all Local, State, and Federal Environmental Regulations.

3.3 EXCAVATION

A. General

1. Excavation shall be unclassified and shall include removal and disposal of all materials encountered regardless of the nature of the materials and shall be understood to include but

not limited to rock, boulders, earth, glacial till, silt, hardpan, fill, foundations, structures, slabs, walls, utilities, pavements, curbs, piping and debris, and others.

2. All excavation shall extend to the dimensions and elevations required for the installation of the work described herein and as indicated on the Drawings. Excavation shall be made to a depth that will allow installation of full depth of concrete slabs, and sub-base as shown on drawings and 1 inch tolerance. Excavation lines shall provide sufficient clearance for the proper execution of all concrete work, including allowances for form work, shoring and inspection.
3. Materials that in the opinion of the Owner's Geotechnical Engineer are not suitable for fill and any surplus earth shall be removed from the site and legally disposed of.
4. Existing utility lines to be retained that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the Contractor, at own expense.

B. Excavation for Foundations

1. Foundation subgrades shall be observed and approved by the Owner's Geotechnical Engineer before proceeding with the construction of foundations. Bottoms of footings shall be founded on natural sand, weathered rock, more competent rock, or structural fill having a net allowed uniform bearing pressures as specified in the Structural Drawings and as approved by the Owner's Geotechnical Engineer.
2. Subgrade of foundations shall be level and free of loose soil, debris, standing water and frost prior to acceptance for placing concrete. A professional Geotechnical Engineer should observe and approve the foundation subgrade to verify that the subgrade material is adequate to provide the recommended allowable bearing pressure.
3. Unauthorized Excavation: When suitable bearing material is encountered at subgrade elevations shown on Drawings and excavation is made to greater depth, the foundations and foundation walls shall be extended to the lower elevation with concrete of the same strength used for the foundations, at no additional cost to the Owner.

C. Subgrade Preparation

1. Lawn subgrade preparation shall be accomplished as follows:
   a. Excavate all topsoil. Excavate natural and/or fill materials down to subgrade elevation and stockpile on-site. Proofroll as described below.
2. Natural undisturbed material shall be graded and compacted to attain a uniform surface. These areas shall be determined by the Geotechnical Engineer.
   a. Prior to constructing foundations the subgrade shall be proofrolled in the presence of the Geotechnical Engineer for the following conditions:
   b. Proofrolling shall be accomplished with a minimum of six passes of a 1-ton walk-behind vibratory roller. Foundation elements shall not be placed until the subgrade is approved by the Geotechnical Engineer.
   c. Soft Areas during Compaction: If any areas show pumping, noticeable weaving, or which are otherwise unsatisfactory, undercut material within the limits and extent ordered by the Geotechnical Engineer. These areas shall be replaced with either concrete of the same strength used for the foundation or structural fill, compacted to 95% of maximum dry density by ASTM D1557. The appropriate water content at the time of compaction should be plus or minus 2 percentage points of optimum

moisture content as determined by the laboratory compaction test aforementioned, unless otherwise directed by the Engineer of Record.

D. Excavation for General Grading:

1. Excavations made below the elevations shown or specified, unless authorized by Change Order, shall be filled and compacted as hereinafter specified, at no additional cost. A Change Order will be issued for authorized additional excavation.

E. Trench Excavation:

1. Unless otherwise shown, specified or required, make trenches for piping and utilities not less than 12 inches or more than 24 inches wider than the outside width of the piping or utilities. Accurately grade bottoms of trenches with bell holes scooped out to provide uniform bearing and support of pipe and utilities on undisturbed soil throughout its entire length, except where other means of supporting pipe are indicated.
2. Trenches for underground conduit and piping, where necessary, shall be excavated to the required depth and bell holes shall be provided where necessary to insure uniform bearing. Trench excavation lines shall provide sufficient clearance for the proper execution of underground mechanical work.
3. Trenches shall be by open cut from the surface. No tunneling will be allowed except by consent of the Geotechnical Engineer. Irregularities at bottom of trench, or where excavation is below required depth, shall be refilled to required grade with compacted granular fill.
4. Pipe trenches shall be excavated and minimum cover shall be provided to required depths as per the Connecticut State Building Code. Excavated materials adjacent to trench as directed shall be neatly banked.
5. Where trenches are in wet or soft ground that in the opinion of the Geotechnical Engineer is unsuitable for supporting the piping, concrete cradles or approved equivalent shall be installed.
6. Where necessary, the sides of trenches and excavations shall be supported by adequate sheeting and bracing and conform with applicable OSHA regulations to insure proper construction and safety of the workers. The Contractor will be held responsible for the sufficiency of sheeting and bracing and for all damages to property or injury to persons resulting from improper quality, strength, placing, maintaining and removing of same.
7. Prior to utility installation, soil subgrades in the utility trenches should be proofrolled as specified herein. Pipe bedding should be placed and compacted in accordance with the pipe manufacturer's requirements or as indicated in the Drawings, whichever is more stringent.
8. Immediately after piping has been installed, tested, inspected, and accepted, piping shall be filled around with special care to solidly fill voids without causing injury to piping. Up to two feet above the pipe's crown, the utility excavation shall be backfilled using structural fill placed in 4-inch thick loose lifts. For the remainder of trench backfill, the excavation shall be backfilled using structural fill placed in 12-inch thick loose lifts. Each layer shall be compacted before placing the next layer. Backfill shall be in such a manner so as to prevent future settlement.

3.4 FILLING AND COMPACTING

A. Structural fill shall be compacted in maximum 9 inch thick, loose lifts to at least 95% of the material's maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D1557). The moisture content shall be held to within +/- 3% of optimum moisture content as determined by ASTM 1557.

B. Ordinary fill shall be compacted in maximum 12 inch thick, loose lifts to at least 92% of the material's maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D1557). The moisture content shall be held to within +/- 3% of optimum moisture content as determined by ASTM 1557.

C. Crushed Stone should be compacted with at least four passes of a vibratory compactor.

D. General

1. Do not commence filling and backfilling operations until construction below finish grade has been approved, underground utilities and mechanical items inspected and tested, forms removed, waterproofing or damproofing and other improvements installed, trash and debris removed, and temporary and permanent bracing installed.
2. Do not commence backfilling, filling and grading until existing subgrade has been compacted to the required density.
3. Fill all excavations, backfill against all walls, and do all filling and grading necessary to bring the surfaces to the level required.
4. No fill material shall be placed on areas where free water is standing, or frozen subsoil area, or on surface which have not been approved for fill placement by the Geotechnical Engineer.
5. Do not backfill against concrete elements until the concrete has obtained its specified compressive strength.
6. Perform backfilling around foundation walls when the first floor provides sufficient bracing to withstand the backfill pressure. All other fill, backfill, and rolling to approximately finished grades shall then be completed.
7. Take particular care when rolling over areas where trenches or other excavations have been made and backfilled.
8. Grade bottoms of pavements and area way bottoms toward sediment pits or catch basins to maintain uniform thickness of the slabs.

E. Grading

1. Prior to placing fill or backfill in any area, grading shall be performed as required to provide for drainage. Ditching or filling around the area will be performed to intercept or divert all surface water. Within the area the ground which fill is to be placed on will be graded so as to provide for unobstructed drainage from every point to a sump or other disposal point.
2. On completion of grading as specified above, closely examine to determine whether excessive wetness, springs, or other seepage of water can be observed at any point. If such conditions exist, positive drainage in suitable form, such as french drains or tilling, must be provided before placement of fill is undertaken.

F. Placement and Compaction of Controlled Fill and Backfill

1. Placement
   a. Begin fill and backfilling in the lowest section of the area. Spread material evenly by mechanical equipment or by manual means above the approved compacted subgrade in lifts not exceeding 10 to 12 inches for material compacted by heavy machinery and 4 inches for material compacted by hand tamping. Build layers as horizontally as practical to prevent thickness of lift from exceeding that specified but provide with sufficient longitudinal and transverse slope to provide for runoff of surface water from every point.
   b. If backfilling on an existing slope is required, first clear and grub any vegetation, root systems and sod. The new slope should then be constructed in a "stepped" fashion beginning at the toe of the existing slope and moving up the face of the existing slope. This approach involves the removal of a portion of the existing slope such that the new fill is benched into the existing slope in lifts. The cut face of the benches created as part of the stepped construction should be sloped such that the individual steps are stable. The slope face of the new fill's exterior edge should be over-built and then cut back to reveal the firm, compacted slope face and all loose, uncompacted material on the exterior slope face should be removed as part of the fine grading process.
2. Moisture Control: The moisture-density curve for the fill use shall be supplied to the Contractor as a guide in controlling moisture to achieve the required degree of compaction. If, in the opinion of the Geotechnical Engineer, fill material becomes too wet for the required compaction, the fill shall be dried by a method approved by the Geotechnical Engineer prior to commencing or continuing compaction operations. Likewise, if, in the opinion of the Geotechnical Engineer, the fill material becomes too dry for the required compaction, the fill shall be moistened by a method approved by the Geotechnical Engineer prior to commencing or continuing compaction operations. The water content at the time of compaction should be within 3% points of the optimum water content.
3. Compaction: Compact each lift to the designated maximum dry laboratory density by ASTM D1557. The degree of compaction shall be checked by the Geotechnical Engineer and each successive lift shall not be placed or compacted until the previous lift is observed and approved by the Geotechnical Engineer. Compact the fill and backfill to elevations and limits shown on Drawings and is subject to final observation and approval by the Geotechnical Engineer.
4. Drainage During Fill Operation: At all times, maintain and operate proper and adequate surface and subsurface drainage to the satisfaction of the Geotechnical Engineer in order to keep the construction site dry and in such condition that placement and compaction of fill may proceed unhindered by saturation of the area.
5. Frost: Do not place fill materials when either the fill materials or the previous lift (or subgrade) on which it is placed is frozen. In the event that any fill which has already been placed on the surface shall become frozen, it shall be scarified and recompacted, or removed, to the approval of the Geotechnical Engineer before the next lift is placed. Remove or recompact any soft spots resulting from frost to the satisfaction of the Engineer before new fill is placed.

3.5 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

D. Settling: Where settling is measurable or observable at excavated areas, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.6 QUALITY CONTROL AND INSPECTION

A. The Owner will employ, at his own expense, a Geotechnical Engineer to review all laboratory test results and submitted reports specified in this Section.

B. Field Observation:

1. Foundation Subgrades: Foundation subgrades shall be observed by Owner's Geotechnical Engineer to verify the design bearing capacities. No foundation shall be constructed unless the Owner's Geotechnical Engineer approves the subgrade.
2. Paved Area and Building Slab Subgrades: Owner's Geotechnical Engineer shall observe Subgrades for paved areas and building slabs. No pavement or slab shall be constructed unless the subgrade approved by the Owner's Geotechnical Engineer.
3. Proofrolling: Proofrolling where required shall be inspected by Owner's Geotechnical Engineer.
4. Backfilling and Compaction: Backfilling and compaction below paved areas, building slabs, behind the foundation walls, and any other backfilling and compaction work shall be observed by the Owner's Geotechnical Engineer. No fill shall be placed unless the previous lift is approved by the Owner's Geotechnical Engineer. Owner's Geotechnical Engineer will take field density tests of the subgrade for every 2500 sq- ft. but not less than 3 tests in each compacted fill layer. Perform field density tests in accordance with ASTM D2922.
5. Contractor shall cooperate with the Geotechnical Engineer in the performance of the required tests.

3.7 DISPOSAL OF EXCAVATED MATERIALS

A. Legally dispose the excavated material to an off-site disposal facility, in accordance with all Local, State, and Federal Environmental regulations.

END OF SECTION 310000

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Comply with water disposal requirements of authorities having jurisdiction.

1.2 SECTION INCLUDES

A. Construction dewatering.

B. Erosion and Sediment Control

1.3 PERFORMANCE CRITERIA

A. Design, provide, test, operate, monitor, and maintain a dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrade.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. All pumps, hoses, electricity, erosion control measures needed.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding surrounding area.

C. Protect subgrade and foundation soils from softening and damage by rain or water accumulation.

D. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

E. Accomplish dewatering without damaging existing buildings adjacent to excavation.

3.2 DEWATERING

A. Install dewatering system using wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavation below ground-water level, place system into operation to lower water to specified levels and then operate it continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner to avoid inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 312319

SECTION 312333 - TRENCH EXCAVATION AND BACKFILL FOR UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 312319 – Dewatering

C. Section 333000 – Site Sanitary Sewers

D. Section 334100 – Storm Sewer Systems

E. Town of Glastonbury Requirements

1.2 SCOPE OF WORK

A. Excavating trenches for the installation of utilities.

B. Backfilling trench with bedding material as specified and finish filling trenches with suitable material to proposed subgrade.

C. Compacting subgrade, bedding, and backfill materials in an acceptable manner.

D. Compliance with all environmental and health and safety regulations.

1.3 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM) Latest Edition

1. D 422 Method for Particle Size Analysis
2. D 698 Test of Moisture Density Relations of Soils - Standard Proctor Method
3. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb. (4.5 Kg)
4. Hammer and 18-inch (457 mm) Drop (Modified Proctor)
5. D 2216 Laboratory Determination of Moisture Content of Soil
6. D 2487 Classification of Soils for Engineering Purposes
7. D 2922 Tests for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
8. D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
9. D 4318 Test for Plastic Limit, Liquid Limit, & Plasticity Index of Soils

B. American Association of State Highway and Transportation Officials (AASHTO) latest edition

1. T 88 Mechanical Analysis of Soils

1.4 QUALITY ASSURANCE

A. A Geotechnical Engineer, selected and paid by owner, may be retained to perform construction inspection and testing on backfilling operations. This inspection will not relieve the Contractor from his responsibility to complete the work in accordance with the plans and specifications.

1.5 SUBMITTALS

A. Shop Drawings or details pertaining to Site Utilities are not required unless use of materials, methods, equipment, or procedures contrary to the Construction Drawings or these specifications are proposed. No work shall be performed until shop drawings, if required, have been accepted by the Owner and Engineer.

B. The Contractor shall contact all utility companies and identify any requirements. Contractor shall provide written confirmation of the status of all utility construction to the Owner at the time of the preconstruction conference or no later than 30 days following the project possession date.

C. Submit a sample of each type of offsite fill and/or bedding material that is to be used in backfilling.

1.6 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of all subsurface utilities, structures and obstructions encountered.

B. Accurately record any as-built variation from the construction plans and specifications. The Contractor shall provide as-built drawings within 30 days of project completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Bedding Material: AASHTO No. 67 processed sand and gravel free from debris, clay lumps, organic, or other deleterious material, and complying with following gradation requirements:
   1. U. S. Sieve: Size Percent Passing (by weight)
      a. 1 Inch: 100
      b. 3/4 Inch: 90-100
      c. 3/8 Inch: 20-55
      d. No. 4: 0-10
      e. No. 8: 0-5

B. Backfill material as approved by the owner and/or the Geotechnical Engineer and utility provider.

PART 3 - EXECUTION

3.1 PREPARATION

A. Set all lines, elevations, and grades for utility and drainage system work and maintain for the duration of work. Provide careful maintenance of benchmarks, property corners, monuments, or other reference points.

B. Protect and maintain in operating condition, existing utilities encountered during utility installation. Repair any damage to surface or subsurface improvements shown on Drawings.

C. Verify location, size, elevation, and other pertinent data required to make connections between existing utilities and drainage systems, and proposed construction indicated on Drawings. Coordinate all building utility connection locations and elevations with architectural plans. Contractor shall comply with all local codes and regulations.

D. Install dewatering systems that will be required to construct the proposed utilities to the design elevations and using the methods described herein. Water pumped out of excavations shall be disposed of on-site, and will not be discharged directly to the town storm drainage system.

E. Over excavate and properly prepare areas of subgrade that are not capable of supporting the proposed systems. These areas are to be stabilized by using acceptable backfill materials and/or additional bedding material placed and compacted as specified to the satisfaction of the Geotechnical Engineer.

3.2 EXCAVATION

A. Contact local utility companies before excavation begins. Dig trenches at proper width and depth for laying pipe, conduit, or cable and in accordance with utility company requirements. Cut trench banks for safety and remove stones as necessary to avoid point-bearing.

B. All trench excavation side walls shall be sloped, shored, sheeted, braced or otherwise supported by means of sufficient strength to protect the workmen within them in accordance with the applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to an exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.

C. Trench width requirements below the top of the pipe shall not be less than 12 inches nor more than 24 inches wider than outside surface of any pipe or conduit that is to be installed. All other trench width requirements for pipe, conduit, or cable shall be the minimum practical width that will allow for proper compaction of trench backfill and satisfy safety and utility company regulations.

D. Accurately grade trench bottom to an elevation 6 inches below the pipe, or as per bedding details in construction drawings. Provide uniform bearing and support for each section of pipe on bedding material at every point along the entire length, except where necessary to excavate for bell holes, pipe joints, or other required connections. Dig bell holes and depressions for joints after trench bottom has been graded. Dig no deeper, longer, or wider than needed to make the joint connection properly.

E. During excavation, stockpile excavated material suitable for backfilling in an orderly manner far enough from the trench to avoid overloading, slides, or cave-ins.

F. Remove excavated materials from the site which are not suitable for backfill.

G. Any abandoned structures utilities or debris discovered during excavation shall be removed and disposed of, or capped.

H. Utility alignments have been designed to avoid expected obstructions wherever possible. If unanticipated significant obstructions are encountered during utility installation work immediately notify the Owner and Engineer.

I. Prevent surface water from flowing into trenches or other excavations by temporary grading or other methods, as required. Remove accumulated water in trenches or other excavations by pumping or other acceptable methods.

J. Utility installation shall meet the following minimum pipe installation depths, or applicable codes and ordinances, measured from finished grade or the paved surface.

1. Sanitary Sewer: 48-inch minimum to top of pipe barrel, or as required by the local utility company, whichever is deeper. Elevations and grades as indicated on Drawings.
2. Storm Sewer: 24-inch minimum to top of pipe barrel. Elevations and grades as shown on Drawings.

3.3 LATERALS

A. All utilities intended to connect to services within any building will be extended to within 5 feet of the exterior face of building in the direction and elevation to connect at those geometrical locations indicated or inferred on the drawings. All utility ends will be plugged and marked by a 2" x 4" piece of wood extending from the utility invert to 4 feet above final grade.

3.4 PIPE BEDDING

A. Accurately cut trenches for pipe or conduit to designated line and grade 6 inches below the bottom of the pipe, to width as specified previously. Compact trench bottoms a minimum of 95% of the maximum dry density as determined by ASTM D1557, Modified Proctor Test.

B. Over excavate wet or unstable soil, if encountered, from trench bottom as necessary to provide a suitable base for continuous and uniform bedding.

C. Place bedding material and compact in 6 inch loose lifts to obtain at least 95% of the maximum dry density. Accurately shape bedding material to conform to lower portion of pipe barrel. After pipe installation, place and compact bedding material as specified above in maximum 6 inch loose layers to the springline of the pipe or per pipe manufacturer’s recommendations.

3.5 BACKFILLING

A. After pipe or conduit has been installed, bedded and tested as necessary, backfill trench to finish grade in 8 inch thick loose lifts of approved fill soils, compacting and testing each lift as specified above.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces. Should these conditions exist, the areas should be removed, replaced and recompacted.

3.6 COMPACTION

A. Exercise proper caution when compacting immediately over top of pipes or conduits.

B. Maintain optimum moisture content of fill materials to attain required compaction density.

END OF SECTION 312333

SECTION 312500 - SOIL EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 024113 – Site Demolition

C. Section 310000 - Earthwork

D. Contract Drawings and Documents

1.2 SCOPE OF WORK

A. Temporary and permanent soil erosion control systems.

1.3 REFERENCE STANDARDS

A. The Connecticut Department of Energy & Environmental Protection's (CTDEEP) Guidelines for Soil Erosion and Sediment Control, latest edition

1.4 QUALITY ASSURANCE

A. The Contractor shall follow Soil Erosion and Sediment Control Notes that are shown on the Contract Drawings.

B. The Contractor shall make frequent inspection of temporary soil erosion controls and maintain them in working order until permanent soil erosion controls are established.

1.5 ENVIRONMENTAL REQUIREMENTS

A. The Contractor shall protect adjacent properties and water resources from soil erosion and sediment damage throughout construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Quick-growing grasses such as wheat, rye or oats in accordance with Contract Drawings.

B. Fencing for siltation control as specified on the Contract Drawings.

C. Fibrous blankets by North American Green SC150BN, biodegradable, or approved Equal.

D. Temporary mulches such as loose hay, straw, netting, wood, cellulose or agricultural silage.

E. Fence stakes shall be metal stakes a minimum of 5 feet in length and be either metal stakes or 2 in x 2 in hardwood stakes driven 1' – 6" into the ground.

F. Filter fabric as specified on the Contract Drawings, or approved equal.

G. Haybales free from invasive species

PART 3 - EXECUTION

3.1 PREPARATION

A. Review site conditions and sediment control plans.

B. Review the soil erosion and sediment control plans as they apply to current conditions. Any proposed deviation from the plans must be submitted to the Owner's Engineer in writing 72 hours prior to commencing that work.

3.2 SOIL EROSION CONTROL AND SLOPE PROTECTION IMPLEMENTATION

A. Place soil erosion control systems in accordance with the Contract Documents prior to any earthwork construction.

B. Limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations by following the construction phasing on the Soil Erosion and Sediment Control Plan.

C. The Contractor will be required to incorporate all permanent soil erosion control features into the project at the earliest practical time to minimize the need for temporary controls. Cut slopes shall be permanently seeded and mulched as the excavation proceeds to the extent considered desirable and practical. Equip catch basins with filter fabric inlet protection immediately upon construction.

D. The temporary soil erosion control systems installed by the Contractor shall be maintained as directed by the Owner's Engineer to control siltation at all times during the life of the contract. The Contractor must respond to any maintenance or additional work ordered by the Owner's Engineer within a 48 hour period.

E. Slopes that erode easily shall be temporarily seeded as the work progresses with quick growing grass grains of wheat, rye or oats unless otherwise specified in the Landscape Specifications. In areas where seeding is ineffective, as determined by the Owner's Engineer or other governing authorities, the Contractor shall provide fibrous netting as shown on Contract Drawings at no additional cost to the Owner.

F. All soil erosion control measures shall be maintained until all permanent improvements to the site are complete unless otherwise directed by the Owner's Engineer.

END OF SECTION 312500

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the state in which Project is located.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using photographs , show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Architect Owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Architect's Owner's written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:

1. Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
2. Compliance with AASHTO Standard Specification for Highway Bridges or AASHTO LRFD Bridge Design Specification, Customary U.S. Units.
3. Compliance with requirements of authorities having jurisdiction.
4. Compliance with utility company requirements.
5. Compliance with railroad requirements.

2.2 MATERIALS

A. Provide materials that are either new or in serviceable condition.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.2 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.

1. Limit vertical offset of adjacent sheet piling to 60 inches.
2. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment .

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.3 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback, and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.4 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 MAINTENANCE

A. Monitor and maintain excavation support and protection system.

B. Prevent surface water from entering excavations by grading, dikes, or other means.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.6 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks daily during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.

1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.7 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.

1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
2. Remove excavation support and protection systems to a minimum depth of 48 inches and as required by local jurisdiction below overlying construction, and abandon remainder.
3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

SECTION 320000 - GENERAL SITE REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

A. The work generally includes, but is not limited to, the following:
   1. Soil Erosion and Sediment Control Measures
   2. Earthwork
   3. Placement of Compacted Fill
   4. Removal of Cut
   5. Rough Grading of Grass Areas
   6. Construction of Storm Drainage System
   7. Construction of On-Site Utilities
   8. Construction of Sidewalks
   9. Construction of Curbs
   10. Fine Grading of Grass Areas
   11. Paving of Parking Areas and Roadways
   12. Striping and Signage
   13. Landscaping

B. Associated work items as described in the Contract Drawings and Documents and all construction methods and procedures necessary for the performance of the work.

C. The Site Contractor shall provide adequate personnel, facilities, material, and equipment to complete the work shown on the Contract Drawings and Documents and as specified herein and in accordance with the requirements of the town within the agreed upon schedule. When these specifications are at variance, the more restrictive requirements shall apply. The Contractor shall employ a qualified supervisor to provide adequate and efficient coordination of the Work and to adhere to all requirements set forth in this specification and general construction practices within the State of Connecticut and those required by the town. The Supervisor shall be present on the site on a continuous full-time basis and have authority to act on behalf of the Contractor.

D. The Contractor shall obtain and pay for the construction of all related site work. The Contractor shall pay for all other fees and services, give notice, file necessary drawings, and obtain permits and certificates of approval required in connection with the related work of their contracts, comply with laws, ordinances, rules and regulations of departments having jurisdiction over this work.

E. Additional Owner and Engineer time for repeat inspections of punch list items after the initial inspections will be charged to the Contractor in the form of a deductive change order.

1.3 CONTRACTOR TO ACCEPT SITE CONDITIONS AND CONTRACT DOCUMENTS

A. The Contractor shall accept the site as is. The Contractor shall make and shall be deemed to have made a thorough site inspection in order to field check existing site conditions, correlate conditions with the drawings and resolve any possible construction conflicts with the Owner and Owner's Engineer prior to commencement of work. This includes a topographic survey of any areas the Contractor requires additional topographic information, and subsurface utility investigations. Any conditions that differ from the existing conditions shown on the drawings that are not brought to the attention of the Owner and Owner's Engineer prior to the start of work shall not be considered grounds for a change order.

B. The work to be performed is as shown on the Contract Drawings. Attempts have been made to note all specific items on the drawings. The contractor is responsible for means and methods of construction; as such, these plans may not completely represent all specific site details of installation required for sitework construction. Contractor is responsible to provide all improvements required to achieve construction depicted on these plans. Incidental items not included in the Contract Documents shall be constructed in accordance with standard engineering or architectural requirements. It shall be the Contractor's responsibility to repair or replace any existing facilities (utilities, streets, sidewalks, walls, etc.) damaged by him during the work. Such repairs or replacement shall be done at the Contractor's own expense to the satisfaction of the Owner.

C. The Contractor shall provide written requests for information to the Owner and Owner's Engineer prior to the construction of any specific sitework item if any sitework item depicted on the plans warrants additional engineering information required for construction and is not related to means and methods of construction. The Contractor shall be responsible for sitework items installed differently than intended as depicted on the plans in the absence of submitting and receiving reviews and/or direction on written requests for information from the Owner or Owner’s Engineer.

D. It is specifically noted that information related to elevations and proposed utilities (such as roadway grades, invert elevations, rim elevations, grate elevations, building finished floor elevations, etc.) may be found in more than one location on the contract documents. Contractor shall specifically review all plans, profiles and any information/data tables for consistency prior to construction. Any inconsistencies or discrepancies that are found shall immediately be brought to the attention of the Owner's Engineer in writing requesting clarification prior to construction.

E. Contractor is specifically noted that there are additional notes, specifications and requirements contained on sheets throughout the plan set and available references to specifications from applicable governing authorities and industry standards. It is the contractor's responsibility to obtain, review and adhere to all applicable requirements.

F. Contractor’s acceptance of the project contract specifically binds the contractor to the requirements noted above and contained in this entire document.

G. Contractor is specifically noted that the project is subject to the conditions and requirements of the following permits:
   1. Permit: Site Plan Approval
      Agency: Town of Glastonbury

1.4 INDEMNIFICATION

A. The Contractor shall indemnify and save harmless the Owner, and its respective agents, officers, employees and Owner’s Engineer (herein collectively called the "indemnities") from and against any and all liability, loss, damages, interest, judgments and liens growing out of, and any and all costs and expenses (including, but not limited to, counsel fees and disbursements) arising out of, or incurred in connection with, any and all claims, demands, suits, actions, or proceedings which may be made or brought against any of the indemnities for or in relation to any violation of this Contract, the laws, statutes, ordinances, rules, regulations, executive orders and agreements herein provided or any injuries, including death at any time resulting therefrom, sustained by any person or persons, or on account of any damage to property, arising out of or in consequence of the performance of or the failure to perform the contract, whether or not such injuries to persons or damage to property are due or claimed to be due to any negligence of the Contractor or its employees, agents, subcontractors or materialmen, the indemnities or any other person.

1.5 WARRANTIES

A. The Contractor shall correct defective work at the Contractor's expense which appears within one year's time from acceptance of work. Failure of Contractor to correct such defects within a reasonable time after being notified to do so shall permit the Owner to cause such defects to be corrected and charge the Contractor the cost of corrections.

B. The Contractor shall submit to the Owner and Owner’s Engineer all material warranties supplied by manufacturers.

1.6 GENERAL QUALITY ASSURANCE

A. References and Standards: The Contractor shall comply with all rules, regulations, laws and ordinances of all Authorities having jurisdiction. All labor, materials, equipment, and services necessary to make the work comply with such requirements shall be provided without additional cost. All Standards shall be the latest edition and revisions.

B. The Contractor shall deliver material to the site, in the approved Manufacturer's original and unopened containers and packaging, bearing labels as to type of material, brand name and manufacturer's name. Delivered materials shall be identical to approved samples. Certifications for materials shall be included with the shipment.

C. The Contractor shall store material under cover (if appropriate) in a clean, dry, above-ground location, and remove materials which are damaged or otherwise not suitable for installation from the job site and replace with acceptable materials.

1.7 SECURITY

A. Protect work, existing premises and Owner's operations from theft, vandalism, and unauthorized entry.

B. Initiate and maintain security program as described herein throughout construction period until Owner acceptance precludes the need for Contractor security.

C. Restrict entrance of persons and vehicles into project site. Allow entrance only to authorized persons with proper identification. Maintain log of workers and visitors, make available to Owner on request.

D. Maintain a list of authorized persons; submit copy to Owner on request.

1.8 SAFETY PROVISIONS:

A. Site safety is entirely the responsibility of the Contractor. The Contractor is hereby made aware that the Owner's Engineer does not have the authority to stop the work on the grounds of unsafe work practices.

B. The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations as required by all authorities having jurisdiction bearing on the conduct of the Work as specified.

C. If any of the Contractor's work is performed contrary to such laws, ordinances, rules and regulations, and/or without the required notices, he shall bear all cost arising therefrom.

D. The Contractor shall also give prior written notice to all concerned utility companies, agencies, authorities, owners, etc., at least forty-eight (48) hours in advance of commencing any work on this Contract.

E. Maintenance materials, including extra materials, spare parts, tools, and software.

1.9 SUBMITTALS:

A. General:
1. The Contractor shall submit to the Owner's Engineer and to Town Officials and/or the Town Engineer, where required, sufficient documentation from the manufacturers that all material and products used by the Contractor meet the required specifications. Such documentation shall be submitted and reviewed prior to the delivery of the material.
2. This documentation shall include shop drawings, vendor drawings, manufacturer's specifications and catalog cuts. The shop drawings shall include plans, elevations, sections and details of the work showing in detail the methods of installation and all data and assumptions considered in the design.
3. The Owner's Engineer will review appropriate documentation for general compliance to the specifications prior to delivery. The Owner's Engineer's review will be made on a timely basis.
4. The review of the Owner's Engineer or failure to review shall not be construed as permitting any departure from Contract requirements, or as relieving the Contractor of responsibility for any errors, including details, dimensions or materials. If submittals show variations from Contract requirements, the Owner's Engineer may review such variations, subject to a proper adjustment in the Contract. If the Contractor fails to describe such variations, he shall not be relieved of the responsibility for executing work in accordance with the Contract Documents even though such submittals identifying other variations have been reviewed. It is specifically noted that variations from items depicted on the plan require the review and approval of the Town Engineer.
5. All submittals required by specifications shall be submitted, unless otherwise stated herein, as follows:

a. Specifications – Three copies of material specifications shall be submitted to the Owner's Engineer unless agreed that less copies will be sufficient.
b. Shop Drawings – A reproducible and two copies shall be submitted to the Owner's Engineer.

6. The work shall not begin until all required submittals for each segment of work have been reviewed.

1.10 PROJECT COORDINATION

A. Cooperate with the Owner when necessary in allocation of mobilization areas of the site for field offices and sheds, for access, traffic and parking facilities.

B. Comply with Owner procedures for intraproject communications; submittals, reports and records, schedules, coordination drawings, and recommendations and resolution of ambiguities and conflicts.

C. Comply with instructions of the Owner and/or applicable utility companies for use of temporary utilities and construction facilities.

D. Submit preliminary progress schedule and coordinate with project construction schedule. After review, revise and resubmit schedule to comply with revised project schedule. During progress of work revise and resubmit as directed.

E. Provide information required by Owner and Owner's Engineer for preparation of coordination drawings.

F. Notify Owner and Owner's Engineer when work is considered ready for substantial completion. Accompany Owner's Engineer on preliminary inspection to determine items to be listed for completion or correction in Contractor's Notice of Substantial Completion and punchlist.

1.11 PROGRESS SCHEDULE

A. The Contractor shall submit a detailed schedule for approval by the Owner before beginning work and shall adhere to the approved schedule. The schedule, which shall list all major and minor construction tasks, shall be based on the requirements set forth by the Owner and Construction Manager and shall be in accordance with the construction phasing plans. All work shall be done in a continuous manner unless otherwise directed by the Owner and Construction Manager and shall be completed at a satisfactory rate of progress. If in the opinion of the Owner, or his/her representative, work is not being done at a satisfactory rate of progress, the Owner may order the Contractor to increase his work force to insure completion of the project on schedule.

1.12 PERMIT APPLICATIONS AND COMPLIANCE

A. The Contractor shall carefully plan and coordinate his work so as to comply with all criteria, conditions and the intent of all project permits.

1.13 ENVIRONMENTAL PROTECTION

A. It is the Contractor's responsibility to assure himself that all applicable Federal, State and local laws, concerning pollution and environmental protection are being complied with by his personnel and subcontractors.

B. When Contractor is in, or it is anticipated that any part of the work may become in non-compliance with applicable Federal, State, and local laws or regulations, the Owner may issue an order stopping all or part of the work until satisfactory corrective actions have been taken, or may order supplemental actions to be taken to stay in, or come into, compliance. No part of the time lost due to any such stop order shall be made subject of a claim for extensions of time, or for extra compensation or damages by the Contractor.

C. In particular, the Contractor shall not allow the discharge of concrete, mortar, grout, gasoline, diesel, or the washing from vessels containing these materials, or other construction materials, into public areas, onto adjacent properties or the sewage or stormwater conveyance systems.

D. Contractor shall provide and maintain all facilities necessary for pollution control under this Contract as long as construction operations continue.

1.14 CONTRACTOR'S REPRESENTATIVES

A. The Contractor shall provide and maintain a capable and experienced field person to oversee all contract operations. The Contractor shall submit references for his proposed representative to, and obtain approval from, the Owner and/or Owner’s Engineer prior to the start of construction. The representative shall be on-site during all operating hours of the project.

B. As appropriate, the Contractor or his subcontractors shall provide qualified supervisory personnel for specialist aspects of the work, such as concrete, landscaping, and site furnishings.

1.15 JOB OFFICE

A. General:
   1. The Contractor shall provide and maintain a suitable site trailer for the use of his supervising personnel at a location agreed upon by the Owner and/or Owner’s Engineer.
   2. The offices shall be equipped with appropriate facilities, including, water, heat, air conditioning, internet, and electricity. The cost for maintaining the office facilities and the trailer shall be paid for by the Contractor for the duration of the project. The contractor shall arrange for weekly office trailer cleaning.
   3. The Contractor shall provide and maintain in a neat and sanitary condition such temporary sanitary conveniences and accommodations for the use of his employees and Owner’s Representative as may be necessary to comply with the requirements and regulations of the Department of Health and other governing agencies having legal jurisdiction.
   4. The Contractor shall provide all security necessary and be entirely responsible for protection of equipment and materials supplied and used in conjunction with his work.
   5. The office shall be maintained throughout the course of construction and shall be removed upon final acceptance of the Contract work.

1.16 SITE ACCESS

A. General
1. The Contractor shall construct any construction access ways shown on the Drawings or as required prior to the execution of his work. The contractor shall be required to maintain all necessary access and parking areas, haul roads, ramps and any other temporary facilities required by the Owner to insure safe and satisfactory operation of the facility and completion of the work in accordance with the schedule. Cleanliness of off-site streets (both private and public) shall be maintained by the Contractor throughout construction. All public roadways shall be kept free of debris and sediment that result from the subject work. The contractor will provide daily sweeping if required by the Town.
2. The Contractor shall coordinate construction fencing with the Owner.

1.17 EXISTING CONDITIONS, UTILITIES AND STRUCTURES

A. Prior to the beginning of any grading work, the Contractor shall make sufficient checks on the topographic conditions and subsurface utilities to satisfy himself that the existing information as shown on the topographic survey and contract documents are adequate for construction. Should any discrepancies be found, they shall be reported to the Owner's Engineer immediately. Claims for extras due to discrepancies in the existing conditions will not be reviewed if the Owner's Engineer and Owner are not notified immediately (within 24 hours of beginning of site work).

B. Verify Locations: Locations of existing underground utilities and structures as shown on the Contract Documents are approximate and may not necessarily be complete. These locations must be verified by the Contractor prior to construction. It is specifically noted that the contractor may require the use of a utility location service in the event the Contractor deems it necessary to perform this verification.

C. Prior to construction of the sanitary, water, gas, electric, telephone, cable and storm sewer systems, the Contractor shall conduct test pits at all proposed utility crossings with existing underground utilities and/or storm pipes. Elevations of existing utilities shall be accurately recorded and submitted to the Owner's Engineer for verification of the proposed design. Any necessary adjustments to the proposed design will be made by the Owner's Engineer in a timely manner.

D. The Contractor is specifically made aware that the exact depth and location of the off-site water and gas mains are unknown. The Contractor shall perform test pits prior to installation of the new laterals where shown on the plans to verify the depth and location of existing connection points.

E. Avoid Damage: The Contractor shall exercise care to avoid damage to all existing structures, poles, utilities, pipes, etc. which are scheduled to remain. In locations where the excavation is carried beneath or adjacent to such facilities, the Contractor shall adequately support such structures, utilities or pipes as necessary to remain in operation and maintain their original position. The Contractor shall be responsible for any damage caused to any utilities by this work, and shall repair any damage without charge to the Owner.

F. The Contractor shall provide written requests for information to the Owner and Owner's Engineer prior to the construction of any specific item if any specific item depicted on the plans warrants additional information required for construction and is not related to means and method of construction. The Contractor shall be responsible for specific sitework items installed differently

than intended as depicted on the plans in the absence of submitting and addressing written requests for information.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use materials appropriate to the work, and meeting with the Owner’s Engineer's approval.

PART 3 - EXECUTION

3.1 GENERAL

A. Execute general measures as appropriate, and meeting with the Owner’s Engineer's approval.

END OF SECTION 320000

SECTION 321216 - ASPHALTIC CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 321613 - Curbs and Sidewalks

C. Section 321723 - Pavement Markings

D. Connecticut Department of Transportation Standard Specifications, latest edition.

E. Contract Drawings and Documents

1.2 SCOPE OF WORK

A. Preparation and placement of asphaltic concrete binder course.

B. Preparation and placement of asphaltic concrete surface course.

1.3 REFERENCE STANDARDS

A. The Asphalt Institute (AI) latest edition

1. MS 2 Mix Design Methods for Asphaltic Concrete and Other Hot Mix Types
2. MS 3 Asphalt Plant Manual
3. MS 19 Basic Asphalt Emulsion Manual

B. US Army Corp of Engineers

1. UN-13 Hot Mix Asphalt Paving Handbook, (CE MP-ET)

C. American Society of Testing and Materials (ASTM) latest edition

1. D 946 Penetration - Graded Asphalt Cement for use in Pavement Construction
2. D 1188 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
3. D 1559 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

D. American Association of State Highway and Transportation Officials (AASHTO) latest edition

1. M 117 Mineral Filler "Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing"
2. M 140 Tack Coat "Emulsified Asphalt"
3. M 208 Tack Coat "Cationic Emulsified Asphalt"

4. M 226 Viscosity Graded Asphalt Cement
5. T 245 Marshall Mix Design

E. Connecticut Department of Transportation Standard Specifications, latest edition.

F. Town of Glastonbury Standards

1.4 QUALITY ASSURANCE

A. At the discretion of the Owner, an Engineer, selected and paid by Owner (herein referenced to as "Owner's Engineer", may be retained to perform construction testing of in-place asphaltic concrete courses for compliance with requirements for thickness, compaction, and surface smoothness. Asphaltic surface and base courses shall be randomly cored at minimum rate of 1 core per 20,000 sq. ft of paving. However, no less than 3 cores in light duty areas and 3 cores in heavy duty areas shall be obtained. Coring holes shall be immediately filled with full-depth asphaltic concrete. Asphaltic concrete pavement samples shall be tested for conformance with mix design.

B. Establish and maintain required lines and elevations.

C. In-place compacted thickness shall not be less than thickness specified on Contract Documents. Areas of deficient paving thickness shall receive tack coat and minimum 1-in. overlay; or shall be removed and replaced to proper thickness, at discretion of Owner; until specified thickness of course is met or exceeded at no additional expense to Owner.

D. Testing shall be performed on finished surface of each asphalt concrete course for smoothness, using 10-ft straightedge applied parallel with, and at right angles to centerline of paved area. Results of tests shall be made available to Owner upon request. Surfaces will not be acceptable if the following 10-ft straightedge tolerances for smoothness are exceeded:

1. Base Course Surface: 1/4-inch
2. Wearing Course Surface: 3/16-inch

E. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner.

F. Field density test for in-place materials shall be performed by examination of field cores in accordance with one of following standards:

1. Bulk specific gravity of paraffin-coated specimens: ASTM D 1188.
2. Bulk specific gravity using saturated surface-dry specimens: ASTM D 2726.

G. Rate of testing shall be 1 core per 20,000 sq. ft of pavement, with minimum of 3 cores. Cores shall be cut from areas representative of project. Areas of insufficient compaction shall be delineated, removed, and replaced in compliance with Specifications at no additional expense to Owner.

1.5 SUBMITTALS

A. Design Mix: Before any asphaltic concrete paving is constructed, submit actual design mix to the Owner's Engineer for review and/or approval. Design mix submittal shall follow the format as indicated in the Asphalt Institute manual MS-2, Marshall Stability Method; and shall include the type/name of the mix, gradation analysis, grade of asphalt cement used, Marshall Stability (lbs.), flow, effective asphalt content (percent), and direct references to the Standard Specifications sections for each material. The design shall be for a mixture listed in the current edition of the Standard Specifications. Mix design over three (3) years old will not be accepted by the Owner's Engineer.

B. Material Certificates: Submit materials certificate to the Owner's Engineer which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein.

C. Testing Results: Results of concrete, steel and paving tests performed by Contractor's testing laboratory shall be submitted to Owner's Engineer in a timely manner.

D. The results of Marshall Tests for the day of installation shall be submitted to the Field Engineer with the first truck delivery each day of asphalt placement.

1.6 PROJECT CONDITIONS

A. Weather Limitations:

1. Apply prime and tack coats when ambient temperature is above 40 degrees Fahrenheit, and when temperature has been above 35 degrees Fahrenheit for 12 hours immediately prior to application. Do not apply when base is wet, contains excess moisture, or during rain.
2. Construct asphaltic concrete paving when atmospheric temperature is above 40 degrees Fahrenheit.

B. Maintain access for vehicular and/or pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide asphalt-aggregate mixture to meet Connecticut Department of Transportation standards.

B. Asphalt Cement: Comply with AASHTO M 226; Table 2 AC-10, AC-20, or AC-30, viscosity grade, depending on local mean annual air temperature. See chart below:

1. Temperature Condition: Asphalt Grades

a. Cold, mean annual air temperature at 45 degrees Fahrenheit or lower: AC-10, 85/100 pen.
b. Warm, mean annual air temperature between 45 degrees Fahrenheit and 75 degrees Fahrenheit: AC-20, 60/70 pen.

c. Hot, mean annual air temperature at 75 degrees Fahrenheit or higher: AC-30

C. Tack Coat: Emulsified asphalt; AASHTO M 140 or AASHTO M 208, SS-1h, CSS-1, or CSS-1h, diluted with 1 part water to 1 part emulsified asphalt.

D. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with AASHTO M 117, if recommended by state highway department specifications.

E. Asphalt-Aggregate Mixture: Unless otherwise noted on Contract Documents, Design Mix shall have minimum stability based on 50-blow Marshall complying with ASTM D 1559 of 1000 lb with flow between 8 and 16. The Design Mix shall be within sieve analysis and bitumen ranges specified below unless approved otherwise by Owner prior to placement.

1. SIEVE ANALYSIS OF MIX

a. Square Sieve: Total Percent Passing

1/2": 100%
3/8": 80 - 100%
#4: 50 - 75%
#8: 30 - 60%
#16: 20 - 45%
#30: 15 - 35%
#50: 10 - 30%
#200: 4 - 10%

b. Percent bitumen by weight of total mix: 5.0 - 8.5 percent
c. Air voids: 3 - 6 percent
d. Aggregate voids filled with asphalt cement: 70 - 82 percent
e. Allowable variance of bitumen by weight of total mix = 0.4 percent

2.2 EQUIPMENT

A. Maintain equipment in satisfactory operating condition and correct breakdowns in manner that will not delay or be detrimental to progress of paving operations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Proof roll prepared base material surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving.

B. Remove loose material from compacted base material surface immediately before applying prime coat.

3.2 APPLICATIONS

A. Tack Coat:

1. Apply to contact surfaces of previously constructed asphaltic concrete base courses or Portland cement concrete and surfaces abutting or projecting into asphaltic concrete or into asphaltic concrete pavement.
2. Apply tack coat to asphaltic concrete base course. Apply emulsified asphalt tack coat between each lift or layer of full depth asphaltic concrete bases and on surface of bases where asphaltic concrete paving will be constructed.
3. Apply emulsified asphalt tack coat in accordance with Connecticut Department of Transportation Standard Specifications.
4. Apply at minimum rate of 0.05 gal per sq. yd of surface.
5. Allow to dry until at proper condition to receive paving.

3.3 ASPHALTIC CONCRETE PLACEMENT

A. Place asphaltic concrete mixture on completed compacted subgrade surface, spread, and strike off. Spread mixture at following minimum temperatures:

1. Ambient temperature between 40 degrees Fahrenheit and 50 degrees Fahrenheit, mixture temp. = 285 degrees Fahrenheit
2. Ambient temperature between 50 degrees Fahrenheit and 60 degrees Fahrenheit, mixture temp. = 280 degrees Fahrenheit
3. Ambient temperature higher than 60 degrees Fahrenheit, mixture temp. = 275 degrees Fahrenheit

B. Whenever possible, pavement shall be spread by finishing machine; however, inaccessible or irregular areas may be placed by hand methods. Hot mixture shall be spread uniformly to required depth with hot shovels and rakes. After spreading, hot mixture shall be carefully smoothed to remove segregated course aggregate and rake marks. Rakes and lutes used for hand spreading shall be type designed for use on asphalt mixtures. Loads shall not be dumped faster that they can be properly spread. Workers shall not stand on loose mixture while spreading.

C. Paving Machine Placement: Apply successive lifts of asphaltic concrete in transverse directions with surface course placed parallel to flow of traffic. Place in typical strips not less than 10-ft wide.

D. Joints: Make joints between old and new pavements, or between successive days and work in manner that will provide continuous bond between adjoining work. Construction joints shall have same texture, density, and smoothness as other sections of asphaltic concrete course. Clean contact surfaces of joints and apply tack coat.

3.4 ROLLING AND COMPACTION

A. Mixture, after being spread, shall be thoroughly compacted by rolling as soon as it will bear the weight of rollers without undue displacement. Number, weight, types of rollers, and sequences of rolling operations shall be such that required density and surface are consistently attained while mixture is in workable condition.

B. The bituminous concrete pavement shall have a minimum thickness as specified on the Contract Documents and should be compacted to a minimum of 96% of the maximum unit weight as determined by the Marshall Mix Design Procedures in accordance with ASTM D-1559.

C. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

D. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling with hot material.

E. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

F. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

G. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphaltic concrete. Compact by rolling to maximum surface density and smoothness.

H. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

I. Scheduling: After complete placement of the base course the contractor may be required to remobilize for the placement of the top course. This schedule requirement will be based on the building progress, and fully at the discretion of the Owner’s Engineer.

END OF SECTION 321216

SECTION 321313 - PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 310000 – Earthwork

C. Section 321613 – Curbs and Sidewalks

D. Connecticut Department of Transportation Standard Specifications, latest edition.

E. Town of Glastonbury Standard Requirements

1.2 SECTION INCLUDES

A. Preparation and placement of concrete walks and other concrete areas as identified on Contract Documents.

1.3 REFERENCE STANDARDS

A. American Concrete Institute (ACI) latest edition

1. 301 Specifications for Structural Concrete for Buildings
2. 304R Guide for Measuring Mixing, Transporting and Placing Concrete
3. 308 Standard Practice for Curing Concrete

B. American Society for Testing and Materials (ASTM) latest edition

1. A 185 Steel Welded Wire Fabric, Plain for Concrete Reinforcement
2. C497 Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
3. A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
4. C33 Concrete Aggregates
5. C 94 Ready-Mixed Concrete
6. C 150 Portland Cement
7. C 260 Air-Entraining Admixtures for Concrete
8. D 309 Liquid Membrane-Forming Compounds for Curing Concrete
9. C494 Chemical Admixtures for Concrete
10. C1751 Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

C. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.

D. Connecticut Department of Transportation Standard Specification, latest edition.

1.4 QUALITY ASSURANCE

A. The Contractor shall pay for the services of a test laboratory, approved by the Engineer, for concrete inspection. The test laboratory shall have at least one Professional Engineer on staff and shall submit proof that any concrete inspectors used on the project shall have successfully completed the ACI course in Concrete Inspection within the past year.

B. Establish and maintain required lines and elevations.

C. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Owner's Engineer.

D. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.

E. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of material.

1.5 SUBMITTALS

A. Submit materials certificate to the Owner's Engineer, which is signed by materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein.

B. The Contractor shall retain an independent testing agency to perform the required tests. The Contractor shall provide any necessary assistance to the testing agency and provide the testing agency with the intended construction schedule at least one week prior to the start of construction.

C. Submit concrete mix design to the Owner's Engineer for review at least 14 days prior to use.

D. Testing results of concrete, steel and paving tests performed by Contractor's testing laboratory shall be submitted to Owner's Engineer in a timely manner.

1.6 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Forms shall be of depth equal to depth of curbing or sidewalk, and so designed as to permit secure fastening together at tops. Coat forms with nonstaining type of coating that will not discolor or deface surface of concrete.

B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185.

C. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.

D. Concrete materials: Comply with applicable requirements for concrete materials, admixtures, bonding materials, curing materials and others as required. Concrete shall have a minimum 28-day compressive strength of 4000 psi.

E. Joint Sealers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D 1751 FS HH-F-341, Type II, Class A.

F. Welded wire fabric as indicated on Contract Documents.

2.2 MIX DESIGN AND TESTING

A. Concrete mix design and testing shall comply with requirements of ACI.

B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following properties:

1. Compressive Strength: 4,500 psi, minimum at 28 days, unless otherwise indicated on Contract Documents.
2. Slump Range: 4-inches +/- 1-inch at time of placement
3. Air Entrainment: 4 to 7 percent

PART 3 - EXECUTION

3.1 PREPARATION

A. Proof-roll prepared base material surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving. Compaction testing for the base material shall be completed prior to the placement of the paving.

B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION

A. Form Construction

1. Set forms to require grades and lines, rigidly braced and secured.
2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
3. Check completed formwork for grade and alignment to following tolerances:

a. Top of forms not more than 1/8-inch in 10-ft
b. Vertical face on longitudinal axis, not more than
c. 1/4-inch in 10-ft

4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.
5. Install 4-inch x 4-inch welded wire fabric as indicated on Contract Documents. Support wire on metal wire chairs to ensure that wire stays mid-depth of sidewalk section during concrete pour.

B. Reinforcement: Locate, place and support reinforcement in accordance with Contract Documents and ACI.

C. Concrete Placement

1. Place concrete in accordance with requirements of Connecticut Department of Transportation Standard Specifications and ACI requirements.
2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at required finish elevation and alignment.
3. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint. Automatic machine may be used for curb and gutter placement at Contractor's option. Machine placement must produce curbs and gutters to required cross-section, lines, grades, finish and jointing as specified for formed concrete. If results are not acceptable, replace with formed concrete as specified.
4. Concrete placement in poor weather conditions shall be subject to limitation of ACI.

D. Joint Construction: Construct expansion, weakened-plane control or contraction, and construction joints straight with face perpendicular to concrete surface. Construct traverse joints perpendicular to centerline, unless otherwise detailed.

1. Weakened-Plane Control or Contraction Joints: Provide joints per the drawings. Construct control joints for depth equal to at least 1/4 concrete thickness, as follows:
2. Form tooled joints in fresh concrete by grooving top with recommended tool and finishing edge with jointer.
3. Form sawed joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.

E. Construction Joints: Place concrete joints at end of placements and at locations where placement operations are stopped for period of more than 1/2 hour, except where such placements terminate at expansion joints. Construct joints using standard metal keyway-section forms.

F. Expansion Joints: Locate expansion joints per the drawings. Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, sidewalks, and other fixed objects.

G. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.

3.3 CONCRETE FINISHING

A. After striking off and consolidating concrete, smooth surface by screening and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10-ft straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.

B. Work edges of sidewalks, gutters, back top edge of curb, and formed joints with edging tool, rounding edge to 1/2-inch radius. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:

1. Paving: provide course, nonslip finish by scoring surface with stiff-bristled broom perpendicular to flow of traffic.
2. Curbs, gutters and sidewalks: Broom finish by drawing fine haired broom across surface perpendicular to line of traffic. Repeat operation as necessary to produce a fine line texture.

C. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Owner’s Engineer.

D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in "water-curing" section of ACI 308.

3.4 BACKFILL

A. After the concrete has set sufficiently, the spaces in front and back of the curb or sidewalk shall be refilled to the required elevation with suitable material in accordance with Section 310000, which shall be compacted until firm and solid and neatly graded.

3.5 CLEANING AND ADJUSTING

A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.

B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

END OF SECTION 321313

SECTION 321440 - STONE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Stone pavers set with polymeric sand joints.

1.3 PERFORMANCE REQUIREMENTS

A. Control of Corrosion and Staining: Prevent galvanic and other forms of corrosion as well as staining by isolating metals and other materials from direct contact with incompatible materials. Use materials that are nonstaining to exposed surfaces of stone and joint materials.

1.4 SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and other manufactured products specified.

1. For stone varieties proposed for use on Project, include data on physical properties required by pertinent ASTM standards.

B. Shop Drawings: Show details of fabrication and installation of stone pavers, including dimensions, arrangement and details of jointing, supporting, anchoring, and details showing relationship with, attachment to, and reception of related work.

C. Stone Samples for Verification: Sets for each variety of stone required; not less than 12 inches (300 mm) square. Include 2 or more samples in each set showing the full range of variations in appearance characteristics expected in completed Work

D. Polymeric Sand Samples for Verification: For each type and color.

E. Qualification Data: For firms and persons specified in the “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed stone paving similar in material, design, and extent to that indicated for Project that has resulted in construction with a record of successful in-service performance.

B. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry with resources to provide materials of consistent quality in appearance and physical properties and to cut and finish material without delaying the Work.

C. Source Limitations for Other Materials: Obtain each type of stone accessory and other material from a single manufacturer for each product.

D. Mockups: Before installing stone store paving and curbs, construct mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for completed Work.

1. Locate mockups in the locations indicated or, if not indicated, as directed by Landscape Architect.

2. Build mockups for the following kinds of work.

a. Typical paving pattern approximately 40 s.f. in area.

b. Include joints and edge retaining devices.

3. Notify Landscape Architect 7 working days in advance of the dates and times when mockups will be constructed.

4. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

a. Acceptance of mockups does not constitute approval of deviations from Contract Documents contained in mockups, unless such deviations are specifically approved by Landscape Architect in writing.

b. Accepted mockups may be retained as part of the finished work.

1.6 DELIVERY. STORAGE. AND HANDLING

A. Deliver materials to Project site in undamaged condition.

1. Deliver products to Project site in original unopened containers labeled with manufacturer's name, product name and designation, color, expiration period, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, or other causes.

1. Lift with wide-belt slings if necessary; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

2. Store stone on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

3. Store cementitious materials off ground, under cover, and in dry location.

1.7 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone paving damaged by frost or freezing conditions.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

B. Stone Paver and Curb Units: Furnish quantity of full-size units for each shape and thickness equal to 5 percent of amount installed.

PART 2 - PRODUCTS

2.1 STONE SOURCES

A. Varieties and Sources: Subject to compliance with requirements, provide the stone varieties indicated on the Drawings for each stone type.

2.2 STONE GENERAL

A. Match Landscape Architect's samples for variety, color, finish, and other stone characteristics relating to aesthetic effects.

B. Provide stone from a single quarry for each variety of stone required.

1. Provide matched blocks extracted from a single bed of quarry stratum unless stone from blocks randomly selected for aesthetic effect is acceptable to Landscape Architect.

C. Quarry stone in a manner to ensure as-quarried block orientations yield finished stone with required characteristics.

D. Make quarried blocks available for examination by Landscape Architect for appearance characteristics.

2.3 STONE FABRICATION

A. General: Fabricate stone pavers in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.

B. Cut stone to produce pieces of thickness, size, and shape indicated and to comply with fabrication and construction tolerances recommended by applicable stone association or, if none, by stone source, for faces, edges, beds, and backs.

C. Finish exposed faces and edges of stone to comply with requirements indicated for finish under each type of stone required and to match approved samples and mockups.

D. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

1. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved samples and mockups.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive paving stone, and conditions under which stone will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone paving and curbs.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of dimension stone cladding.

2. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Advise installers of other work about specific requirements for placement of inserts, flashing reglets, and similar items to be used by stone paving installer for anchoring and supporting stone. Furnish installers of other work with Drawings or templates showing locations of these items.

B. Protect stone during installation.

C. Clean stone surfaces that have become dirty or stained by removing soil, stains, and foreign materials before selling. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 SETTING STONE, GENERAL

A. Execute stone installation by skilled mechanics and employ skilled stone fitters at the site to do necessary field cutting as stone is set.

1. Use power saws to cut stone. Produce lines cut straight and true, with edges eased slightly to prevent snipping.

B. Contiguous Work: Provide reveals and openings as required to accommodate contiguous work.

C. Set stone to comply with requirements indicated on Drawings and Shop Drawings. Shim and adjust supports and accessories to set stone accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: Do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch (9 mm) maximum.

B. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

C. Variation in Plane between Adjacent Payers: Do not exceed 1/32-inch difference between planes of adjacent units.

3.5 ADJUSTING AND CLEANING

A. Remove and replace stone paving of the following description:

1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are acceptable to Landscape Architect.

2. Defective joints

3. Stone and joints not matching approved samples and mockups.

B. B. Replace in a manner that results in stone paving matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. C. Clean stone pavers not less than 6 days after completion of pointing, using clean water and fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage stone.

3.6 PROTECTION

D. A. Provide final protection and maintain conditions, in a manner acceptable to fabricator and Installer that ensure dimension stone cladding is without damage or deterioration at the time of Substantial Completion.

END OF SECTION 321440

\\langan.com\data\NHV\data7\140212701\Project Data\Specifications\LA+P\321440 - Stone Paving.doc

SECTION 321541 - STABILIZED CRUSHED STONE PAVING

PART 1 - GENERAL

1.1 SCOPE OF SERVICES

A Work included in this section.

1. Decomposed granite or crushed 3/8” or ¼” minus aggregate paving with Stabilizer binder additive.

1.2 RELATED REQUIREMENTS

A. Related Documents: General provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specifications, apply to this Section.

B. The Contract Documents are complementary. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the intent of this Section.

1.3 SYSTEM DESCRIPTION

A. Decomposed granite or crushed 3/8” or ¼” minus aggregate paving with Stabilizer binder additive and SportGrids® fibers for strength. Fibers are an optional additive, best when extra load bearing strength is needed.

1.4 SUBMITTALS

A. Products: Five lb. sample and sieve analysis for grading of decomposed granite or crushed 3/8” or ¼” minus aggregate.

1.5 TESTS

A. Perform gradation of decomposed granite material or 3/8” or ¼” minus crushed aggregate paving with Stabilizer additive at location as directed by owner’s representative.

1.6 ENVIRONMENTAL CONDITIONS

A. Do not install decomposed granite or crushed 3/8” or ¼” minus aggregate paving during rainy conditions.

1.7 QUALITY ASSURANCE

A. Installer – provide evidence to indicate successful experience in providing decomposed granite or crushed 3/8” or ¼” minus aggregate paving containing Stabilizer binder additive.

1.8 EXCESS MATERIALS

A. Provide owner’s authorized representative with the following excess materials for use in future decomposed granite or 3/8” or ¼” crushed aggregate paving repair:

20 – 50 lb. bags of the aggregate paving

1 – 40 lb. bag of the Stabilizer additive

PART 2 – PRODUCTS

2.1 DECOMPOSED GRANITE OR 3/8" OR ¼" CRUSHED AGGREGATE SCREENINGS

A. Crushed Stone Sieve Analysis Percentage of Weight Passing a Square Mesh Sieve AASHTOT11-82 and T27-82.

¼" MINUS AGGREGATE GRADATION	
Sieve Designation	Range of % Passing
3/8"	100
No. 4	95-100
No. 8	75-80
No. 16	55-65
No. 30	40-50
No. 50	25-35
No. 100	20-25
No. 200	5-15

B. Acceptable local supplier – list to be provided.

2.2 STABILIZER BINDER

A. Patented, non-toxic, organic binder that is a colorless and odorless concentrated powder that binds decomposed granite or crushed 3/8" or ¼" minus aggregate together to produce a firm surface

B. Provided by Stabilizer Solutions, Inc., 1-800-336-2468 or approved equal.

2.3 SYNTHETIC FIBER REINFORCEMENT (OPTIONAL)

A. Provided by Stabilizer Solutions, Inc., 8-800-336-2468. As recommended.

PART 3 - EXECUTION

3.1 BLENDING STABILIZER

A. Blend 12 – 16 lbs. of Stabilizer per ton of decomposed granite or crushed 3/8" or ¼" minus aggregate screenings. It is critical that Stabilizer be thoroughly and uniformly mixed throughout decomposed granite or crushed ¼" or 3/8" minus aggregate screenings.

3.2 BLENDING SPORTGRIDS® FIBERS (OPTIONAL, ONLY IF RECOMMENDED)

A. Blend 3 to 5 points of SportGrids® fibers per ton of decomposed granite or crushed 3/8" or ¼" minus aggregate screenings.

3.3 PLACEMENT OF DECOMPOSED GRANITE SCREENINGS OR CRUSHED 3/8" OR ¼" MINUS AGGREGATE SCREENINGS

A. Upon thorough moisture penetration, compact aggregate screenings to 95% relative compaction by compaction equipment such as: double drum roller (2-4 ton) or single drum roller (1000 lbs.) vibratory plate tamp. Do not begin compaction for 6 hours after placement and up to 48 hours.

B. Take care in compacting decomposed granite or crushed 3/8" or ¼" minus aggregate screenings when adjacent planting and irrigation systems.

3.4 REPAIRS AND PROTECTION

A. Remove and replace decomposed granite or crushed 3/8" or ¼" minus aggregate paving that is damaged, defective or does not meet requirements of this section.

3.5 MAINTENANCE

A, Remove debris, such as paper, grass clippings, leaves or other organic materials by mechanically blowing or hand raking the surface as needed.

B. During the first year, a minor amount of loose aggregate will appear on the surface (1/16 to ¼ inch). If this material exceeds a ¼ of an inch, redistribute the material over the entire surface. Water thoroughly to the depth of 1". Compact with power roller of no less than 1000 lbs. This process should be repeated as needed.

C. If cracking occurs, simply sweep fines into the cracks, water thoroughly and hand tamp with an 8" to 10" hand tamp late.

3.6 REPAIRS

A. Excavate damaged area to the depth of the Stabilized aggregate and square up side walls.

B. If area is dry, moisten damaged portion.

C. Pre-blend the dry required amount of Stabilizer. Thoroughly moisten mix with 25 to 35 galls per ton of pre-blended material or to approximately 10% moisture content.

D. Add water to the pre-blended aggregate and Stabilizer. Thoroughly moisten mix with 25 to 35 gallons per ton of pre-blended material or to approximately 10% moisture content.

E. Apply moistened pre-blended aggregate to excavated area to finish grate.

F. Compact with an 8" to 10" hand tamp or 250 to 300 pound roller (if area is high traffic such as, cart path, driveway, parking lot, use a larger 1000 lb. roller). Keep traffic off areas for 12 to 48 hours after repair has been completed.

END OF SECTION 321541

SECTION 321613 – CONCRETE CURB AND SIDEWALKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 310000 - Earthwork

C. Connecticut Department of Transportation Standard Specifications Latest Edition

D. Town of Glastonbury Standard Requirements

1.2 SCOPE OF WORK

A. Preparation and Placement of Concrete Sidewalk

B. Preparation and Placement of Concrete Curb

1.3 REFERENCE STANDARDS

A. American Concrete Institute (ACI) latest edition

1. 301 Specifications for Structural Concrete for Buildings
2. 304R Guide for Measuring Mixing, Transporting and Placing Concrete
3. 308 Standard Practice for Curing Concrete

B. American Society for Testing and Materials (ASTM) latest edition

1. A 185 Steel Welded Wire Fabric, Plain for Concrete Reinforcement
2. C497 Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
3. A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
4. C33 Concrete Aggregates
5. C 94 Ready-Mixed Concrete
6. C 150 Portland Cement
7. C 260 Air-Entraining Admixtures for Concrete
8. D 309 Liquid Membrane-Forming Compounds for Curing Concrete
9. C494 Chemical Admixtures for Concrete
10. C1751 Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

C. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.

D. Connecticut Department of Transportation Standard Specifications, latest edition.

1.4 QUALITY ASSURANCE

A. The Contractor shall warrant that concrete curb and base is 4,500 psi unless otherwise noted on the Construction Documents.

B. Establish and maintain required lines and elevations.

C. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Owner.

D. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.

E. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 30 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of material.

1.5 SUBMITTALS

A. Submit concrete mix design to the Owner's Engineer for review at least 14 days prior to use.

1.6 PROJECT CONDITIONS

A. Contractor shall maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. The forms shall be of a depth equal to the depth of curbing or sidewalk, and so designed as to permit secure fastening together at the tops. Coat forms with non-staining type coating that will not discolor or deface surface of concrete.

B. Concrete Materials: Comply with requirements of Connecticut Department of Transportation Standard Specifications and applicable Section 321613 for concrete materials, admixtures, bonding materials, curing materials and others as required. Concrete shall have a minimum 28-day compressive strength of 4,500 psi.

C. Joint Fillers: Resilient pre-molded bituminous impregnated fiberboard units complying with AASHTO M 213.

D. Welded wire fabric as indicated on Contract Documents.

E. Products containing materials with recycled content will be documented in accordance with the procedure outlined in the Project Documents.

F. Products containing materials manufactured and extracted, harvested or recovered within 500 miles will be documented in accordance with the procedure outlined in the Project Documents.

G. Adhesives or sealants used for work in this section shall meet the goals of the CT HPB requirements as indicated in the Project Documents, where applicable.

2.2 MIX DESIGN AND TESTING

A. Concrete mix design and testing shall comply with requirements of ACI and Section 321613 of these Specifications as they relate to Cast-in-Place Concrete.

B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce the following properties:

1. Compressive Strength: 4,500 psi, minimum at 28 days, unless otherwise indicated on the Contract Drawings.

2. Slump Range: 3-inches +/- 1-inch at time of placement

3. Air Entrainment: 4 to 7 percent

PART 3 - EXECUTION

3.1 PREPARATION

A. Proof-roll prepared base material surface to check for unstable areas. The paving work shall begin after any unsuitable areas have been corrected and are ready to receive paving. Compaction testing for the base material shall be completed prior to the placement of the paving.

B. Surface Preparation: Remove loose material from compacted base material surface to produce a firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION

A. Form Construction

1. Set forms to required grades and lines, rigidly braced and secured.
2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place a minimum of 24 hours after concrete placement.
3. Check completed formwork for grade and alignment to following tolerances:
4. Top of forms not more than 1/8-inch in 10-ft.
5. Vertical face on longitude axis, not more than 1/4-inch in 10-ft.
6. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.

7. Install 6-inch x 6-inch welded wire fabric as indicated on Contract Documents. Support wire on metal wire chairs to ensure that wire stays mid-depth of sidewalk section during concrete pour.

B. Concrete Placement

1. Comply with applicable requirements of ACI and Architectural Specifications.
2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at the required finish elevation and alignment.
3. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of dowels, and joint devices.
4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 2 hours, place construction joint. Automatic machine may be used for curb and gutter placement at Contractor's option. Machine placement must produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, replace with formed concrete as specified.
5. Concrete placement shall be conducted in accordance with related ACI recommended procedures.

C. Joint Construction

1. Transverse Expansion Joints: Transverse expansion joint in sidewalk shall have the filler cut to the exact cross section of the sidewalk. The joints shall be similar to the type of expansion joint used in the adjacent pavement. Joint spacing as specified on the plans.

D. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 2-inches or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.

E. Joint Sealants: All joints shall be sealed with approved exterior pavement joint sealants and shall be installed per manufacturer's recommendations.

3.3 CONCRETE FINISHING

A. After striking off and consolidating concrete, smooth surface by screening and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10-ft straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.

B. Work edges of sidewalks, back top edge of integral curb, and formed joints with an edging took, and round to 2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and troweling when excess moisture or surface sheen has disappeared, complete surface finishing as follows:

1. Inclined Slab Surfaces: Provide coarse, non-slip finish by scoring surface with stiff-bristled broom perpendicular to line of traffic.
2. Curbs, gutters, and sidewalks: Broom Finish by drawing fine-hair broom across surface perpendicular to line of traffic. Repeat operation as necessary to produce a fine line texture.

C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed.

D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in the "water-curing" section of ACI 308-81.

3.4 BACKFILL

A. After the concrete has set sufficiently, the spaces in front and back of the curb and gutter or sidewalk shall be refilled to the required elevation with suitable material in accordance with Section 310000, which shall be compacted until firm and solid and neatly graded.

3.5 CLEANING AND ADJUSTING

A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.

B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

END OF SECTION 321613

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMETNS

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

B. Contract Drawings and Documents

1.2 SECTION INCLUDES

A. Preparation and application of painted pavement markings.

1.3 REFERENCE STANDARDS

A. Connecticut Department of Transportation Standard Specifications, latest edition.

B. Manual on Uniform Traffic Control Devices, latest edition.

1.4 PROJECT CONDITIONS

A. Maintain access for vehicular and/or pedestrian traffic as required for other construction activities. Utilize flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Paint shall be non-bleeding, quick-drying, alkyd petroleum base paint suitable for traffic-bearing surface and shall be mixed in accordance with manufacturer's instructions before application.

B. Provide ready-mixed one component waterborne traffic line paint. Materials shall be 4800 Series Traffic Paint Water Reducible Acrylic from ICI Paints or equal.

1. Colors

a. Yellow: 1 Gallon 20087 & 5 Gallon 20088
b. White: 1 Gallon 25524 & 5 Gallon 22683
c. Blue: 1 Gallon 20089 & 5 Gallon 20090
d. Red: 1 Gallon 43613 & 5 Gallon 43614
e. Black: 1 Gallon 26565 & 5 Gallon 26566

C. Preformed pavement markings shall be Stamark Intersection Grade Tape Series A420 as manufactured by 3M Traffic Control Materials Division, or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Sweep and clean surface to eliminate loose material and dust.

B. Where existing pavement markings are indicated on Contract Documents to be removed or would interfere with adhesion of new paint, motorized abrasive device shall be used to remove markings. Equipment employed shall not damage existing paving or create surface hazardous to vehicle or pedestrian traffic. Within public rights-of-way, method of marking removal shall be approved by appropriate governing authority.

3.2 APPLICATION

A. Apply two (2) coats of paint at manufacturer's recommended rate, without addition of thinner, with maximum of 100 sq. ft per gal. Apply with mechanical equipment to produce uniform straight edges. At sidewalk curbs and crosswalks, use straightedge to ensure uniform, clean, and straight stripe.

B. Install preformed pavement markings according to manufacturers recommended procedures for the specified material.

C. Following items shall be painted with colors noted below:

1. Pedestrian Crosswalks: White
2. Light Pole Bases, and Bollards: Yellow, or as specified in Contract Drawings.
3. Fire Lanes: Yellow, or as required by Owner
4. Drop Off Lane: Yellow, or as required by Owner
5. Lane Striping where separating traffic moving in opposite directions: Yellow
6. Lane Striping where separating traffic moving in the same direction: White
7. Handicap Symbols: Blue or per local code and as shown on Contract Documents.
8. Parking Stall Striping: White and as shown on Contract Documents
9. Stop Bar: White
10. Directional Arrows: White

D. The Minimum Required total Dry Film Thickness (DFT): The DFT shall be the minimum required dry film thickness as measured in mils. or as required by sections 2.1 of this specification as well as part of the referenced standard in section 1.2 of the same.

E. System Coverage Requirements:

1. 1st Coat - 3.0 mils DFT
2. 2nd Coat - 6.0 mils DFT

F. Exterior Paint Systems: Provide the following paint systems as indicated:

1. Parking stall, division and limit lines shall be 4" in width, true and straight. Color: White – DFT 6.0 mils.
2. Stop legends shall be as detailed on Drawing. Color: White - DFT 6.0 mils.
3. Wheelchair legends shall be as detailed on Drawing. Color: Blue. Parking stall striping shall be Blue at Handicapped stalls only - DFT 6.0 mils.
4. Diagonal striping Handicapped. Color: Blue - DFT 6.0 mils.
5. Diagonal striping Loading Zone and/or Bus Drop Off Areas. Color: Yellow - DFT 6.0 mils.
6. Directional signage shall be as detailed on Drawing. Color: White - DFT 6.0 mils.
7. Centerline striping shall be 4" in width as detailed on Drawings. Color: White - DFT 6.0 mils.

END OF SECTION 321723

SECTION 323300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SCOPE OF WORK

A. Section Includes:

1. Benches
2. Bike Racks

B. Related Requirements

1. Construction Drawings and Documents

1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each each material, color and texture specified.

C. Samples for Verification: For each type of exposed finish, not less than 6-inch long linear components and 4-inch square sheet components.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For site furnishings.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Benches

1. C-138 Classic Series, 6 ft. length with end armrests, wood slat seating, black powdercoated metal (to be verified during submittal review), as manufactured by Victor Stanley, P.O. Drawer 330, Dunkirk, MD 20754 or approved equal.

B. Bike Racks

1. BRWS-101, black powdercoated metal (to be verified during submittal review), as manufactured by Victor Stanley, P.O. Drawer 330, Dunkirk, MD 20754 or approved equal.

2.2 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. 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.

B. Proceed with Installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer’s written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required. Contractor is responsible for concrete footing as well as bolt assembly as necessary to secure final selected furnishings.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

END OF SECTION 323300

SECTION 329100 - SOIL PREPARATION AND MIXES

PART 1 - GENERAL

1.1 SECTION SUMMARY

A. Testing off-site borrow soil, existing topsoil and amendment materials for approved use in planting soil mixes. Verification testing of on-site sub-soils.

B. Furnishing material from approved off-site source(s) as a base component for planting soil mixes and furnishing other soil amendment materials.

C. Amending, preparing, and mixing planting soils for plant areas.

D. Placing, spreading, and fine grading pre-mixed planting soil material of the type(s) indicated for plant areas.

E. Protecting all plant mix installations with snow fencing, filter fabric, or other approved means, over the surface area plant bed installations, until substantial completion.

F. Protection of finished paving, light poles utility or other finished work by means of wooden protection boards, or other approved means, over the area of construction concurrent with any and all construction operations.

1.2 RELATED REQUIREMENTS

A. Related Documents: General provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specifications, apply to this Section.

B. The Contract Documents are complementary. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the intent of this Section.

1.3 SUBMITTALS

A. Refer to and comply with Section 320000, General Conditions, for procedures and additional submittal criteria.

B. Product Data: Submit technical descriptive data for each manufactured or packaged product of this Section. Include manufacturer’s product testing and analysis and installation instructions for manufactured or processed items and materials.

C. Locations: Submit locations of material sources. Submit location of mixing sites.

D. Certificates:

1. Submit certified analysis for each soil treatment, amendment, and fertilizer material specified and as used. Include guaranteed analysis and weight for packaged materials.

E. Test Reports; Submit written reports of each sample tested. Each report shall include the following as a minimum and such other information required specific to material tested:

1. Date issued.

2. Project Title and names of Contractor and supplier.

3. Testing laboratory name, address and telephone number, and name(s), as applicable, of each field and laboratory inspector.

4. Date, place, and time of sampling or test, with record of temperature and weather conditions.

5. Location of material source.

6. Type of test.

7. Results of tests including identification of deviations from acceptable ranges. Identify any toxic substance(s) harmful to plant growth or life.

F. Samples:

1. Leaf mold, each source, 5 lb. packaged.

2. Base material, each source, 5 lb. packaged.

3. Each mix type specified, 5 lb. packaged.

G. Statement(s) of Qualifications: Submit within 45 days of notice to proceed to confirm qualifications as specified in Article 1.4, herein.

H. Schedule and Protection Plan: Submit a detailed plan for scheduling and sequencing of all contract work and for protection of soil mixes and other completed work including coordination with contractors requiring access through the site. Indicate with schedules and plans the utilization of soil mix and subsoil protection measures (filter fabric and snow fencing) over the surface area of plant bed installations, until substantial completion. Indicate with schedules and plans the utilization of finished work protection measures (wooden protection boards or other approved methods) over the work area of construction operations concurrent with all construction operations until substantial completion.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Installation and maintenance foreman on the job shall be competent English-speaking supervisor(s), experienced in landscape installation and maintenance. Perform work with personnel totally familiar with planting soil preparation and planting installations under the supervision of a foreman experienced with landscape work.

2. Agricultural Chemist: Experienced person or persons employed by public or private soils testing laboratory, qualified and capable of performing tests, making soil recommendations, and issuing reports as specified. Testing Laboratory and Agricultural Chemist shall be as approved by the Landscape Architect.

B. References:

1. Association of Official Agricultural Chemists.

2. American Society for Testing and Materials (ASTM) using test criteria as specified or required by other references.

C. Pre-installation Conferences: Person(s) responsible for soil preparation and mixes of this Section shall attend Pre-installation Conference(s) to coordinate with work of other sections. Refer to and comply with review and Conference criteria in Sections 310000, 329200, and 329300.

D. Inspections and Testing:

1. Soil, leaf mold, and other material testing and soil mix testing required in this Section or additionally required by Owner's Representative shall be furnished and paid for by Contractor.

2. Owner's Representative or Landscape Architect reserve the right to take and analyze at any time such additional samples of materials as deemed necessary for verification of conformance to specification requirements. Contractor shall furnish samples for this purpose upon request and shall perform testing as requested.

1.5 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of local, state and federal authorities having jurisdiction Provide labor, materials, equipment and services necessary to make work comply with such requirements without additional cost to Owner.

B. Procure and pay for permits and licenses required for work of this section.

1.6 PROJECT/SITE CONDITIONS

A. Acquaintance With Existing Site Conditions:

1. Through study of all Contract Documents and by careful examination of the site, become informed as to the nature and location of the work, the nature of surface and subsurface soil conditions, the character, quality and quantity of the materials to be encountered, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and all other matters which can in any way affect the work.

2. Investigate the conditions to public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of this work site. Conform to all governmental regulations in regard to the transportation of materials to, from, and at the job site, and secure in advance such permits as may be necessary.

3. Should the Contractor, in the course of work, find any discrepancies between Contract Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Owner, it will be Contractor's duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.

B. Environmental Requirements:

1. Perform both off site mixing and on-site soil work only during suitable weather conditions. Do not disc, rototill, or work soil when frozen, excessively wet, or in otherwise unsatisfactory condition.

2. Soil mixes shall not be handled, hauled, or placed during rain or wet weather or when wet near or above field capacity.

C. Sequencing and Scheduling: Adjust, relate together, and otherwise coordinate work of this Section with work of Project and all other Sections of Project Specifications.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packaged materials to the location where soils are to be mixed, in unopened bags or containers, each bearing the name, guarantee, and trademark of the producer, material composition, manufacturers' certified analysis, and the weight of the materials Retain packages for the Construction Manager or Owner's Representative.

B. Soil or amendment materials stored on site temporarily in stockpiles prior to placement shall be protected from intrusion of contaminants and erosion. All temporary storage means and methods shall be approved by Owner's Representative.

C. After mixing, soil materials shall be covered with a tarpaulin until time of actual use.

PART 2 - PRODUCTS

2.1 PLANT MIX MATERIALS

A. General:

1. All plant mix materials shall fulfill the requirements for new plant mixes as specified.

2. Samples of individual components of plant mixes and also blended plant mixes shall be submitted by the Contractor for testing and analysis to the approved testing laboratory. Include verification testing of on-site sub-soils. Comply with specific material requirements specified.

a. No base component material for plant mix shall be used until certified test reports by an agricultural chemist have been received and approved by Landscape Architect.

b. As necessary, make any and all soil mix amendments and resubmit test reports indicating amendments until approved.

3. Owner's Representative may request additional testing by Contractor for confirmation of mix quality at any time until completion. See Article 1.4, herein for additional requirements.

4. All imported soil materials shall be free of hazardous substances and meet the clean soil criteria as defined by CTDEEP. Certification of compliance shall be provided to landscape architect by contractor not less than 2 weeks prior to its intended use.

B. Base Component Material:

1. Base Component Material shall be a mix of Sand and Sandy Loam. Base component materials shall not be site salvaged unless approved by Landscape Architect.

2. Base Component Material shall be mixed by volume with 4 parts Sandy Loam to 5 parts Sand. The mix may need to be adjusted to reflect any slight variation of soils. Any and all modifications involving alternates must be approved by the Landscape Architect.

3. Test Base Component Materials, both individual components and mixed materials, for compliance with material specifications. These test criteria and results, when approved, shall establish the standard to which all subsequent Base Component Material tests must conform.

4. Prior to mixing Base Component Material with organic matter (leaf mold), have one (1) composite sample tested from each 500 c.y. of material intended for use in soil mixes of lawn and planting work.

a. Base Component Material shall meet specified requirements. The only allowable amendments to the Base Component Material will be for adjustment of nutrient levels and then only by means established by these specifications.

b. Perform the following tests and submit test reports. Failure to include any of the criteria stated below will be sufficient cause for rejection of the test reports.

1) Particle size analysis/distribution as defined below as well as with a hydrometer method.

2) Fertility analysis - pH, soluble salts, nitrate, phosphate, potassium, calcium and magnesium.

3) Organic matter content (% ovendry weight of soil).

4) Toxic substance content.

5) Material drainage rate.

5. Material Requirements, Sand:

a. Physical Analysis (Soil Texture):

1)

Sieve Size	% Passing	% Retained	Dimension Class
1”	100.0	0.0	Gravel
1/4”	100.0	0.0	Fine Gravel
#10	96.6	3.4	Very Coarse Sand
#20	82.8	13.8	Coarse Sand
#40	38.4	44.4	Coarse Sand
#60	12.0	26.4	Medium Sand
#80	5.5	6.5	Fine Sand
#100	3.7	1.8	Very Fine Sand
#200	1.4	2.3	Very Fine Sand
Pan	1.4		Silt/Clay

2) Test results must be submitted for percent (%) retained as well as for per-cent (%) passing for all sieve sizes. Failure to include any of the aforementioned criteria will be cause for rejection of the test report.

b. Chemical Analysis:

1) Organic matter content (% ovendry weight of soil)

2) Soil reaction (pH) - 6.0 (±0.5)

3) Soluble salt content (Conductivity) - Less than 0.5 mm hos/cm for a 1:2 soil to water ratio.

4) Toxic substance content harmful to plant growth.

c. Material Drainage at a rate of 55 to 70% of the total volume of water within 3 minutes. Soil should be saturated prior to conducting test.

6. Material Requirements, Sandy Loam:

   a. Physical Analysis (Soil Texture):

      1)

Sieve Size	% Passing	% Retained	Dimension Class
1”	100.0	0.0	Gravel
1/4”	99.0	1.0	Fine Gravel
#10	97.9	1.1	Very Coarse Sand
#20	88.0	8.9	Coarse Sand
#40	58.2	29.8	Coarse Sand
#60	39.6	18.6	Medium Sand
#80	32.9	6.7	Fine Sand
#100	30.7	2.2	Very Fine Sand
#200	18.7	12.0	Very Fine Sand
Pan	18.7		Silt/Clay

      2) Test results must be submitted for percent (%) retained as well as for percent (%) passing for all sieve sizes. Failure to include any of the aforementioned criteria will be cause for rejection of the test report.

   b. Chemical Analysis:

      1) Organic matter content (% ovendry weight of soil)

      2) Total content shall be within the range of 3 to 4%.

      3) Soil reaction (pH) - 6.0 (±0.5)

      4) Soluble salt content (Conductivity) - Less than 3.1 mm hos/cm for a 1:2 soil to water ratio.

      5) Toxic substance content harmful to plant growth.

   c. Hydrometer Testing:

      1) Sand - 63.8%

      2) Silt - 23.2%

      3) Clay - 13.0%

7. Before base component material is used for mixing with amendments, handle and pile Base Component Material in the following manner:

   a. Homogenize to make a uniform mix, free of subsoil lenses and other irregularities.

b. Aerate the base material to make a friable planting medium.

c. Separate out and remove all clay lumps, stones, stocks, roots, and other debris.

8. Material Requirements, Base Component Material (Combination of 5 parts Sand and 4 parts Sandy Loam) Material shall substantially conform to the following:

a. Physical Analysis (Soil Texture):

1) Sieve Size % Passing % Retained Dimension Class

1` Silt/Clay

b. Chemical Analysis:

1) Organic matter content (% ovendry weight of soil): 1.6

2) Soil reaction (pH): 5.3

3) Soluble salt content (Conductivity): 4 mm hos/cm.

c. Hydrometer Testing:

1) Sand-84.8

2) Silt - 10.0

3) Clay- 5.2

d. Percolation: 60% passing in 2 minutes, 40% retained.

C. Organic Matter:

1. Leaf Mold: Shredded leaf litter, composted for a minimum of one year (12 months) and tested to confirm the following characteristics:

a. The leaf mold must be free of debris such as plastic fragments, glass, and metal fragments.

b. The leaf mold must be free of stones larger than 1/2", large branches, and large roots.

c. Woodchips over 1" in length or diameter should be removed by screening.

d. The leaf mold should have a pH value measured as a 1: 5 dilute in the range from 6.5 - 7.2.

e. The soluble salts measurement (Electric Conductivity) should not exceed 0.5 millimhos/cm measured as a 1: 5 dilute.

f. The organic matter content should be from 60 - 90% by weight.

g. The carbon/nitrogen ratio should fall between 12: 1 and 25: 1.

h. Heavy metal content not to exceed (less than) the following indicated - amounts:

1) Element: Acetate Extract: HCL Extract

a) Iron: 0.5 ppm: 3.1 ppm

b) Manganese: 0.5 ppm: 15.4 ppm

c) Molybdenum: 0.4 ppm: 0.8 ppm

d) Zinc: 0.2 ppm: 4.4 ppm

e) Aluminum: 0.2 ppm: 1.2 ppm

f) Boron: 1.1 ppm: 1.7 ppm

g) Copper: None: 0.01 ppm

h) Lead: 0.1 ppm: 0.4 ppm

i) Selenium: None: 0.4 ppm

j) Mercury: None: None

k) Chromium: None: None

l) Cadmium: None: 0.02 ppm

m) Nickel: None: 0.04 ppm

n) Cobalt: None: 0.05 ppm

2) None = none detected = below detection limits of 0.01 ppm.

2. Test leaf mold material:

a. For compliance with material specifications including organic matter, pH, and heavy metal content. Have one (1) composite sample tested for each new source of supply, each variable pile within each source of supply, and each 500 c.y. of material or as directed by Owner’s Representative.

2.2 SOIL AMENDMENT MATERIAL

A. Ground Limestone: Ground Limestone as a soil amendment material will only be used pending results of analysis.

1. Provide a Ground Agricultural Limestone with a minimum of 88% of calcium and magnesium carbonates.

2. Ground Limestone material shall have a total 100% passing the 10 mesh sieve, minimum of 90% passing the 20 mesh sieve, and a minimum of 60% passing the 100 mesh sieve.

B. Herbicides: For possible use if there is seed germination on-site after sub-grade placement prior to planting mix installation or after subsequent plant mix installation. Under no circumstances are materials to be applied without specific instruction from the Landscape Architect, or Owner's Representative.

1. Herbicides shall be approved before use for type and rate of application by the Landscape Architect and by local and state agencies with jurisdiction.

2. Post emergent herbicide shall be Roundup, as manufactured by Monsanto Agricultural Products Company, C3NJ, St. Louis, MO 63166, or an approved equal.

C. Soil Amendments: incorporate thoroughly with top six (6) in. of lawn and planting areas per 1,000 square feet:

1. 6 cu. yd. Approved Organic Amendment

2. 30 lbs. 6-20-20 Commercial Fertilizer

3. 50 lbs. Dololite Lime

4. 10 lbs. Iron Sulfate

D. Controlled Release Fertilizer:

1. Type: Osmocote 17-6-12 plus minors.

2. PLANTING SOIL MIXES

E. Adequate quantities of mixed planting soil materials shall be provided to attain, after compaction and natural settlement, all design finish grades. Verify quantities for placement as specified in Sections 02930 and 02900 to suit conditions.

F. Uniformly mix ingredients as specified for each Mix Type (Base Component Material, leaf mold, and other ingredients deemed to be necessary as a result of testing) by wind rowing/tilling on an approved hard surface area. Organic matter shall be maintained moist, not wet, during mixing. Mixing of Amendments: Add leaf mold in proportions as specified and as confirmed by testing. Other amendments shall not be added unless approved to extent and quantity by Landscape Architect and Owner's Representative and additional tests have been conducted to verify type and quantity of amendment is acceptable.

G. Testing of Plant Mixes:

1. Perform initial tests to confirm compliance with base material and mix specifications. These test results, when approved, will establish the standard to which all other test results must conform.

2. Follow-up Testing: Have one (1) composite sample tested prior to delivery and upon arrival to the site from each 500 c.y. of material or as required by Owner's Representative intended for use in each type of lawn and plant mix to include the following

a. Sieve Analysis: Use sieve sizes as specified for Base Component Material.

b. Composition Analysis: Use the hydrometer method and classify the soil.

c. Nutrient Analysis:

1) Have nutrient levels (nitrate nitrogen, phosphate, potassium, magnesium, calcium, ammonium, iron, and manganese) tested, and request testing laboratory recommendations for additional fertilizer requirements at both lawn and all plant areas if nutrient levels are below average.

2) Nutrient deficiencies in soils of plant areas shall be corrected at time of installation.

3) Nutrient deficiencies in soils of lawn areas shall be corrected both at time of lawn installations and during maintenance period as specified.

d. Test organic matter, pH, soluble salts, and percolation.

H. Soil Mix Types: Provide the following planting soil mix types at the locations indicated. Percentages of components, unless otherwise noted, will be established upon completion of individual test results for components of the various mixes. The controlling factor will be the percent (%) organic matter as specified for each mix. Note that percent (%) by volume of components will be, in large part, determined by the leaf mold. Specifically the bulk density reading of the leaf mold will directly impact the organic matter readings which have been specified for each mix.

1. Planting Soil

a. Organic Matter: 5.0 to 6.0%.

b. Base Component Materials: 60-70%. (Exact percent to be identified through testing as previously specified)

c. Leaf mold: 30-40%. (Exact percent to be identified through testing as previously specified)

d. Other Amendments as required by test results and as approved.

I. Stockpiling

1. General: Stockpiling on-site, off-site and at source should be restricted to no more than the needs of what can be used in a 24-hr. period. Stockpiles should be no more than 6 feet in height to prevent anaerobic conditions within the pile(s). Stockpiles shall be sheltered from weather to prevent excessive water absorption and blowing by winds as approved by Owner's Representative.

2.3 SUPPLEMENTAL CHEMICAL COMPONENTS:

A. The following but not limited to chemical components may or may not be used depending on the outcome of the solids agricultural suitability test.

B. Dolomite Lime: Agricultural grade mineral soil conditioner containing 35% minimum magnesium carbonate and 49% minimum calcium carbonate, 100% passing #65 sieve. "Kaiser Dolomite 65 AG" as manufactured by Kaiser, Inc. Mineral Products Department, or equal.

C. Iron Sulfate (Ferric or Ferrous): Supplied by a commercial fertilizer supplier, containing 20% Fe as ferrous sulfate.

D. Single Superphosphate: Commercial product containing 20% to 25% available phosphoric acid.

E. Potassium Nitrate: Commercial product: 13-0-44.

F. Calcium Nitrate: Agricultural grade containing 15-1/2% nitrogen.

PART 3 - EXECUTION

3.1 VERIFICATIONS

A. Prior to construction and soil placement operations at planting areas, ascertain the location of all electric cables, conduits, underdrainage systems and utility lines.

B. Take proper precautions so as not to disturb or damage sub-surface elements. Contractor failing to take these precautions shall be responsible for making requisite repairs to damaged utilities at Contractor's own expense.

C. Verify that required underground utilities are available, in proper location, and ready for use. Coordinate with other trades.

D. Verify that all work requiring access through or adjacent to areas where plant mixes are to be placed has been completed and no further access will be required. In the event that access will be required, this must be coordinated with the Owner's Representative.

3.2 PREPARATION OF SUBGRADE

A. Prior to dumping and spreading sand and plant mix soils, the Contractor shall furnish and install grade stakes on a 10 foot grid in open areas and sufficiently spaced in other areas to insure correct line and grade of subgrade and finished grade.

1. Verify as constructed or existing subgrade elevations and do whatever additional grading is necessary to bring the subgrade to a true, smooth, slope parallel to the finish grade at all areas to receive planting soil for lawns.

2. Clean up subgrade and dispose of all debris and garbage prior to inspection.

B. Spray all vegetation on subgrade with a post emergent weed killer at a rate of application approved by the Landscape Architect and government agencies with jurisdiction.

C. Any soils polluted by gasoline, oil, plaster, construction debris, unacceptable soils, or other substances which would render-subgrade unsuitable for a proper lawn or plant growth shall be removed from the premises whether or not such pollution occurs or exists prior to or during the Contract period. In the event that such material is placed, this material shall be removed and replaced with approved material. All remedial operations associated with soil mixes and controlled fill shall be reviewed and approved by the Owner's Representative.

3.3 PLANTING MIXTURES

A. Planting Mixture for planters and plant backfill shall be of the type(s) indicated in accordance with the planting details, and shall be pre-mixed and placed as specified.

1. Bring to pH levels of 6.0 (+/- 0.5). pH-shall be verified by testing.

2. Lower pH by using elemental sulfur product. Peat moss or copper sulfate may not be used to lower pH.

B. All amendments shall be thoroughly incorporated into the mixture to assure uniform distribution. Delay mixing of fertilizers if planting will not follow within a few days.

3.4 PLACING PLANTING SOIL

A. Remove all large clods, lumps, brush, roots, stumps, litter, and other foreign material and stones one-half inch (1/2") in diameter or larger. Dispose of removed material legally off-site.

B. Do not place a muddy or wet soil mix.

C. Place and spread planting soil mix of the type specified over approved subgrade to a depth sufficiently greater than the depth required for planting areas so that after natural settlement, misting and/or light rolling, as previously approved by Landscape Architect and Owner's Representative, the completed work will conform to the lines, grades, and elevations shown or otherwise indicated.

D. Grading Tolerances: Lawn and Planting areas shall be fine graded within ±1/10 (0.10) feet of grades indicated on drawings. Maintain all "flat" areas and slopes to allow free flow of surface drainage without ponding.

END OF SECTION 329100

SECTION 329200 - LAWNS AND GRASSES

PART 1 GENERAL

1.1 DESCRIPTION

A. General: Provide lawns and sod in accordance with the contract documents.

B. Related Work Specified Elsewhere:

1. Section 329300 – Landscape Planting

2. Section 329100 - Soil Preparation and Mixes

1.2 RELATED REQUIREMENTS

A. Related Documents: General provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specifications, apply to this Section.

B. The Contract Documents are complementary. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the intent of this Section.

1.3 REFERENCES

A. Hortus III - 1976 Edition, Bailey Horatorium, Cornell University.

B. Technical Association of the Pulp and Paper Industry for Wood Cellulose.

C. Contract Drawings and Documents

1.4 EXAMINATION OF SITE AND DOCUMENTS

A. 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.

B. Plans, specifications, surveys, measurements, other documents and dimensions under which the work is to be performed are believed to be correct; but the Contractor shall have examined them for himself during the Bidding period, as no additional compensation will be made for errors for inaccuracies that may be found therein.

1.5 SUBMITTALS TO LANDSCAPE ARCHITECT

A. Product Data: Manufacturer's current catalog cuts and specifications of the following:

1. Fertilizer

2. Mulch

B. Certificates:

1. Certificates of inspection as required by law for transportation of each shipment of seed and sod along with invoice.

2. Seed mix certificate including fertilizer and rate of application.

1.6 FIELD QUALITY CONTROL

A. Tests: Samples of materials may be taken and tested for conformity to Specifications at any time.

B. Rejected Materials: Remove rejected materials immediately from the site at contractor's expense. Pay cost of testing of materials not meeting Specifications.

1.7 DELIVERY, STORAGE AND HANDLING

A. Seed:

1. Delivery: Furnish standard seed in unopened manufacturer's standard containers bearing quantity, analysis and name of manufacturer

2. Storage: Store seed with protection from weather, rodents or other conditions, which would damage or impair the effectiveness of the product.

B. Sod:

1. Harvest and Delivery: Harvest from the source and deliver to project site within 24 hours. Deliver only as much sod as can be installed in one day's work.

2. Review: Sod not transplanted within this time period shall be reviewed prior to installation.

C. Mulch:

1. Labeling: Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

2. Storage: Store seed with protection from weather, rodents or other conditions, which would damage or impair the effectiveness of the product.

1.8 PROJECT/SITE CONDITIONS

A. Existing Conditions: For protection of existing plants to remain, refer to Spec Section 329300 – Landscape Planting

1.9 SEQUENCING AND SCHEDULING

A. Period of Application of Hydroseeding:

1. Irrigated Areas: Within fourteen (14) calendar days after the completion of finish grading in any area.

B. Scheduling:

1. Hydroseeding: Perform on a section-by-section basis, upon approval of Landscape Architect, and immediately after finish grading and irrigation installation except for seasonal Limitations.

a. Season: Plant in Fall or Spring.

1) Allow sufficient time for full germination and 2 mowings before preliminary acceptance.

2. Embankment and Slopes: Complete in a continuous manner.

3. Acceptable Planting Window:

a. Place grass seed or sod only at seasonal times within appropriate temperature range and wind conditions for plant development as approved by Landscape Architect:

b. Acceptable Seeding Seasons/Times:

1) Spring: April 1st - June 15th

2) Fall: September 1st - October 15th

c. Seeding or sodding at any time other than within the above seasons shall be allowed only when the Contractor submits a written request for permission to do so and permission is granted in writing by the Owner. Newly seeded or sodded areas, if installed out of season, must be continuously watered according to best recommended and Landscape Architect approved practice. Contractor shall be responsible for providing an acceptable stand of grass as specified.

1.10 WARRANTY

A. The 90 day maintenance period begins with the Landscape Architects certification of substantial completion. The warranty period begins after the final acceptance of the maintenance period. The final acceptance occurs upon satisfactory completion of all work, included in the 90 day maintenance period, but exclusive of replacement of materials under the Warranty Period.

B. Time Period: Warrant that lawns and sod shall be in a healthy and flourishing condition of active growth one (1) year from date.

C. Appearance During Warranty: Lawns and sod shall be free of dead or dying patches, and all areas shall show foliage of a normal density, size and color.

D. Delays: Delays caused by the Contractor in completing planting operations, which extend the planting into more than one planting season, shall extend the Warranty Period correspondingly.

E. Coverage: Warrant growth and coverage of hydroseeded planting to the effect that a minimum of 95% shall be covered with specified planting after one growing season with no bare spots.

F. Exceptions: Contractor shall not be held responsible for failures due to neglect by owner, vandalism, etc., during Warranty Period. Report such conditions in writing.

PART 2 PRODUCTS

2.1 MANUFACTURERS/GROWERS

A. Lawn Sod: Obtain sod from a certified source within proximity of the project site and of a variety which will thrive under local conditions.

B. Hydro Mulch and Soil Stabilizer: Obtain mulch and soil stabilizer from a certified source within proximity of the project site.

C. Fertilizer:

1. Regular Type: Nitrogen content derived from organic sources; bearing manufacturer's statement of analysis. Minimum requirements: 12% nitrogen, 4% phosphoric acid, 8% potash.

2. Slow-release Type: 50% of nitrogen is in slow-release form. Content derived from organic or inorganic sources; bearing manufacturer's statement of analysis. Minimum requirements: 12% nitrogen, 4% phosphoric acid, 8% potash.

3. Commercial Mixed Type: Nitrogen content derived from organic or inorganic sources, bearing manufacturer's statement of analysis. Minimum requirements: 10% nitrogen, 10% phosphoric acid, 10% potash.

D. Lime: Ground limestone containing not less than 85% carbonates; 50% passing 100 mesh sieve and 90% passing 20 mesh sieve.

E. Seed: Shall be of a mix as specified on the plans furnished in un-opened containers and providing percentage of seed varieties and inert matter. All non-turf seeds shall be purchased and applied at a Pure Live Seed (PLS) rate as indicated on the plans. This may require the contractor to purchase/apply seed at a high rate as measured by bulk weight.

F. Straw Bales: Clean bales of straw of hay, wheat, rye, oats or barley.

G. Hydromulch: Wood cellulose fiber containing no germination inhibiting or growth inhibiting agents. Characteristics shall be as follows:

1. Percent moisture content: 9.0% (+3.0%)

2. Percent organic matter: 99.2% (+0.8).

3. Percent ash content: 0.8% (+0.2%).

4. pH: 4.8 (+0.5).

5. Water Holding Capacity: 1150 grams water/100 grams fiber, minimum.

H. Mulch: Clean, seed free straw of hay, wheat, rye, oats or barley.

I. Staking Pegs: 3/4" diameter by 8" long softwood.

J. Water: Clean, potable.

2.2 ACCESSORIES

A. Mulch: Shall be Product: "Silva Fiber", "X-100 Spra-mulch", or "Conwed".

1. Composition: Green-colored, fibrous, 100% virgin wood fibre mulch containing no growth or germination-inhibiting factors.

2. Weight: Weight specifications of this material from suppliers, and for all applications, shall refer only to air dry weight of the fiber material. Absolute air dry weight is based on the normal standards for wood cellulose and is considered equivalent to 10% moisture.

3. Dispersion in Slurry: Mulch shall be manufactured in such manner that after addition to and agitation in slurry tanks with fertilizer, seed, water and other approved additives, fibers in the material will become uniformly suspended to form a homogeneous slurry.

4. Absorption Capacity: When hydraulically sprayed on the ground, the material will form a blotter-like groundcover impregnated uniformly with seed, which will allow absorption of moisture and allow rainfall to percolate to the underlying soil.

2.3 HYDROSEED EQUIPMENT (if required)

A. Type: Commercial type hydro-seeder for the application of slurry. Equipment shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend and homogeneously mix slurry.

B. Distribution Lines: Large enough to prevent stoppage and to provide even distribution of the slurry over the ground.

C. Pump Capacity: 150 psi at the nozzle.

D. Slurry-Tank: Minimum capacity of 1,000 gallons and shall be mounted on a traveling unit which will place the slurry tank and spray nozzles within sufficient proximity to the areas to be seeded.

2.4 MIXES

A. Hydroseeding Mix per (1,000 Sq. Ft.)

1. Lawn Areas:

a. 30 lbs. - Mulch

b. 7 lbs. - Lawn Seed

c. 10 lbs. - Fertilizer

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Stones, Weeds, Debris: Verify that all areas to receive hydroseeding and sodding are clear of stones larger than 1/2 in. diameter, weeds, debris and other extraneous materials.

2. Grades: Verify that grades are within 1 in. plus or minus of the required finished grades. Verify that fertilization have been installed in another section. Report all variations in writing.

3.2 PREPARATION

A. Soil Moisture:

1. Excessive Moisture: Do not commence work of this section when soil moisture content is so great that excessive compaction will occur, nor when it is so dry that dust will form in air or that clods will not break readily.

2. Inadequate Moisture: Apply water, as necessary, to bring soil moisture content to an acceptable level.

3.3 HYDROSEEDED LAWN

A. Preparation: Do all slurry preparation at the job site.

1. Water: Add water to the tank when the engine is at half throttle. When the water level has reached the height of the agitator shaft, establish good re-circulation and add seed.

2. Seed: Do not allow seed to remain more than 30 min. in slurry.

3. Fertilizer: Add fertilizer, followed by the mulch. The mulch shall only be added to the mixture after the seed, and when the tank is at least 1/3 filled with water.

4. Mixing: Open the engine throttle to full speed when the tank is half-filled with water. Add all the mulch by the time the tank is 2/3 to 3/4 full. Commence spraying immediately when the tank is full.

B. Seed Bed Preparation:

1. Rolling: Roll amended soil with 200 pound water ballast roller and bring to finish grade.

2. Raking: Lightly rake seed bed surface to 1/4 in. depth. Seed immediately thereafter, provided the seed bed has remained in friable condition. Application:

a. General: Apply specified slurry mix in a sweeping motion to form a uniform mat at the specified rate. Keep hydroseeding within designated areas and keep from contact with other plant materials.

b. Unused Mix: Do not use a slurry mixture, which has not been applied within 4 hours of mixing. Promptly remove from the site.

c. Protection: After application, do not operate any equipment over the hydroseeded areas.

d. Reseeding: Reseed all areas and parts of areas, which fail to show a uniform stand of lawn until all areas are covered with strands of lawn.

3.4 SODDED LAWN INSTALLATION

A. Sod Bed Preparation:

1. Rolling: Roll amended soil with 200 pound water ballast roller.

2. Moistening: After all unevenness in the soil surface has been corrected, lightly moisten the soil immediately prior to laying the sod.

3. Timing: Sod immediately thereafter, provided the sod bed has remained in friable condition.

B. Sodding Operations:

1. Starter Strip: Lay the first row of sod in a straight line, with subsequent rows parallel to and tightly against each other, with no spaces between strips. Stagger lateral joints. Do not stretch or overlap sod. Butt all joints tightly to eliminate all voids.

2. Cutting: Use a sharp knife to cut sod to fit curves and paving.

3. Tamping and Rolling: Thoroughly tamp and roll sod to make contact with sod bed. Roll each entire section of completed sod.

4. Watering: Thoroughly water sod immediately after installation to wet the underside of the new sod pad and the soil immediately below to a depth of 6 in.

5. Top-Dress Fertilizer: Apply at the rate of six (6) pounds per 1,000 square feet at 25 days and at 50 days after sodding.

3.5 CLEANING

A. Hydroseed Overspray: Immediately after application, thoroughly wash off any plant materials, planting areas, or paved areas not intended to receive slurry mix.

B. Erosion: Immediately restore eroded areas. Keep all adjacent paved surfaces cleaned of dirt, mud or stains and organic debris.

END OF SECTION 329200

SECTION 329300 - LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall furnish all materials and perform all work in accordance with these specifications, drawings, and instructions provided by the Owner's representative hereafter also referred to as Landscape Architect.

B. The work shall include everything shown on the drawings and required by the specifications and everything to which in the judgment of the Landscape Architect is incidental to what is shown on the drawings or required by the specifications.

1.2 RELATED REQUIREMENTS

A. Related Documents: General provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specifications, apply to this Section.

B. The Contract Documents are complementary. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the intent of this Section.

1.3 REFERENCES

A. Plant material shall in all cases conform with requirements of the American Standard for Nursery Stock latest versions of rules and grading adopted by the American Association of Nurserymen, Inc., but upgraded to meet the following additional requirements.

1.4 QUALITY ASSURANCE

A. All work completed and materials furnished and installed shall be of the best quality and shall be in strict accordance with the intention of the drawings, specifications and samples. The Contractor shall cooperate with the Landscape Architect so that no error or discrepancy in the drawings or specifications shall cause defective or inappropriate materials to be used or poor workmanship to be allowed and so that the work may proceed in the most efficient and effective manner. If there is a discrepancy between the graphic count of plants and the plant list count of plants on the Landscape Plan, the graphic count shall govern.

B. Work must be carried out only during weather conditions favorable to landscape construction and to the health and welfare of plants. The suitability of such weather conditions shall be determined by the Landscape Architect.

C. Before commencing work, all trees and shrubs which are to be saved must be protected from damage by the placement of fencing flagged for visibility or some other suitable protective procedure consistent w/ tree protection measures on the plans and approved by the Owner's Construction Manager. No work may begin until this requirement is fulfilled.

D. In order to avoid damage to roots, bark or lower branches, no truck or other equipment shall be driven or parked within the drip line of any tree, unless the tree overspreads a paved way.

E. The contractor shall use any and all precautionary measures when performing work around trees, walks, pavements, utilities, and any other features either existing or previously installed under this Contract.

F. The Contractor shall adjust depth of earthwork and topsoiling when working immediately adjacent to any of the aforementioned features in order to prevent disturbing tree roots, undermining walks and pavements, and damage in general to any existing or newly incorporated item.

G. Plants transported to the project in open vehicles shall be covered with tarpaulins or other suitable covers securely fastened to the body of the vehicle to prevent injury to the plants. Closed vehicles shall be adequately ventilated to prevent overheating of the plants. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage shall be cause for rejection. All plants shall be kept moist, fresh, and protected. Such protection shall encompass the entire period during which the plants are in transit, being handled, or are in temporary storage.

H. Where excavating, fill, or grading is required within the branch spread of trees that are to remain, the work shall be performed as follows:

1. TRENCHING: When trenching occurs around trees to remain, the tree roots shall not be cut but the trench shall be tunneled under or around the roots by careful hand digging and without injury to the roots.

2. RAISING GRADES: When the existing grade at tree is below the new finished grade, and fill not exceeding 16 inches (16") is required, clean, washed gravel graded from one to two inches (1" - 2") in size shall be placed directly around the tree trunk. The gravel shall extend out from trunk on all sides a minimum of 18 inches (18") and finish approximately two inches (2") above the finished grade at tree. Install gravel before any earth fill is placed. New earth fill shall not be left in contact with the trunks of any trees requiring fill. Where fill exceeding 16 inches (16") is required, a dry laid tree well shall be constructed around the trunk of any tree to be preserved. The tree well shall extend out from the trunk on all sides a minimum of three feet (3') and to three inches (3") above finish grade or as indicated in the drawings. Coarse grade rock shall be placed directly around the tree well extending out to the drip line of the tree. Clean, washed gravel graded from one to two inches (1" - 2") in size shall be placed directly over the coarse rock to a depth of three inches (3"). Approved backfill/topsoil material shall be placed directly over the washed gravel to desired finished grade.

3. LOWERING GRADES: Existing trees in areas where the new finished grade is to be lowered shall have regrading work done by hand to elevation as indicated. Roots as required shall be cut cleanly three inches (3") below finished grade.

4. Trees marked for preservation that are located more than six inches (6") above proposed grades shall stand on broad, rounded mounds and be graded smoothly into the lower level. Trees located more than 16 inches (16") above proposed grades shall have a dry laid stone wall, or other retaining structure as detailed on the plans, constructed a minimum of five feet (5') from the trunk. Exposed or broken roots shall be cut clean and covered with topsoil immediately to prevent desiccation.

I. The Landscape Architect reserves the right to inspect and reject plants at any time and at any place, and reserves the right to inspect plants at the growing nursery.

J. The Landscape Architect shall have the final approval for acceptance of the landscape planting work.

1.5 SAMPLES

A. It is the responsibility of the Contractor, before ordering or purchasing materials, to provide samples of those materials to the Landscape Architect for approval, if so requested.

B. The Contractor is to submit certification tags from trees, shrubs and miscellaneous materials verifying type, quality and purity.

1.6 QUALITY OF PLANTS

A. Plant shall in all cases conform with requirements of the American Standard for Nursery Stock latest versions of rules and grading adopted by the American Association of Nurserymen, Inc., but upgraded to meet the following additional requirements.

B. Unless specifically noted otherwise, all plants shall be of selected specimen quality, exceptionally heavy, symmetrical, tightly knit, so trained or favored in their development and appearance as to be superior in form, number of branches, compactness and symmetry. All plants shall have a normal habit or sound, healthy, vigorous plants with well-developed root system.

C. Plants shall be free of disease, insect pests, eggs or larvae.

D. Plants shall not be pruned before delivery.

E. Trees with abrasion of the bark, sunscalds, disfiguring knots or fresh cuts of limbs over one and one-fourth inches (1-1/4") which have not completely calloused shall be rejected.

F. All plants shall be typical of their species or variety and shall have a normal habit of growth and be legibly tagged with the proper name. All plants shall have been grown under climatic conditions similar to those in the locality of the site of the project under construction or have been acclimated to such condition for at least two (2) years.

G. The root system of each shall be well provided with fibrous roots. All parts shall be sound, healthy, vigorous, and well-branched.

H. All plants designated ball and burlap (B&B) must be moved with the root systems as solid units with balls of earth firmly wrapped with burlap. The diameter and depth of the balls of earth must be sufficient to encompass the fibrous root feeding systems necessary for the healthy development of the plant. No plant shall be accepted when the ball of earth surrounding its roots has been badly cracked or broken preparatory to or during the process of planting. The balls shall remain intact during all operations. All plants that cannot be planted at once must be heeled-in by setting in the ground and covering the balls with soil or mulch and then watering. Hemp burlap and twine is preferable to treated. If treated burlap or twine is used, all twine is to be cut from around trunk and all burlap is to be removed.

I. The trunk of each tree specified as ‘tree form’ shall be a single trunk growing from a single unmutilated crown of roots. No part of the trunk shall be conspicuously crooked as compared with normal trees of the same variety.

J. The thickness of each shrub shall correspond to the trade classification "No.1". Single stemmed or thin plants shall not be accepted. The side branches must be generous, well twigged, and the plant as a whole well branched to the ground. The plants must be in healthy condition, free from dead wood, bruises or other root or branch injuries.

K. Plants shall be measured when branches are in their normal position.

L. Shrubs shall meet the requirements for spread, height or container size stated in the Plant List. The measurements are to be taken from the ground level to the average height of the shrub and not to the longest branch. Height and spread dimensions specified refer to the main body of the trees (measured from the crown of the roots to the tip of the top branch) shall be not less than the minimum size designated.

M. Caliper measurements shall be taken at a point on the trunk six inches (6") above natural ground line for trees up to four inches (4") in caliper, and at a point 12 inches (12") above the natural ground line for trees exceeding four inches (4") in caliper.

N. If a range of size is given, no plant shall be less than the minimum size, and not less than 50% of the plants shall be as large as the upper half of the range specified.

O. The measurements specified are the minimum size acceptable and, where pruning is required, are the measurements after pruning.

1.7 MAINTENANCE OPERATIONS BEFORE APPROVAL

A. Plant care shall begin immediately after each plant is satisfactorily installed and shall continue throughout the life of the contract until final acceptance of the project.

B. Care shall include, but not be limited to, replacing mulch that has been displaced by erosion or other means, repairing and reshaping water rings or saucers, maintaining stakes and guys as originally installed, watering when needed or directed, and performing any other work required to keep the plants in a healthy condition.

C. Contractor shall remove and replace all dead, defective and/or rejected plants as required before final acceptance.

1.8 NOTIFICATION OF DELIVERY

A. Unless otherwise authorized by the Landscape Architect, the Contractor shall notify the Landscape Architect at least 48 hours in advance of the anticipated delivery date of any plant materials. A legible copy of the invoice, showing kinds and sizes of materials included for each shipment shall be furnished to the Landscape Architect.

1.9 GUARANTEE

A. The condition of all new plant materials is the responsibility of the Contractor and shall be approved by the Landscape Architect.

B. Until final approval, any replacement of plant materials that may be necessary shall be at the expense of the Contractor.

C. In addition to other standard provisions, the Contractor's bid amount shall also provide for the following:

1. Maintenance necessary during Establishment Period including provision of supplemental irrigation, through final acceptance.

2. Replacement in kind, or with a substitute acceptable to the Landscape Architect, of all plant materials not in a healthy growing condition or that has died back to the crown or beyond normal pruning limits.

3. The Contractor shall also be responsible for any damage caused by his operations and shall dispose of all rubbish and excess soil as directed.

PART 2 - PLANTING MATERIALS

2.1 TOPSOIL

A. Work included – Topsoil incidental to landscape planting operations shall be as described in Section 329100 Soil Preparation and Mixes.

2.2 SHREDDED HARDWOOD BARK MULCH

A. Shredded hardwood bark mulch or approved equal shall be used as a four inch (4") top dressing in all plant beds and around all trees planted by landscape contractor. Single trees or shrubs shall be mulched to the outside edge of the saucer. Mulch shall be of sufficient character as not to be easily displaced by wind or water runoff.

2.3 TAKING MATERIALS

A. Plant materials which satisfy the requirements of this specification should not require staking, however contractor shall install stakes if requested by the Landscape Architect or Owner.

B. Stakes shall be 2" x 2" x 8' white oak pressure treated for stakes. Three (3) stakes per tree.

C. Guy wire for tree staking shall be pliable No. 12 galvanized soft steel wire.

D. Hose shall be two-ply fiber-bearing rubber garden hose, not less than one-half inch (½") inside diameter, black or green, and of suitable length.

2.4 WATER

A. On-site water shall be furnished by the Contractor. Hose and other watering equipment shall be furnished by the Contractor.

2.5 ANTI-DESICCANT SPRAY

A. Spray shall be an emulsion which will provide a protection fill over plant surfaces. It shall be permeable enough to permit transpiration such as "Wilt-Pruf", manufactured by Nursery

Product Specialties Company, Croton Falls, New York, or other approved equal. It shall be delivered in the manufacturer's containers and mixed according to the manufacturer's instructions.

PART 3 - PLANTING PROCEDURES AND EXECUTION

3.1 PLANTING COORDINATION

A. The Contractor shall inform the Landscape Architect of the date when the planting shall commence and of the anticipated delivery date of the material.

B. Failure to notify the Landscape Architect in advance of order to arrange proper scheduling may result in loss of time or rejection of a plant or plants not installed as specified or directed.

3.2 DIGGING AND HANDLING

A. Bare rooted shrubs shall be dug with adequate fibrous roots. Roots of these plants shall be covered with a uniformly thick coating of mud by being puddled immediately after they are dug, or packed in moist straw, or moss.

B. Balled and burlapped plants shall be dug with firm natural balls of earth of sufficient diameter and depth to include most of the fibrous roots.

C. Roots or balls of all plants shall be adequately protected at all times from the sun and from drying winds.

D. All balled and burlapped plants which cannot be planted immediately upon delivery shall be set on the ground in a shady location and shall be well protected with soil, wet mulch or other acceptable material. Plant material shall be kept moist with periodic watering with fresh clean water. Bare rooted plants, which cannot be planted immediately, shall be heeled-in upon delivery. All shall be kept moist. At no time shall plants be staged in direct sun or on asphalt surfaces.

E. Bundles of plants shall be opened and the plants separated before the roots are covered. Care shall be taken to prevent air pockets among the roots. During planting operations, bare roots shall be covered with canvas, hay or other suitable material. No plant shall be bound with wire or rope at any time so as to damage the bark or break the branches.

3.3 TREES AND SHRUB PLANTING OPERATIONS

A. Planting operations shall be performed at a steady rate of work unless weather conditions make it impossible to work. No plant material shall be planted in frozen ground.

B. The Contractor shall provide sufficient tools and equipment required to carry out the planting operation.

C. All plants too large for two men to lift in and out of holes shall be placed with a sling. Do not rock trees in holes to raise ball elevation.

D. For soil mix for plant holes, see Materials - 2.1 Topsoil.

E. If rock or other underground obstruction is encountered, the Landscape Architect may require plant pits to be relocated, the pits enlarged or the plants deleted from the contract.

F. Locations containing unsuitable subsoil shall be treated in one of the following manners:

1. Where unsuitability within the construction site is deemed by the Landscape Architect to be due to excessive compaction caused by heavy equipment or by the presence of boards, mortar, concrete or other construction materials in sub-grade, and where the natural subsoil is other than A.A.S.T.H.O. classification of A6 or 7, the Contractor shall loosen such areas with spikes, discing, or other means to loosen the soil to a condition acceptable by the Landscape Architect. The Contractor shall also remove all debris and objectionable material. Soil should be loosened to a minimal depth of 12 inches (12") with additional loosening as required to obtain adequate drainage. Contractor may introduce sand or organic matter into the subsoil to obtain adequate drainage as directed by the Landscape Architect. All such remedial measures shall be considered as incidental to the work and no extra payment shall be made for this part of the work.

2. Where sub-grade is deemed by the Landscape Architect/ Engineer to be unsuitable because the natural subsoil falls into an A.A.S.T.H.O. classification of A6 or 7 and contains moisture in excess of 30%, then such a condition shall be rendered suitable by installation of a sub-drainage system or by other means described elsewhere in these specifications. Where such conditions have not been known or revealed prior to planting time and where they have not been recognized in the preparation of plans and specifications, then the Landscape Architect shall issue a change order to install the proper remedial measures, all of which shall be in addition to the contract sum.

G. Adjustments in locations of planting beds and bed outlines shall be made as directed. In the event that pits or areas for planting are prepared and backfilled with topsoil to grade prior to commencement of lawn operations, they shall be so marked that when the work of planting proceeds, they can be readily located. In case underground obstructions such as ledges or utilities are encountered, location shall be changed under the direction of the Landscape Architect without charge, to the owner.

H. Holes for trees shall be at least two and one-half times (2.5Xs) greater in diameter than the diameter of the root ball and of a depth that allows the tree to sit at the same elevation as grows in the nursery. Holes for shrubs and vines shall be at least 12 inches (12") greater in diameter than the spread of the root system and of a depth that allows the shrub and vines to sit at the same elevation as grown in the nursery.

I. To the topsoil in the backfilling of tree holes and shrub beds, there shall be added as the progress of the work permits, ground limestone if soil tests indicate it is needed and with prior approval by landscape architect, and commercial fertilizer at the rate of three (3) pounds for tree up to three inches (3") in caliper, one (1) pound per one inch (1") in caliper for larger trees, six (6) ounces for small shrubs and eight (8) ounces for each shrub four feet (4') or over. Ground limestone shall be omitted in the case of acid soil plants. The limestone and fertilizer shall be thoroughly mixed with the topsoil in the planting operation.

J. The plants shall be planted in the center of the holes and at the same depth as they previously grew. Topsoil shall be backfilled in layers of not more than eight inches (8") and each layer watered sufficiently to settle before the next layer is put in place. Topsoil shall be tamped under edges of balled plants. Enough topsoil shall be used to bring the surfaces to finish grade when settled.

1. A saucer shall be provided around each plant as shown on the drawings.

2. Plants shall be soaked with water twice within the first twenty-four (24) hours of time of planting. Water shall be applied with low pressure so as to soak in thoroughly without dislodging the topsoil.

3. A three-inch (3") layer (after settlement) of mulch or approved equal shall be applied directly on to the entire area of each saucer or planting bed.

3.4 MAINTENANCE DURING CONSTRUCTION

A. Maintenance shall begin immediately after planting. Plants shall be watered, mulched, weeded, pruned, sprayed, fertilized, cultivated, and otherwise maintained and protected until provisional acceptance. Settled plants shall be reset to proper grade and position, planting saucer restored and dead material removed. Stakes and wires shall be tightened and repaired. Defective work shall be corrected as soon as possible after it becomes apparent and weather and season permit.

B. If a substantial number of plants are sickly or dead at the time of inspection, acceptance shall not be granted and the Contractor's responsibility for maintenance of all plants shall be extended until replacements are made or existing plants are deemed acceptable by the Landscape Architect.

C. All replacements shall be plants of the same kind and size specified on the Plant List. They shall be furnished and planted as specified above. The cost shall be borne by the Contractor. Replacements resulting from removal, loss, or damage due to occupancy of the project in any part, vandalism, physical damage by animals, vehicles, etc., and losses due to curtailment of water by local authorities shall be approved and paid for by the Owner.

D. Plants shall be guaranteed for a period of one (1) year after inspection and provisional acceptance.

E. At the end of the Establishment Period, inspection shall be made again. Any plant required under this contract that is dead or unsatisfactory to the Landscape Architect or Owner shall be removed from the site. These shall be replaced during the normal planting season.

PART 4 - MAINTENANCE CONTRACT

4.1 GENERAL LANDSCAPING

A. Contractor shall provide the Owner with a written proposal due no later than the established possession date for landscape maintenance from an experienced local A.A.N. certified nursery business capable of performing the work outlined herein. The proposal shall be for a period of 1 year and be renewable in one-year increments. Maintenance will begin immediately after completion of substantial completion, the maintenance contract work shall not void the guarantee of the plant material for the first year after acceptance by the Owner. Replacement of

dead plant material shall be covered under the warrantee of the original installation, final approval and acceptance of the landscaping and irrigation by the Owner.

B. Landscape maintenance shall include all necessary watering, cultivation, weeding, pruning, wound dressing, disease and insect pest control, protective spraying, straightening plants which lean or sag, adjustments of plants which settle or are planted too low, mowing of turf areas, replacement of mulch that has been displaced by erosion or other means, repairing and reshaping of water rings or saucers, re-placement of mulch that has been displaced by erosion or subsidence, and the reseeding or replanting of those areas affected. Removal of all rubbish, waste, tools, and equipment used in the execution of the contract at the end of each work day, and any other procedure consistent with good horticultural practice necessary to insure normal, vigorous and healthy growth of all plant material are also part of this maintenance contract.

C. During the first year of the maintenance contract, any replacement of plant material shall be the responsibility of the installing contractor.

D. Landscape maintenance contractor shall purchase and maintain Contractor's general liability insurance in the amounts of $10,000 to protect him from the Contractor's operations under the maintenance contract. Certification of such insurance shall be filed with the Owner prior to the commencement of the work.

4.2 WATERING

A. The irrigation system, if installed on the site, shall be used by the maintenance contractor for the watering program, but any failure of the system does not eliminate the Contractor's responsibility of maintaining the desired level of moisture necessary to maintain vigorous, healthy growth.

B. The quality of water applied at one time shall be sufficient to penetrate the soil to a minimum of eight inches (8") in shrub beds and six inches (6") in turf areas at a rate, which will prevent saturation of the soil.

C. On-site water shall be furnished by the Owner. Hose, portable tanks, pumps, nozzles or any other watering equipment required to transport water from available locations and apply it by approved methods shall be furnished by the Contractor.

4.3 WEEDING

A. Maintenance contractor shall keep all planting areas free from weeds and undesirable grasses by a method and by materials approved by the A.N.A.

4.4 DISEASE AND INSECT PEST CONTROL

A. Inspect all plant material at least once a month to locate any disease or insect pest infestations. Upon the discovery of any disease or insect pest infestation, identify, or have identified, the nature or species of the infestation. A method of control in accordance with common A.N.A. standards shall be immediately implemented.

4.5 FERTILIZING

A. Maintenance contractor is to fertilize plant material on a regularly scheduled program to fit the requirements of the plant material to maintain vigorous and healthy plant growth.

4.6 PRUNING AND REPAIR

A. The amount of pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches or to maintain safety in vehicular use areas. Pruning shall be done in such a manner as to not change the natural habit or shape of the plant. All cuts shall be made flush, leaving no stubs.

4.7 MOWING

A. Mow all grass areas at regular intervals to keep the grass height from exceeding three inches (3"). Mow grass areas in such a manner as to prevent clippings from blowing on paved areas, and sidewalks. Cleanup after mowing shall include sweeping or blowing of paved areas and sidewalks to clear them of mowing debris.

4.8 CLEAN UP

A. During the course of maintenance planting, excess and waste materials shall be continuously and promptly removed at the end of each work day.

4.9 MAINTENANCE REPORT AND SCHEDULE OF ACTIVITIES

A. Maintenance contractor shall provide a schedule and report to store management and to the address referenced in this section, 4.1, A. that details his planned maintenance activities including any subcontractors.

4.10 MAINTENANCE CONTRACT

A. These terms and conditions herein outlined shall be attached and made a part of a maintenance contract with the Owner.

4.11 TERMINATION OF THE MAINTENANCE CONTRACT

A. If the Owner fails to make payment for a period of ninety (90) days without written clarification, the maintenance contractor may, upon twelve (12) additional days' written notice to the Owner, terminate the contract and recover from the Owner, payment for all work executed and for any proven loss sustained upon any materials, equipment, or tools, including reasonable profit and damages applicable to the maintenance contract.

B. If the maintenance contractor defaults or persistently fails or neglects to carry out the work in accordance with the maintenance contract, the Owner, after twelve (12) days' written notice to the maintenance contractor, and without prejudice to any other remedy they may have, may make good such deficiencies and deduct the cost thereof, including compensation for additional services made necessary thereby, from the payment then or thereafter due the contractor, or at their option, may terminate the contract.

END OF SECTION 329300

SECTION 329353 - LANDSCAPE MAINTENANCE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 329200 – Lawns and Grasses

C. Section 329300 – Landscape Planting

1.2 SUMMARY

A. Provide labor, materials, equipment, services and transportation to complete work.

1. Plant and turf maintenance including pruning, watering, drainage, irrigation, fertilizing, weed and pest control, and adjusting tree guys.

2. Guaranty and replacement of unacceptable plants.

3. Providing Owner with Maintenance Manual.

1.3 REFERENCES

A. Comply with applicable requirements of:

1. State of Connecticut Department of Transportation (ConnDOT) Standard Specifications for Roads, Bridges and Incidental Construction, Latest addition

2. American Association of Nurserymen, American Standards for Nursery Stock, (ANSI Z60.1), latest edition, published by the American Association of Nurserymen, 1250 I Street, N.W., Suite 500 Washington, D.C. 20005.

1.4 DEFINITIONS

A. Maintenance: consists of keeping turf, woody, perennial and annual plants in healthy growing condition including watering, weeding, cultivating, remulching, removal and replacement of dead plant material, resetting plants to proper grades or upright positions and maintaining saucer.

1.5 SUBMITTALS

A. Materials List: provide list of materials to be used in maintenance; materials shall be the same as approved in related sections:

1. Fertilizers, soil amendments, testing see Section 329100 – Soil Preparation and Mixes.

2. Plant materials, mulch, and related materials, see Section 329300 – Landscape Planting.

B. Pest and Disease Treatment

1. Submit plan for pest and disease treatment; identify proposed materials and methods.

2. Explain why a problem does or may exist.

C. Maintenance Manual

1. Provide a maintenance manual to Owner describing operations for on-going upkeep of the installed plants. The manual shall address itself to specified types and uses of plants installed, and provide information for care of both newly installed plants and long-term maintenance.

2. Provide specific information on the following items:

a. Watering: Watering season; diagnosis of watering need; frequency of watering; amount; time of day; methods and equipment; equipment maintenance.

b. Fertilization: Fertilizing seasons; analysis for fertilizer selection; application rates and methods; preparation and conditions; application times; application equipment; post-application operations and care; precautions for fertilizer use.

c. Liming: Liming season; analysis for liming; application rate; method and equipment for application.

d. Pruning: Pruning goals and purposes; methods and techniques (relate to species); equipment; season; cleanup and disposal; precautions.

e. Mulching of beds: Depths of mulch; refreshment and replacement of mulch.

f. Miscellaneous plant maintenance: Weeding and weed control; pest and disease control; leaf and litter removal; bed edging; professional assistance for plant care; and plant replacement as necessary.

3. Include a month-by-month calendar of maintenance procedures, indicating operations listed above.

4. Include a developed Record Keeping document to be completed by the maintenance staff and submitted weekly to the Owner's Representative during active maintenance period.

5. Submit a copy of maintenance manual to Owner's Representative for approval. Submit prior to planting completion. Owner's Representative may request revisions to manual to meet intent of project design.

6. Submit three copies of manual to Owner at acceptance meeting for planting work. Acceptance shall not be granted until manual has been submitted and approved.

1.6 QUALITY ASSURANCE

A. Qualifications: contractor shall have minimum five years' experience in landscape maintenance.

B. Regulatory Requirements

1. Secure permits, licenses, and pay fees including traffic control.

2. Comply with laws, regulations, and quarantines for agricultural and horticultural products.

1.7 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: deliver materials in unopened containers bearing the manufacturer's name. Transport materials without damage. Protect finishes from abrasion, dirt, oils, grease, and chemicals. Pack materials to protect from weather.

B. Acceptance at Site: verify in writing that delivered materials conform to specifications and approved submittals.

C. Storage and Protection:

1. The Town will not provide areas of storage for the maintenance contractor.

2. Store materials in dry place, on pallets, off the ground; protect from sun.

3. Protect materials from theft, damage, weather, dirt, oils, grease, and construction.

1.8 PROJECT/SITE CONDITIONS

A. Environmental Requirements: do not work soils when dry, wet, or frozen.

1. Field Test

a. Form soil in palm of hand, if soil retains shape and crumbles upon touching, the soil may be worked.

b. If soil will not retain shape it is too dry and should not be worked.

c. If soil retains shape and will not crumble, it is too wet and should not be worked.

B. Planting Seasons: see Section 329300 - Landscape Planting

1.9 SUBSTANTIAL COMPLETION

A. Upon completion of planting, request Owner's Representative's review to determine if work is substantially complete. If work is complete, Owner's Representative will issue a Letter of Substantial Completion that establishes the effective date of the start of the 2 year Maintenance Period for plantings and turf.

1. If work is not substantially complete, Owner's Representative will make a list of outstanding work to be done on a timely schedule agreed upon by Contractor and Owner's Representative.

2. Contractor shall notify Owner's Representative when outstanding work is accomplished and ready for review. When outstanding work is complete, in the judgment of Owner's Representative, a Letter of Substantial Completion will be issued.

1.10 PRELIMINARY ACCEPTANCE

A. After the Letter of Substantial Completeness the work will be reviewed for completeness and of Preliminary Acceptance

B. Plantings and turf shall be in thriving and vigorous condition at the time of review for Preliminary Acceptance. If plantings and turf are acceptable, Owner's Representative will issue a Letter of Preliminary Acceptance establishing the effective date of the two-year Guaranty Period.

1. If plantings are not thriving, in the judgment of Owner's Representative, remedial actions by Contractor will be required to repair or replace plantings.

2. Remedial work shall be done immediately and in accordance with related work of other sections.

3. At the conclusion of remedial work, Owner's Representative will review work and extend the Guaranty Period to incorporate new plantings.

1.11 FINAL ACCEPTANCE

A. After the 2-year Maintenance and Guaranty Period, plantings and turf will be reviewed.

B. Plantings and turf shall be in thriving and vigorous condition at the time of review for Final Acceptance. If plantings and turf are acceptable, Owner's Representative will issue a Letter of Final Acceptance.

1. If plantings and turf are not thriving, in the judgment of Owner's Representative, remedial actions by Contractor will be required to replace plantings.

2. Remedial work shall be done immediately and in accordance with related work of other sections.

3. At the conclusion of remedial work, Owner's Representative will review work and extend the Maintenance and Guaranty Period until plantings are deemed acceptable.

PART 2 - MATERIALS

2.1 MATERIALS

A. Materials utilized during the maintenance period shall be the same specified in the work of the related sections:

1. Fertilizers, soil amendments, testing, see Section 329100 – Soil Preparation and Mixes.

2. Sod and related materials, see Section 329200 – Lawns and Grasses

3. Plants, mulch, and related materials, see Section 329300 - Landscape Planting.

2.2 BIOLOGICAL, HORTICULTURAL, HERBICIDAL AND OTHER PEST CONTROL

A. Material Specification: shall be by a licensed pest control operator, with authority to purchase, utilize, and specify agricultural chemicals and agricultural products.

B. Use the least hazardous, least intrusive materials and methods.

2.3 EQUIPMENT

A. Vehicles: in good working order so oil and grease does not stain pavements and poison plantings. Signs identifying the vehicles shall be clearly displayed.

B. Machinery: in good working order so oil and grease does not stain pavements and poison plantings.

2.4 WATER

A. Water: Furnished by Contractor, suitable for irrigation and free from ingredients harmful to plant life.

B. Hoses and other watering equipment to be furnished by Contractor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: in the event field conditions are not as shown on Drawings and outlined in the Specifications, notify Owner’s Representative in writing.

3.2 PREPARATION

A. Protection:

1. Agricultural Chemicals: protect site improvements from contact with agricultural chemicals, soil amendments, and fertilizers.

3.3 PRUNING

A. Pruning: prune with approval of Owner’s Representative.

1. Remove dead branches, rubbing branches, and branches growing towards plant center.

3.4 DRAINAGE

A. Observe drainage in plant pits with hand soil augur.

B. Verify plant pits are draining; plant pits not draining shall be identified on the plan and brought to the attention of Owner’s Representative.

3.5 PLANTS

A. Maintain plants in vigorous condition throughout the Maintenance and Guaranty Periods.

B. Replace plants that are missing, dead, not true to name or size as specified, or not in satisfactory growth, as determined by Owner’s Representative. Replace plants found unacceptable within one month or in first month of next growing season, whichever comes first.

C. Plants must show a minimum of 75% healthy head with obvious growth since planting. Signs of disease, injury, or damage shall have been successfully treated or plant shall be rejected as determined by Owner’s Representative.

D. Replacements plants shall be same kind and size as specified in plant list. Furnish and plant. Cost of replacement borne by Contractor except where it can be shown loss resulted from vandalism, fire, theft, or other causes beyond Contractor's control. Restore areas damaged or disturbed by replacement operations to their original condition.

3.6 WATERING

A. Water at a rate of one inch of water every five to seven days. Apply water such that it penetrates the soil to a depth of 6”.

B. Trees require a minimum of ten gallons each and shrubs a minimum of five gallons each per week.

C. If spring or fall months experience below average rainfall, periodic watering could be extended as part of this contract and at no additional charge as requested by Owner’s Representative.

D. If natural rainfall provides water to meet watering requirements, weekly watering could be reduced but only at the request of Owner’s Representative.

3.7 PLANT BASINS

A. Keep foot tamped and shaped earth dikes around plantings.

3.8 MULCH

A. Maintain mulch at 2” depth in planting areas with the exception of at stems and trunks of plants where mulch to be placed to a 0” depth and increasing to a depth of 2” at edge of rootballs and beyond.

B. If re-mulching is required in maintenance period, remove existing mulch as needed to maintain maximum 2" cover.

C. Maintain finish grades around plantings, at pavement edges, and at irrigation fixtures.

3.9 TREATMENT OF PEST AND DISEASES

A. Spray for both insect pests and diseases during maintenance period with notification and permission of Owner's Representative. Apply herbicides, insecticides and fungicides as prescribed by their manufacturer and in accordance with State laws. Contractor shall possess from the State of Connecticut the proper registrations and permits for application of materials or have applications made by approved, qualified firm holding registrations and permits. Furnish copies of permits in connection with materials to Owner's Representative. Spraying to be considered only after full consideration has been given to alternative pest control strategies. The least toxic approach to pest control shall be used.

3.10 ADJUSTING

A. Re-set settled plants to proper grade and position.

B. Restore planting saucer and adjacent material.

3.11 CLEANING

A. Clean up, remove and dispose off-site excess planting mixture, soil and debris generated under work of this section.

B. Wash and sweep clean site improvements and building surfaces. Clean spills and oversprays immediately.

C. Repair damage caused by maintenance operations.

3.12 PROTECTION

A. Protect work of this section until Final Acceptance.

B. Protect planted areas and soils from compaction by construction traffic and from contamination by construction materials.

END OF SECTION 329353

SECTION 333000 - SITE SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Work performed under this section shall be subject to all the Contract Documents including the Drawings, the General Conditions, the Supplementary Conditions and Division 1 General Requirements.

B. Section 310000 – Earthwork

C. Section 312333 –Trench Excavation and Backfill for Utilities

D. Town of Glastonbury Water Pollution Control Authority standards and requirements

1.2 SCOPE OF WORK

A. Work under this section of the specifications shall consist of providing all labor, plant facilities, materials and equipment necessary to install all of the sanitary sewer facilities. This work shall include but not be limited to the installation of sanitary sewers consisting of pipe, cleanouts, laterals, wye connections, and all necessary and required accessory items and operations as shown on the Details and Drawings

B. Furnish factory-fabricated fittings of the same type and class of material as the pipe, or of material having equal or superior physical and chemical properties.

C. All necessary coordination with governing sewerage authority including local sewerage authority and local health department and/or Connecticut Department of Energy and Environmental Protection.

D. Testing of sanitary sewer system

E. Abandonment and removal of existing sanitary sewer pipes and manholes as required

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's certificate for castings, pipe and accessories to certify that products meet or exceed specified requirements.

B. Submit shop drawings of the precast structures to the Owner’s Engineer for review prior to fabrication. Shop drawings shall include dimensions, reinforcing, joint treatment, invert elevations and invert locations.

C. Submit shop drawings of structure tops including frames and covers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The Contractor shall install materials based on this specification or per the specifications of the Town of Glastonbury, whichever is more restrictive.

B. Polyvinyl Chloride (PVC) Pipe: ASTM D3034-93 for pipe and fittings, minimum wall thickness SDR-35. Provide minimum three feet of pipe cover in the pavement area.

C. Cleanouts: Iron body type with extra heavy bronze plugs. Cover shall consist of Neenah Foundary Company Pattern No. R-1914 with locking cover, or approved equal.

D. Pipe joint: Rubber gasketed tongue-and-groove joints in all pipes.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall install all sanitary sewer structures and pipe in the locations as shown on the Drawings and/or as approved by the Owner's Representative. Pipe shall be of the type and sizes specified and shall be laid accurately to line and grade. Structures shall be accurately located and properly oriented.

3.2 EXCAVATION AND BACKFILL

A. The provisions of Section 312333 entitled “Trench Excavation and Backfill for Utilities” shall govern all Work under this Section.

3.3 STORAGE AND HANDLING OF PIPE

A. All pipe shall be protected against impact, shock and free fall, and only equipment of sufficient capacity and proper design shall be used in the handling of the pipe. Storage of pipe on the job shall be in accordance with the pipe manufacturer's recommendations, subject to the approval of the Owner's Representative.

3.4 DAMAGE TO PIPE

A. Pipe which is defective from any cause, including damage caused by handling, and determined by the Owner's Representative as unrepairable, shall be unacceptable for installation and shall be replaced at no cost to the Owner as directed by the Owner's Representative. Damaged pipe shall be immediately marked with white paint and separated from usable pipe on site.

B. Pipe that is damaged or disturbed through any cause prior to acceptance of the Work shall be repaired, realigned or replaced as directed by the Owner's Representative, at the Contractor's expense.

3.5 PIPE INSTALLATION

A. Laying Pipe - Each length of pipe shall be laid with firm, full and even bearing throughout its entire length, in a trench prepared and maintained in accordance with Section 312333 entitled "Trench Excavation and Backfill for Utilities". Pipe will be laid with bells upgrade.

B. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. The interior of the pipe and the jointing seal shall be free from sand, dirt and trash before installing in the line. Extreme care must be taken to keep the bells of the pipe free from dirt and rocks so that joints may be properly assembled without over stressing the bells. No pipe is to be trimmed or chipped to fit.

C. No length of pipe shall be laid until the preceding lengths of pipe have been thoroughly embedded in place, so as to prevent movement or disturbance of the pipe.

D. Full Lengths of Pipe - Only full lengths of pipe are to be used in the installation except that partial lengths of pipe may be used at the entrance to structures where necessary to obtain a proper connection to the structure.

E. Pipe Entrances to Structures - All pipe entering structures shall be cut flush with the inside face of the structure, and the cut ends of the pipe surface of the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges or imperfections that will impede the flow of water or affect the hydraulic characteristics of the installation.

F. Bedding and Backfilling - The type of materials to be used in bedding and backfilling and the method of placement shall conform to the requirements Section 312333 entitled "Trench Excavation and Backfill for Utilities" and as shown on the Details of the Drawings.

G. Protection During Construction - The Contractor shall protect the installation at all times during construction, and movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be performed at the Contractor's risk.

H. At all times when pipe laying is not in progress, all open ends of pipes shall be closed by temporary water tight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been pumped dry and all danger of water entering the pipe has passed.

I. Tolerance - Pipe shall be laid accurately to the line and grade as shown on the Drawings and/or as approved by the Owner's Representative. Allowable tolerances shall be 1/4 inch in grade and 1/2 inch in line in any section of pipe between manholes. No adverse grades shall be allowed. Deviations from these tolerances shall be grounds for rejection of the line of pipe by the Owner's Representative. Any line which has been rejected shall be rebuilt to the correct line and grade by the Contractor at his own expense.

J. Do not lay the sanitary sewer line closer than ten feet horizontally or 18" vertically to a water main or service line. Where sanitary sewer lines cross water lines, encase the sewer in six inches of concrete for a distance of ten feet on each side of the crossing or substitute rubber-gasketed pressure pipe for the pipe being used for the same distance if approved by the appropriate sewerage authority.

3.6 PIPE JOINTS

A. All joints are to be made watertight in accordance with the requirements specified herein.

B. Pipe shall be jointed in strict accordance with the pipe manufacturer's instructions. Jointing of all pipe shall be done entirely in the trench.

C. Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 3 feet horizontally to the water line.

D. Where sanitary sewer lines pass less than 18 inches below the water line, provide concrete encasement. The length of encasement is to be increased to the nearest joint beyond the specified horizontal offset distance.

E. Make joints between ductile-iron pipe and other types of pipe with standard manufactured ductile-iron adapters and fittings or as directed by the local sewerage authority. Install ductile-iron piping and fittings in accordance with the recommendations of the pipe manufacturer.

3.7 INTERFACE WITH EXISTING FACILITIES

A. Connect to existing facilities in accordance with the requirements of the facility owner.

3.8 MODIFICATIONS OF EXISTING STRUCTURES

A. Not applicable.

3.9 SERVICE LINES

A. General - The Contractor shall terminate sanitary laterals five feet from the building.

B. Coordination with Building Contractor - The Contractor will be required to coordinate his work with the work of the Building Contractor to determine the exact location and elevation of the point of entry into the building. If the Building Contractor has installed his portion of the sanitary sewer service line, work under this contract shall also include final connection of the sanitary sewer service line five feet outside the building line to the building service line at no additional cost to the Owner. The Contractor shall consult the latest architectural/mechanical drawings to confirm lateral locations.

3.10 INSPECTION AND TESTING

A. General - The Contractor shall test the completed sewers, including manholes and laterals for leakage by low-pressure air test, infiltration and exfiltration tests as specified herein and any other testing required by the local sewer authority. The Contractor shall furnish all necessary equipment, materials and labor for performing the tests as specified. The Contractor shall notify the Owner's Representative and the sewage authority at least 48 hours prior to the start of testing. Sections of pipe tested for infiltration and exfiltration prior to completion of the project shall be subject to additional leakage tests, if warranted in the opinion of the Owner's Representative,

and/or the sewage authority prior to acceptance of the project.

B. Infiltration and Exfiltration Testing - The test length intervals for either type of leakage test shall be approved by the Owner's Representative and the sewage authority, but in no event shall they exceed 1000 feet. In the case of sewers laid on steep grades, the length of line to be tested by exfiltration at any one time may be limited by the maximum allowable internal pressure on the pipe and joints at the lower end of the line.

C. The test period, wherein the measurements are taken shall not be less than four hours in either type of test.

D. Depending on field conditions, the following test for leakage shall be employed:

E. Infiltration Test - The test may be used only when groundwater levels are at least four feet above the highest point of the crown of the sewer being tested and after the trench has been backfilled and compacted. The groundwater leakage into the pipe will be measured near the lower end of the section of sewer under test.

F. Exfiltration Test - This test consists of filling the pipe with water to provide a head of at least five feet above the top of the pipe or five feet above groundwater, whichever is higher, at the highest point of the pipe line under test, and measuring the loss of water from the line by the amount which must be added to maintain the original level. In this test, the line must remain filled with water for at least 24 hours prior to the taking of measurements. Exfiltration shall be measured by the drop of water level in a closed-end standpipe or in one of the sewer manholes available for convenient measuring.

G. When a standpipe and plug arrangement is used in the upper manhole of a line under test, there must be some positive method of releasing entrapped air in the sewer prior to taking measurements.

H. Leakage Requirements - The total leakage of any section tested shall not exceed the rate of 50 gallons per day per mile per inch of nominal pipe diameter. For purposes of determining the maximum allowable leakage, manholes shall be considered as sections of 48 inch diameter pipe, five feet long, and the equivalent leakage allowance shall be 2.25 gallons per manhole per 24 hours.

I. Low Pressure Air Testing - The sewer mains and/or laterals shall be tested for leakage by the use of low-pressure air as specified hereinafter or by the local sewage authority and as approved by the Owner's Representative. The test length shall not exceed one interval of pipe between two manholes. Air test procedures may be dangerous and the Contractor shall take all necessary precautions to prevent blowouts.

J. The proper procedure for air testing of sanitary sewers shall be as described in ASTM C-828, latest edition, entitled "Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines (4-12 inches)". Although the title specifies vitrified clay pipe, the same procedure maybe used for any other pipe material.

K. It is important that test plugs be properly installed to prevent blowouts. It is also important to maintain pressure relief devices to prevent system over pressurization.

L. Correction of Defective Work - If leakage exceeds the specified amount, the Contractor shall, at

his own expense, make the necessary repairs or replacements required to permanently reduce the leakage to within the specified limit, and the tests shall be repeated until the leakage requirement is met.

M. Any defects found in the system are to be repaired at the expense of the Contractor so as to conform strictly to the Specifications and to the satisfaction of the Owner's Representative. All repairs shown necessary by the tests are to be made, broken or cracked pipe replaced, all deposits removed, and sanitary sewer left true to line and grade and entirely clean, free from lumps of cement, protruding gaskets, bulkheads, etc., and ready for use before final acceptance by the Owner.

N. Compliance with Agency Requirements - In the event of conflict between the leakage test requirements specified herein with the leakage test requirements of agencies having jurisdiction over all or any portion of the sanitary sewers installed under this Contract, the more restrictive requirements shall govern.

3.11 CLEANING AND REPAIR

A. The Contractor will be required to clean the entire sanitary sewer system of all debris and obstructions. This shall include, but not be limited to removal of all formwork from structures, concrete and mortar droppings, construction debris and dirt. The system shall be thoroughly flushed clean and the Contractor shall furnish all necessary hose, pumps, pipe and other equipment that may be required for this purpose. No debris shall be flushed into existing sanitary sewers or streams; all debris shall be removed from the system.

B. After the system has been cleaned, the Contractor shall thoroughly inspect the system and all repairs shown to be necessary shall be promptly performed by the Contractor.

C. All work of cleaning and repair as specified herein shall be performed at the Contractor's expense and to the complete satisfaction of the Owner's Representative.

3.12 FINAL INSPECTION

A. Upon completion of the Work and before final acceptance by the Owner, the entire sanitary sewer system shall be subjected to a final inspection in the presence of the Site Engineer and/or Owner's Representative and local sewerage authority. The Work shall not be considered as complete until all requirements for line, grade, cleanliness, leakage tests and workmanship have been met.

END OF SECTION 333000

SECTION 334100 - STORM SEWER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 320000 - General Requirements

C. Section 020100 - Protection of Existing Utilities

D. Section 310000 - Earthwork

E. Section 312333 - Trench Excavation and Backfill for Utilities

F. Section 312500 - Soil Erosion and Sediment Control

G. All necessary construction permits.

H. Town of Glastonbury standard requirements

1.2 SCOPE OF WORK

A. Work under this section shall consist of providing all labor, plant facilities, materials, tools, equipment, shop drawings and supervision necessary and required to install all of the storm drainage facilities as specified in accordance with the Contract Documents. This work shall include but not be limited to:

1. Installation of the drainage system consisting of manholes, catch basins, yard drains, cleanouts, pipes, and all necessary and required accessory items and operations.
2. Connection to existing drainage facilities.

1.3 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM) latest edition.
1. A706 Type 1R
2. C14 Concrete Sewer, Storm Drain, and Culvert Pipe.
3. C55 Concrete Building Brick.
4. C76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
5. C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
6. C478 Precast Reinforced Concrete Manhole Sections.
7. C923 Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes.
8. D1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.

9. D2922 Test Methods for Density of Soil and Soil - Aggregate in Place by Nuclear Methods (Shallow Depth).
10. D3017 Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
11. American Association of State Highway and Transportation Officials (AASHTO) - latest edition
12. International Masonry Industry All-Weather Council (IMIAC): Recommended Practices and Guide Specification for Cold Weather Masonry Construction.

1.4 QUALITY ASSURANCE

A. An Engineer, selected and paid by the Owner (herein referenced to as “Owner’s Engineer”), may be retained to perform construction inspection on-site based on measurement, visual observation, and judgment.

B. Visual field confirmation may be performed by the Owner’s Engineer as part of the construction testing requirements.

C. All costs related to reinspection due to failures shall be paid for by the Contractor at no additional expense to Owner. The Owner reserves the right to direct any inspection that is deemed necessary. Contractor shall provide free access to site for inspection activities.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's certificate for castings, pipe and accessories to certify that products meet or exceed specified requirements.

B. Submit shop drawings of the precast structures to the Owner’s Engineer for review prior to fabrication. Shop drawings shall include dimensions, reinforcing, joint treatment, invert elevations and invert locations.

C. Submit shop drawings of structure tops including frames, covers, and/or grates.

1.6 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.

B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.7 COORDINATION

A. Coordinate the Work with termination of storm sewer connection outside building including connection to existing storm sewer system.

PART 2 - PRODUCTS

2.1 SEWER PIPE MATERIALS AND ACCESSORIES

A. Reinforced Concrete Pipe (RCP): Straight and flared end sections complying with requirements of ASTM C 76, Class III unless another class type is indicated on the Contract Documents, installed with flexible plastic (Bitumen) gaskets at all joints. Gaskets shall comply with AASHTO M-198 75I, Type B, and shall be installed in strict accordance with pipe manufacturer's recommendations.

B. Corrugated High Density Polyethylene Pipe (HDPE) Smooth Interior: Shall conform with AASHTO Designation M294 and M252. Pipe must be installed in accordance with pipe manufacturer’s installation Guidelines for Culvert Storm Drainage Applications. Acceptable manufacturers: Advanced Drainage Systems, Inc. “ADS N-12” and HANCOR, Inc. “Hi-Q” or approved equal.

C. Polyvinyl Chloride Pipe (PVC): On-site pipe and fittings shall comply with ASTM D 3034, rated SDR 35 unless otherwise specified on the Contract Documents or required by the local utility. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification. Pipe joints shall be integrally molded bell ends per ASTM D 3034, Table 2, with factory supplied elastomeric gaskets and lubricant.

2.2 CATCH BASINS, YARD DRAINS, MANHOLES AND COMPONENTS

A. General: All manholes, catch basins and yard drains shall be built in accordance with, and in the locations shown on the Contract Documents. All structures will require shop drawings approved by the Owner's Engineer.

B. No concrete or masonry shall be placed when the temperature is below forty (40) degrees Fahrenheit, or when indications are for lower temperatures within twenty-four (24) hours, unless protection of concrete and masonry is approved by the Owner's Engineer. Damage to the structure because of freezing shall be corrected by the Contractor at his own expense, to the satisfaction of the Owner's Engineer.

C. Manholes, catch basins and yard inlets shall be constructed as soon as the pipe laying reaches the location of the structures. Should the Contractor continue his pipe laying without making provisions for completion of the structures, the Owner's Engineer shall have the authority to stop the pipe laying operations until the structure is completed.

D. Any structure which is mislocated or oriented improperly shall be removed and re-built in its proper location, alignment and orientation at the Contractor's expense.

E. Precast Reinforced Concrete Structures:

1. Precast concrete in accordance with AASHTO M199-93/ASTM C478-90b and reinforcing steel in conformance with ASTM 615. Provide minimum load rating of H20.
2. Construct manholes of precast concrete sections as required by Contract Documents to size, shape, and depth indicated, but never less than 4-ft inside diameter. Structure size shall be selected to accommodate the inflow and outflow pipes.

3. Gaskets to be in accordance with ASTM C923 & C361
4. Mortar and Grout: Mortar for finishing and sealing shall be Class "C". Honeycombing less than two (2) inches deep shall be repaired using Class "D" mortar.
5. Brick Transition Reinforcement: Formed steel 8-gage wire with galvanized finish.
6. Foundations: All foundations shall rest on firm soil of uniform bearing and stone subbase as shown on Contract Documents.
7. Inverts: Brick or smooth concrete invert channels shall be constructed in all manholes and in all catch basins and drain inlets which do not have sumps, to insure a smooth flow of water through the structure.
8. The invert channel shall be constructed to the elevations shown on the Contract Documents and/or as approved by the Owner's Engineer. Channels shall slope smoothly and evenly from the entrance pipe to the outlet pipe.
9. Frames, Cover, and Gratings: Frames, Covers and/or gratings for manholes, catch basins, and drain inlets shall be of the type and size indicated on the Contract Documents. Frames shall be well bedded in mortar and shall be set accurately to the correct alignment and grade.
10. Ladder Rungs: In accordance with ASTM C-478/D-4101/A-615/M-199 standards.
11. Grout around pipes which protrude through the walls of the structure and on all joints shall contain "Antihydro", or other approved additive to insure water tightness. Cement grout shall contain two parts cement to one part sand and additive in accordance with manufacturer's recommendations. Mortar shall be applied to the bottom 1/3 of the opening before the pipe is inserted.
12. The top grade of the precast concrete corbel section shall be set sufficiently below finished grade to permit a maximum of seven (7) and a minimum of two (2) courses of 8-inch brick to be used as risers to adjust the grade of the casting. Manhole frames shall be set on a grout pad as specified herein above.
13. Provide precast manhole shaft construction with eccentric cone top section and lipped male/female rubber gasket joints or mortar joints.
14. Brick shall be new units conforming to AASHTO Designation M-91, latest revision, Grade MS.
15. Mortar shall conform to ASTM C270, Type M.
16. Pipe joints for rigid pipes shall be made with mortar, grout, gaskets, or as recommended by the pipe manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Contract Documents.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.

B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

C. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

3.3 GENERAL

A. The Contractor shall install all drainage structures and pipe in the locations shown on the Contract Documents and/or as approved by the Owner's Engineer. Pipe shall be of the type and sizes specified and shall be laid accurately to line and grade. Structures shall be accurately located and properly oriented.

B. Excavation and Backfill shall be in accordance with Section 312333 of these specifications.

C. Storage and Handling of Pipe - All pipe shall be protected against impact, shock and free fall, and only equipment of sufficient capacity and proper design shall be used in the handling of the pipe. Storage of pipe on the job shall be in accordance with the pipe manufacturer's recommendations.

D. Damage to Pipe - Pipe which is defective from any cause, including damage caused by handling, and determined by the Owner's Engineer as unrepairable, shall be unacceptable for installation and shall be replaced at no cost to the Owner as directed by the Owner's Engineer.

E. Pipe that is damaged or disturbed through any cause prior to acceptance of the Work, shall be repaired, realigned or replaced as directed by the Owner's Engineer, at the Contractor's expense.

3.4 BEDDING

A. Excavate pipe trench and place bedding material in accordance with Section 312333 for work of this Section.

3.5 INSTALLATION - PIPE

A. General: Install pipe, fittings, and accessories in accordance with ASTM C12, ASTM D2321, manufacturer's instructions and/or state or local requirements. Seal joints to be watertight.

B. Laying Pipe: Each length of pipe shall be laid with firm, full and even bearing throughout the entire length, in a trench prepared and maintained in accordance with Section 312333 of these Specifications and Contract Documents. Pipe shall be laid upgrade unless otherwise approved by the Owner’s Engineer.

C. Bell and spigot pipe shall be laid with the bell end upgrade. The pipe shall be joined so that there will be uniform space around the pipe. Trimming of the pipe shall not be allowed.

D. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. Prior to placing a length of pipe, the end of the previously laid length shall be carefully and thoroughly wiped smooth and clean to obtain an even and close fitting joint.

E. No length of pipe shall be laid until the preceding lengths of pipe have been thoroughly embedded in place, so as to prevent movement or disturbance of the pipe.

F. Place pipe on minimum 6-inch thick bed of compacted bedding or as detailed on the Contract Documents. Place and compact bedding aggregate at sides and to the springline of the pipe or per manufacturer's recommendations. The type of materials to be used in bedding and backfilling and the method and placement shall conform to the requirements of these Specifications.

G. Full Lengths of Pipe: Only full lengths of pipe shall be used in the installation except that partial lengths of pipe may be used at the entrance to structures where necessary to obtain a proper connection to the structure.

H. Pipe Entrances to Structures: All pipe entering structures (e.g.: manholes, catch basins, etc.) shall be cut flush with the inside of the structure, and the cut ends of the pipe and surface of the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges, or imperfections that will impede the flow of water or affect the hydraulic characteristics of the installation.

I. Refer to the Sections 310000 and 312333 of these Specifications for backfill requirements. Do not displace or damage pipe when compacting.

J. Protection During Construction: The Contractor shall protect the installation at all times during construction, and movement of construction equipment, vehicles and loads over and or adjacent to any pipe shall be performed at the Contractor's risk.

K. Tolerance: Pipe shall be laid accurately to the line and grade shown on the Contract Documents and/or as approved by the Owner's Engineer with maximum variation from true slope of 1/8-inch in 10-ft. Allowable tolerances shall be 1/2-inch on grade and 1-inch on line in any section of pipe between structures. Deviations from these tolerances shall be a basis for rejection of the line of pipe by the Owner's Engineer. Any line which has been rejected shall be rebuilt to correct line and grade by the Contractor at his own expense.

3.6 INSTALLATION - CATCH BASINS, MANHOLES AND YARD DRAINS

A. Precast structures shall be installed only after shop drawings have been approved by Owner's Engineer.

B. Form bottom of excavation clean and smooth to correct elevation.

C. Place precast reinforced concrete sections with provision for storm sewer pipe sections at the location and elevation specified on the Contract Documents.

D. Level top surface of each precast concrete shaft sections as assembly progresses.

E. Establish elevations and pipe inverts for inlets and outlets as indicated.

F. Lay brick masonry in running bond with full 3/8-inch mortar joints to receive casting assembly. Level casting frame in grout to receive grated inlet or manhole cover.

3.7 PLACING PRE-CAST MANHOLE BARREL SECTIONS

A. Place base pad to proper elevation and location and trowel top surface level for placement of manhole barrel.

B. Place manhole barrel plumb and level to correct elevations and anchor to base pad.
   1. After completion of slab foundation the first joint of manhole barrel shall be lowered into position, grooved end first, and set level and plumb on concrete base. Align and adjust to proper grade prior to placing and forming invert which shall be poured immediately after setting of first section of manhole barrel.
   2. Prior to setting subsequent manhole barrel sections, apply primer to tongue and groove ends and allow to set in accordance with manufacturer recommendations. Place "Ram-nek", or equivalent, plastic rope on tongue end. Lower next section into position, and remove excess material from interior of structure. Add additional material on exterior of joint, if necessary, for completely watertight joint.

3.8 PIPE JOINTS

A. Mortar Joints (RCP): After each length of RCP is laid, the lower portion of the bell shall be filled with mortar, and the succeeding length shall be laid in place so that the inner surfaces of the abutting lengths are flush. The remainder of the joint shall be completely filled with mortar and sufficient additional mortar used to form a bead around the joint flush with the outside diameter of the bell. The inside of the joint shall be wiped and finished smooth. Joints shall be thoroughly wet before the mortar is placed.

B. Cold Applied Joint Sealer (RCP): Bell and spigot or tongue and groove RCP shall be wiped clean and dry before applying the sealer to the pipe joint. Before the pipes are placed in contact with each other, the spigot end or tongue end of the pope shall be completely covered with an excess of sealer, and then the pipe shall be laid to the established line and grade so that the inside surfaces of abutting pipe are flush.

3.9 INTERFACE WITH EXISTING FACILITIES

A. Requirements: The Contractor shall make all required connections of the proposed drainage facilities into existing drainage facilities, where and as shown on the Contract Documents and/or as approved by the Owner's Engineer.

B. Compliance With Facility Owner Requirements: Connections made into existing drainage facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor will be required to comply with all such requirements, including securing of all required permits, and paying the costs thereof. The cost of making the connections in accordance with the requirements of the Owner of the existing facility shall be included in the Contract Sum.

3.10 REMOVAL OF EXISTING UTILITIES

A. The Contractor shall remove and legally dispose of off-site all abandoned storm sewer items encountered during installation of the storm drainage facilities.

3.11 MODIFICATIONS OF EXISTING STRUCTURES

A. General: The Contractor shall alter, reconstruct and/or convert existing structures where and as shown on the Contract Documents, and/or as approved by the Owner's Engineer. In general, alterations shall be performed with the same type of material used in the original construction unless otherwise indicated on the Contract Documents or approved by the Owner's Engineer.

B. Damage to Existing Installations: The Contractor shall exercise extreme care during such alteration, reconstruction and/or conversions so as not to damage any portions of the structure and/or pipe shown to remain. Any such damage shall be repaired by the Contractor at his own expense and to the satisfaction of the Owner's Engineer and Owner of the damaged structure.

3.12 CLEANING AND REPAIR

A. The Contractor will be required to clean the entire drainage system of all debris and obstructions. This shall include, but not be limited to, removal of all formwork from structures, concrete and mortar droppings, construction debris and dirt. The system shall be thoroughly flushed clean and the Contractor shall furnish all necessary hose, pumps, pipe and other equipment that may be required for this purpose. No debris shall be flushed into existing storm drains or streams; all debris shall be removed from the system and disposed of in accordance with all governing agencies.

B. After the system has been cleaned, the Contractor shall thoroughly inspect the system along with the Owner’s Engineer and all repairs shown to be necessary shall be promptly made by the Contractor.

C. All Work of cleaning and repair as specified herein shall be performed at the Contractor's expense and to the complete satisfaction of the Owner's Engineer.

3.13 FINAL INSPECTION

A. Upon completion of the Work and before final acceptance by the Owner, the entire drainage system shall be subject to a final inspection in the presence of the Owner’s Engineer and Town Engineer. The Work shall not be considered as complete until all requirements for line, grade, cleanliness, and workmanship have been completed to the satisfaction of the Owner's Engineer and the Town Engineer.

END OF SECTION 334100

APPENDIX A - GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information. This Document and its attachments are not part of the Contract Documents.

B. Because subsurface conditions indicated by the soil borings are a sampling in relation to the entire construction area, and for other reasons, the Owner, the Architect, the Architect's consultants, and the firm reporting the subsurface conditions do not warranty the conditions below the depths of the borings or that the strata logged from the borings are necessarily typical of the entire site. Any party using the information described in the soil borings and geotechnical report shall accept full responsibility for its use.

C. Soil-boring data for Project, obtained by GEI Consultants, dated July 11, 2019 is available for viewing as appended to this Document.

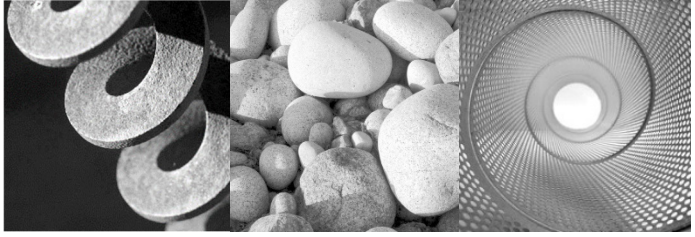
D. A geotechnical investigation report for Project, prepared by GEI Consultants, dated August 23, 2019, is available for viewing as appended to this Document.

1. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.
2. Any party using information described in the geotechnical report shall make additional test borings and conduct other exploratory operations that may be required to determine the character of subsurface materials that may be encountered.

E. Related Requirements:

1. "Instructions to Bidders" for the Bidder's responsibilities for examination of Project site and existing conditions.

END OF APPENDIX A



GEI Consultants

Consulting
Engineers and
Scientists

Geotechnical Report

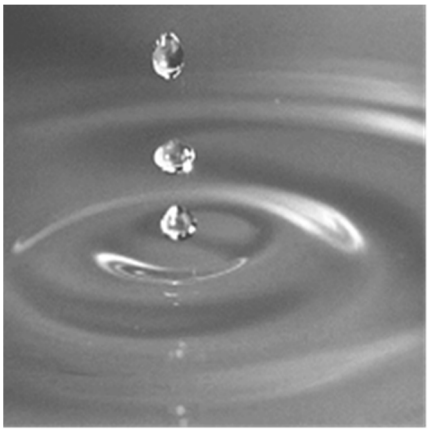
Welles-Turner Library Additions

2407 Main Street
Glastonbury, Connecticut

Submitted to:
TSKP Studio
146 Wyllys Street, Bldg 1-203
Hartford, CT 06810

Submitted by:
GEI Consultants, Inc.
455 Winding Brook Drive, Suite 201
Glastonbury, CT 06106
860.368.5300

August 23, 2019
Project No. 1903744



Matthew Glunt, P.E.
Senior Geotechnical Engineer

Sarah Cote, P.E.
Geotechnical Engineer

Table of Contents

Figures

Appendices

1. Introduction

1.1 Project Summary

According to the provided information, the project referenced herein at the Welles-Turner Library in Glastonbury will consist of a two-story addition (approx. 75 ft x 55 ft) off the southwest corner and a single-story addition (approx. 45 ft. x 35 ft.) off the lower-level Children's Services area. This report was prepared to address foundation and site preparation recommendations for the proposed construction.

1.2 Scope of Services

Our scope of work included the following tasks:

- Reviewed conceptual site plans and building layout drawings.
- Engaged a subcontractor to drill two (2) test borings
- Observed soil samples recovered from the test borings and prepared test boring logs
- Engaged a testing laboratory to perform grain-size and compressibility analyses on soil samples from the test borings.
- Developed recommendations for foundation design and construction
- Prepared this *Geotechnical Report*.

1.3 Authorization

Our work was performed in general accordance with our proposal dated July 1, 2019.

1.4 Vertical Reference

Ground surface elevations in this report and on the attached boring logs were estimated from a 1997 topographic survey of the site, which was provided to GEI. To our knowledge, a survey of current site conditions has not yet been conducted.

2. Site and Project Description

2.1 Site Description

The Welles-Turner Library is located at 2407 Main Street in Glastonbury, Connecticut, as shown on Figure 1. The current facility consists of the original colonial-style three-story structure, a two-story connection with finished lower level, and a C-shaped two-story addition at the rear with stepped-down lower level. We understand the original structure was built in 1953, with rear additions added in 1965 and 1998.

We reviewed the 1997 existing and proposed conditions plans as part of this evaluation. Main Street and the front entrance are significantly higher in grade than the rear portion of the property. Prior to 1997, the rear of the property consisted of a parking area that backed up to low-lying marshland. Historic borings show that the previous parking area was constructed with at least 6 feet of fill over natural grade. The survey at that time shows a steep slope at the rear of the parking area down to standing water at approx. El. 31 ft. There was also a 36-inch RCP storm sewer noted running north-south the low-lying area.

2.2 Proposed Construction

Design plans are currently in the conceptual phase. We understand the project will likely include a two-story addition (approx. 75 ft x 55 ft) off the southwest corner and a small single-story addition (approx. 45 ft. x 35 ft.) off the lower-level Children's Services area. The parking area may also be expanded to the west to maintain current capacity.

Grading plans have not been finalized; however, we expect floor elevation of the new additions to match current conditions.

3. Exploration Procedures

3.1 Field Testing Procedures

The boring locations were laid out on the site using the provided site layout plan. The locations shown on Figure 2 should be considered approximate. No formal survey of boring locations or ground surface elevations was performed by GEI.

Two (2) soil test borings were performed at the site on July 11, 2019, by Seaboard Drilling, Inc., under subcontract to GEI, with a truck-mounted drilling rig. The borings were advanced to depths of 52 feet and 22 feet using drive and wash and hollow-stem augering techniques, respectively. Soil test boring logs are attached in Appendix A.

Standard Penetration Testing (SPT) and split-spoon sampling was performed continuously through the upper 12 feet of the borings and at 5-foot intervals thereafter using a 140-lb. safety hammer. Representative samples of the soils obtained by the sampler were classified in general accordance with ASTM D2488 by the on-site GEI representative. The samples were placed in appropriately identified sealed glass jars and transported to our office for storage and laboratory assignment. An undisturbed (Shelby) tube was also obtained from the lower varved clay stratum for further compressibility testing in the laboratory.

The depth to groundwater was measured prior to backfilling. All boreholes were backfilled with drill cuttings upon completion. Borings advanced within paved areas were brought to grade with cold-patch asphalt.

3.2 Historic Borings

Several test borings were conducted near the current development area prior to construction of the 1998 addition ("Geotechnical Study", Clarence Welti, P.C., February 1997). We have reviewed the relevant boring data, compared it to the current data for consistency, and have incorporated it into our evaluation, as appropriate. However, we make no specific claim as to the accuracy of data previously obtained at the site by others. The approximate locations of previous borings are shown on Figure 2 for reference purposes.

3.3 Laboratory Testing

Laboratory testing was conducted on representative soil samples to confirm field identification of the soils and establish engineering characteristics for design. Tests performed by GeoTesting Express, under subcontract to GEI, included the following:

- Three (3) grain-size analyses with standard sieve set (ASTM D422)
- Three (3) moisture content analyses (ASTM D2216)
- One (1) Incremental consolidation test (ASTM D2435)

Results of the laboratory tests are attached in Appendix B.

4. Subsurface Conditions

4.1 Geologic Setting

As shown on Figure 1, this area of Glastonbury lies adjacent to an eastward bend in the Connecticut River, with Main Street following the approximate transition between recent low-lying alluvial materials and older terraces to the east. The soils beneath the property are composed of alluvial fine sands overlying thick deposits of glaciolacustrine varved clay and silt. Previous borings at the site indicate that the varved deposits transition to fine sand at a depth of about 85 feet.

Bedrock at the site is mapped as Portland Arkose, a reddish-brown sandstone (Rodgers, USGS, 1985).

4.2 Subsurface Conditions

The generalized subsurface conditions at the site are described below, in order of increasing depth. The subsurface conditions between boring locations may differ. The nature and extent of variations between the sampling points will not become evident until construction.

Pavement – Borings advanced in the parking lot encountered approximately 5 to 6 inches of asphalt. The thickness of any stone base present was indeterminate. Note the 1997 design plans call for 7 inches of asphalt over 6 inches of processed stone base in this rear parking area.

Fill – The area behind the current facility appears to have been backfilled above natural grade in two separate iterations. Extending back about 20 feet from the current building, this material was placed to construct the parking area used prior to the 1998 additions. Although our borings did not sample this material, the historic borings B-4 and B-6 were used for reference. This material was described as brown to reddish-brown silty sand with gravel extending to approximately El. 31 ft. Standard Penetration Test (SPT) N-values ranged from 3 to 8 blows/foot (bpf), indicating loose to very loose conditions.

Extending back through the remainder of the current addition footprint, this fill was placed over low-lying ground in conjunction with the 1997-1998 work. This material was noted in GEI borings B-1 and B-2 to depths of about 5 feet (El. 30.8 to 30.5 ft.). This is consistent with the recommendation at the time to muck out soft, wet, organic-laden sediments and bring the current parking area to grade with compacted granular fill. In the GEI borings, the more recent fill was classified as silty sand with gravel with up to about 17 percent silt fines. SPT N-values ranged from 26 to 79 bpf, indicating medium dense to very dense conditions.

Native Sand– Native sands were encountered below the fill to a depth of 25 feet below grade in B1, and to the termination depth of 22 feet below grade in B2. The upper 1 to 2 feet of this stratum was described as slightly organic dark brown fine sand to silty sand. The native sands generally become coarser and denser with depth.

SPT N-values were generally between 6 and 24 blows per foot (bpf), indicating a loose to medium dense consistency.

Lacustrine Varved Clays – Glacial lake deposits comprised of varved (finely layered) clay and silt typical to the region were encountered below the sand in GEI boring B1 and in several historic borings. The clay portion of the varve is generally thicker, gray to dark gray, and consists of medium to high plasticity clay (CH). The silt portion is typically the minor constituent and consists of tan to brown, low to moderate plasticity silt (ML). The thickness of the clay and silt portions of the varves is typically 1/8 to ½ -inch, and the varves are typically spaced ¼ to ¾-inch apart.

SPT N-values were generally between 2 and 4 bpf in the varved clays, indicating soft to very soft conditions. The clay deposits continued to the termination depth of 52 feet in B1 and up to about 85 feet in the deepest nearby historic boring.

4.3 Groundwater Conditions

Groundwater was encountered at a depth of 6.5 feet (El. 29.0 ft) in boring B-2 at the time of drilling. As drilling fluids were used to advance B-1, a suitable groundwater measurement was not obtained there. For reference, groundwater elevations recorded in the 1997 investigation ranged from about El. 32.5 ft. to El. 31.0 ft., with lower elevations towards the rear of the property.

Groundwater levels are subject to seasonal and weather-related variations. Groundwater measurements made at different times and different locations may be significantly different than the measurements taken as part of this investigation.

5. Design Recommendations

5.1 Foundation Design

5.1.1 General Considerations

The proposed addition will span over 5 to 6 feet of fill previously placed in two iterations (pre-1997 and 1997/1998) over low-lying native soils. Although the fill appears relatively uniform and did not contain appreciable amounts of deleterious material, we do not have documentation that describes how the fill was placed, or if it was placed with sufficient engineering controls. The pre-1997 fill appears to be in a loose to very loose condition in place. Although the widely-spaced borings did not indicate this, there is also potential that some unsuitable (organic-laden, soft, etc.) materials typical to low-lying ground remain in place below the fill.

The existing fill is not suitable for direct support of the additions. We recommend this material be removed and replaced in accordance with Section 5.1.3.

5.1.2 Existing Foundations

The 1997 addition of the existing library is supported on 4-ft wide spread footings and individual 5.5-ft by 5.5-ft column footings set at approximately 20 feet to 23 feet on center. Information pertinent to design and construction of the proposed two-story addition includes:

- Bottom of footings = 33’-0” (NAVD88)
- Top of slab = 37’-3” (NAVD88)

The drawings indicate that the subgrade consists of compacted structural fill over an 18-inch platform of 3/8-inch crushed stone, which was placed over a geotextile fabric. The geotextile was placed over native fine sand following the removal of unsuitable soil (previously placed fill).

Current plans show a Children’s Services addition off the south side of the children’s area. Structural information regarding this part of the facility is not as readily available; however, there is a note on the 1997 drawings that appears to indicate that footings bear at an elevation of 32’-2”.

5.1.3 Design of New Foundations

The existing fill below the additions is not suitable for direct structural support. We recommend removing this material below all footings and replacing it, as such:

1. Remove all existing fill materials and, if encountered, unsuitable organic native soils beneath building footings. Based on the boring results, removals on the order of 5 to 6 feet should be expected, to an approximate elevation of +30.5 to +31.0 feet. The resulting subgrade will likely consist of brown to dark brown fine sand with silt.
2. Groundwater will likely be at or very near the exposed subgrade elevation. Dewatering with, at minimum, sumps and pumping will likely be required to expose the native subgrade and allow for backfilling.
3. A working platform consisting of 6 inches of compacted crushed stone surrounded by geotextile fabric should be used to help stabilize the subgrade and facilitate excavation dewatering.
4. The excavated areas should be backfilled to bearing grade with Structural Fill or crushed stone. Subject to approval by GEI in the field, we expect most excavated soils will be suitable for re-use as backfill, so long as it is not saturated, laden with deleterious materials, or otherwise unsuitable.

The undercutting and backfill operations should be done under the observation of a GEI representative.

The maximum allowable bearing pressures for the design of footings are:

Table 1: Allowable Bearing Pressure

Bearing Stratum	Allowable Bearing Pressure
Structural Fill	2.0 tons/ft^2

Minimum individual column footing and wall footing widths should be at least 30 and 18 inches, respectively.

5.1.4 Bearing Depth

All new foundations adjacent to the existing structure should bear at the same elevations as the existing foundations. These elevations should be verified in the field by the contractor. All exterior footings should bear at least 3½ feet below the adjacent exterior grade for frost protection. Interior footings should be founded at least 18 inches below the bottom of the floor slab. The tops of all footings should be at least 6 inches below the bottom of the overlying floor slab.

5.2 Floor Slab Design

The ground floor of the additions may be designed as a slab-on-grade. The floor slab should bear on a minimum 6-inch thick base course of compacted crushed stone placed over a soil subgrade prepared in accordance with Section 6.1.

For design of slabs with a crushed stone base, a modulus of subgrade reaction of 200 pounds per cubic inch (pci) is recommended for design. We recommend that contraction joints be incorporated between the slab-on-grade and the columns and perimeter walls of the proposed building to accommodate minor differential settlement.

5.3 Groundwater Control

To limit moisture infiltration into finished spaces, a 15-mil polyethylene vapor barrier should be placed beneath all moisture sensitive floor slabs. The vapor barrier should be sealed at the foundation walls, columns, and utility penetrations, and panels should be overlapped and joints sealed.

We also recommend that perimeter foundation drains be incorporated into the design. As feasible, these drains should be designed to drain by gravity into an approved discharge location and include cleanouts at periodic intervals. The perimeter drain should consist of a 6-in. diameter perforated PVC or HDPE pipe surrounded by crushed stone wrapped in a non-woven geotextile filter fabric.

5.4 Settlement

Assuming the recommendations given in this report are followed, we estimate total settlement of the building will be less than 1-inch, and the differential settlement between adjacent footings will be less than ½-inch. We expect nearly all of expected settlements will occur during construction or soon after.

5.5 Seismic Design

The 2018 edition of the Connecticut Building Code document mirrors the 2015 International Building Code, with exception of the revisions and supplemental information provided by state building officials.

Based on the criteria of Building Code Section 1613.3.2 and the SPT N-values measured on site, we recommend the use of Site Class E for seismic design. The Site Class was used in conjunction with the seismic hazard (S_S, S_1) for this location to determine spectral design values, as follows:

Table 2: Seismic Design Values

2018 Connecticut Building Code	
S_S	0.18 g
S_1	0.063 g
S_{DS}	0.300 g
S_{D1}	0.148 g
PGA	0.227 g

Peak ground acceleration (PGA_M) corresponds to the value corrected for site effects, as shown in ASCE 7-10. Seismic design factors given above correspond to Seismic Design Category C for Risk Category I, II, or III structures.

The soils below the foundation level at this site are not considered susceptible to liquefaction.

6. Construction Considerations

6.1 Subgrade Preparation

6.1.1 General

To prepare the site for grading operations, topsoil, organic matter, existing pavements, and other deleterious material should be stripped from the building and site improvement areas. Soft, wet, or otherwise un-suitable soils should be removed and replaced, or potentially re-compacted in-place.

6.1.2 Removal/Re-routing of Utilities

Existing utilities to remain in use should be rerouted around the proposed building footprint. Remove existing utilities to be abandoned prior to construction. If not removed, any pipes over 3 inches in diameter should be filled with flowable fill or grout. Otherwise, these pipes may serve as conduits for subsurface erosion resulting in formation of voids below foundations or floor slabs. Where existing utilities are left in place and plugged in the building footprint, it may be necessary to undercut poorly compacted backfill to provide adequate support for footings or slabs.

6.1.3 Foundations

The existing fill is not suitable for direct foundation support. The existing fill should be excavated and replaced below all footings as discussed in Section 5.1.3. Bearing surfaces should be free of standing water, frost, and loose soil before placement of reinforcing steel and concrete. We recommend that a GEI representative observe the final preparation of all subgrades prior to footing construction.

6.1.4 Slab-on-Grade

The existing fill is also not suitable for direct support of slab-on-grade. We recommend that at minimum the top 2 feet of fill below the floor slab be removed and replaced with compacted Structural Fill. Subject to approval by GEI in the field, we expect most excavated soils will be suitable for re-use as Structural Fill for this purpose, so long as it is not saturated, laden with deleterious materials, or otherwise unsuitable.

After undercutting of fill and prior to backfilling, the resulting subgrade should be proof-rolled under the observation of the geotechnical engineer. Additional undercutting and replacement may be required if the fill is especially soft or laden with debris. We recommend that GEI be engaged to observe the excavations and preparation of slab-on-grade subgrades prior to construction.

6.2 Excavation and Dewatering

Excavation is expected to be in soil, and conventional excavation with a backhoe appears feasible. Excavations should be sloped or shored in accordance with the local, state, and federal regulations, including Occupational Safety and Health Agency (OSHA 29 CFR Part 1926) excavation trench safety standards.

Groundwater should be expected within site excavations, particularly near the transition between the existing fill and native subgrade. Where encountered, we expect that excavation dewatering may be accomplished with filtered sumps and pumps. Discharge of dewatering effluent should be done in accordance with all applicable regulations. The site should be graded to route storm water runoff away from excavations.

6.3 Freezing Conditions

The soils at the site are frost susceptible. Therefore, if construction is performed during freezing weather, special precautions will be required to prevent the subgrade soils from freezing. Freezing of the soil beneath the foundation during construction may result in subsequent settlement of the structure.

All subgrades should be free of frost before placement of concrete. Frost-susceptible soils that have frozen should be removed and replaced with compacted Structural Fill. The footing and the soil adjacent to the footing should be insulated until they are backfilled. Soil placed as fill should be free of frost, as should the ground on which it is placed.

If slabs-on-grade or footings are built and left exposed during the winter, precautions should be taken to prevent freezing of the underlying soil.

6.4 Backfilling and Compaction

Recommended specifications for gradation and compaction of backfill soils are provided in the attached recommended Material Specifications in Appendix D. Fill placed within the building limits, within a 3-foot wide zone outside foundation walls, and under pavements should meet the compaction requirements for Structural Fill. Backfill placed in non-structural areas should meet the compaction requirements for Ordinary Fill.

Existing fills can potentially be re-used as Structural Fill, subject to the following conditions:

1) The soil is screened to remove deleterious materials such as brick, asphalt, organics, etc.
2) Excavated soils are not contaminated.

3) The soil is placed and compacted in accordance with the recommended material specifications and remains stable under movement of grading equipment.

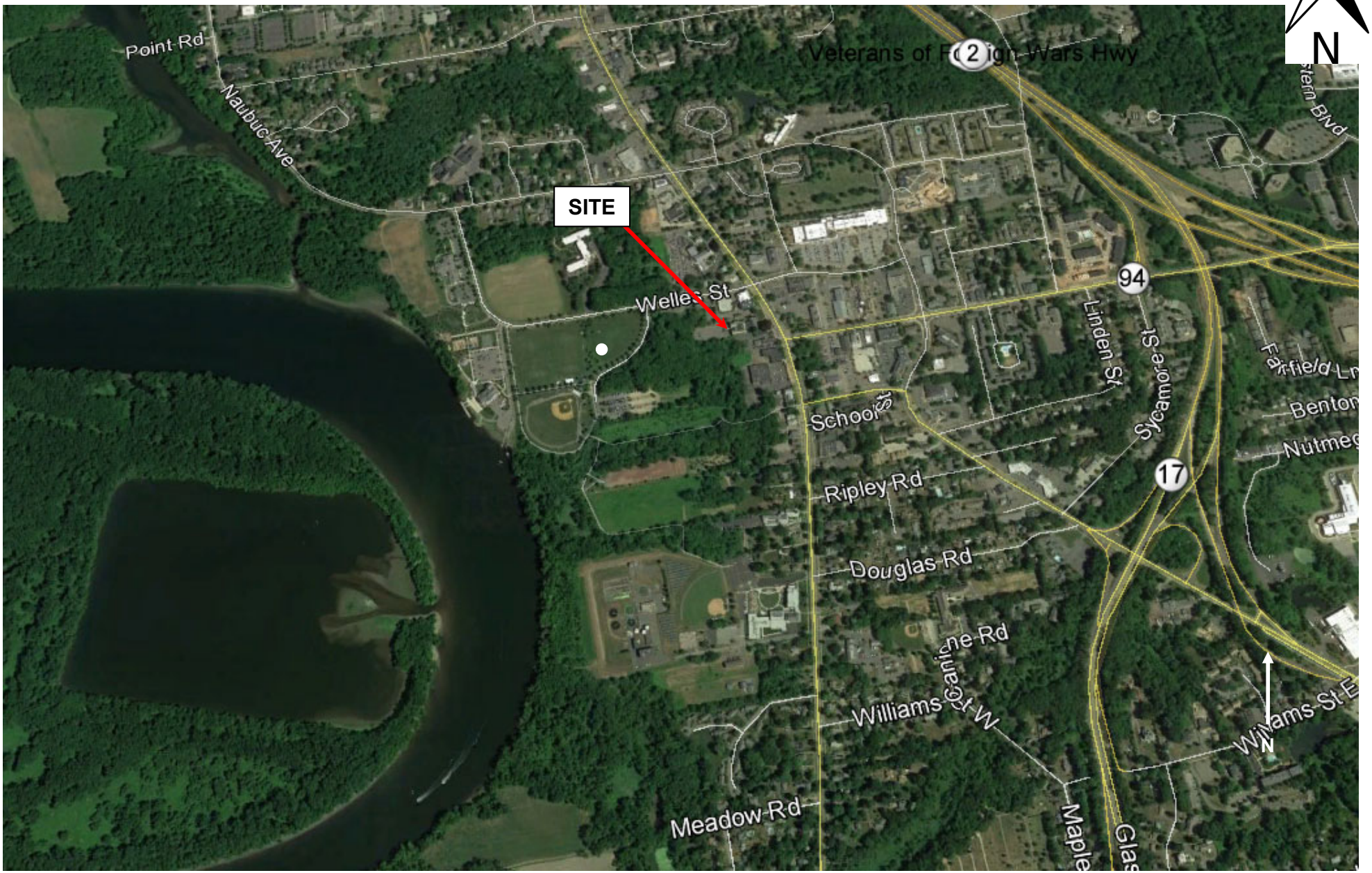
Soils to be used as fill imported from off-site should also meet the attached gradation requirements. Proposed borrow materials that fall slightly outside of these specifications may also be suitable for use, subject to review and approval by GEI.

7. Limitations

This report was prepared for the use of the project design team, exclusively. Our recommendations are based on the project information provided to us at the time of this report and may require modification if there are any changes in the nature, design, or location of the proposed building. We cannot accept responsibility for designs based on our recommendations unless we are engaged to review the final plans and specifications to determine whether any changes in the project affect the validity of our recommendations, and whether our recommendations have been properly implemented in the design.

Our professional services for this project have been performed in accordance with generally accepted engineering practices. No warranty, expressed or implied, is made.

Figures



SCALE:	NTS
DRAWN BY:	SC
CHECKED BY:	--
DATE:	8/12/19

GEI Consultants

SITE LOCATION PLAN
WELLES-TURNER LIBRARY ADDITIONS
GLASTONBURY, CONNECTICUT

PROJECT NO: 1903744

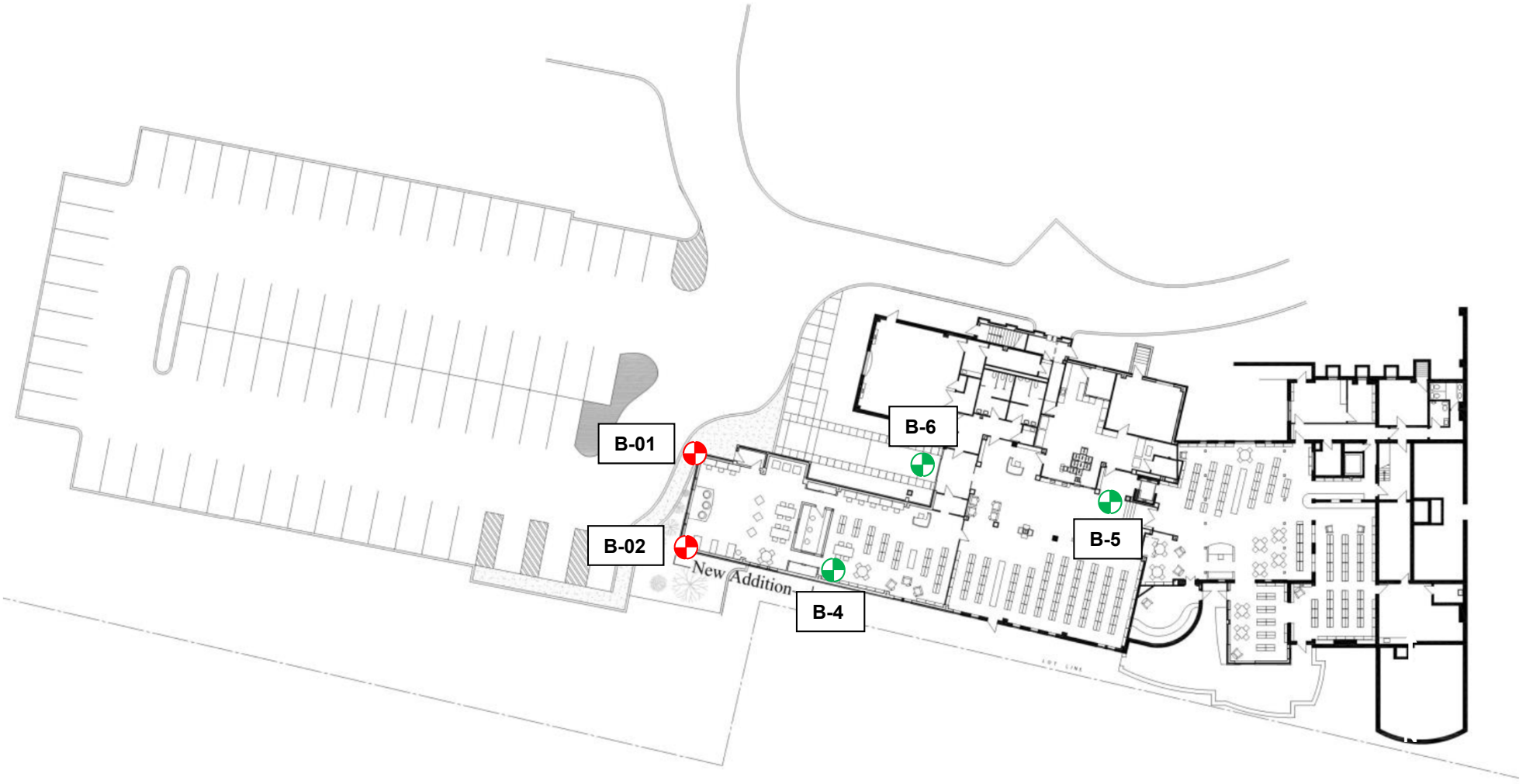
FIGURE NO.
1

LEGEND

Approx. Boring Location (GEI – 2019)

Approx. Boring Location (Others – 1996/1997)

N



SOURCE: Site Plan provided by TSKP Studio

SCALE:	NTS
DRAWN BY:	SC
CHECKED BY:	MG
DATE:	8/12/19

GEI Consultants

BORING LOCATION PLAN
WELLES-TURNER LIBRARY ADDITIONS
GLASTONBURY, CONNECTICUT

PROJECT NO: 1903744

FIGURE NO.
2

Appendix A

Boring Logs

BORING INFORMATION

LOCATION: See plan

GROUND SURFACE EL. (ft): 35.8 **DATE START/END:** 7/11/2019 - 7/11/2019

VERTICAL DATUM: NAVD 88 **DRILLING COMPANY:** Seaboard Drilling, Inc.

TOTAL DEPTH (ft): 52.0 **DRILLER NAME:** D.Feeley

LOGGED BY: B. Akereyeni **RIG TYPE:** Mobile Drill B-53

BORING B1

DRILLING INFORMATION

HAMMER TYPE: Safety Hammer - spooling winch **CASING I.D./O.D.:** 4 inch/ NA **CORE BARREL TYPE:** N/A

AUGER I.D./O.D.: NA / NA **DRILL ROD O.D.:** NM **CORE BARREL I.D./O.D.** NA / NA

DRILLING METHOD: Drive and Wash

WATER LEVEL DEPTHS (ft): Not encountered

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D. = Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
								6" Asphalt
		S2	1 to 3	24/14	12-25-27-30		FILL	S1: NARROWLY GRADED SAND (SP); ~90% fine sand, ~5% fine gravel, ~5% silt, brown, damp, occasional debris. FILL
		S2	3 to 5	24/19	36-37-42-46			S2: WIDELY GRADED SAND WITH SILT (SW-SM); ~80% fine to medium sand, ~10% fine gravel, ~10% silt, light brown, damp, occasional asphalt fragments. FILL.
30	5	S3	5 to 7	24/11	8-7-3-3		NATIVE SAND	S3: NARROWLY GRADED SAND WITH SILT (SP-SM); 75.7% fine to medium sand, 14.1% silt, 10.2% gravel, dark brown, wet.
		S4	7 to 9	24/15	6-12-17-15			S4: NARROWLY GRADED SAND WITH SILT (SP-SM); ~90% fine sand, ~10% silt, brown, wet.
	10	S5	10 to 12	24/21	9-9-10-12			S5: SILTY SAND (SM); ~85% fine sand, ~15% silt, reddish brown, wet.
20	15	S6	15 to 17	24/20	8-3-6-6			S6: WIDELY GRADED SAND (SW); ~80% fine to coarse sand, ~10% fine gravel, ~10% silt, brown, wet.
	20	S7	20 to 22	24/16	7-11-13-14			S7: NARROWLY GRADED SAND (SP); ~90% fine sand, ~5% fine gravel, ~5% silt, brown, wet.

NOTES:

PROJECT NAME: Welles-Turner Library Additions

CITY/STATE: Glastonbury, Connecticut

GEI PROJECT NUMBER: 1903744

GEI Consultants

LOCATION: See plan
GROUND SURFACE EL. (ft): 35.8 **DATE START/END:** 7/11/2019 - 7/11/2019
VERTICAL DATUM: NAVD 88 **DRILLING COMPANY:** Seaboard Drilling, Inc.

BORING B1

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
	25	S8	25 to 27	24/24	2-1-2-4		VARVED DEPOSITS	S8: VARVED DEPOSITS (CL/ML); ~95% fines, ~ 5% fine sand, gray medium plasticity clay and reddish brown sand varves (~1/8 to 1/4-inch thick), wet.
10								
	30	S9	30 to 32	24/24	2-1-2-2			S9:Similar to S8.
		U1	32 to 34	24/24				UNDISTURBED SAMPLE
	35	S10	35 to 37	24/24	1-1-1-4			S10: Similar to S9.
0								
	40	S11	40 to 42	24/24	2-1-2-7			S11: VARVED DEPOSITS (CL/ML); ~90% fines, ~ 10% fine sand, gray medium plasticity clay and reddish brown silt varves (~1/8 to 1/4-inch thick), wet.
	45	S12	45 to 47	24/24	WOH-WOH-2-4			S12: VARVED DEPOSITS (CL/ML); ~95% fines, ~ 5% fine sand, gray medium plasticity clay and reddish brown silt varves (~1/8 to 1/4-inch thick), wet.
-10								
	50	S13	50 to 52	24/24	WOH-4-4-3			S13: Similar to S12.
	55							Terminated at planned depth. Backfillled with drill cuttings and cold asphalt patch.

NOTES:

PROJECT NAME: Welles-Turner Library Additions

CITY/STATE: Glastonbury, Connecticut

GEI PROJECT NUMBER: 1903744

GEI Consultants

BORING INFORMATION

LOCATION: See plan
GROUND SURFACE EL. (ft): 35.5
VERTICAL DATUM: NAVD 88
TOTAL DEPTH (ft): 22.0
LOGGED BY: B. Akereyeni
DATE START/END: 7/11/2019 - 7/11/2019
DRILLING COMPANY: Seaboard Drilling, Inc.
DRILLER NAME: D.Feeley
RIG TYPE: Mobile Drill B-53

BORING
B2

DRILLING INFORMATION

HAMMER TYPE: Safety Hammer - spooling winch
AUGER I.D./O.D.: 4 inch / NA
DRILLING METHOD: Hollow Stem Auger
CASING I.D./O.D.: NA/ NA
DRILL ROD O.D.: NM
CORE BARREL TYPE: N/A
CORE BARREL I.D./O.D. NA / NA
WATER LEVEL DEPTHS (ft): ▼ 6.5 7/11/2019 3:12 pm Inside augers

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D. = Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
								5" Asphalt.
		S1	1 to 3	24/15	13-17-15-18		FILL	S1: SILTY SAND WITH GRAVEL (SM); 73.6% fine to medium sand, 17.2% silt, 9.2% medium gravel (up to 1/2"), brown, damp. FILL.
		S2	3 to 5	24/16	18-13-13-13			S2: Similar to S1.
30	5	S3	5 to 7	24/20	3-3-3-4		NATIVE SAND	S3: WIDELY GRADED SAND WITH SILT (SW-SM); ~90% fine to medium sand, ~10% silt, dark brown, moist, slightly organic.
		S4	7 to 9	24/14	6-11-12-11			S4: Similar to S3.
	10	S5	10 to 12	24/18	8-8-9-9			S5: WIDELY GRADED SAND WITH SILT (SW-SM); ~90% fine to coarse sand, ~10% silt, brown, wet.
20	15	S6	15 to 17	24/11	6-8-8-7			S6: Similar to S5.
	20	S7	20 to 22	24/18	7-7-10-13			S7: WIDELY GRADED SAND (SW); ~85% fine to coarse sand, ~10% fine gravel, ~5% silt, brown, wet. Fragmented cobbles up to 1".
								Terminated at planned depth. Backfillled with drill cuttings and cold asphalt patch.

NOTES:

PROJECT NAME: Welles-Turner Library Additions
CITY/STATE: Glastonbury, Connecticut
GEI PROJECT NUMBER: 1903744

GEI Consultants

Appendix B

Laboratory Test Results

GeoTesting EXPRESS

Client:	GEI Consultants, Inc.				
Project:	Welles Turner Library				
Location:	Glastonbury, CT			Project No:	GTX-310366
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	07/31/19	Checked By:	bfs
Depth :	---	Test Id:	516117		

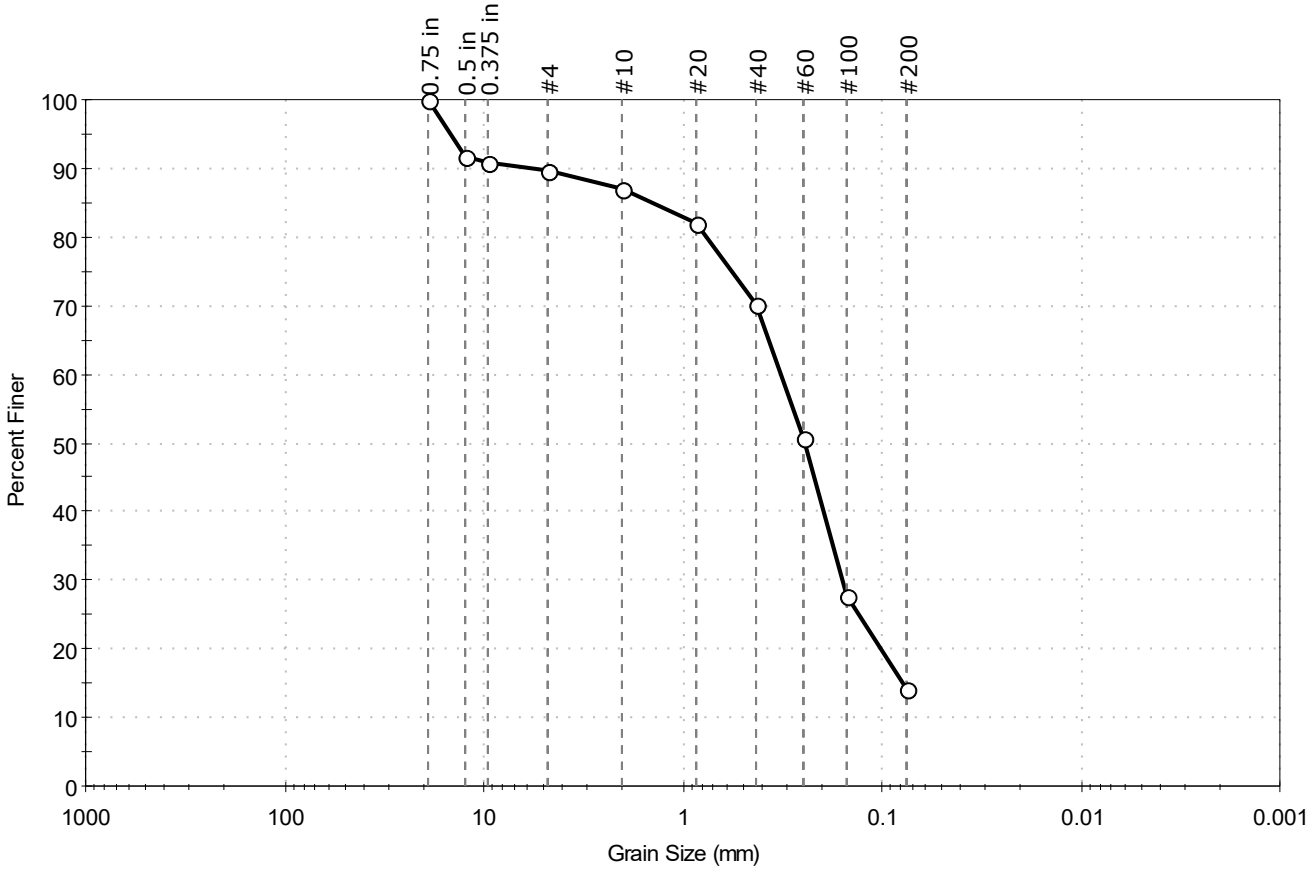
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
B1	S3	5-7	Moist, dark brown silty sand	16.9
B2	S1	1-3	Moist, dark brown silty sand	9.8
B2	S3	5-7	Moist, dark brown silty sand	23.8

Notes: Temperature of Drying : 110º Celsius

Client:	GEI Consultants, Inc.				
Project:	Welles Turner Library				
Location:	Glastonbury, CT			Project No:	GTX-310366
Boring ID:	B1	Sample Type:	jar	Tested By:	ckg
Sample ID:	S3	Test Date:	08/06/19	Checked By:	bfs
Depth :	5-7	Test Id:	516112		
Test Comment:	---				
Visual Description:	Moist, dark brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	10.2	75.7	14.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	92		
0.375 in	9.50	91		
#4	4.75	90		
#10	2.00	87		
#20	0.85	82		
#40	0.42	70		
#60	0.25	51		
#100	0.15	28		
#200	0.075	14		

Coefficients

D_{85} = 1.3891 mm
D_{30} = 0.1577 mm
D_{60} = 0.3222 mm
D_{15} = 0.0787 mm
D_{50} = 0.2461 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

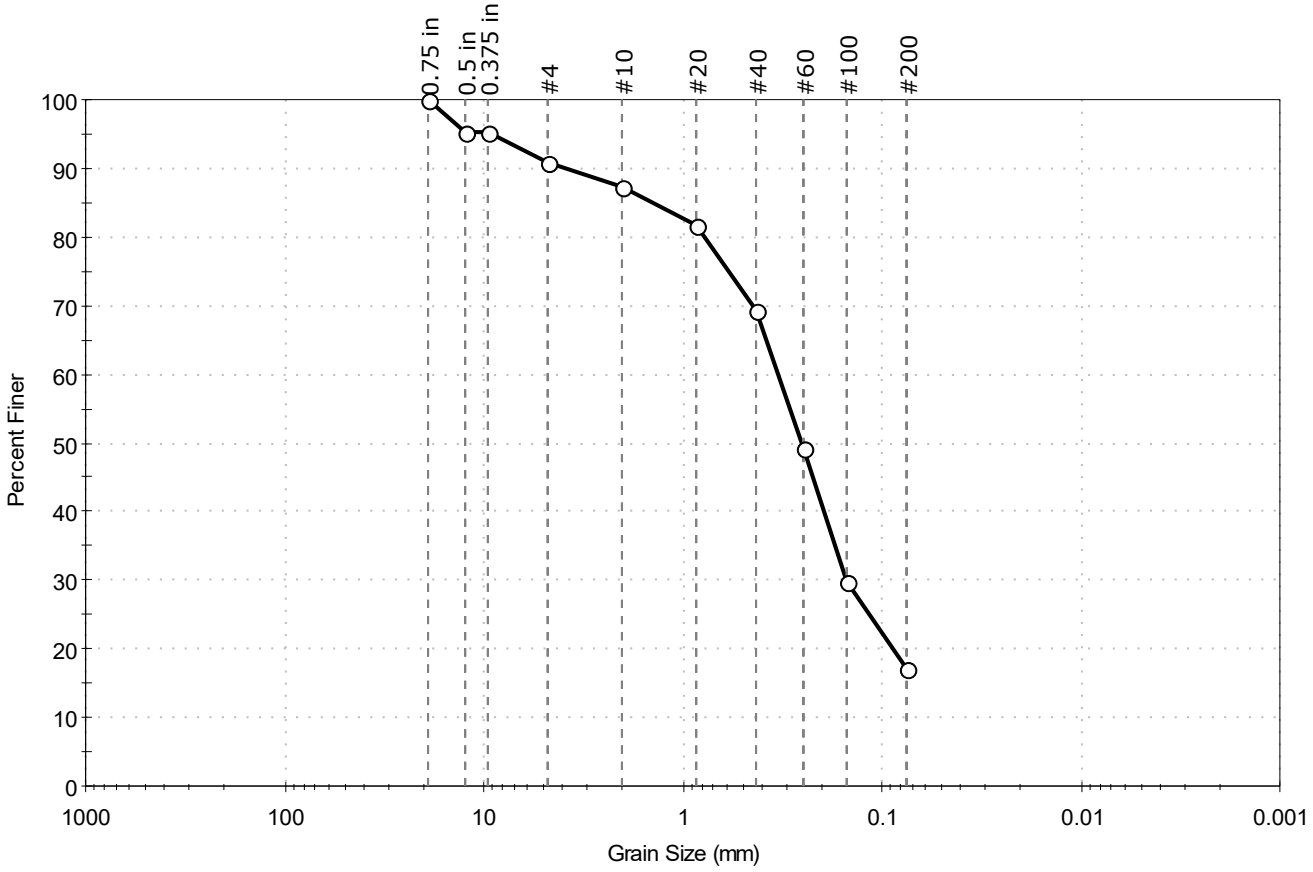
Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GEI Consultants, Inc.				
Project:	Welles Turner Library				
Location:	Glastonbury, CT			Project No:	GTX-310366
Boring ID:	B2	Sample Type:	jar	Tested By:	ckg
Sample ID:	S1	Test Date:	08/06/19	Checked By:	bfs
Depth :	1-3	Test Id:	516113		
Test Comment:	---				
Visual Description:	Moist, dark brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	9.2	73.6	17.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	95		
0.375 in	9.50	95		
#4	4.75	91		
#10	2.00	87		
#20	0.85	82		
#40	0.42	69		
#60	0.25	49		
#100	0.15	30		
#200	0.075	17		

Coefficients

D_{85} = 1.3903 mm D_{30} = 0.1506 mm

D_{60} = 0.3317 mm D_{15} = N/A

D_{50} = 0.2552 mm D_{10} = N/A

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

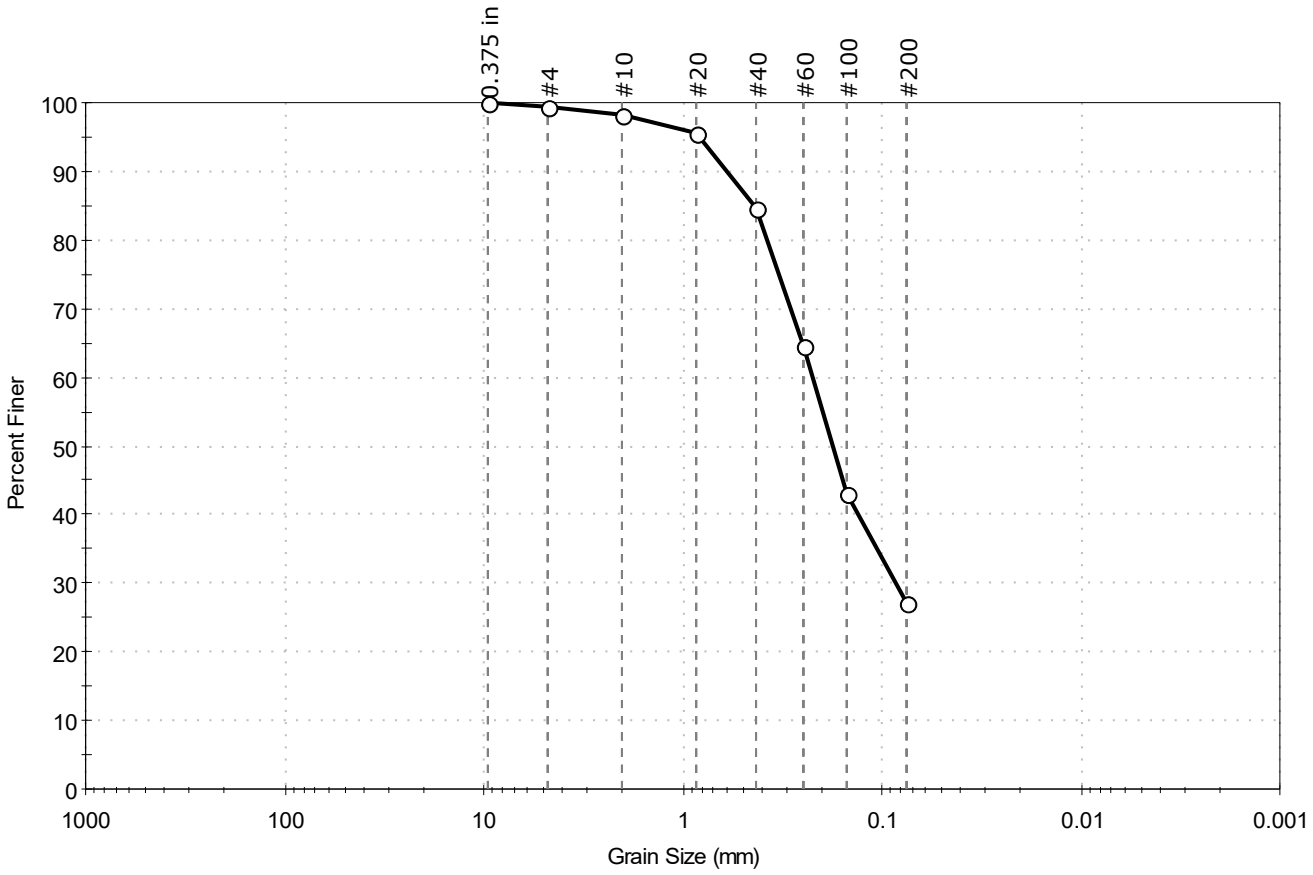
Sand/Gravel Hardness : HARD

printed 8/7/2019 8:36:21 AM

GeoTesting EXPRESS

Client:	GEI Consultants, Inc.				
Project:	Welles Turner Library				
Location:	Glastonbury, CT			Project No:	GTX-310366
Boring ID:	B2	Sample Type:	jar	Tested By:	ckg
Sample ID:	S3	Test Date:	08/06/19	Checked By:	bfs
Depth :	5-7	Test Id:	516114		
Test Comment:	---				
Visual Description:	Moist, dark brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.4	72.3	27.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	98		
#20	0.85	96		
#40	0.42	85		
#60	0.25	65		
#100	0.15	43		
#200	0.075	27		

Coefficients

D_{85} = 0.4326 mm	D_{30} = 0.0846 mm
D_{60} = 0.2244 mm	D_{15} = N/A
D_{50} = 0.1771 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

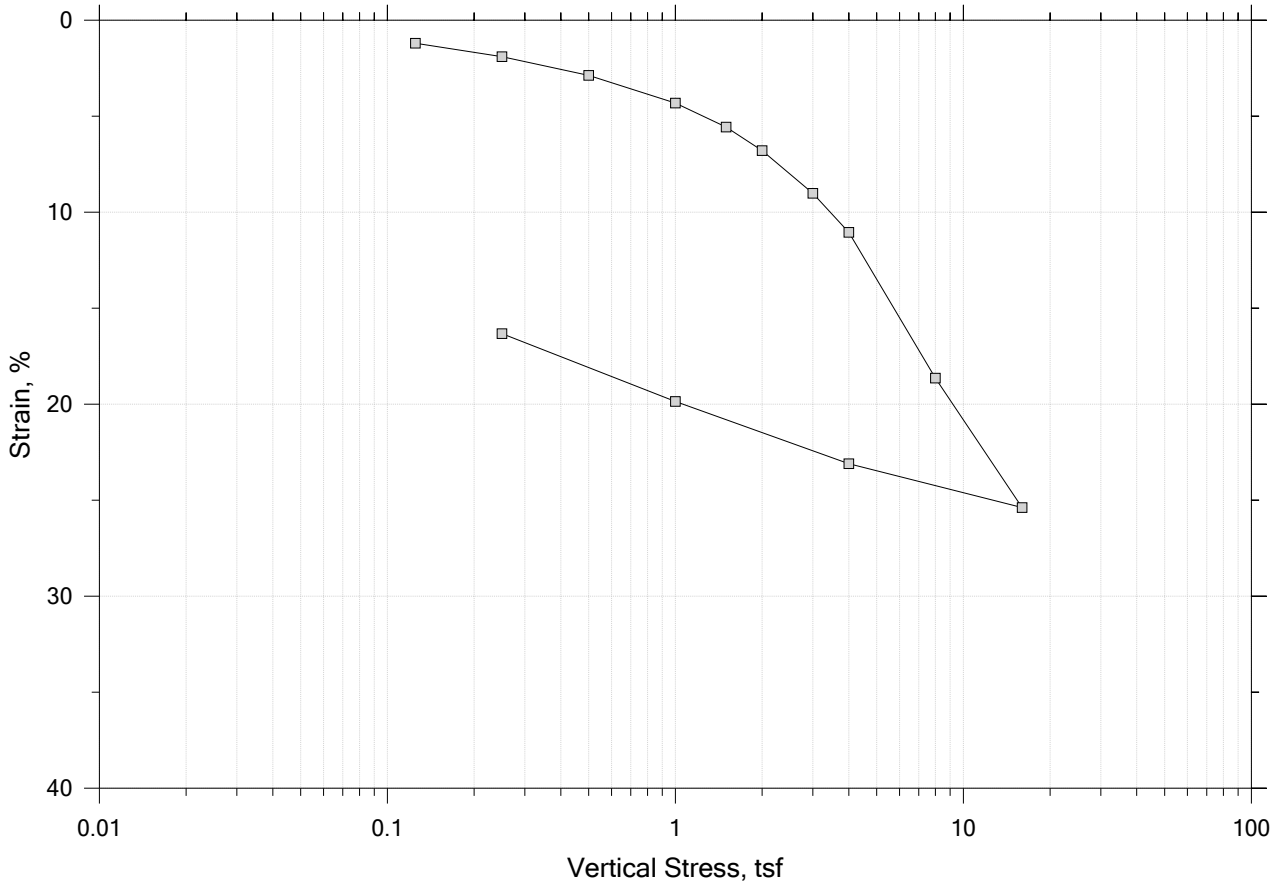
Sand/Gravel Particle Shape : ---

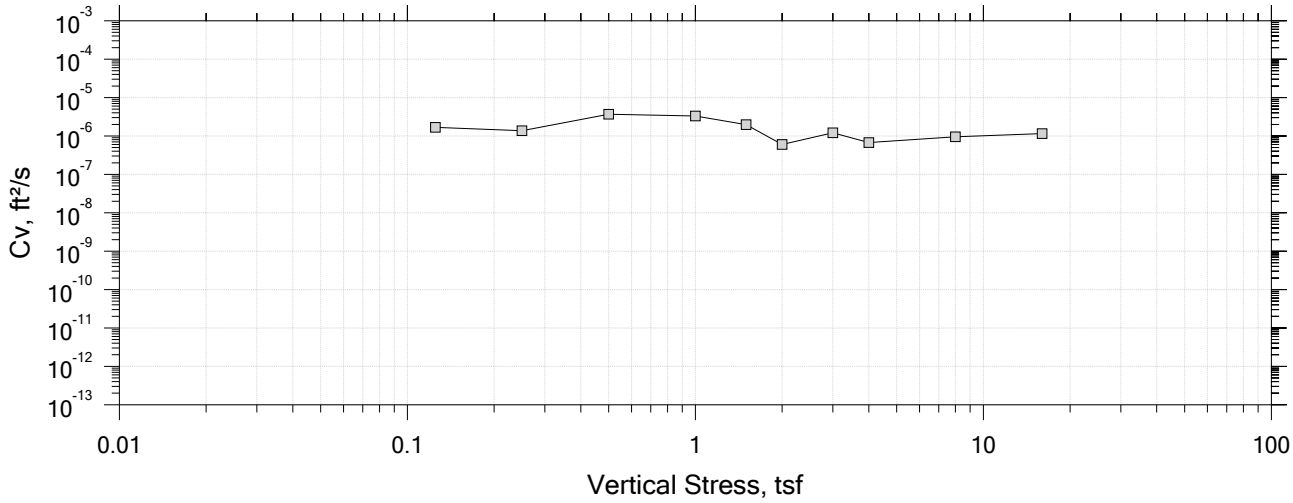
Sand/Gravel Hardness : ---

printed 8/7/2019 8:36:23 AM

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

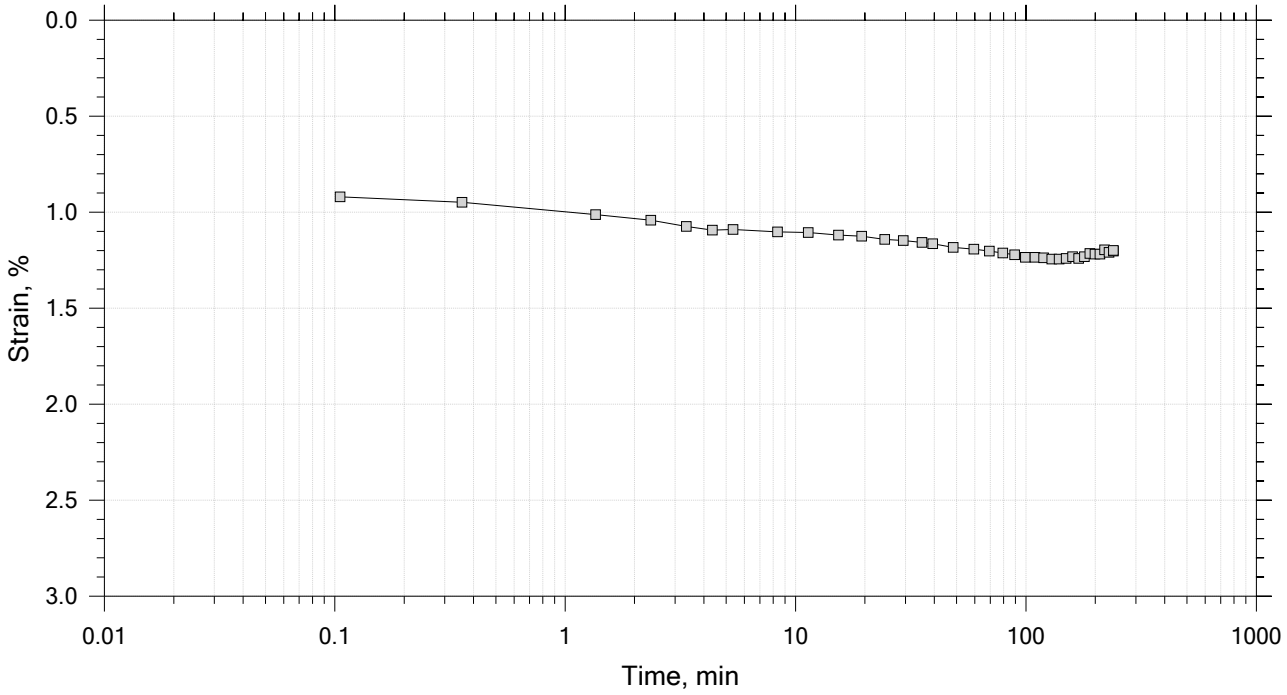


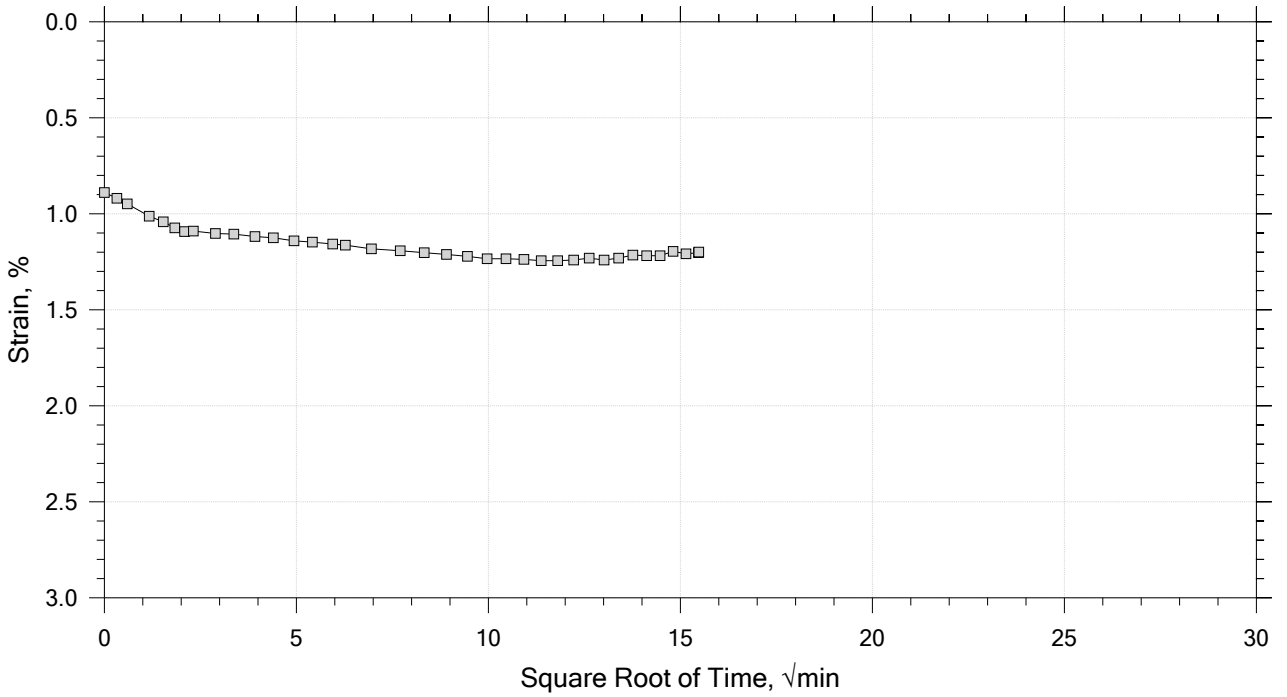


GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 13
Constant Load Step
Stress: 0.125 tsf

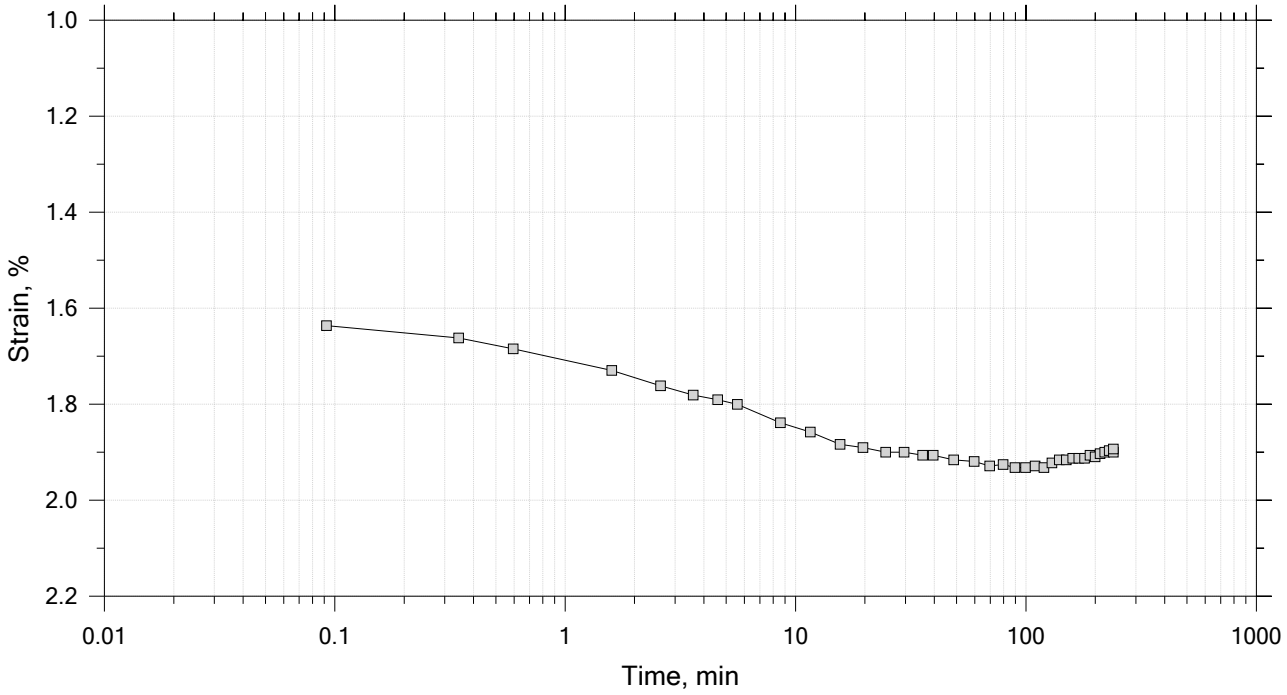


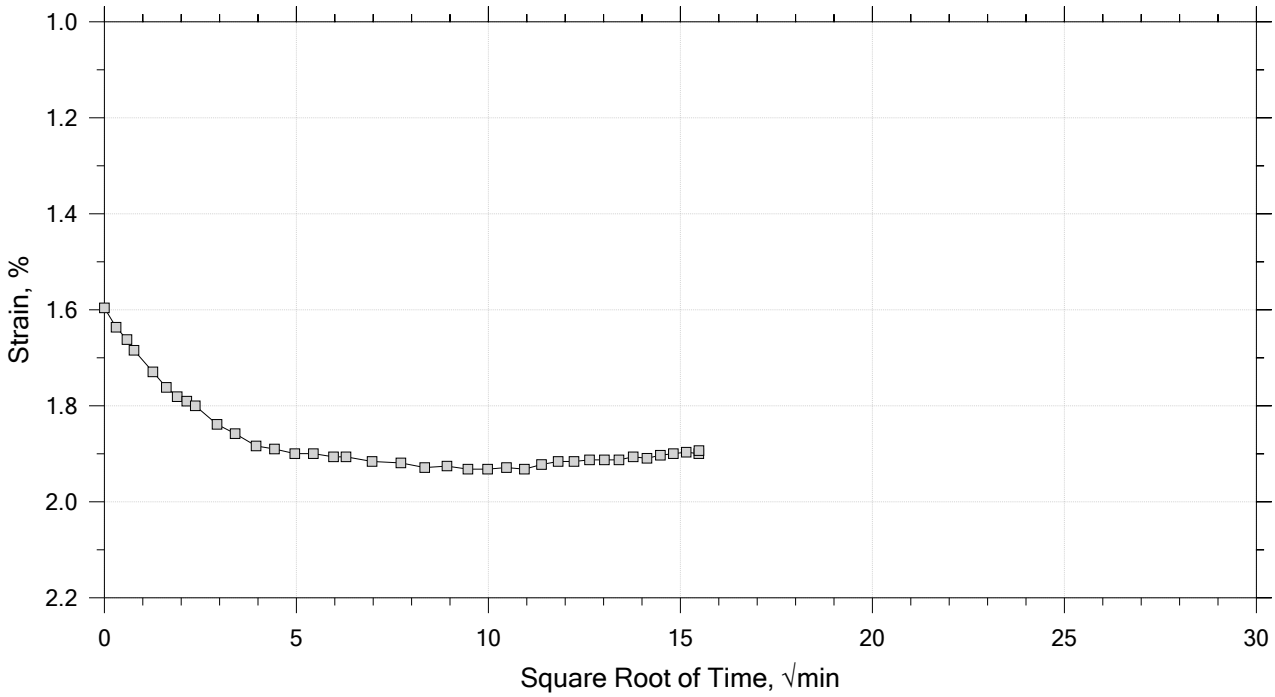


GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 13
Constant Load Step
Stress: 0.25 tsf

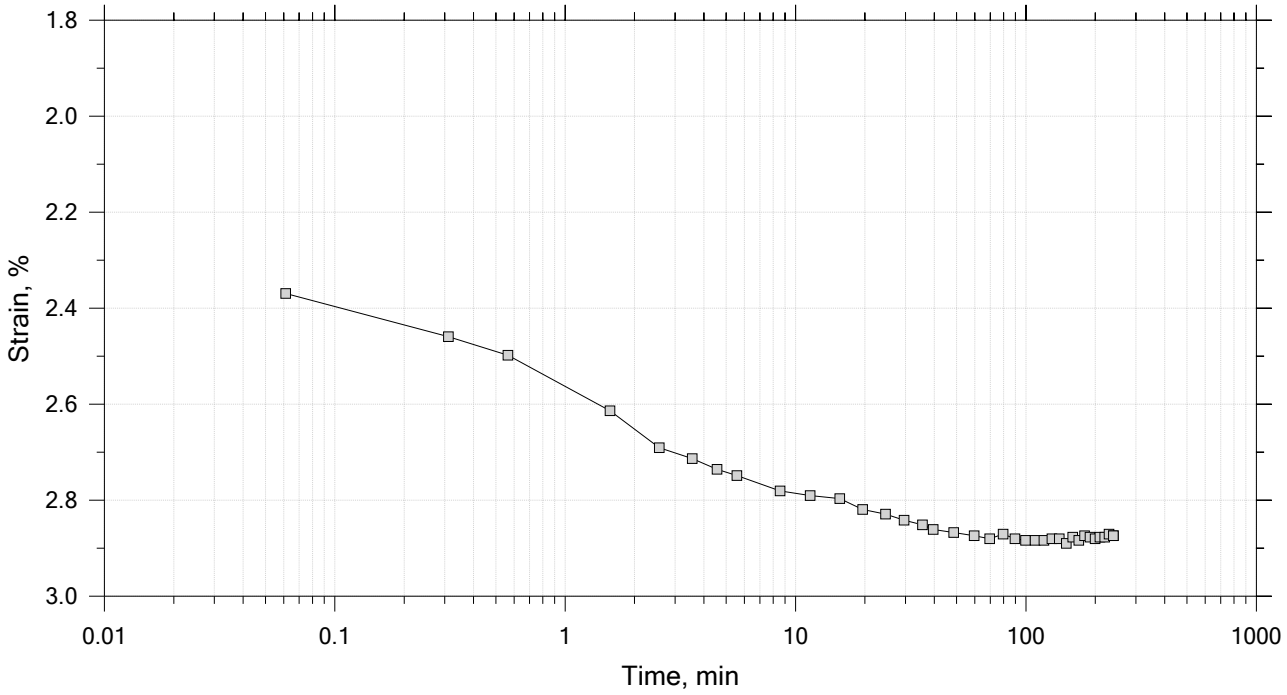


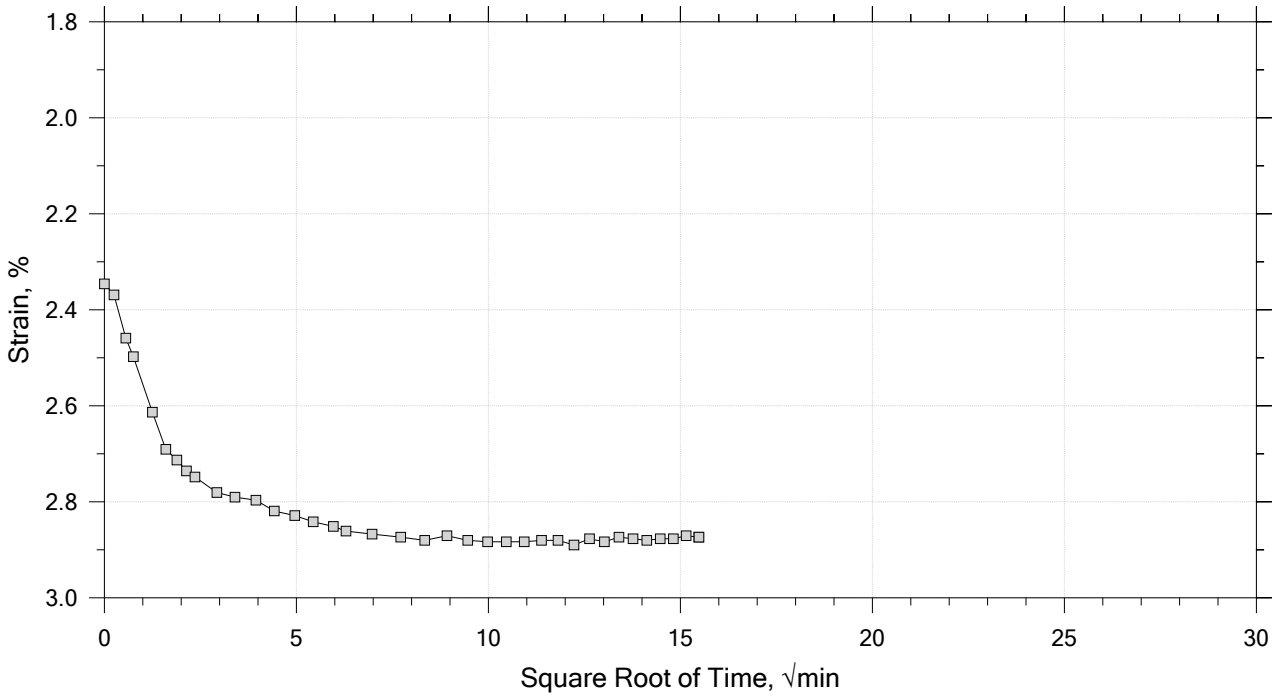


GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 13
Constant Load Step
Stress: 0.5 tsf





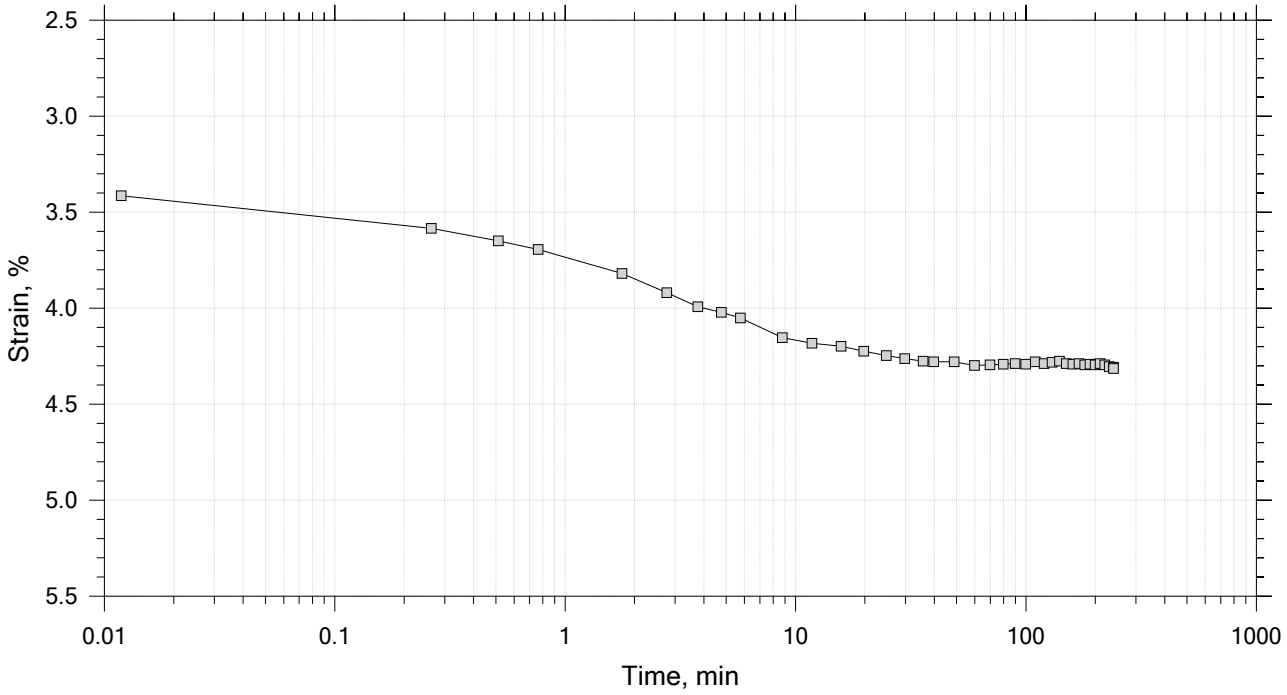
GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

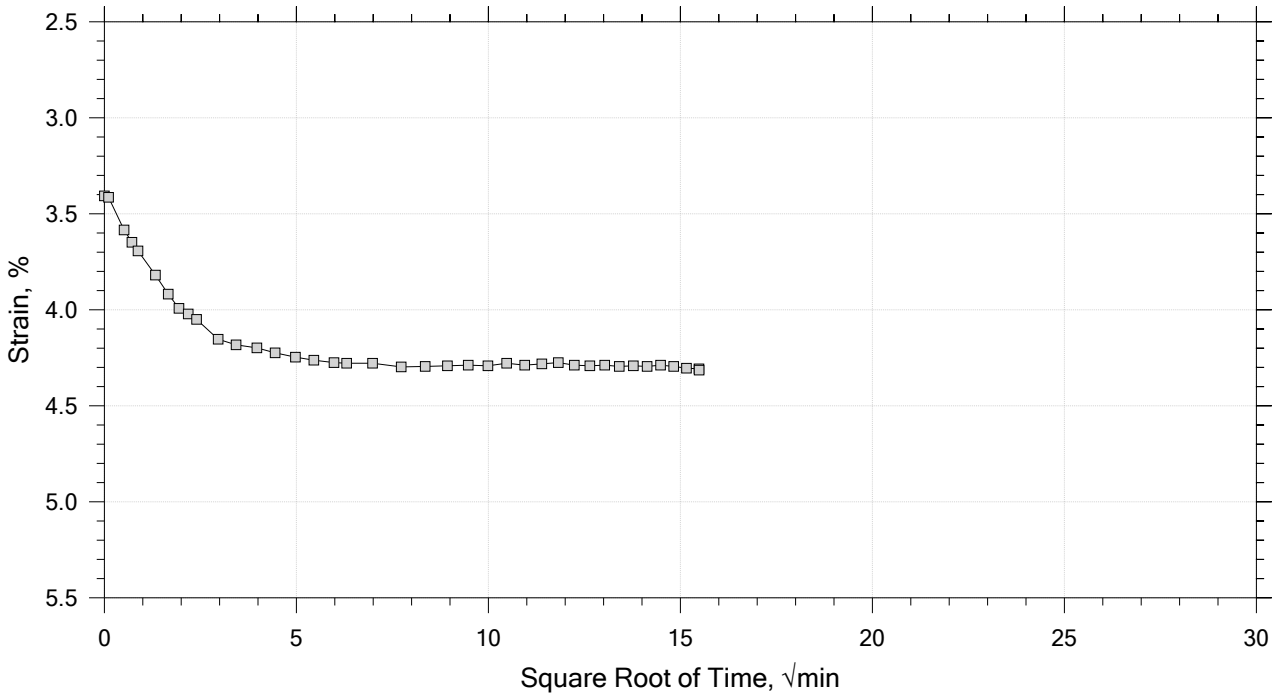
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 13

Constant Load Step

Stress: 1 tsf

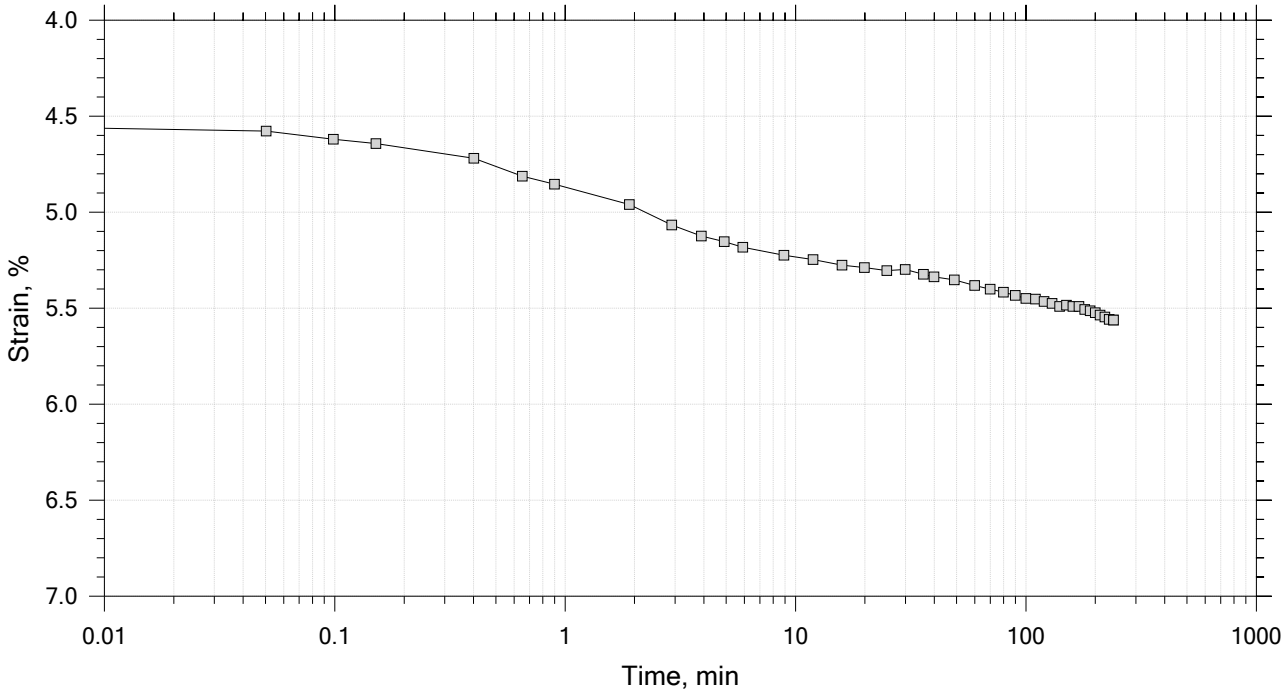


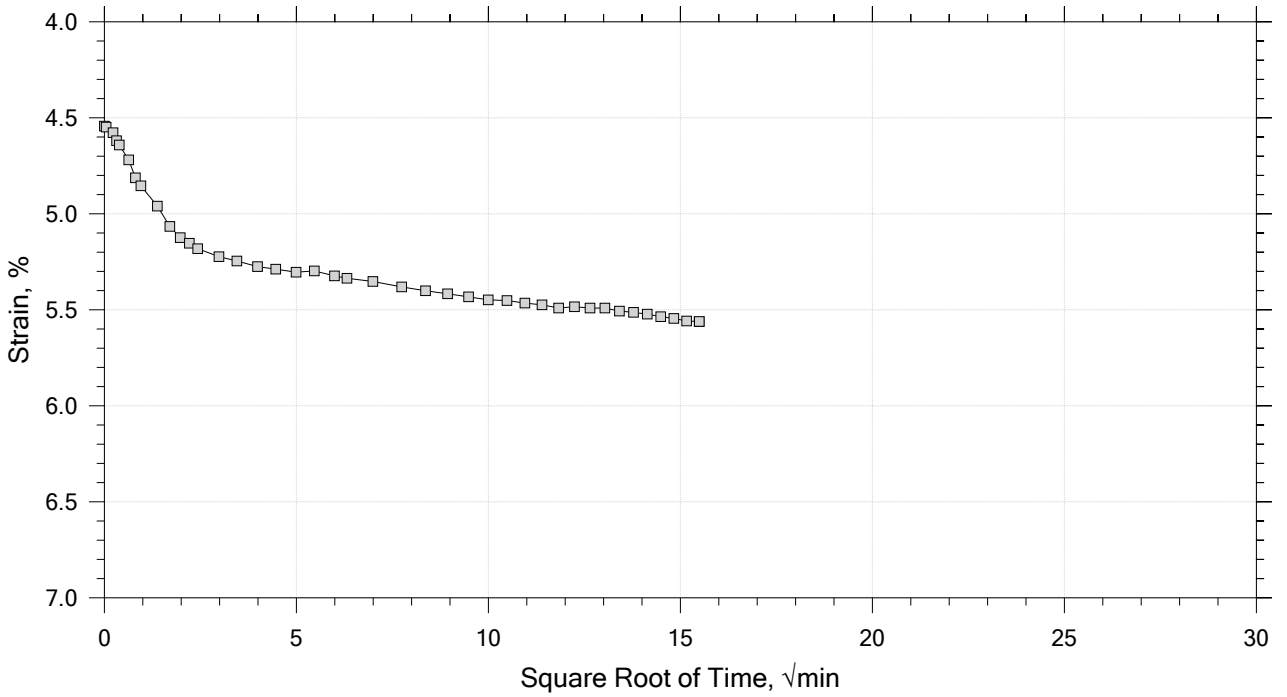


GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 13
Constant Load Step
Stress: 1.5 tsf





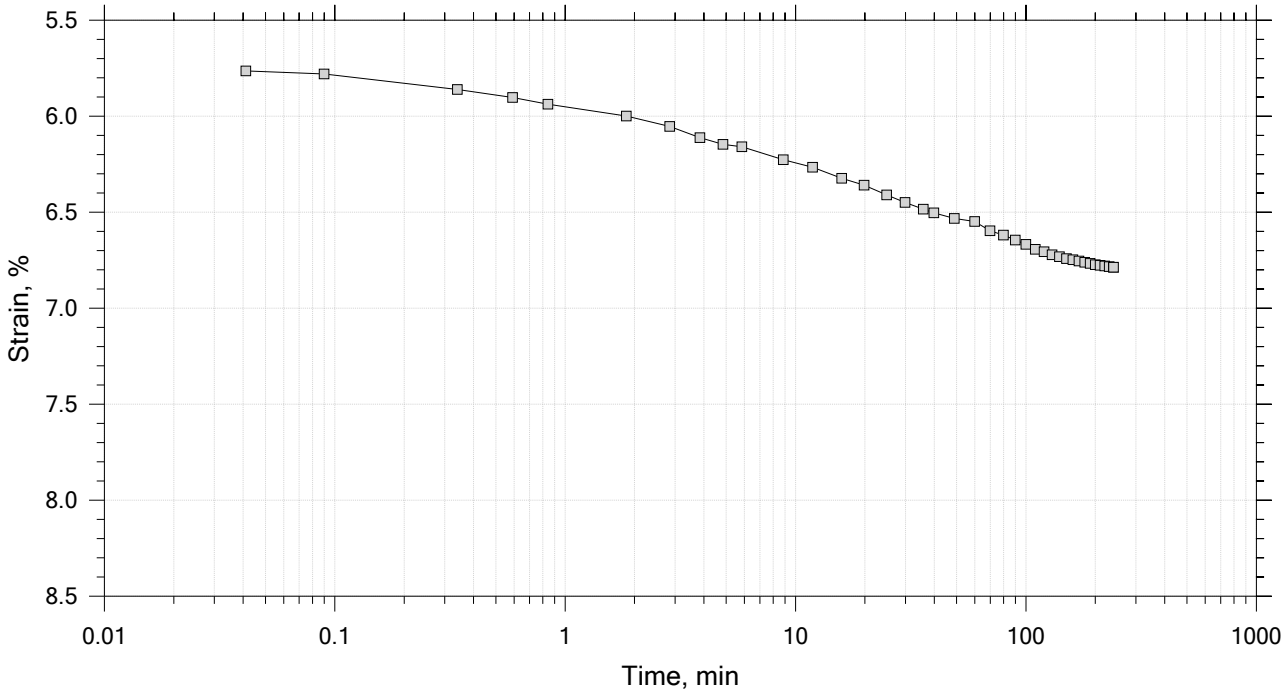
Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
Boring No.: B-1	Tested By: md	Checked By: mcm
Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
Test No.: IP-1	Sample Type: Tube	Elevation: ---
Description: Moist reddish brown clay		
Remarks: System LTIII-B		

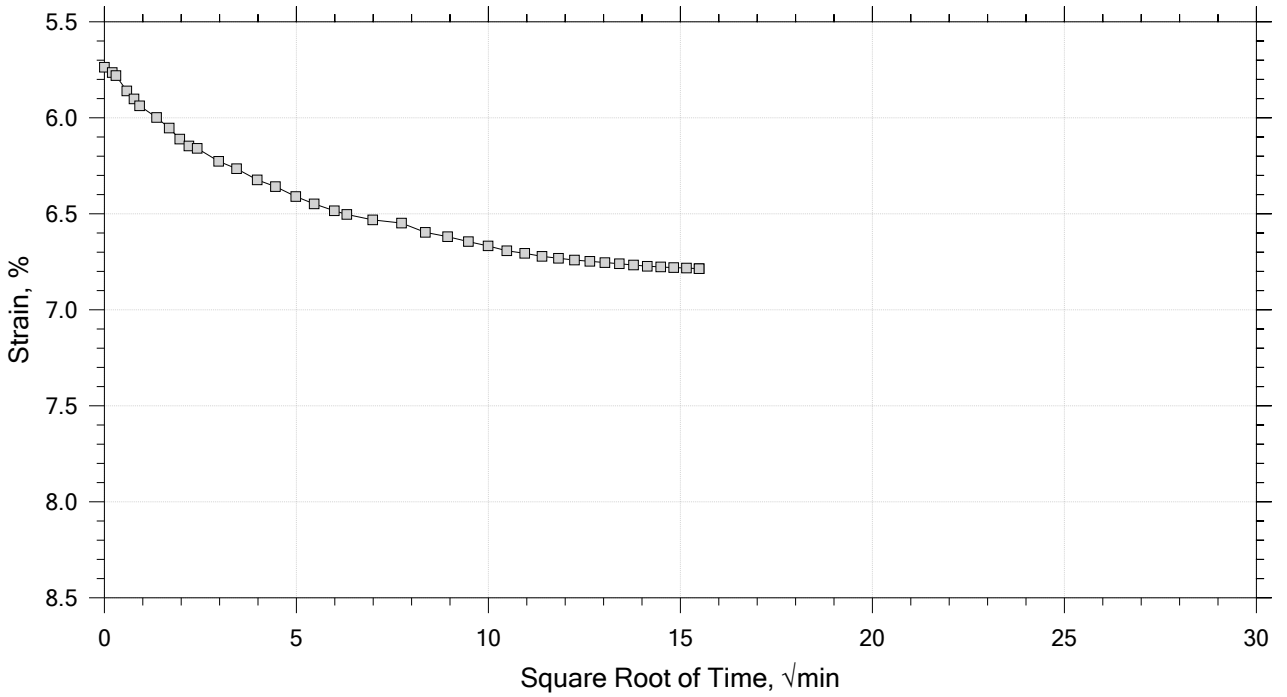
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 13

Constant Load Step

Stress: 2 tsf





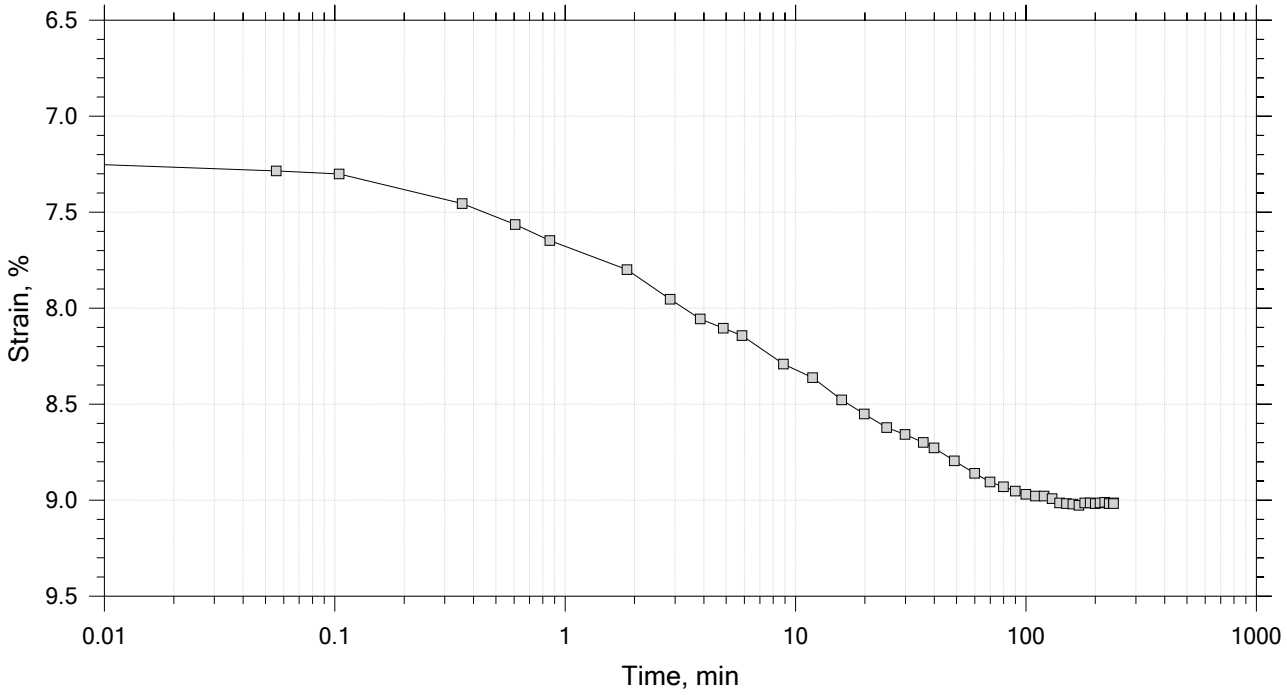
Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
Boring No.: B-1	Tested By: md	Checked By: mcm
Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
Test No.: IP-1	Sample Type: Tube	Elevation: ---
Description: Moist reddish brown clay		
Remarks: System LTIII-B		

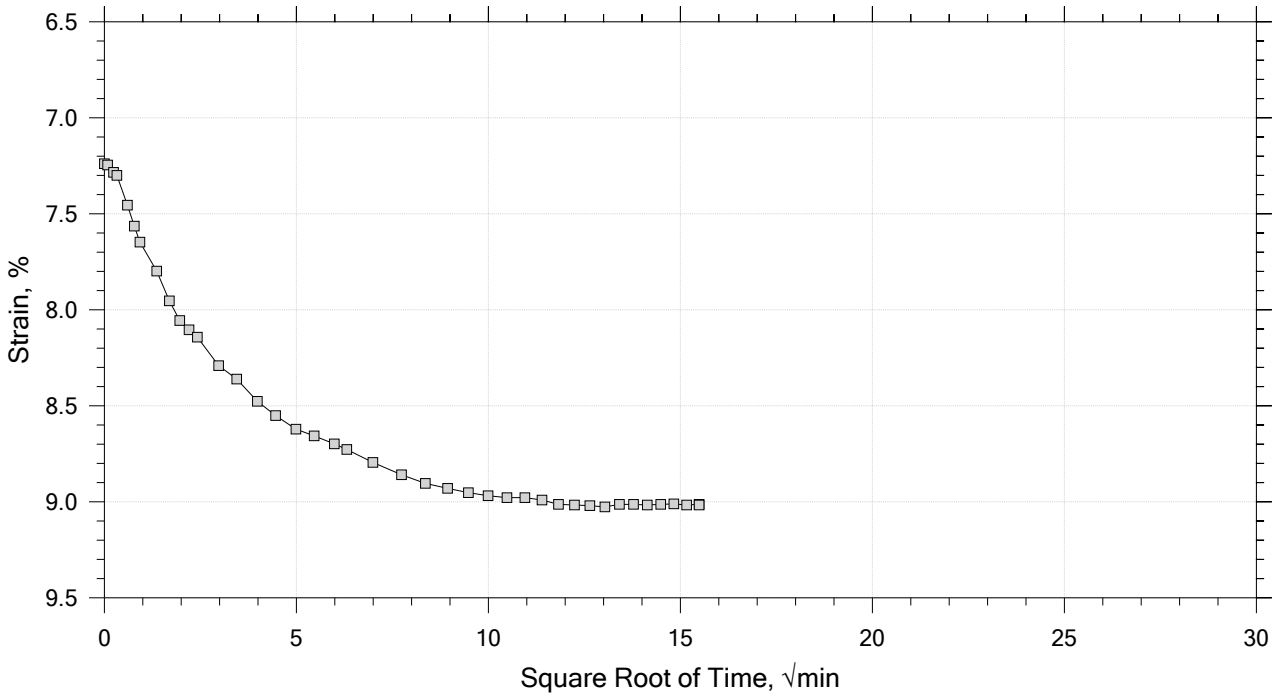
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 13

Constant Load Step

Stress: 3 tsf

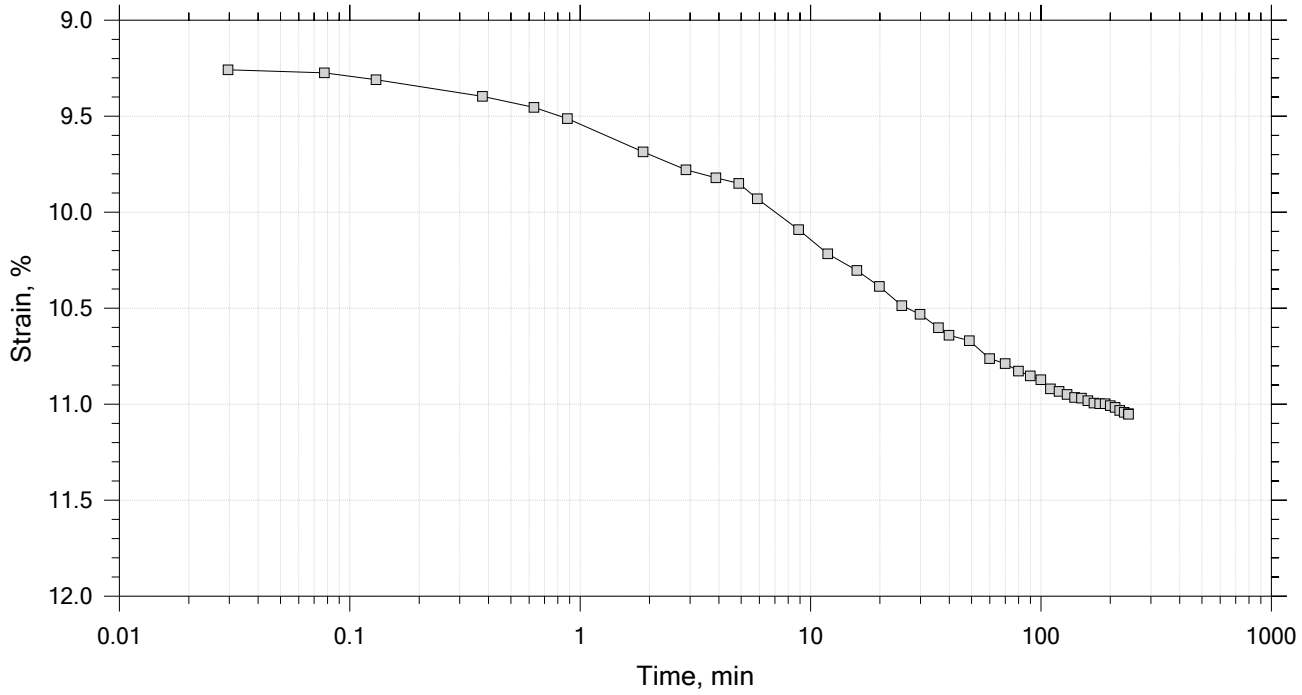


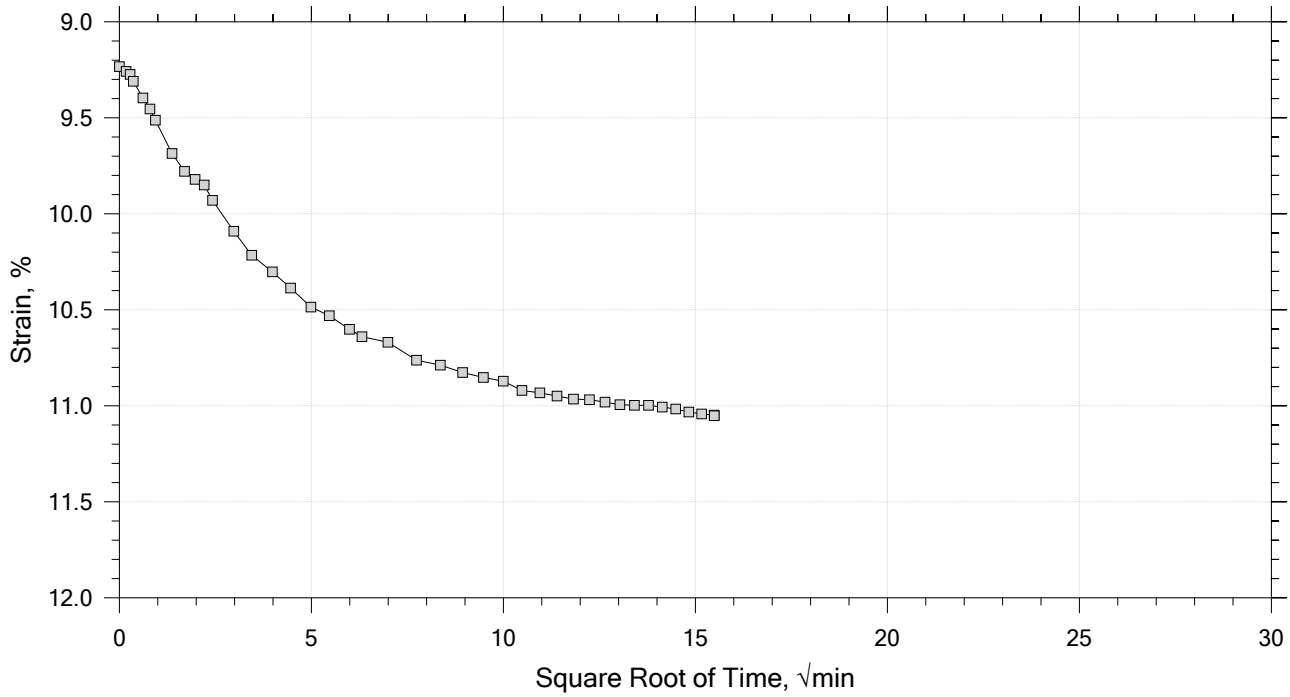


Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
Boring No.: B-1	Tested By: md	Checked By: mcm
Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
Test No.: IP-1	Sample Type: Tube	Elevation: ---
Description: Moist reddish brown clay		
Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 13
Constant Load Step
Stress: 4 tsf





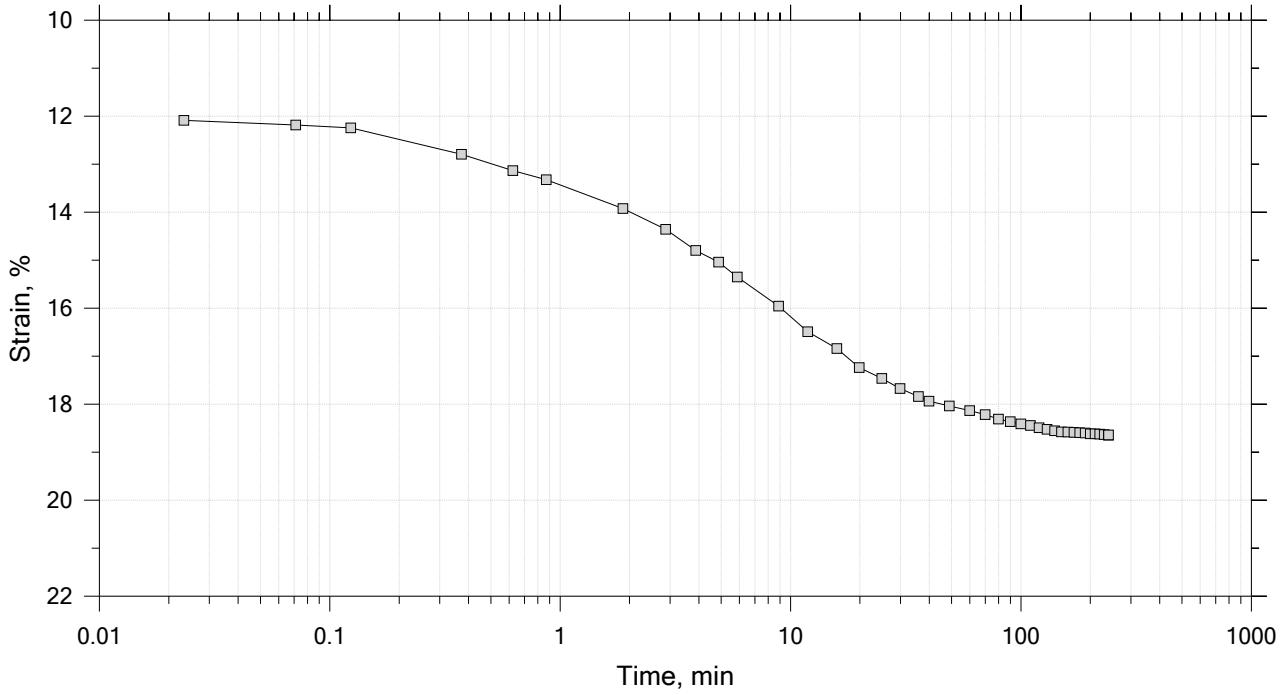
GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

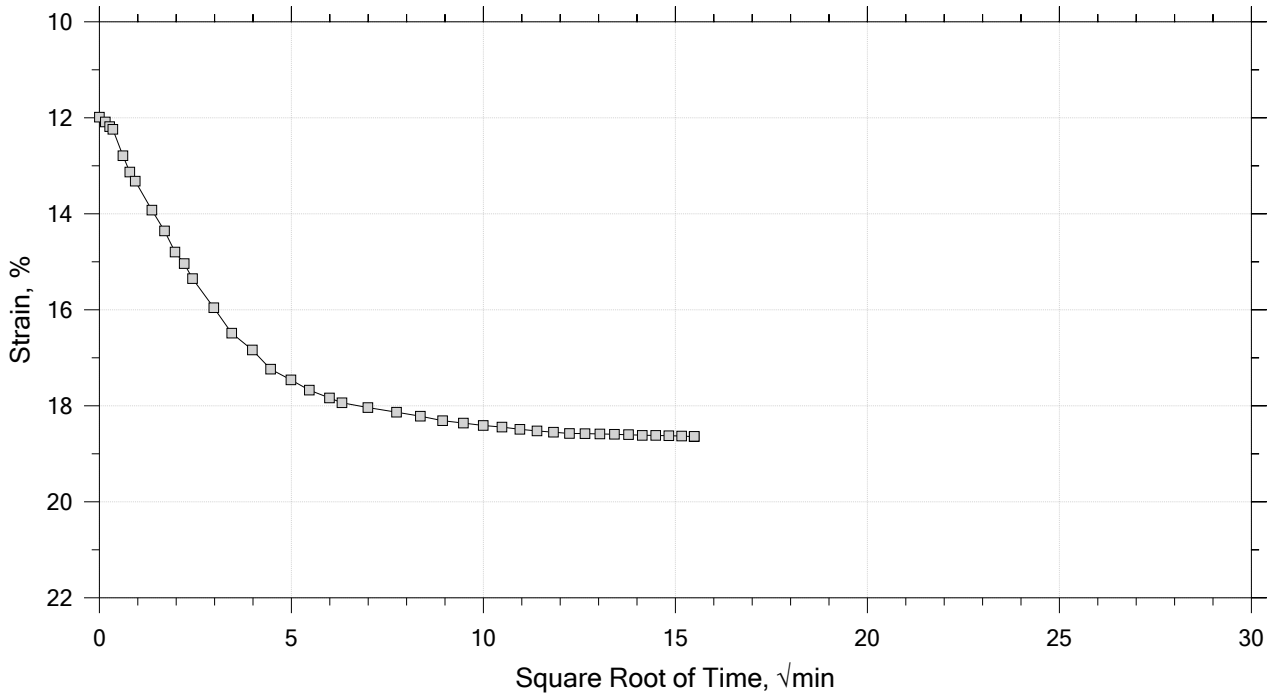
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 13

Constant Load Step

Stress: 8 tsf

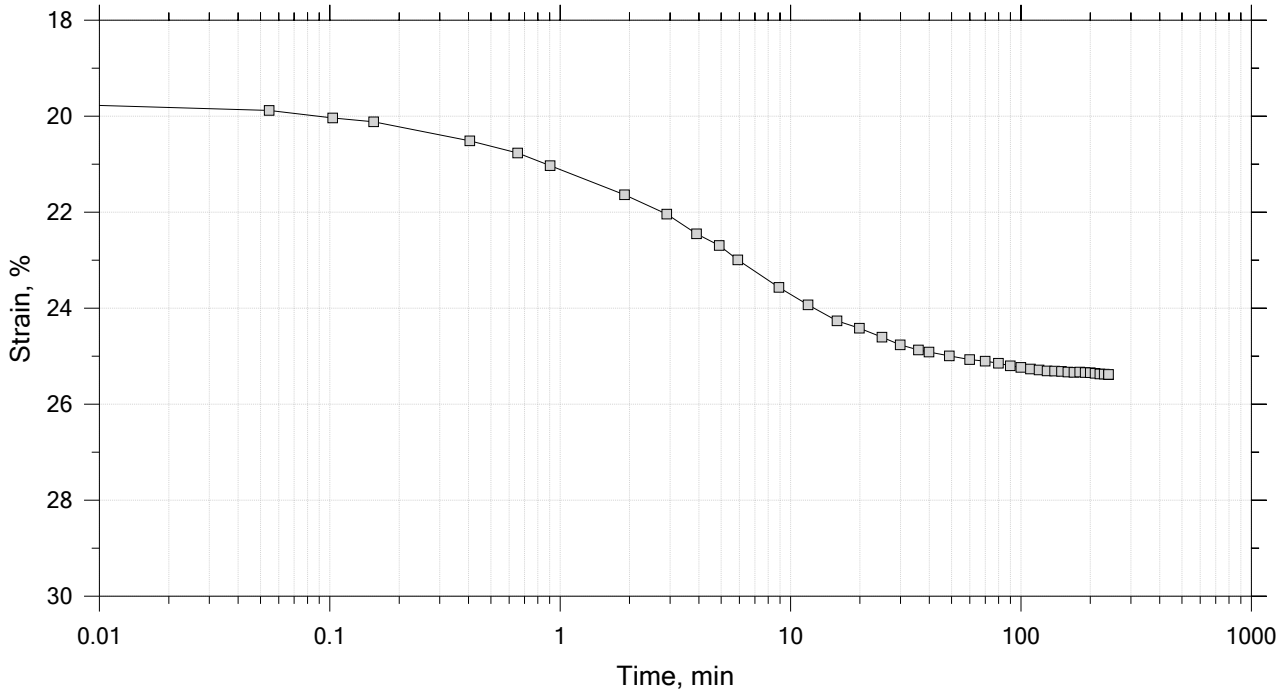


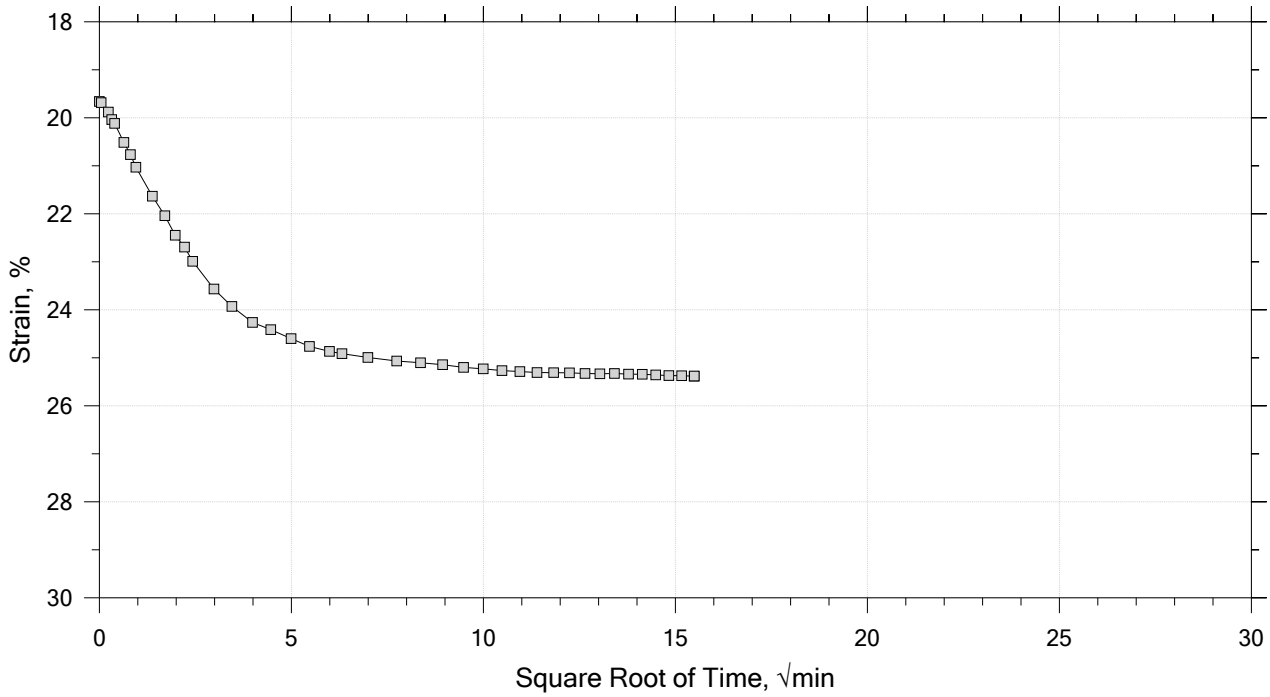


GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 13
Constant Load Step
Stress: 16 tsf

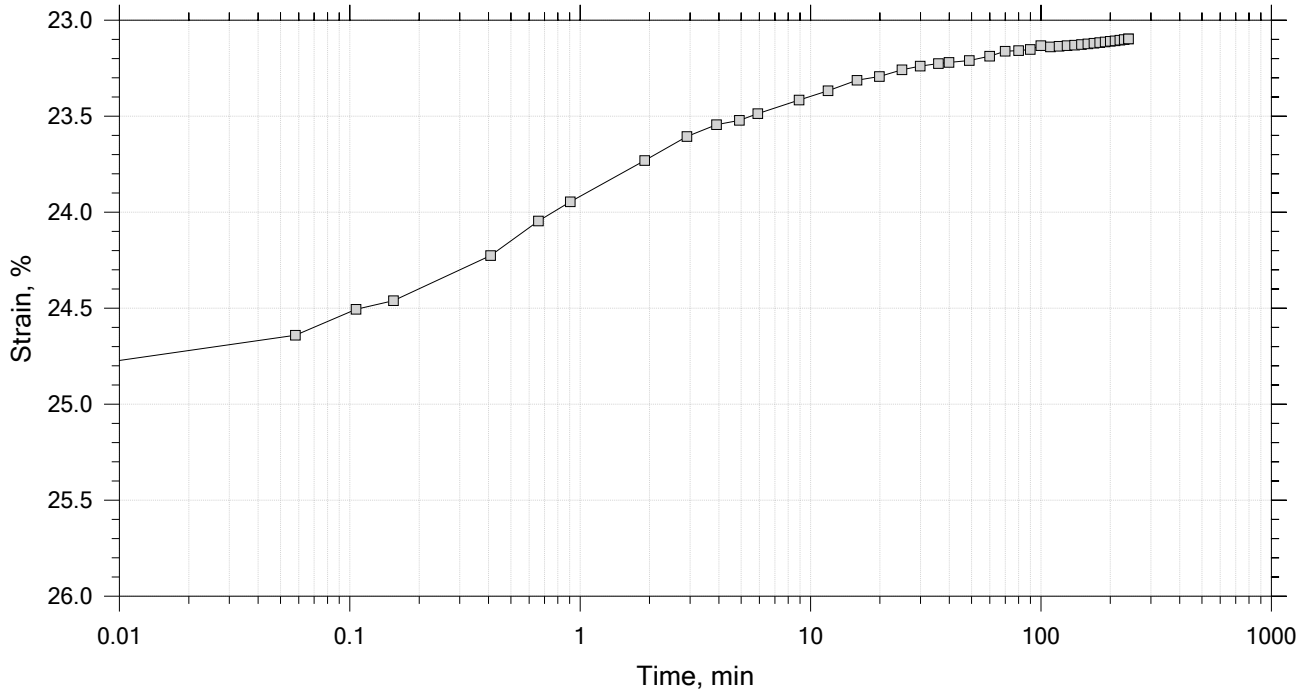


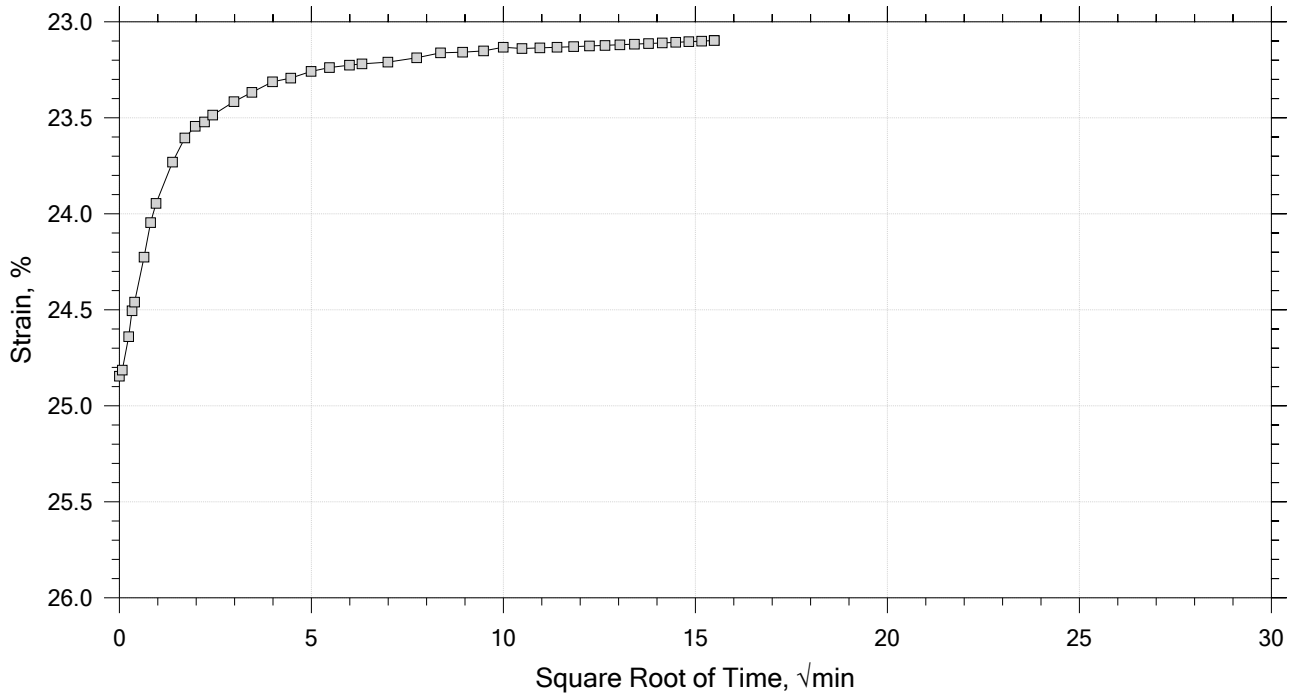


GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 13
Constant Load Step
Stress: 4 tsf

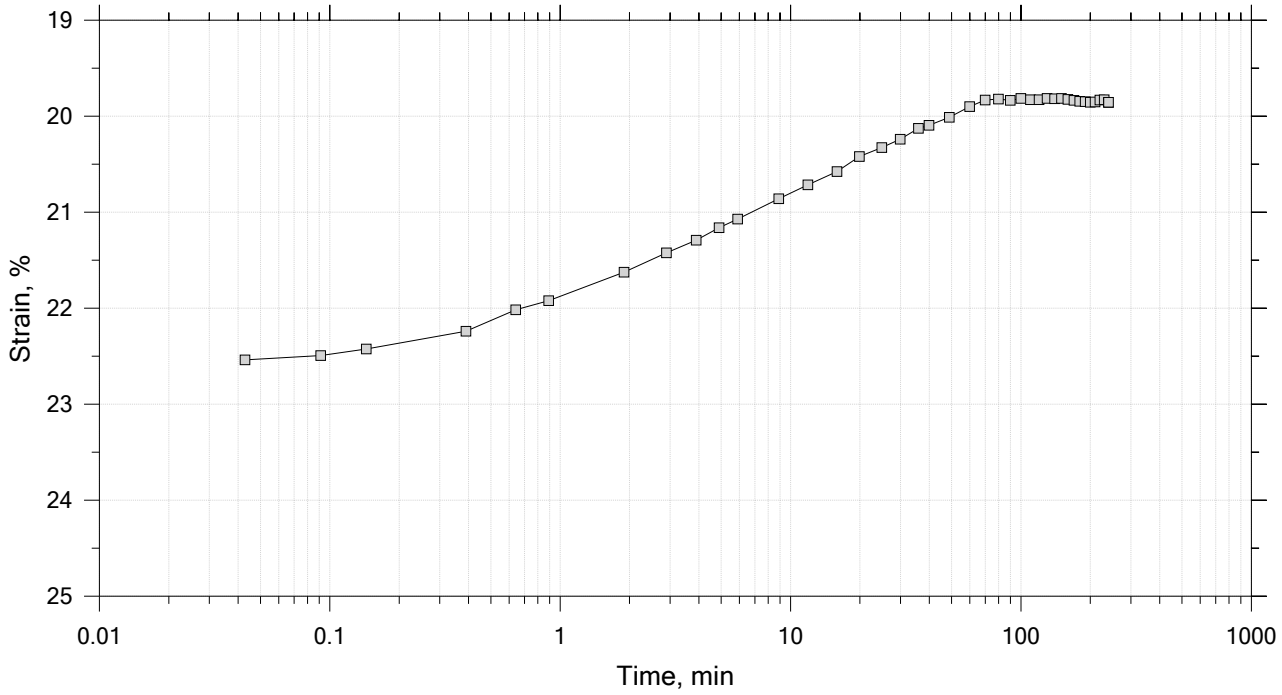


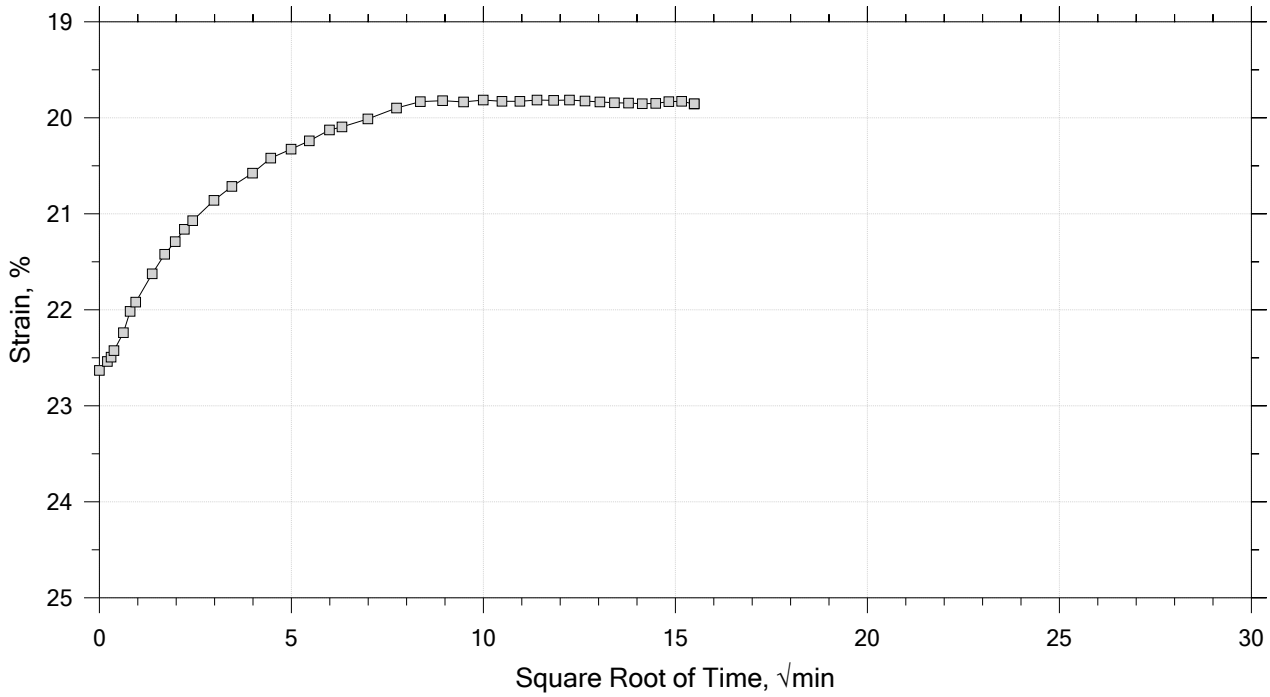


GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 12 of 13
Constant Load Step
Stress: 1 tsf

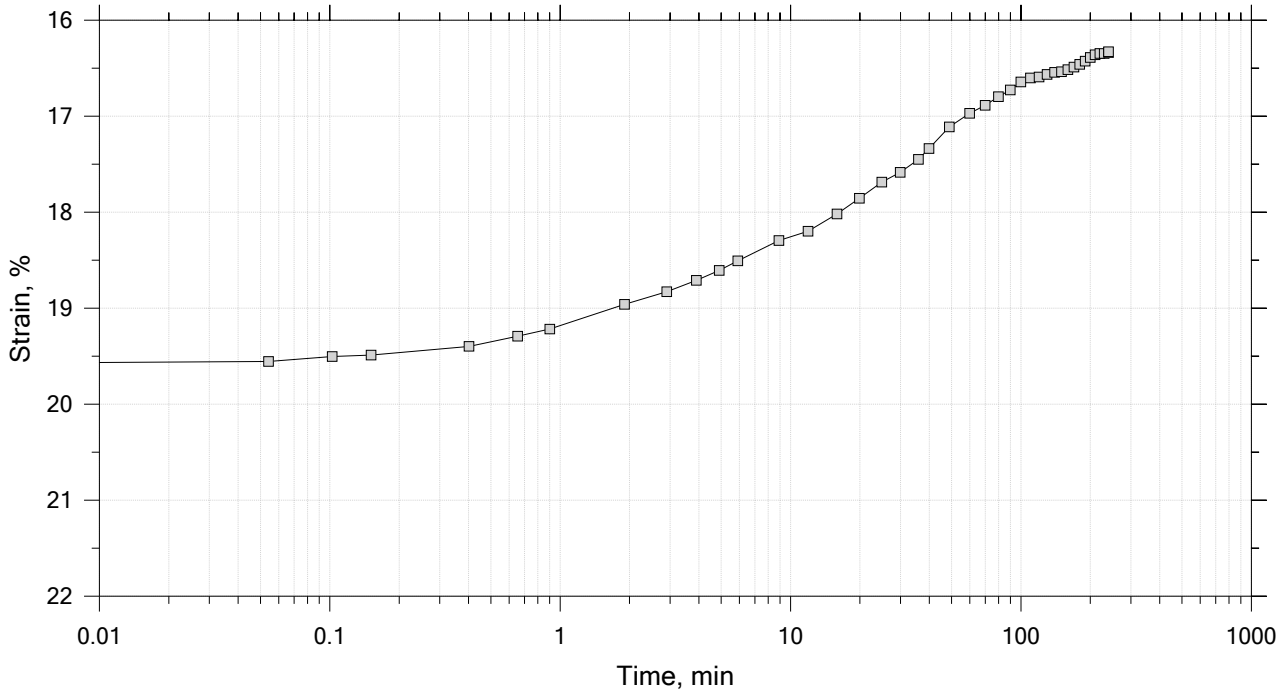


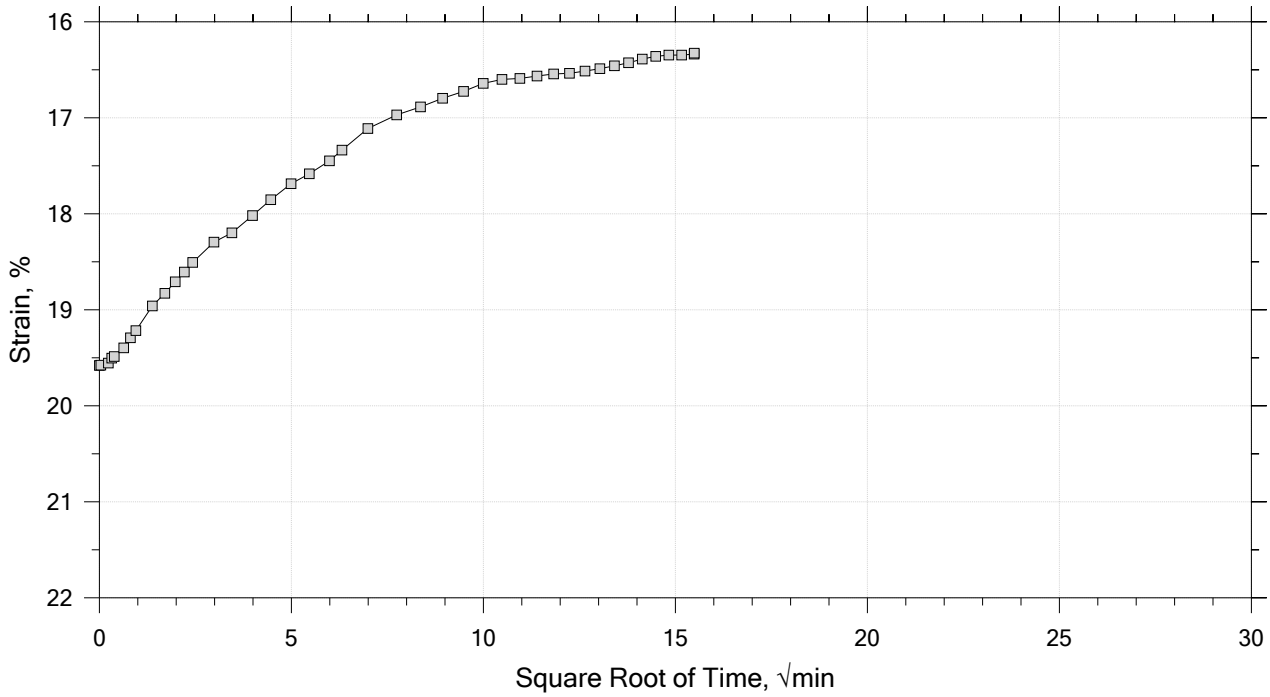


GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 13 of 13
Constant Load Step
Stress: 0.25 tsf





GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.73	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 1.23	Plastic Limit: ---
Final Height: 0.87 in	Final Void Ratio: 0.94	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	C-2213	RING		D1338
Mass Container, gm	9.13	109.4	109.4	8.64
Mass Container + Wet Soil, gm	266.7	251.64	241.87	139.82
Mass Container + Dry Soil, gm	176.43	207.96	207.96	106.24
Mass Dry Soil, gm	167.3	98.56	98.56	97.6
Water Content, %	53.96	44.32	34.41	34.41
Void Ratio	---	1.23	0.94	---
Degree of Saturation, %	---	98.45	100.00	---
Dry Unit Weight, pcf	---	76.491	87.92	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Log of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/s	Mv 1/tsf	k ft/day	Ca %
1	0.125	0.01199	1.20	1.20	0.000	0.00e+00	9.59e-02	0.00e+00	0.00e+00
2	0.250	0.01893	1.19	1.89	0.000	0.00e+00	5.55e-02	0.00e+00	0.00e+00
3	0.500	0.02874	1.17	2.87	0.000	0.00e+00	3.92e-02	0.00e+00	0.00e+00
4	1.00	0.04314	1.13	4.31	0.000	0.00e+00	2.88e-02	0.00e+00	0.00e+00
5	1.50	0.05561	1.11	5.56	0.000	0.00e+00	2.49e-02	0.00e+00	0.00e+00
6	2.00	0.06786	1.08	6.79	0.000	0.00e+00	2.45e-02	0.00e+00	0.00e+00
7	3.00	0.09017	1.03	9.02	0.000	0.00e+00	2.23e-02	0.00e+00	0.00e+00
8	4.00	0.1105	0.983	11.1	7.113	6.49e-07	2.03e-02	3.56e-05	0.00e+00
9	8.00	0.1864	0.814	18.6	4.079	1.01e-06	1.90e-02	5.18e-05	0.00e+00
10	16.0	0.2538	0.664	25.4	2.915	1.19e-06	8.43e-03	2.70e-05	0.00e+00
11	4.00	0.2310	0.715	23.1	0.670	4.88e-06	1.90e-03	2.50e-05	0.00e+00
12	1.00	0.1985	0.787	19.9	0.000	0.00e+00	1.08e-02	0.00e+00	0.00e+00
13	0.250	0.1633	0.866	16.3	0.000	0.00e+00	4.70e-02	0.00e+00	0.00e+00

GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.125	0.01199	1.20	1.20	16.848	1.44e-06	9.59e-02	3.72e-04
2	0.250	0.01893	1.19	1.89	18.225	1.31e-06	5.55e-02	1.96e-04
3	0.500	0.02874	1.17	2.87	6.942	3.37e-06	3.92e-02	3.56e-04
4	1.00	0.04314	1.13	4.31	6.812	3.35e-06	2.88e-02	2.60e-04
5	1.50	0.05561	1.11	5.56	12.854	1.72e-06	2.49e-02	1.16e-04
6	2.00	0.06786	1.08	6.79	36.973	5.84e-07	2.45e-02	3.86e-05
7	3.00	0.09017	1.03	9.02	20.543	1.01e-06	2.23e-02	6.10e-05
8	4.00	0.1105	0.983	11.1	27.463	7.23e-07	2.03e-02	3.97e-05
9	8.00	0.1864	0.814	18.6	20.058	8.87e-07	1.90e-02	4.54e-05
10	16.0	0.2538	0.664	25.4	13.378	1.12e-06	8.43e-03	2.54e-05
11	4.00	0.2310	0.715	23.1	3.465	4.06e-06	1.90e-03	2.08e-05
12	1.00	0.1985	0.787	19.9	13.792	1.10e-06	1.08e-02	3.20e-05
13	0.250	0.1633	0.866	16.3	61.915	2.66e-07	4.70e-02	3.37e-05

GeoTesting EXPRESS	Project: Welles Turner Library	Location: Glastonbury, CT	Project No.: GTX-310366
	Boring No.: B-1	Tested By: md	Checked By: mcm
	Sample No.: U-1	Test Date: 07/29/19	Depth: 32-34 ft
	Test No.: IP-1	Sample Type: Tube	Elevation: ---
	Description: Moist reddish brown clay		
	Remarks: System LTIII-B		
	Displacement at End of Increment		

Appendix C

Historic Borings *(For Reference Purposes Only)*

CLARENCE WELTI ASSOC., INC.
P.O. BOX 397
GLASTONBURY, CONN 06033

CLIENT
TOWN OF GLASTONBURY

PROJECT NAME
~~ADDITION-WELLES TURNER LIBRARY~~
LOCATION
GLASTONBURY, CT

DRILLING PROCEDURES: 1 (1., 2., 3., 4., (Select one or more))
1. HOLLOW STEM AUGER, Diameter ~~3.75"~~
2. DRIVEN CASING, Diameter
3. DRILLED CASING, Diameter
4. ROCK CORING, Diameter & type

HOLE NO. ~~B-4~~ Surface Elevation 327

GROUND WATER OBSERVATIONS
AT ~~6.5~~ FT. AFTER ~~0~~ HOURS
AT ____ FT. AFTER ____ HOURS

START DATE 7/15/96
FINISH DATE 7/15/96

DEPTH	SAMPLE NO.	SAMPLE BLOWS/6"	SAMPLE DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	~~3-3-4-4~~	~~1.0'-3.0'~~		* .25'	
	2	~~2-2-2-1~~	~~3.0'-5.0'~~		** 1.0'	
5	3	~~2-2-1-2~~	~~5.0'-7.0'~~		BR.FINE-MED.SAND,LITTLE SILT,TRACE FINE-MED.GRAVEL	
	4	~~6-10-14-22~~	~~7.0'-9.0'~~		6.0'	
					*** 7.5'	
10	5	~~4-5-5~~	~~10.0'-11.5'~~		BR.FINE-MED.SAND,TRACE SILT	
					11.0'	
					BR.MED.-FINE SAND,TRACE SILT	
15	6	~~6-5-8~~	~~15.0'-16.5'~~		14.0'	
					BR.MED.-FINE SAND	
					18.0'	
20	7	~~8-12-15~~	~~20.0'-21.5'~~		BR.FINE SAND,TRACE SILT	
					21.5'	
					BOTTOM OF BORING @ 21.5'	
25						
					*ASPHALT	
					**RED/BR.MED.-FINE SAND,SOME SILT,LITTLE FINE-MED.GRAVEL	
					***DARK BR.FINE-MED.SAND,SOME SILT	
30						
35						
40						

LEGEND: Col. A

Sample Type
D = Dry C = Cored W = Washed
UP = Undisturbed Piston
TP = Test Pit A = Auger V = Vane Test
UT = Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density	Cohesive Consistency
0-10 Loose	0-4 Soft
10-30 Med.Dense	4-8 M/Stiff
30-50 Dense	8-15 Stiff
50 + VeryDense	15-30 V-Stiff

Driller: CHRISTIANA
Helper:
Inspector:
Sheet 1 of 1

1. Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2. ***Water readings*** represent driller observations — not interpretations.

CLARENCE WELTI ASSOC., INC.
P.O. BOX 397
GLASTONBURY, CONN 06033

CLIENT
TOWN OF GLASTONBURY

PROJECT NAME
~~ADDITION-WELLES TURNER LIBRARY~~

LOCATION
GLASTONBURY, CT

DRILLING PROCEDURES: 1 (1., 2., 3., 4., (Select one or more))

1. HOLLOW STEM AUGER, Diameter ~~3.75"~~
2. DRIVEN CASING, Diameter
3. DRILLED CASING, Diameter
4. ROCK CORING, Diameter & type

HOLE NO. ~~B-5~~ Surface Elevation ~~391~~

GROUND WATER OBSERVATIONS
AT ~~6.5~~ FT. AFTER ~~0~~ HOURS
AT ____ FT. AFTER ____ HOURS

START DATE 7/15/96
FINISH DATE 7/15/96

DEPTH	SAMPLE NO.	SAMPLE BLOWS/6"	SAMPLE DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	~~4-4-3-2~~	~~1.0'-3.0'~~		* .25'	
	2	~~3-3-4-5~~	~~3.0'-5.0'~~		** 2.0'	
5	3	~~3-3-5-7~~	~~5.0'-7.0'~~		BR.FINE-MED.SAND,LITTLE SILT,TRACE FINE-MED.GRAVEL	
					6.5'	
					BR.FINE-MED.SAND	
10	4	~~3-3-5~~	~~10.0'-11.5'~~			
15	5	~~3-4-3~~	~~15.0'-16.5'~~		14.0'	
					RED/BR.FINE-MED.SAND,SOME SILT	
					18.0'	
20	6	~~3-5-7~~	~~20.0'-21.5'~~		RED/BR.FINE SAND,SOME SILT,LITTLE CLAY LAYERS	
					21.5'	
					BOTTOM OF BORING @ 21.5'	
25					*ASPHALT	
					**RED/BR.MED.-FINE SAND,SOME SILT & FINE-MED.GRAVEL	
30						
35						
40						

LEGEND: Col. A

Sample Type
D = Dry C = Cored W = Washed
UP = Undisturbed Piston
TP = Test Pit A = Auger V = Vane Test
UT = Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density	Cohesive Consistency
0-10 Loose	0-4 Soft
10-30 Med.Dense	4-8 M/Stiff
30-50 Dense	8-15 Stiff
50 + Very Dense	15-30 V-Stiff

Driller: CHRISTIANA
Helper: ____
Inspector: ____
Sheet 1 of 1

1. Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2. ***Water readings*** represent driller observations — not interpretations.

CLARENCE WELTI ASSOC., INC.
P.O. BOX 397
GLASTONBURY, CONN 06033

CLIENT
TOWN OF GLASTONBURY

PROJECT NAME
WELLS-TURNER LIBRARY ADDITION
LOCATION
GLASTONBURY, CT

	AUGER	CASING	SAMPLER	CORE BAR.
TYPE	HSA		SS	
SIZE I.D.	3.75		1.5	
HAMMER WT.			140 LB.	
HAMMER FALL			30"	

OFFSET
LINE & STA.
N. COORDINATE
E. COORDINATE

SURFACE ELEV.
HOLE NO. **B-6**

GROUND WATER OBSERVATIONS
AT 5.8 FT. AFTER 0 HOURS
AT FT. AFTER HOURS

START DATE 1/23/97
FINISH DATE 1/23/97

DEPTH	SAMPLE NO.	SAMPLE BLOWS/6"	SAMPLE DEPTH	A	STRATUM DESCRIPTION + REMARKS	ELEV.
0					ASPHALT .2	
					RED/BR.FINE-MED.SAND & FINE-MED.GRAVEL,TR.SILT-FILL	
					GRAY/BR.FINE-MED.SAND,TR.SILT-FILL 2.0	
5	1	1-1-2	5.00'-6.50'			
10	2	9-12-12	10.00'-11.50'		BR.FINE SAND,LITTLE SILT (LITTLE RED SILT AND FINE SAND LAYERS) 9.0	
15	3	5-7-8	15.00'-16.50'		BR.FINE SAND,LITTLE SILT 14.0	
20	4	6-9-6	20.00'-21.50'			
25	5	2-3-2	25.00'-26.50'		GRAY VARVED CLAY,SOME SILT 26.0	
30	6	1-1-2-2	32.00'-34.00'			
35						

LEGEND: COL. A:
SAMPLE TYPE: D=DRY A=AUGER C=CORE U=UNDISTURBED PISTON S=SPLIT SPOON
PROPORTIONS USED: TRACE=0-10% LITTLE=10-20% SOME=20-35% AND=35-50%

DRILLER: BROMLEY
INSPECTOR:

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT TOWN OF GLASTONBURY	PROJECT NAME WELLS-TURNER LIBRARY ADDITION LOCATION GLASTONBURY, CT

DEPTH	SAMPLE NO.	SAMPLE BLOWS/6"	SAMPLE DEPTH	A	STRATUM DESCRIPTION + REMARKS	ELEV.
40						
	7	2-4-5	42.00'-43.50'			
45						
50	8	3-4-4	50.00'-51.50'			
55						
60	9	4-5-4	60.00'-61.50'			
65						
70	10	5-6-6	70.00'-71.50'			
75						

LEGEND: COL. A:

SAMPLE TYPE: D=DRY A=AUGER C=CORE U=UNDISTURBED PISTON S=SPLIT SPOON

PROPORTIONS USED: TRACE=0-10% LITTLE=10-20% SOME=20-35% AND=35-50%

DRILLER: BROMLEY
INSPECTOR:

SHEET 2 OF 3 | HOLE NO. B-6

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT TOWN OF GLASTONBURY	PROJECT NAME WELLS-TURNER LIBRARY ADDITION LOCATION GLASTONBURY, CT

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + REMARKS	ELEV.
80	11	4-6-9	80.00'-81.50'			
					RED FINE SAND AND SILT, SOME CLAY & SILT LAYERS	82.0
85						
90	12	9-12-15	90.00'-91.50'			
95					RED FINE SAND,SOME SILT	95.0
100	13	12-17-20	100.00'-101.50'			
					BOTTOM OF BORING @ 101.5'	101.5
105						
110						
115						

LEGEND COL. A:
SAMPLE TYPE: D=DRY A=AUGER C=CORE U=UNDISTURBED PISTON S=SPLIT SPOON
PROPORTIONS USED: TRACE=0-10% LITTLE=10-20% SOME=20-35% AND=35-50%

DRILLER: BROMLEY
INSPECTOR:

SHEET 3 OF 3 | HOLE NO. B-6

Appendix D

Recommended Material Specifications

Recommended Material Specifications
Welles-Turner Library Additions
Glastonbury, CT

The on-site soil can be re-used as Structural Fill or Ordinary Fill, provided it can meet the appropriate compaction requirements and does not contain deleterious materials. Soils to be used as fill imported from off-site should also meet the gradation requirements given below.

Structural Fill

Structural Fill should consist of hard, durable sand and gravel. It should be free of clay, organic matter, surface coatings, and other deleterious materials. Soil finer than the No. 200 sieve (the "fines") should be nonplastic. Structural Fill shall meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
3 inches	100
1 - ½ inch	55 – 100
No. 4	35 – 85
No. 16	20 – 65
No. 50	5 – 40
No. 200 (fines)	0 – 10

Structural Fill should be compacted in maximum 9-inch-thick, loose lifts to at least 95 percent of the maximum dry density determined in accordance with ASTM D1557 (Modified AASHTO Compaction). The moisture content should be held to within +/- 3 percent of optimum moisture content (as determined by ASTM D1557).

Ordinary Fill

Ordinary fill should consist of hard, durable sand and gravel, free of clay, organic matter, surface coatings, and other deleterious materials. Soil finer than the No. 200 sieve (the "fines") should be nonplastic. Ordinary Fill shall meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
6 inches	100
3 inches	80 – 100
No. 4	20 – 100
No. 200 (fines)	0 – 20

Ordinary fill should be compacted in maximum 12-inch-thick, loose lifts to at least 92 percent of the maximum dry density determined in accordance with ASTM D1557 (Modified AASHTO Compaction). The moisture content should be held to within +/- 3 percent of optimum moisture content (as determined by ASTM D1557).

Crushed Stone

Crushed Stone should consist of a ¾-inch size durable crushed rock or durable crushed gravel stone and shall conform to the requirements of the ConnDOT Form 817, Section M.01.01, No. 6. Crushed stone should be compacted with at least four passes of a vibratory compactor.

Geotextile Fabric

Geotextile fabric should be a non-woven fabric, consisting of Mirafi 140N or an approved equal product.