

ERV REPLACEMENT

**BROMFIELD HIGH SCHOOL
14 MASSACHUSETTS AVENUE
HARVARD, MASSACHUSETTS**



**HARVARD PUBLIC SCHOOLS
HARVARD, MASSACHUSETTS 01451**

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS
FOR
TECHNICAL SPECIFICATIONS

TITLE PAGE

TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS

DIVISION 01 – GENERAL REQUIREMENTS

01 00 00 – GENERAL REQUIREMENTS

01 10 00 – SPECIAL CONDITIONS

01 14 00 – WORK RESTRICTIONS

01 30 00 – SUBMITTALS

01 31 00 – SUMMARY OF WORK

01 70 00 – CONTRACT CLOSEOUT

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING

23 00 00 – MECHANICAL

DIVISION 26 – ELECTRICAL

26 00 00 – ELECTRICAL

DIVISION 01

SECTION 01 00 00

GENERAL REQUIREMENTS

PART 1 - SUMMARY OF WORK

1.01 CONTRACT DOCUMENTS

- A. The general provisions of the Contract Documents and General Conditions apply to the work specified in this section.

1.02 SPECIFICATION ARRANGEMENT

- A. Titles to and arrangements of sections and paragraphs in these specifications are used merely for convenience and shall not be taken as a correct or complete segregation of the several categories of materials, equipment and labor, nor as an attempt to outline or define jurisdictional procedures.

1.03 INTENT

- A. The entire work provided for in these technical specifications and on the Drawings shall be constructed and finished in every respect in a good workmanlike and substantial manner. All parts necessary for the proper and complete execution of the work whether the same may have been specifically mentioned or not, or indicated in a manner corresponding with the rest of the work shall be provided as if the same were particularly described and specifically provided for herein. It is not intended that the Drawings shall show every detailed piece of material or equipment, but such parts and pieces as may be in accordance with the best practices and regulatory requirements, even though not shown, shall be furnished and installed. All materials and equipment shall be new, unless specifically stated otherwise in these Contract Documents.

1.04 SCOPE

- A. The work required by these specifications shall include furnishing all labor, skill, supervision, tools, construction plant, equipment and materials and performing all operations necessary for the properly completed contract work as shown on the Drawings, as mentioned in these specifications, and as evidently required, to the complete satisfaction of the Engineer.

1.05 GENERAL DESCRIPTION OF WORK

- A. The work under this Section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems.

- B. Furnish all labor and materials to perform demolition work as shown on the Drawings, as required for the installation of new work, and as specified hereinafter.
- C. Contractor shall final clean each work area upon completion and acceptance to the standards and specifications of the Awarding Authority.
- D. All work shall be in strict conformance with all applicable code requirements.
- E. Proposals shall be inclusive of all work for complete installation and operation of equipment herein before described.

1.06 ORDER OF AND COMPLETION OF WORK

- A. Upon the award of the contract, the Contractor shall commence work immediately, carry it on with all reasonable and proper activity and dispatch, give all notices, take out all permits and pay all charge, fees and rates therefore, and bring the work to entire completion within the period of time specified in the contract. "Entire Completion" as herein used, shall be construed as meaning the completion of all work as called for by these specifications and the contract executed in accordance herewith and the date when such completion takes place will be decided by the Engineer.

1.07 PROTECTION - IN GENERAL

- A. The Contractor is to cover and protect his work and materials from all damage during the process of the work and deliver the whole in a clean perfect condition.

1.08 CONSTRUCTION RISKS

- A. The Contractor will understand that the materials, work in place and equipment, are entirely at his risk, including loss by theft or fire during the construction period, and he will be held responsible and liable for its safety.

1.09 SANITARY ACCOMMODATIONS

- A. The Contractor shall use a designated toilet within the building.

1.10 UTILITIES

- A. Water and electric power shall be available from existing sources where Contractor's use is not excessive and does not interfere with normal use of the building. Where existing utilities of the facility are not adequate or cannot be used, the Contractor is responsible for providing alternative sources, the cost of which is to be included in bid price. The use of the facility's utilities shall be coordinated through the Engineer.
- B. Fuel oil, temporary lighting, gas and other utilities (except for heating the building) shall be provided by the Contractor, the cost of which is to be included in the Bid Price.

- C. The Contractor shall provide all wiring, cables, hoses, safety devices, switches, etc., necessary for the utilities used by the Contractor and remove the same upon completion.

1.11 RECORD DRAWINGS

- A. The Contractor shall maintain at the job site, at all times, a complete and separate set of black line prints of the Drawings on which he shall mark clearly, accurately, and promptly as the work progresses, any changes in the work made by change orders or other instructions issued by the Engineer. These drawings shall be used daily to record the progress of the work by coloring in the various pipes, equipment and associated appurtenances when installed. This progress shall incorporate both the above stated changes together with all other deviations from the design, whether resulting from the job conditions encountered in the field or from any other cause. Principal dimensions of all concealed work and valve numbers shall be recorded as applicable.
- B. The marked-up prints shall be used as a guide in determining the progress of work installed. The Engineer will inspect these prints periodically and if found to be inaccurate or incomplete, they shall be corrected immediately.

- 1.12 At completion of work these marked-up prints shall be the basis of the preparation of the final record drawings. Each drawing shall be marked "RECORD AS BUILT DRAWINGS" and dated when printed. Two complete and reproducible sets of as-built drawings must be submitted before final acceptance of the work. The cost of preparing the record drawings shall be borne by the Contractor.

1.13 ENGINEERING (Refer to "General Specifications")

1.14 OFFICE

- A. None required.

1.15 VISITATION TO SITE

- A. All bidders shall, before submitting a bid, visit the site to familiarize themselves with existing conditions. Lack of knowledge of on-site conditions shall not be cause for changes to the contract values.

1.16 DISPOSAL OF WASTE MATERIALS

- A. The Contractor shall be responsible for the removal of all waste material and equipment from the site.
- B. The Contractor shall be responsible for the removal of all hazardous materials and improperly licensed disposal sites, disposal and transportation permits.

1.17 BUILDING SECURITY

- A. The Owner will provide security for the building, however, it shall be the responsibility of the Contractor to secure all exit doors in the area where work is to be performed, coordinating same with the chief custodian or an assigned representative of the Owner. The Owner will not provide security or be responsible for the Contractor's property, fixtures, fittings, tools, equipment, etc.

1.18 ACCESS TO BUILDING

- A. The building will be opened during regular working hours. Exceptions to this clause may be made by mutual agreement between the Owner and the Contractor in the initial phase of the project.

1.19 PUBLIC PROTECTION

- A. While the work is in progress, erect safe barricades to effectively protect persons from injury.
- B. Protect all ground areas where stationary equipment is placed and protect wall areas from hoisting or material conveyers.
- C. Power-brooming may create a dust problem in finished areas. The Contractor will be responsible for spreading drop cloths or plastic over furniture. Clean up of these areas so affected will be the responsibility of the Contractor.
- D. During the demolition or rigging work, plywood barriers shall be installed at all corridors leading to the loading dock.

1.20 CUTTING AND PATCHING

- A. General Requirements:
 - 1. All of the contract documents including General and Supplementary Conditions and Division 01 General Requirements, apply to the work of this Section.
- B. Work Included:
 - 1. The intent of this Section is to describe, in general, procedures for performance of minor alterations, minor removals, and cutting and patching including:
 - a. All necessary cutting, coring, drilling, grouting, and patching to fit together the several parts of the work including repairs in kind of disturbed existing surfaces.
 - b. Where conflicts exist between the requirements specified herein and those of the Technical Trade Sections, those of the Trade Sections shall prevail.

- c. The Contractor shall be responsible for all his cutting, coring, drilling, grouting, fitting and patching of the work that may be required to make its several parts come together properly and fit, as shown upon, or reasonably implied by, Drawings and Specifications for completed structure, and he shall make good after them as Engineer may direct.
- d. Expense caused by defective or ill-timed work shall be borne by party responsible therefore.

C. Cutting and Patching Operations:

- 1. Patch and refinish to match adjacent work in quality and appearance at locations where installed work has been installed and requires reworking to accommodate other work, or has been damaged.
- 2. Patch and match using skilled mechanics. The quality of patched or extended work shall be not less than that specified for new work.
- 3. Patch or replace any portion of a finished surface which is found to be damaged, lifted, discolored, or shows other imperfections, with matching material.
 - a. Provide adequate support or substrate prior to patching the finish.
 - b. Refinish patched portions of painted or coated surfaces in a manner to produce uniform color and texture over entire surface.
 - c. When surface finish cannot be matched, refinish the entire surface to the nearest intersections.
 - d. Patch all vertical shafts for new piping, controls and electrical as 2-hr fire rated enclosures.
- 4. Make the transition as smooth and workmanlike as possible. Patched work shall match adjacent work in texture and appearance so that the patch or transition is invisible to the naked eye at a distance of five feet.

END OF SECTION

DIVISION 01

SECTION 01 10 00

SPECIAL CONDITIONS

PART 1 - GENERAL

1.01 RESPONSIBILITY AND COMPLIANCE

- A. All requirements set forth under this Section are directed to the General Contractor.
- B. Be responsible for arranging for facilities as specified herein and as required for proper and expeditious prosecution of the work. Pay costs for such general services and temporary facilities, except as otherwise specified, until final acceptance of the work, and remove same at completion of work.
- C. Comply with applicable OSHA, state, and municipal regulations and requirements for services and facilities required under this section, and in performance of all requirements of this Contract.

1.02 COORDINATION OF THE WORK

- A. The Contractor shall coordinate all work with all adjacent work and shall cooperate with all other trades so as to facilitate general progress of the work. Each trade shall afford all other trades every reasonable opportunity for the installation of their respective work and for the storage of their materials and equipment. The Contractor shall be responsible for coordination.
- B. The Contractor shall assume responsibility for the correctness and adequacy of his work. The Contractor shall be responsible for and pay for all damages done by his work or his workmen.
- C. The Contractor shall cooperate with, and provide access and working area to other Owner's contractors for the performance of specific work assigned to them.

1.03 PROJECT MEETINGS

- A. The Contractor will be required to meet with the Owner, Engineer and the Owner's representatives, at the site of the work, at regular intervals during the course of the contract for purposes of progress review, coordination of shop schedules, sample submittals, and any other items of work requiring such coordination.

1.04 EXISTING BUILDING CONDITIONS

- A. Before ordering any materials or doing any work, verify all measurements and existing building conditions and be responsible for the correctness of same. No extra charge or

compensation will be allowed on account of difference between actual dimensions and the measurements indicated on the Drawings; any difference which may be found shall be submitted to the Engineer in writing for consideration before proceeding with the work.

1.05 PROTECTION OF EXISTING CONDITIONS

- A. Take all proper precautions to protect the Owner and adjoining property from injury and unnecessary interference; and replace or put in good condition any existing items which are damaged or injured in carrying out the work, unless designated to permanently be removed or demolished.
- B. Keep all access drives and walks clear of debris during building operations. Repair streets, drives, curbs, sidewalks, poles, and the like, where disturbed by building operation and leave them in as good condition after completion of the work as before operations started.

1.06 TESTS AND INSPECTION

- A. Make, or have made, such tests and inspections on workmanship and materials as may be required by the building code, state or municipal laws, or as called for under the various sections of this Specification.
- B. Bear all expense to such tests and inspections, unless otherwise specified under the various sections of the Specifications and furnish all labor, tools, instruments, water, temporary power and light, construction, and equipment necessary for these tests and inspection. Furnish records of all tests and inspections to the Engineer. Remove all temporary work, materials, and equipment upon completion of tests and inspections.
- C. Where, the various sections of the Specifications, inspections and testing of materials, processes, and the like is called for, the selection of bureaus, laboratories, and/or agencies for such inspection and testing shall be subject to the approval of the Engineer.
- D. Should any material or work be found, after testing or inspections, to be defective or inferior, remove and replace such material and/or work with new sound materials and/or work as approved by the Engineer, and bear all costs thereof.

1.07 FIRE PROTECTION AND PREVENTION

- A. Comply with the following minimum requirements for fire prevention:
 - 1. Provide sufficient quantity of carbon dioxide fire extinguishers in all areas of work.
 - 2. Do not permit an accumulation of inflammable rubbish to stay in the building overnight.

3. Store no more than one gallon, in an approved safety can or sealed container, of any volatile inflammable liquid in any portion of the building.
4. Keep all used paint rags in a can with sufficient water to cover.
5. Make arrangements for periodic inspection by local fire protection authorities and insurance underwriters' inspections. Cooperate with said authorities to facilitate proper inspection of the premises. Comply with all applicable laws and ordinances and with the Owner's fire prevention requirements.
6. Ensure that tarpaulins that may be used during construction of work are made of material which is resistant to fire, water, and weather, are U.L. approved, and comply with FS-CCC-D-746.

1.08 ACCIDENT PREVENTION

- A. Comply with all federal, state and municipal recommendations and requirements for safety, and accident prevention, and those of the Associated General Contractors of America, and the American Standards Association Standard A10.2. Ensure that the field superintendent conducts regular, frequent inspections of the site for compliance with safety regulations.
- B. Neither the Owner nor the Engineer shall be responsible for providing a safe working place for the Contractor, contractors, or their employees, or any individual responsible to them for the work.

1.09 WELDING AND CUTTING

- A. Where electric or gas welding or cutting work is done above or within then (10) feet of combustible material or above space that may be occupied by persons, use interposed shields of incombustible material to protect against fire damage or injury due to sparks and hot metal.
- B. Place tank supplying gases for gas welding or cutting at no greater distance from the work than is necessary for safety, securely fastened and maintained in an upright position where practicable. Such tanks, when stored for use, shall be remote from any combustible material and free from exposure to the rays of the sun or high temperatures.
- C. Maintain suitable fire extinguishing equipment near all welding and cutting operations. When operations cease for the noon hour or at the end of the day, thoroughly wet down the surroundings adjacent to welding and cutting operations.
- D. Station a workman equipped with suitable fire extinguishing equipment near welding and cutting operations to see that sparks do not lodge in floor cracks or pass-through floor or wall openings or lodge in any combustible material. Keep the workman at the source of work which offers special hazards for thirty (30) minutes after the job is completed to make sure that smoldering fires have not been started.

- E. Place a qualified electrician in charge of installing and repairing electric or arc welding equipment.
- F. All welding and cuttings shall be performed by certified welders.
- G. Contractor shall be responsible for all costs associated with fire details required by the Local Fire Department during welding and cutting operations.

1.10 OVERLOADING

- A. Do not permit materials and fabricated work to be stacked on, or be transported over, floor and roof construction that would stress any of said construction beyond the designed live loads.

1.11 RUBBISH REMOVAL

- A. Ensure that each workman engaged upon the work bears his full responsibility for cleaning up during and immediately upon completion of his work, and removes all rubbish, waste, tools, equipment, and appurtenances caused by and used in the execution of his work, but this shall in no way be construed to relieve the Contractor of his primary responsibility for maintaining the building and site clean and free of debris, leaving all work in a clean and proper condition satisfactory to the Engineer and/or Owner.
- B. Do not permit rubbish to be thrown from the windows of the building.
- C. Immediately after unpacking, all packing materials, case lumber, excelsior, wrapping or other rubbish, flammable or otherwise, shall be collected and removed from the building and premises.

1.12 BLASTING

- A. No blasting will be permitted.

1.13 WORK AREAS, STORAGE, ACCESS, AND PARKING

- A. The Contractor's work areas shall be as designated on the Drawings, and shall be strictly adhered to. Access to the existing building shall be kept free of all obstructions at all times. Assume full responsibility for trespass on and/or damage to other property by a person employed on the project.
- B. Storage trailer shall be provided by the Contractor for storage of materials on site. Trailer location shall be coordinated with Owner. Storage of materials beyond the designated area will not be permitted.
- C. Vehicular access to the site, and parking for employees' vehicles shall be restricted only to the specific areas designated by the Owner.

1.14 TEMPORARY SCAFFOLDING AND CONVEYANCES

- A. Furnish, install, maintain, remove and pay for all temporary staging and planking, ladders, hoisting (including operator), rigging, and safety devices for all trades.
- B. Staging shall be approved design, erected and removed by experienced stage builders and shall have all accident prevention devices required by state and local laws.
- C. Permit no materials to be passed through the finished openings of exterior walls, without first providing protection to the opening thereof of a type as approved by the Engineer. Be responsible, and bear all costs, for repairs and/or replacement of damaged work caused thereby.

1.15 TEMPORARY PROTECTION

- A. Furnish, erect, and maintain for the duration of the work period, temporary fire-retardant, dustproof coverings as required to prevent the spread of dust beyond the immediate area where work is being performed.

1.16 ADVERTISING MATTER

- A. Signs or advertisements will not be allowed on building enclosure or premises, unless written approval has been obtained from the Owner.
- B. Advertising matter shall not appear on equipment, unless so specified. However, nameplates of a nominal size and inconspicuous nature will be permitted.

1.17 MUNICIPAL POLICE AND FIRE DEPARTMENT SERVICES

- A. Make all necessary arrangements with the municipal police and fire departments in advance of times when regular off-duty, or reserve police officers or firemen will be needed for traffic control protection or fire watch, due to the operations performed under this Contract. Pay police officers and firemen at the prevailing wage rates in the municipality for such services. Extend the Workingmen's Compensation Insurance and Employer's Liability Insurance, required under the General Contract to cover police and firemen used on the project.

1.18 USE AND OCCUPANCY PRIOR TO ACCEPTANCE BY THE OWNER

- A. Prior to the date of completion as stipulated in the Contract, or authorized extension thereof, the Contractor agrees to permit selected use and occupancy of the building(s) or any portion thereof before final acceptance by the Owner. The building will be occupied, for normal function thereof, during the stipulated construction period.
- B. If the project has not been completed and accepted by the Owner, by the date of completion, the Owner at his election may from time to time occupy the building(s) or any portion of any building as the work in connection therewith is completed to such a degree as will, in the opinion of the Owner, permit the use of the building(s) or other portions of the project for the purpose for which they are intended.

- C. The Owner will, prior to any such partial occupancy, give notice to the Contractor thereof and such occupancy shall be predicated upon the following items:
1. In the case of partial occupancy prior to the stipulated completed date, the Owner shall secure endorsement from the insurance carrier and consent of the surety permitting occupancy of the building or use of the project during the remaining period of construction.
 2. In the case of partial occupancy after the stipulated completion date, the Contractor shall extend all the necessary insurance coverage as stipulated until the date of final acceptance of the project is issued by the Owner. It is further noted that the use and occupancy prior to the formal acceptance does not relieve the Contractor of his responsibility to maintain the insurance coverage as required under the supplementary conditions.
 3. The one-year guarantee period called for in the contract documents shall not commence until the date of Substantial Completion of all work under the Contract, as determined by the Engineer.
 4. The occupancy of the building or any portion thereof by the Owner shall not constitute an acceptance of work not performed in accordance with the contract documents or relieve the Contractor of liabilities, to perform any work required by the Contract, but not completed at the time of occupancy.
 5. The Contractor shall be relieved of all maintenance costs on the portion of the building occupied under this agreement.
 6. The Contractor will not be held responsible for wear and tear or damage resulting solely from temporary occupancy.

1.19 GLASS BREAKAGE

- A. The contractor shall be responsible for all breakage of glass as a direct or indirect result of his work or actions of his workmen, from the time the construction operations commence until the project is complete. Replace all broken glass and deliver the building with all glazing intact and clean.

1.20 DAMAGE TO EXISTING SURFACES

- A. The Contractor shall be fully responsible for any damage to existing surfaces caused by the operations of this Contract, and shall correct all such damage to the Owner's satisfaction, at no additional cost to the Contract.

1.21 FINAL CLEANING

- A. Before the final inspection, thoroughly clean the entire exterior and interior areas of the building where construction work has been performed, the immediate surrounding areas,

and corridors, stairs, halls, storage areas, temporary offices and toilets, including the following:

1. Remove all construction facilities, debris, and rubbish from the Owner's property and legally dispose of same beyond the site limits.
2. Sweep, dust, wash, and polish all finished surfaces. This includes cleaning of the work of all finished trades where needed, whether or not cleaning for such trades is included in their respective sections.
3. Leave pipe and duct spaces, chases, and furred spaces thoroughly clean.
4. Wash and polish all new glass on both sides, such work being performed by a window cleaning contractor specializing in such work.
5. Clean all new and altered ceilings, wall surfaces, floors, window and door frames, hardware, metal work, glass, glazing, enameled metals, and the like.

END OF SECTION

DIVISION 01

SECTION 01 14 00

WORK RESTRICTIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Use of site.
- B. Access to Site.
- C. Coordination with occupants.
- D. Worker conduct, appearance and Work Rules.

1.02 USE OF SITE

- A. Use of, and access to, site will be Subject to special requirements of the Owner, as directed.
 - 1. Prior to beginning the Work of this Contract, the Contractor shall meet with the Owner's Project Manager, and the Engineer to determine procedures regarding access and use of the site, locations and access to staging and storage areas, tree protection, temporary barriers and fencing, and any special site conditions or restrictions regarding the use of the site areas surrounding the construction.
 - 2. Hours of construction, must be verified with the Owner's Project Manager. Provisions for working hours other than those originally agreed upon, must be arranged with the Owner and confirmed 48 hours before the phase of Work requiring special work hours begins.
 - 3. Interior work involving cutting, drilling, hammering or other dust and noise generating procedures must be verified with the Owner.
 - 4. Use of Owner's receiving/shipping areas and loading dock: Contractor is responsible to deliver and receive all materials and equipment. Contractor is not permitted to have supplies or equipment shipped directly to them in care of the Owner.
 - 5. The Owner will supply storage facilities for equipment and furnishings scheduled for salvage and reuse, except equipment scheduled for refinishing or repair.

6. Security: Owner access must be permitted at all times in all construction areas, for purposes of security.
- B. The Contractor, subcontractors and their personnel are not permitted to use any of the Building's facilities or be present, unless by specific invitation, in any areas of the building which are under control of, or occupied by the Owner.
- C. Confine operations to areas within Contract limits indicated on the Drawings. Portions of the site and building beyond areas in which construction operations are indicated are not to be disturbed.
 1. Use of on-site areas for storage of materials must be prearranged with Owner. Schedule deliveries to minimize requirements for storage of materials.

1.03 ACCESS TO SITE

- A. The Owner intends to occupy parking areas and access roads during construction. Notify the Owner of work which will affect the use of these areas; coordinate work schedule with Owner. The Contractor shall consult with the Owner on the best ways to provide access and on changes to access areas as the work progresses.
- B. Keep all public roads and walks, and access drive to facility clear of debris caused by this Work during building operations.

1.04 COORDINATION WITH OCCUPANTS

- A. General: Perform all work in such a manner as to prevent interference with the operations and function of the Building, nor endanger the health, safety and well-being of the facility, staff and building's occupants.
 1. Take all measures to ensure the safety of staff, students, and the general public. The Contractor must take every reasonable precaution and employ all necessary measures including extra cleaning, special supervisory personnel, and additional temporary barriers and signage to facilitate the clean, quiet, safe, and continual operation of the facility.
 2. The work will be done in an occupied building, on an active site, that is accessible to the public. It is imperative that the Contractor, its subcontractors and all their personnel treat the building occupants with consideration and respect. No unnecessary noise or disruption of the academic or social activities of the Building will be permitted.
- B. Interruption of services: Any major work entailing disruption to heating, lighting, life safety system utility connections or other similar major disruption to building functioning must be coordinated with the Owner, and temporary services, safety precautions, or connections provided. Do not shut down any service without approval of the Owner's Project Manager.

1. Provide both Owner's Project Manager and Engineer with 48-hour notification for any disruption of service; provide notification for connecting, disconnecting, turning on or turning off any service which may affect Owner's operations.
2. Provide 48-hour notice to local fire department of disruptions in electrical services, fire alarm services and emergency power services.
3. Any action either planned or unplanned, by the Contractor which impairs the operation of anyone or the activation of the fire alarm detection and or suppression system shall cause notification of the appropriate party. In case of unplanned, accidental, impairment, the Contractor will immediately notify the Owner's Project Manager. The Contractor should be prepared to provide assistance as required to correct the problem.

1.05 WORKER CONDUCT, APPEARANCE AND WORK RULES

- A. The conduct and appearance of each worker at the job site is of paramount importance. The Owner's Project Manager, acting in behalf of the Owner, reserves the right to require any worker to be banished from the Site.
- B. Privacy: Conduct all work of the Contract with the maximum effort to maintain the privacy of the Owner's operations, students, and staff. Do not permit the workers to peer into other areas of the building visible from the work area. Invasion of privacy is a major infraction of the work rules.
- C. General Conduct and Demeanor: All construction workers shall treat all other workers, Owner's staff and the public with respect and courtesy.
- D. Physical Appearance: Require each worker to dress appropriately in a clean, neat, and professional manner. Workers may not be "shirtless" at anytime.
- E. Radios and Television: The use of entertainment devices, including personal devices with headphones or earphones is strictly prohibited at all times. Control the volume of communication radios and loudspeakers to avoid creating a nuisance.
- F. Smoking: Smoking is strictly prohibited on building property.
- G. Language: Foul and rude language is strictly prohibited.
- H. Physical Actions: Running, horseplay, fighting, and other unprofessional conduct is prohibited. Fighting is a major infraction of the work rules.
- I. Stealing: Stealing of any materials, objects, furnishings, equipment, fixtures, supplies, clothing, or other items will not be tolerated and is a major infraction of the work rules.
- J. Sexual Harassment: All forms of physical and verbal sexual harassment will not be tolerated and is a major infraction of the work rules. Sexual harassment includes, without limitation: touching, whistling, sexually explicit stories, jokes, drawings, photos

and similar representations, exhibitionism and all other sexually oriented offensive behavior.

- K. Employees of the contractor, vendors, sub-contractors, sub-sub contractors and any and all workers shall wear identification badges at all times during work on the site. Badges shall be issued by the General Contractor.
- L. Warnings and Dismissal:
 - 1. For minor infractions of the rules, the Owner's Project Manager may issue a warning. Only one warning will be allowed per worker. A second infraction will result in immediate dismissal of the worker from the Site.
 - 2. For major infractions of the rules, the worker shall be dismissed immediately without warning and is subject to possible criminal prosecution.
- M. Notification of Workers: Clearly notify and educate each worker about these Work Rules and the requirements for worker conduct and appearance.
 - 1. Recommendation: The Owner's Project Manager recommends that the Contractor notify each worker of the work rules in writing and obtain a signed acknowledgment of the worker's understanding of the work rules as a condition of employment on this project.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION

DIVISION 01

SECTION 01 30 00

SUBMITTALS

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

- A. The “Form of Agreement between Owner and Contractor”, together with all Amendments and Supplements as hereinbefore listed, shall apply and are hereby made a part of this section of the Specifications.
- B. The sections of these specifications entitled “Special Conditions”, “Minimum Wage Determination”, and Division 01, “General Requirements” shall apply and are hereby made a part of this section of the Specifications.

1.02 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- A. Samples:
 - 1. Office samples of sufficient size and quantity shall clearly illustrate:
 - a. Functional characteristics of product or material, with integrally related parts and attachment devices.
 - b. Full range or color samples.
- B. General Contractor’s Responsibilities:
 - 1. Coordinate each submittal with requirements of contract documents.
 - 2. The general contractor’s responsibility for errors and omissions in submittals is not relieved by the Engineer’s review and approval of submittals.
 - 3. Contractor shall notify the Engineer in writing at time of submission, of deviations in submittals from requirements of contract documents or previous submissions.
 - 4. Work that requires submittals shall not commence unless submittals with Engineer’s stamp and initials or signature indicating review and approval.
 - 5. After Engineer’s review and approval, distribute copies.
- C. Submission Requirements:
 - 1. Make submittals promptly in accordance with approved schedules, and in such sequence as to cause no delay in the work.

SUBMITTALS

2. Shop drawings shall be submitted in accordance with Amendments and Supplements to General Conditions.
3. Submit number of samples specified in each Section of the Specification.
4. Forward submittals with transmittal letter, in duplicate.
5. Submittals shall include:
 - a. Date and revision dates
 - b. Project title and number
 - c. The names of:
 - 1) Engineer
 - 2) General Contractor
 - 3) Sub-contractor
 - 4) Supplier
 - 5) Manufacturer
 - 6) Separate detailer when pertinent
 - d. Identification of product or material
 - e. Relation to adjacent structure or materials
 - f. Field dimensions, clearly identified as such
 - g. Specification section number
 - h. Applicable standards, such as ASTM number
 - i. A blank space, five-inch by four-inch, for designer's stamp
 - j. Identification of deviations from contract documents
 - k. General contractor's stamp, initialed or signed certifying review and approval of submittal.

D. Re-submission Requirements:

1. Product Data and Samples: Submit new data and samples as required from previous submittals.

- E. Distribution of Submittals After Review and Approval:
1. Distribute copies of shop drawings and product data that display the Engineer's stamp to appropriate sub-contractors.
 2. Distribute one approved copy of shop drawings and product data to the project manager.
 3. Distribute samples as directed by the Engineer.

END OF SECTION

DIVISION 01

SECTION 01 31 00

SUMMARY OF WORK

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. The Contractor, as a minimum, shall fulfill the Contract Schedule specified hereinafter.
- B. The school building will be open from 7:00 AM until 7:00 PM Monday – Fridays. (Except for Holidays/Weekends)
- C. There will be no custodial fees if work is performed between the hours of 7:00 AM and 7:00 PM.
- D. If, in the opinion of the Owner, the Contractor is disruptive to the safety of the occupants, the Contractor shall perform all work after hours at no additional cost to the Owner.
- E. All cutting in occupied areas shall be performed during non-occupied periods.
- F. A legal means of egress shall be maintained during construction at all times.
- G. During fire alarm drills, the Contractor shall immediately clear the area of work and provide complete safe access through the work area. Review this procedure with the Building Department and Fire Department.

1.02 SPECIAL PROJECT REQUIREMENTS

- A. Existing Equipment to be Removed: The Awarding Authority shall designate equipment, materials, etc. indicated to be removed which shall remain the property of the owner. Items to be turned over to the owner shall be carefully removed from service and transported by the Contractor to a place designated by the owner.

1.03 CONTRACT AND PHASING SCHEDULE

- A. Time for Completion
 - 1. The time limits stated in the contract documents are of the essence of the contract.
 - 2. Work shall commence on the date the Awarding Authority issues a Notice to Proceed.
 - 3. Work shall be substantially complete within **120 calendar days**

4. Work under this contract shall be completed within **134 calendar days.**
5. The school building will be open from 7:00 AM until 7:00 PM (except holidays/weekends).
6. No work shall be done on holidays, Saturdays, or Sundays, other than for emergencies, unless written approval is granted by the owner.
7. There will be no custodial fees if work is performed between the hours of 7:00 AM and 7:00 PM.

1.04 LIQUIDATED DAMAGES

- A. The work shall be completed on or before said dates. In case the work embraced in this contract shall not have been completed due to the failure of the Contractor to complete the work or any part of the work within the time specified, the Owner shall recover as liquidated damages as indicated in the Awarding Authority Contract.
- B. Owner and Contractor recognize that Owner will suffer financial loss if the work is not completed on schedule, thus, such liquidated damages for delay reflect an agreed upon approximation of loss suffered by Owner because of such delay and do not constitute a penalty.

END OF SECTION

DIVISION 01

SECTION 01 70 00

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

- A. The "Form of Agreement between Owner and Contractor", together with all Amendments and Supplements as hereinbefore listed, shall apply and are hereby made a part of this section of the Specifications.
- B. The sections of these specifications entitled "Special Conditions", "Minimum Wage Determination", and Division 01, "General Requirements" shall apply and are hereby made a part of this section of the Specifications.

1.02 FINAL CLEANING

- A. Unless otherwise specified under the various sections of the specifications, the General Contractor shall perform final cleaning operations as herein specified prior to final inspection.
- B. Maintain project site free from accumulations of waste, debris, and rubbish, caused by operations. At completion of work, remove water, materials, rubbish, tools, equipment, machinery and surplus materials, and clean all sight-exposed surfaces; leave project clean and ready for occupancy.
- C. Cleaning shall include all surfaces, interior and exterior in which the General Contractor has performed work and has used as access to areas where work was performed whether existing or new.
- D. Refer to sections of the specifications for cleaning of specific products or work.
- E. Use only those materials which will not create hazards to health or property and which will not damage surfaces.
- F. Use only those cleaning materials and methods that are recommended by the manufacturer or surface material to be cleaned.
- G. Employ experienced workmen, or professional cleaners, for final cleaning operations.
- H. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed interior and exterior surfaces.
- I. Repair, patch and touch up marred surfaces to specified finish, to match adjacent surfaces.

- J. Prior to final completion, the General Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces, and all work areas, to verify that the entire work is clean.
- K. Broom clean exterior paved surfaces and rake clean other surfaces of the grounds.

1.03 GLASS

- A. The General Contractor shall survey the worksite prior to the start of construction and identify all existing broken or cracked glass. All glass broken during performance of the work of this contract shall be replaced at the expense of the General Contractor.
- B. Prior to final completion, or User Agency Use and Occupancy, the General Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces, and all work areas, to verify that the entire work is clean.

1.04 OPERATING AND MAINTENANCE REQUIREMENTS

- A. At least one month prior to the time of turning over this contract to the Owner for Use and Occupancy or Final Acceptance, the General Contractor shall secure and deliver to the Owner via the Engineer two complete maintenance manuals, shop drawings, and other data.
 - 1. Catalog sheets, maintenance manuals, and approved shop drawings of all equipment.
 - 2. Names, address and telephone numbers of repair and service companies for each of the major systems installed under this contract.

1.05 CLOSEOUT REQUIREMENTS AND SUBMITTALS

- A. Final Inspection:
 - 1. The General Contractor shall submit written certification that:
 - a. Project has been inspected for compliance with contract documents and has satisfied the Building Department and the Owner.
 - b. Equipment and systems have been tested in the presence of Engineer and are operational and satisfactory.
 - c. Project is completed, and ready for final inspection.
 - 2. Building Department Use and Occupancy Permit:
 - a. Arrange for a final inspection and secure the signed Certificate of Inspection for Use and Occupancy from the Building Department if required.

1.06 GUARANTEES AND WARRANTIES

- A. Submit to the Engineer all extended guarantees and warranties that have been specified in various, individual sections of the specifications.

END OF SECTION

DIVISION 23

SECTION 230000

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 CONDITIONS

- A. The GENERAL REQUIREMENTS, DIVISION 01, and BIDDING AND CONTRACT REQUIREMENTS, DIVISION 00, are hereby made a part of this Specification Section.
- B. The "General Conditions of the Contract for Constitution," AIA Document A201, latest Edition, Electronic Format, as published by the American Institute of Architects, together with all Amendments and Supplemental General Conditions as herein before listed shall apply and are hereby made part of this Section of the Specifications.
- C. The sections of these specifications entitled "Special Conditions," "Minimum Wage Determination," and Division 01, "General Requirements" shall apply and are hereby made a part of this section of the Specifications.
- D. Examine all Drawings and all Sections of the Specifications for requirements therein affecting the work and this Section. The exact scope of work cannot be determined without a thorough review of all specification sections and other contract documents.

1.2 SCOPE OF WORK

- A. The work under this Section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems, in general, to include the following items:
 - 1. Energy Recovery Unit
 - 2. Galvanized Sheet Metal Duct System
 - 3. Duct Insulation
 - 4. Testing and Balancing of Air Systems
 - 5. Vibration Isolation
 - 6. Provide a complete system of automatic temperature controls, as shown on the Drawings and called for in this Specification.
 - 7. Systems shall be complete, including all appurtenances for fully workable systems.
 - 8. Cutting and Patching
 - 9. Fire-stopping
 - 10. Seismic Provisions
- B. Provide any other component or related system (whether or not listed) which is part of the overall design and basic equipment and deemed necessary for its completion, thoroughness and readiness for operation in perfect condition.
- C. Furnish, set up and maintain all derricks, hoisting machinery, scaffolds, staging and planking as required for the work.
- D. Supply the service of an experienced and competent supervisor who shall be in charge of the HVAC Contractor's work at the site.

- E. The HVAC Contractor shall be held responsible for subletting any work shown or specified herein, but not classified as HVAC work in order to avoid any jurisdictional disputes and work stoppage arising therefrom.
- F. All electrical apparatus and controls furnished as a part of the HVAC work shall conform to applicable requirements under DIVISION 26 - ELECTRICAL.
- G. All work shall be coordinated with the Construction Schedule.

1.3 WORK NOT INCLUDED

- A. Power wiring is specified in Division 26 - Electrical, and will be provided by the Electrical Subcontractor.

1.4 PRODUCTS FURNISHED, BUT NOT INSTALLED UNDER THIS SECTION

- A. Furnish roof curbs for installation by the Roofing Subcontractor.

1.5 PRODUCTS INSTALLED, BUT NOT FURNISHED UNDER THIS SECTION

- A. Install duct-mounted smoke detectors which will be furnished by the Electrical subcontractor. The HVAC Contractor shall wire the appropriate fan to shut down upon detection of smoke. The Electrical Subcontractor shall power wire and wire the smoke detector to the fire alarm panel.

1.6 CODES, ORDINANCES, AND PERMITS

- A. Installation of systems and equipment provided under this section shall be done in strict accordance with Massachusetts Department of Public Safety Codes, Massachusetts Department of Environmental Protection, Massachusetts State Building Code and Town of Harvard Regulations having jurisdiction.
- B. All pressure vessels shall conform to ASME and Massachusetts codes and regulations.
- C. All work, where applicable, shall conform to NFPA codes and all material shall be U.L. approved.
- D. All electrical apparatus furnished under this section shall be approved by the U.L. and shall be so labeled or listed where such is applicable. Where custom-built equipment is specified and the U.L. label or listing is not applicable to the completed product, all components used in the construction of such equipment shall be labeled or listed by U.L. where such is applicable to the component.
- E. Give notices, file plans, obtain permits and licenses, pay fees and obtain necessary approvals from authorities having jurisdiction. Deliver certificates of inspection to Engineer. No work shall be covered before examination and approval by Engineer, inspectors, and authorities having jurisdiction. Replace imperfect or condemned work conforming to requirements, satisfactory to Engineer, and without extra cost to the Owner. If work is covered before due inspection and approval, the installing contractors shall pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

1.7 RECORD DRAWINGS

- A. Refer to DIVISION 01 - GENERAL REQUIREMENTS, of the Specifications for record drawings and procedures to be provided under this section.

1.8 CLEANING

- A. During the progress of the heating, ventilating and air conditioning work, clean up and remove all oil, grease and other debris caused by this work. At completion, the Contractor shall clean all equipment, piping and duct systems and leave all work in perfect operating condition.

1.9 RESPONSIBILITY

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

1.10 PROTECTION OF MATERIALS, WORK, AND GROUNDS

- A. Materials, fixtures and equipment shall be properly protected and all pipe and duct openings shall be temporarily closed so as to prevent obstruction and damage.
- B. Protect and preserve all materials, supplies and equipment of every description and all work performed. Protect all existing equipment and property of any kind from damage during the operations. Damage shall be repaired or replaced promptly by the Contractor at his expense.

1.11 DRAWINGS

- A. It is the intention of the Specifications and Drawings to call for finished work, tested and ready for operation. Any apparatus, appliance, material or work not shown on the Drawings, but mentioned in the Specifications or vice-versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by the Contractor without additional expense to the Owner.
- B. The Drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the project and shall have the approval of the Engineer before being installed. The Contractor shall follow Drawings, including his shop drawings, in laying out work and shall check the Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Engineer before proceeding with the installation. The Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
- C. Size of ducts and pipes and methods of running them are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To

carry out the true intent and purpose of the Drawings, all necessary parts to make complete approved working systems ready for use, shall be furnished without extra charge. All work shall be installed in such a manner as to avoid being unsightly.

- D. All measurements shall be taken at the building by the Contractor, prior to purchasing and installing the equipment and piping.

1.12 SHOP DRAWINGS

- A. Provide electronic shop drawings for the following:

1. Energy Recovery Unit
2. Insulation, each type
3. Automatic Temperature Controls components complete with wiring diagrams
4. Sequence of Controls
5. Sheetmetal Standards
6. Sheetmetal Shop Drawings
7. Vibration Isolation

1.13 OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS

- A. Provide O&M manuals and maintenance instructions for all equipment and systems.

1.14 UNDERWRITERS' LABEL AND LISTING

- A. All electrical apparatus furnished under this Section shall be approved by the UL and shall be labeled or listed where such is applicable. Where custom-built equipment is specified and the UL label or listing is not applicable to the completed product, all components used in the construction of such equipment shall be labeled or listed by UL where such is applicable to the component.

1.15 CUTTING AND PATCHING

- A. All cutting and patching associated with demolition work and necessary for the proper installation of new HVAC systems to be performed under this Section and subsections shall be performed by the HVAC Contractor.
- B. All work shall be fully coordinated with all phases of construction, in order to minimize the requirements for cutting and patching.
- C. The contractor shall see that all such chases, openings, and sleeves are located accurately and are of the proper size and shape and shall consult with the Engineer in reference to this work. In so doing, he shall confine the cutting to the smallest extent possible consistent with the work to be done. In no case shall piers or structural members be cut without the approval of the Engineer.
- D. Carefully fit around, close up, repair, patch, and point around the work specified herein to the entire satisfaction of the Engineer.
- E. Fill and patch all openings or holes left in the existing structures by the removal of existing equipment by himself, his contractors or other filed subcontractors.

- F. All of this work shall be carefully done by workmen competent to do such work and with the proper and smallest tools applicable.
- G. Any cost caused by defective or ill-timed work shall be the contractor's responsibility therefor.

1.16 GUARANTEE

- A. Guarantee that all work installed will be free from any and all defects in workmanship and/or materials and that all apparatus will develop capacities and characteristics specified.
- B. If, during a period of one year from the date of final completion and acceptance of the work, any such defects in workmanship, material or performance appear, the HVAC Contractor will, without cost to the Owner, remedy such defects within a reasonable time to be specified in notice from the Architect.
- C. Provide all refrigeration compressors with the manufacturer's extended replacement warranty for a total of five years. All warranties must have been submitted prior to Final Payment.
- D. Correct all damage to insulation, paint or building caused by defects in his work, equipment, and its operation. Guarantee shall include startup, shutdown, maintenance, and 24-hour service during the guarantee period.
- E. Any apparatus that requires excessive service during the warranty period will be considered defective and shall be replaced.

1.17 ELECTRICAL

- A. All electrical apparatus and controls furnished as a part of this Section shall conform to applicable requirements under DIVISION 26 - ELECTRICAL.
- B. All motors furnished under this Section shall be furnished by the manufacturer of the equipment served and shall be mounted and aligned so as to run free and true. Each motor shall be built to conform to the latest applicable NEMA, ANSI and IEEE standards for the type and duty of service it is to perform.
- C. Each motor shall be designed to operate on 60 Hz, and each shall be expressly wound for the voltage specified. Each motor shall operate satisfactorily at rated load and frequency with a voltage variation no greater than plus or minus 10 percent of voltage specified. Dual voltage 208/220 motors will not be accepted.
- D. All motors shall be provided with adequate starting and protective equipment and each shall have a terminal box of adequate size to accommodate the required conduit and wires.
- E. Motor controllers shall be equipped with all poles, auxiliary contacts and other devices necessary to permit the interlocking and control sequences required. Controller operating coils shall be generally designed for 120 volt operation, and 3 phase motors shall be provided with thermal overload protection in all phases.

- F. Furnish all magnetic starters for each and every motor furnished under this section of the specification, except where otherwise indicated. The Electrical Sub-Contractor shall install and wire the starter. The Contractor shall provide disconnects for all HVAC equipment. The Electric Sub-Contractor shall install and wire all disconnects. All starters for motors over 10 HP shall be solid state with reduced inrush design. The maximum allowable inrush shall be 2.5 times running load amperage. All starters for fractional HP motors shall be provided with manufacturer's standard motor starter.
- G. Furnish and install all low voltage and/or line voltage control wiring for all HVAC equipment to be installed including, but not limited to boiler/burner units, chillers, cooling towers, pumps, unit ventilators, roof top units, air handling units, fan coils, and fans. All wiring shall be preformed by a licensed electrician.

1.18 VERIFYING CONDITIONS

- A. Before commencing any work under this section, verify all governing dimensions and examine all adjoining work on which this work is in any way associated or connected. Failure to visit the jobsite will in no way relieve the Contractor from installing the work according to the intent of these specifications and at no additional cost to the Owner.
- B. Each bidder shall visit the site and inspect conditions affecting the proposed work. Failure to do so and misinterpretation of the Plans and Specifications resulting therefrom shall be entirely the responsibility of the bidder.
- C. Each bidder shall make note of the existing conditions affecting hauling, rigging, transportation, installation, etc., in connection with his work and shall make all provisions for transportation of all materials and equipment.
- D. Where field conditions require, the Contractor shall arrange for equipment to be shipped to the job, dismantled and assembled in place.

1.19 PAINTING

- A. All finish field painting shall be provided by general contractor.

1.20 STANDARDS

- A. The latest published issue of the standards, recommendations, or requirements of the following listed societies, associations, or institutes in effect at the date of Contract are part of this Specification. These shall be considered as minimum requirements; specific requirements of this specification and/or associated drawings shall have precedence. In case of conflict between published requirements, the Owner's representative shall determine which is to be followed.

- | | | |
|----|--------|---|
| 1. | AMCA | Air Moving and Conditioning Association |
| 2. | ANSI | American National Standards Institute |
| 3. | ASHRAE | American Society for Heating, Refrigerating, and Air Conditioning Engineers |
| 4. | ASME | American Society of Mechanical Engineers |
| 5. | ASTM | American Society for Testing and Materials |
| 6. | FIA | Factory Insurance Association |
| 7. | IEEE | Institute of Electrical and Electronic Engineers |
| 8. | MCAA | Mechanical Contractors Association of America |

9.	NEMA	National Electrical Manufacturers Association
10.	NFPA	National Fire Protection Association
11.	SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
12.	UL	Underwriters' Laboratories, Inc.
13.	OSHA	Occupational Safety and Health Act
14.	NEC	National Electric Code

1.21 COOPERATION AND COORDINATION WITH OTHER TRADES

- A. The work shall be so performed that the progress of the entire building construction including all other trades, shall not be delayed nor interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as desired.
- B. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other Sections. Any conflicts shall be referred immediately to the Architect for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Architect's satisfaction, at no expense to the Owner.
- C. Where work of this section will be installed in close proximity to work of other sections or where there is evidence that the work of this section will interfere with work of other sections, assist in working out space conditions to make satisfactory adjustment. Prepare and submit for approval 3/8 inch scale or larger working drawings and sections, clearly showing how this work is to be installed in relation to the work of other sections. If the work of this section is installed before coordinating with other trades or so as to cause interference with work of other trades, make changes necessary to protect conditions without extra charge.
- D. Keep fully informed as to the shape, size and position of all openings required for all apparatus and give information in advance to build openings into the work. Furnish and set in place all sleeves, pockets, supports and incidentals.
- E. All distribution systems which require pitch or slope such as storm and sanitary drains and water piping shall have the right of way over those which do not. Confer with other trades as to the location of pipes, lights and apparatus and install work to avoid interferences.
- F. This Contractor shall, with the approval of the Architect and without extra charge, make reasonable modifications in his work as required by normal structural interferences, or by interference with work of other trades, or for proper execution of the work.
- G. This Contractor shall protect all materials and work of other trades from damage that may be caused by his work and shall make good any damages so caused.

1.22 SEISMIC RESTRAINT REQUIREMENTS

- A. For each seismic restraint, provide certified calculations to verify adequacy to meet the following design requirements:
 - 1. Ability to accommodate relative seismic displacements of supported item between points of support.
 - 2. Ability to accommodate the required seismic forces.

- B. For each respective set of anchor bolts provide calculations to verify adequacy to meet combined seismic-induced sheer and tension forces.
- C. For each weldment between structure and item subject to seismic force, provide calculations to verify adequacy.
- D. Calculations shall be stamped by a professional engineer who is registered in the Commonwealth of Massachusetts and has specific experience in seismic calculations.
- E. Restraints shall maintain the restrained item in a captive position without short circuiting the vibration isolation.
- F. Provide seismic restraints for all piping, ductwork and equipment in accordance with the requirements of the Massachusetts State Building Code, 780 CMR, 8th Edition, and referenced requirements of BOCA and NFPA.

1.23 FINAL ACCEPTANCE

- A. Final acceptance of Ownership of the HVAC system installed within this scope of work shall be contingent on passing a satisfactory system pressure test, mechanical performance test and cooling and heating function test to determine that the system will perform according to the contract requirements. The above tests shall be witnessed by the Engineer and the Owner at his option and acceptance will only be granted in writing by the Owner after receipt of certification from the Engineer that the design criteria have been met.
- B. The work shall be so performed that the progress of the entire building construction, including all other trades, shall not be delayed or interfered with. Materials and apparatus shall be installed as fast as conditions permit and must be installed promptly when and as desired.
- C. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other Sections. Any conflicts shall be referred immediately to the Engineer for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Engineer's satisfaction, at no expense to the Owner.
- D. Where work of this section will be installed in close proximity to work of other sections or where there is evidence that the work of this section will interfere with work of other sections, assist in working out space conditions to make satisfactory adjustment. If so directed, prepare and submit for approval 3/8 inch scale or larger working drawings and sections, clearly showing how this work is to be installed in relation to the work of other sections. If the work of this section is installed before coordinating with other trades or so as to cause interference with work of other trades, make changes necessary to protect conditions without extra charge.

PART 2 - PRODUCTS

2.1 ENERGY RECOVERY UNITS

- A. Approved Manufacturers
 - 1. Greenheck

2. Addison
3. Aeon
4. Valent

B. MANUFACTURED UNITS

1. Packaged Air-to-Air Energy Recovery Units shall be fully assembled at the factory and consist of an insulated metal cabinet, downturned outdoor air intake hood, motorized insulated low leakage intake damper, filter assemblies for both intake and exhaust air, energy wheel, airside coil, engineered P trap assembly with P trap, supply air blower assembly, exhaust air blower assembly electrical control unit with all specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection except with electric post heat and exhaust fan only power which have dual point power.

C. CABINET

1. Materials: Formed, insulated double wall construction, fabricated to permit access to internal components for maintenance.
 - a. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish.
 - b. Internal assemblies: 20 gauge, galvanized (G90) steel except for motor supports which shall be 14 gauge galvanized (G90) steel.
2. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - a. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - 1) Thickness: 1 inch (25 mm)
 - 2) Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - 3) Location and application: Full coverage of entire cabinet exterior to include walls and roof of unit. Insulation shall be of semi-rigid type and installed between inner and outer shells of all cabinet exterior components.
 - b. Materials: Rigid urethane foam
 - 1) Thickness: 1 inch (25 mm)
 - 2) Meets UL94HF-1 flame requirements.
 - 3) Location and application: Doors and the floor of the unit.
3. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18 gauge galvanized G90 steel.
4. Condensate drain pan: Pan shall be formed of welded austenitic stainless steel sheet material and provided with a welded drain connection at the front for connection to a P trap. Drain pan shall be sloped in two directions to provide positive draining.
5. P trap: An engineered P trap (condensate drain) assembly shall be provided for each unit, to include cleanout ports, cleanout tool, vacuum break device and see-through reservoir to permit visual verification of water or glycol solution levels.

6. Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt with a five year warranty. The wheel media shall be a polymer film matrix in a stainless steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. The polymer film material shall be coated with silica gel desiccant and shall be designed and constructed to permit cleaning and servicing. The energy wheel is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.
7. Compressed refrigerant coils shall be AHRI Certified and shall be (silver) soldered or brazed into the compressed refrigerant system. Coil shall be constructed of copper tubing, permanently bonded to aluminum fins and enclosed in a galvanized steel frame. If two compressors are used as components of a packaged DX system in the ERU, then the evaporator coil shall be of "interlaced" configuration, permitting independent operation of either compressor without conflict with the other compressor.
8. Supply Air and Exhaust Air blower assemblies: Blower assemblies consist of an electric motor and a belt driven blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on 1.125 inch thick neoprene vibration isolators.
9. Control panel / connections: Energy Recovery Unit shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections. Optional electric post heater shall have a separate electrical control center and separate high voltage power circuit as shown on the plans.
10. Shall be encased in a weather-tight metal housing with intake air vents. Large, metal lift-off or hinged door shall provide easy access to the enclosed vest plate, control circuitry, gas train, burner assembly and exhaust blower.
11. Packaged DX System: Energy Recovery Air Unit shall have an integral compressor(s) and evaporator coil located within the weather-tight unit housing. Condenser coils and appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the ERU and mounted on the exterior of the ERU. Condenser fan motors shall be three phase, type 56 frame, Open Air Over and Shaft Up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Motors shall be UL Recognized and CSA Certified. The refrigerant compressor(s) shall be digital hermetic scroll-type and shall be equipped with liquid line filter drier, thermal expansion valve (TXV), manual reset high pressure and low pressure cutouts and all appurtenant sensors, service ports and safety devices. Compressed refrigerant system shall be fully charged with R-410A refrigerant. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil.

Packaged DX Control and Diagnostics: The Packaged DX system shall be controlled by an onboard digital controller (DDC) that indicates both owner-supplied settings and fault conditions that may occur. The DDC shall be programmed to indicate the following faults:

- Global alarm condition (active when there is at least one alarm)
- Supply Air Proving alarm
- Dirty Filter Alarm
- Compressor Trip alarm
- Compressor Locked Out alarm
- Supply Air Temperature Low Limit alarm
- Sensor #1 Out of Range (outside air temperature)
- Sensor #2 Out of Range (supply air temperature)
- Sensor #3 Out of Range (cold coil leaving air temperature)

12. Motorized dampers / Intake Air, Motorized dampers of insulated low leakage type shall be factory installed.

D. BLOWER SECTION

1. Blower section construction, Supply Air and Exhaust Air: Belt drive motor and blower shall be assembled onto a 14 gauge galvanized steel platform and must have neoprene vibration isolation devices.
2. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
3. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.
4. Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.
5. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

E. MOTORS

1. General: Blower motors greater than 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPCAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley. Comply with requirements in Division 23 05 13, matched with fan load.
2. Motors shall be 60 cycle, 3 phase 460 volts.

F. UNIT CONTROLS

1. The ERU shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors or it can be operated as a heating and cooling system controlled by a Building Management System (BMS).

G. FILTER SECTION

1. Energy Recovery Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. Combination of MERV 8 and MERV 13 pleated filters shall be provided in the intake air stream and MERV 8 filters in the exhaust air stream.

2.2 INSULATION

- A. Furnish all insulation required for the air-conditioning system, including:
 1. Pipe insulation for:

- a. Refrigerant Piping, drain piping including fittings, valves, strainers, etc.
 - b. All exterior pipe.
2. Duct insulation for:
- a. All supply, return and fresh air ductwork.
 - b. All exterior ductwork.
- B. In general, exhaust air ducts (indoors) shall not be insulated.
- C. Refrigerant Pipe: For refrigerant liquid piping provide 1" closed cell elastomeric insulation with heat transfer not to exceed 0.28 BTU/hr/ft²/°F/inch.
- D. Insulate the all supply, return, outdoor and exhaust air ductwork (within attic) with 1.5" thick, 3/4 lb. density fiberglass duct insulation, ASTM C533, maximum service temperature 450°F, with factory applied flame retardant PSK facing (UL labeled).
- E. Fiberglass Insulation:
1. Fiberglass shall meet ASTM C 335 for thermal efficiency.
- F. Ends of insulation shall be sealed with material as recommended by the manufacturer.
- G. A complete moisture and vapor seal shall be provided wherever insulation terminates against metal hangers, anchors and other projections through insulation on cold surfaces.
- H. Fire Hazard Rating: Insulation materials, coatings and other accessories shall individually have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed. Ratings shall be determined by U.L. "Test Method for Fire Hazard Classification of Building Materials", No. 823 or NFPA No. 225 or ASTM E84.
- I. Identification: Furnish and apply piping identification to all piping, showing direction of flow approximately 30'-0" O.C. on bottom, side or top of all pipes. Furnish and apply name or classification of service adjacent to each arrow. Piping identification shall be plastic cloth pipe markers.
- J. Exterior Ductwork: Ductwork to be installed outdoors shall be insulated with 2" thick, 1.5 lb. Density polyolefin foam insulation. Joints to be sealed per manufacture's recommendation. Insulation shall then be wrapped with rubberized asphalt/10 mil polyethylene film membrane.

2.3 DUCT LINER

- A. Furnish and install flexible duct liner insulation in the following locations:
1. Energy Recover Unit - first 10'-0" on supply and return sides.
 2. Exhaust Fans - first 10'-0" on inlet sides.
 3. Fan Coil Units - first 10'-0" on supply and return sides.
 4. Transfer Ducts- provide the whole transfer lined.
- B. Duct liner shall be flexible, fabricated from glass fibers bonded with thermosetting resin. Airstream surface to be protected with an acrylic surface coating that does not support microbial growth as per ASTM G21 and G22.

- C. Duct liner to be 1" thick, 1-1/2" lb. per cu.ft. density.
- D. "K" ("ksi") Value: ASTM C 518, 0.25 at 75°F.
- E. Noise Reduction Coefficient: NRC = .70 or higher based on Type "A" mounting, tested in accordance to ASTM C 423.
- F. Maximum Velocity: 5,000 ft/min.
- G. Adhesive: Meeting ASTM C 916.
- H. Fasteners: Manufactured duct liner galvanized steel pins, welded or mechanically fastened.
- I. Installation to be in strict accordance with manufacturer's recommendations.

2.4 VIBRATION ISOLATION

- A. General:
 - 1. All vibration isolators shall be the product of a single approved manufacturer.
 - 2. Model numbers hereinafter specified are from Mason Industries. Other equivalent units by Consolidated Kinetics, Vibration Mountings and Controls or approved equal are acceptable.
- B. Submittals shall include all spring deflections, spring diameters, scale drawings, attachment details, and rated capacity indicating adequacy for each piece of equipment served.

2.5 AUTOMATIC TEMPERATURE CONTROL

- A. General:
 - 1. Furnish and install, as hereinafter specified, a combination direct digital/electric/electronic temperature control system. The system to be comprised of a network of an independent Stand-Alone Digital Controllers (SDCs), various Application Specific Controllers (ASCs), electric/electronic control equipment, thermostats, sensors, controllers, valves, dampers, actuators, panels, software and other accessory equipment, along with a complete system of electrical control wiring and software generation to fill the intent of the specifications and provide for a complete and operable system. Systems and components manufactured under ISO-9001 certification are preferred.
 - 2. All control equipment to be fully proportioning, and the latest state of the art in manufacture and design.
 - 3. The control systems to be installed by competent control mechanics and electricians under the supervision of the manufacturer of the control equipment. All control equipment to be the product of one (1) manufacturer and all ATC components to be capable of interfacing with the HVAC equipment. The factory trained control contractor must maintain adequate staff and offer standard services to fully support the Owner in the timely maintenance, repair, and operation of the control system. Contractors who do not maintain such staff and offer services or who must develop same for this project are not acceptable. Bids from franchised dealers as well as wholesale, distributor or representative type ATC contractors, or

others whose principal business is not the manufacture, installation and service of temperature control systems will not be acceptable.

4. The Automatic Temperature Control (ATC) Contractor shall have a large support, technical and engineering staff on call 24 hours a day with a minimum of 20 technicians and 5 support engineers. This staff shall be based within 50 miles of the Town of Harvard. The ATC Contractor must support all hardware and software regardless of age. The ATC Contractor shall be "forward-backward" supportive. The software shall be extremely user friendly. Changes in programming must be made without having to rewrite the programming. Local branch/company/division must offer onsite and offsite computer operations training.

B. Scope:

1. The control system provided to consist of all microprocessors, personnel computer, software, database entry, transformers, transducers, relays, thermostats, dampers, damper operators, valves, valve operators and all other necessary control components, along with a complete system, interlocking and communication wiring/cabling to fill the intent of the specification and provide for a complete and operable system. Provide damper operators for equipment such as mixing dampers, where such operators are not supplied by the equipment manufacturers.
2. Alarms, where applicable, and all interlocking wiring required to be provided by the ATC Contractor.
3. The ATC Contractor to review and study all HVAC, Electrical and HVAC drawings and entire specification to familiarize himself with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc., he has to provide.
4. All interlocking wiring and installation of all required control devices associated with roof top units, air handling units, unit ventilators, exhaust fans, chiller, cooling tower, pumps, DX cooling, boilers, fan boxes, etc., to be provided by the ATC Contractor. Close coordination to be exercised between the ATC Contractor and the HVAC Contractor and equipment manufacturers so that installation will be provided in a manner to result in fully operable systems, as intended in these specifications.
5. The ATC Contractor shall furnish all required SDCs/ASCs and miscellaneous control devices to the manufacturers of the following equipment for installation by the respective manufacturer at the factory:

a. Energy Recovery Units

6. The ATC Contractor shall closely coordinate with the equipment manufacturers to ensure that controls are properly installed at the respective manufacturer's factories in strict compliance with the specifications and all sequence of control.
7. The ATC Contractor shall provide all power wiring, conduit, etc. for all his components requiring such. Provide power wiring from breakers in electric panels to ATC panels. All wiring to be done in strict conformance with Division 26.
8. Provide CO₂ sensors to control the rate of ventilation air introduced into the spaces via the sequences outlined on the drawings.
9. The Automatic Temperature Control Contractor shall be available during the balancing and adjusting period to set damper positions in accordance with the Balancing Contractor's settings as indicated on the schedule sheets.

C. Incidental Work By Others:

1. The following incidental work to be furnished by the designated Contractor under the supervision of the ATC Contractor:

- a. The HVAC contractor to coordinate required work with ATC and, without limiting the generality thereof, the work he is to perform for ATC to include the following:
 - 1) Install automatic valves, sensor wells and other similar equipment that are specified to be supplied by the ATC Contractor.
 - 2) Furnish and install all necessary valved pressure taps, water, drain and overflow connections and piping.
 - 3) Provide, on magnetic starters furnished, all necessary auxiliary contacts, with buttons and switches in required configurations.
 - 4) Install all automatic dampers and install duct smoke detectors to control air handling unit shutdown, where applicable.
 - 5) Provide necessary blank-off plate (safing) required to install dampers that are smaller than duct size.
 - 6) Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
 - 7) Provide access doors or other approved means of access through ceiling and walls for service to control equipment.
- b. The HVAC Contractor shall coordinate transfer of SDCs/ASCs and miscellaneous control devices provided by the ATC Contractor to the manufacturers of the following equipment:
 - 1) Fan Coils
 - 2) Energy Recovery Units
- c. The Electrical Subcontractor to:
 - 1) Provide all power wiring (110 VAC or greater) to motors. Provide "spare" breakers in electric panels to be used as a power source by ATC Contractor for ATC panels.
 - 2) Provide power sources for use of the ATC contractor where shown on the electrical plans for ATC compliance with Paragraph E below. In general, this will be used for powering terminal controllers and actuators.

D. Electric Wiring:

1. All electric wiring, wiring connections and all interlocking required for the installation of the temperature control system, as herein specified, to be provided by the ATC Contractor, unless specifically shown on the Electrical drawings or called for in the Electrical Specifications, Division 26. Power to valves and actuators to be by the ATC Contractor, except as specifically noted in the Electrical drawings and specifications.
2. All wiring and wiring methods to comply with the requirements of the Electrical Section of the specifications.
3. Provide, on magnetic starters, all necessary auxiliary contacts, with buttons and switches in required configurations.

E. Submittal Brochure:

1. The following to be submitted for Approval:

- a. Control drawings with detailed piping and wiring diagrams, including bill of material and a written sequence of operation for each system controlled by the ATC contractor. Diagrams to include individual wiring and tubing marking designation, interlock details and wiring details of interfaces to other manufacturers system.
- b. A symbols key and an overall LAN Architecture Diagram.
- c. Panel layouts and nameplate lists for all local and central panels.
- d. Valve and damper schedules showing size, configuration, capacity and location of all equipment.
- e. Data sheets for all control system components.
- f. Control strategies (software flow charts) must be included within the second ATC shop drawing submittal. The listing of each strategy must be in English and demonstrate the desired ATC sequence of operation. Submittal must be complete with proposed schedules, listing of setpoints and end device point listing and addresses.
- g. Auto-Cad 2004 compatible as-built drawings (cd).
- h. Upon project completion, submit operation and maintenance manuals, consisting of the following:
 - 1) Index sheet, listing contents in alphabetical order
 - 2) Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams
 - 3) Description of sequence of operations
 - 4) As-Built interconnection wiring diagrams
 - 5) Operator's Manual
 - 6) Trunk cable schematic showing remote electronic panel locations, and all trunk data
 - 7) List of connected data points, including panels to which they are connected and input device (ionization detector, thermostat, etc.)
 - 8) Conduit routing diagrams

F. Guarantee:

1. In addition to the guarantee requirements of the Contract and General Conditions, the Contractor shall obtain in the name of the Owner the standard manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. These guarantees are in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.
2. Upon completion of the installation, the ATC Contractor shall submit to the Owner an agreement to provide the necessary programmed maintenance, to keep the various control systems in proper working condition, for a period of one (1) year commencing at final project acceptance. Additionally, this contractor to submit to the owner its standard agreement to support the system operation. This service must include operators support, application support, remote diagnostic support (via remote, on-line telephone support services) as well as database management support. This service shall be available 365 days per year, 24 hours a day.
3. The programmed maintenance agreement shall fully describe the maintenance work to be performed and shall advise as to the cost of this work prior to awarding of Contract.

G. Instruction and Adjustment:

1. Upon completion of the project, the ATC Contractor to:
 - a. Fine-tune and “debug” all software control loops, routines, programs and sequences of control associated with the control system supplied.
 - b. Completely adjust and make ready for use, all transmitters, relays, damper operators, valves, etc., provided under this Section. This contractor shall furnish copies of complete, detailed, calibrating checkout and commissionary documentation for each controller.
 - 1) Documentation to list each procedure and shall be signed by the control specialist performing the service.
 - c. The ATC Contractor shall provide an on-site training program for the Owner’s staff in the operation and use of the control system. Training to include three (3) segments, as follows:
 - 1) Include 16 hours (e.g. one (2) eight (8) hour day) of classroom and hands-on training. This segment to instruct Owner’s personnel in the system configuration, component characteristics, control strategy on each controlled system and all requirements for daily operation and use of the system. This segment to give the Owner’s representative a working proficiency in day-to-day operational requirements (i.e., system monitoring, alarm acknowledgment, HVAC system troubleshooting techniques, setpoint and time schedule adjustments, manual override, etc.).
 - 2) All training to take place at the site and at times mutually agreed to between the ATC Contractor and the Owner. The ATC Contractor to provide to the Owner’s designated representative, at least three (3) weeks before each segment, a course syllabus outline and schedule. The ATC Contractor to provide all training material, reference material and training aids, as required, all as part of his Contract cost.

H. Equipment:

1. General:
 - a. The system to be comprised of a network of stand-alone digital controllers, application specific controllers, all networked together via an RS-485 LAN to provide a complete control system, as herein specified. Controls for each system shall be provided as described in the sequences of operation.
2. Stand-Alone Digital Controllers (SDC):
 - a. Stand Alone Digital Controllers (SDC) to be modular 16 bit microprocessor based direct digital controllers providing a multi-tasking operating system for control functions simultaneous with all other facility management, operator interfaces and system communications functions.
 - b. The SDC operating software to be written in a high level programming language to ensure compatibility with future system enhancements. All programming defining the functions to be performed by the SDC, including but not limited to application programs and point database, to be protected from loss due to power failure for a minimum of six (6) months. Systems providing nonvolatile memory are preferred. Systems without nonvolatile

memory to provide battery backup sufficient to provide protection for the six (6) month period.

- 1) In the event of the loss of normal power, there shall be an orderly shutdown of all SDCs to prevent the loss of normal power, there shall be an orderly shutdown of all SDCs to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data.
 - 2) Upon restoration of normal power, the SDC shall automatically resume full operation without manual intervention.
 - 3) Should SDC memory be lost for any reason, the panel will automatically receive a download via the local area network, phone lines, or connected computer. In addition, the user shall have the capability of reloading the SDC via the local area network, via the local RS-232C port, or via telephone line dial-in.
- c. The SDC to have an access protected user-friendly English language, alphanumeric liquid crystal display (LCD), full function select keypad and an RS-232C communications interface port. The RS-232C communications interface port may be connected to printers, VT-100 class terminals or auto-dial/auto answer modems for remote telecommunications.
- d. The SDC to provide English language display with protected customer access allowing changes of sequences, schedules, setpoints, limits and other operating parameter of control programs.
- e. The SDC to provide true floating point arithmetic calculations. To accommodate accumulation of large totalized values, the SDC is to support calculation and accumulation of values up to ten (10) to the thirty eighth power.
- f. The SDC to provide access through the panel mounted, integral keypad/display for monitoring, changing, or modifying any system parameter of any digital controller on the Network, assuming the user is of sufficient user access level.
- 1) The operator shall have the ability to manually override automatic or centrally executed commands at the SDC via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
 - 2) Switches shall be mounted either within the SDC's key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
 - 3) SDC's shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. SDC's shall also collect override activity information for reports.
 - 4) SDC's shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LED's or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.
- g. The SDC to be capable of providing daily FMS profile reports and monthly summary reports as well as defined trend reports and maintenance time reminder function. The SDC to perform "Time of Day Scheduling," "Optimum Start/Stop," "Enthalpy Optimization" and all other industry available, control

- optimization strategies, such as “Electric Demand Limiting,” “Supply Air Reset” and “Soft Start Ramp-up” for their connected systems of equipment.
- h. All SDC’s to have as a standard feature of their system software, complete libraries of control algorithms for DDC, Energy Management, and Facilities Management functions, including, but not limited to two-position control, proportional control, proportional plus integral control, P+I+D control, automatic loop tuning control, hot water reset, fan speed/CFM control, morning warm-up, etc. as well as custom process programming defined by the Operator. These resident libraries of algorithms to be drawn from the creation of the application programming of the SDC.
 - i. Contractor to provide a blueprint documentation of the software application program for the SDC. Documentation provided to include block software flowcharts showing the interconnection between each of the control algorithms and sequences. Program listings to be on the same blueprint, along with the program flowchart, and description of the sequence of operations. This blueprint to be stored and maintained in the SDC panel. System acceptance to not be completed until this documentation is provided and located at each panel.
 - j. The SDC’s to communicate to provide coordination for global electric demand limiting control. Demand limiting algorithm to be resident within the selected SDC in control of the specific items of equipment. Demand limiting to be sliding window demand control with a minimum of three user definable time of day demand limit setpoints. Multiple load shed tables to be definable, and be shed for rotational or sequential restoration as appropriate for the loads within each designated shed table.
 - k. Reports can be designated as automatically printed, or called-up for report print out on demand. When specified alarm conditions occur, the SDC to be capable of providing a report printout listing the status of specific items associated with the equipment generating the alarm. Reports to record the time the status information was taken, and allow operational personnel to use this information to diagnose the alarm situation.
 - l. For specific systems of equipment, the SDC to record a continuous log of values of selected variables. Upon occurrence of an alarm, or some specific combination of performance conditions, the report will be printed, showing the status of each of these variables for each of the 15 minutes immediately prior to the occurrence of “triggering” condition.
 - m. SDC Software to include a multi-level user access password system. Password restrictions to confine the user to certain system capabilities as defined by the Owner. Capabilities to be able to be restricted to one, some, or all of the followings: System monitoring, setpoint change, system override, algorithm change, report request, report generation, etc.
 - n. All sensing inputs to be provided via industry standard signals. Temperatures, humidities, differential pressure signals, and other signal inputs shall be one of the following types:
 - 1) 0-20 mA
 - 2) 4-20 mA
 - 3) 0-5 VDC
 - 4) 0-12 VDC
 - 5) 1000 ohm platinum RTD
 - 6) 1000 ohm Balco
 - 7) 10 k ohm Thermistor

- 8) All signal inputs to be compatible with the controllers used, and with the requirements for readout of variables in true scales engineering units as specified.
 - o. Control panel to internally provide test points for the circuit driving the equipment contactor, for the purpose of troubleshooting the 120 VAC or 240 VAC circuit to the contactor. All such relays or digital output modules to provide a pilot light or LED display of this same status. On/Off output modules to be of the modular construction that can be easily and quickly replaced, on an individual basis, if the module were to be damaged.
 - p. Modulating outputs to be industry standard 0-5 VDC, or 0-12 VDC with definable output spans, to adapt to industry available control products. Milliamp outputs of 0-20 mA or 4-20 mA are also acceptable. Drive open/Drive closed type modulating outputs are acceptable provided that they also provide within the control panel, a meter, gauge, or display indicating via on board display of HHOT, the commanded position signal for the actuating device. This meter, gauge, or display must provide either a 0-100 percent position indication, or read out directly in the engineering units of the signal being used. Drive open/drive closed type controllers to include sufficient components and control algorithms to comply with this requirement. In the case of Drive open/closed technology, position feedback to be provided to insure positive indication that the control device is at the commanded position.
 - q. Spare wiring/cabling: For each SDC, provide two (2) spare twisted, shielded pairs of wires to terminate at the SDC on one end and at the controlled unit at the other. Label both ends of spare wiring as "SPARE".
3. Application Specific Controllers (ASC):
 - a. Each SDC shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through LAN Device Networks.
 - b. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Provide the following types of ASCs as a minimum:
 - 1) Central System Controllers
 - 2) Terminal Equipment Controllers
 - c. Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.
 - d. Central System Controllers:
 - 1) Provide for control of central HVAC systems and equipment including, but not limited to, the following:
 - a) Energy Recovery Units
 - 2) Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Provide a hand/off/ automatic switch for each digital output for manual override capability. Switches shall be mounted either within the controller's key-accessed enclosure,

or externally mounted with each switch keyed to prevent unauthorized overrides. In addition, each switch position shall be supervised in order to inform the system that automatic control has been overridden.

- 3) Each controller shall support its own real-time operating system. Provide either non-volatile memory or a time clock with battery backup to allow for stand-alone operation in the event communication with its SDC is lost and to insure protection during power outages.
 - 4) All programs shall be field-customized to meet the user's exact control strategy requirements. Central System controllers utilizing pre-packaged or canned programs shall not be acceptable. Where required, provide SDCs for all central equipment in order to meet custom control strategy requirements.
 - 5) Programming of central system controllers shall utilize the same language and code as used by SDC to maximize system flexibility and ease of use.
 - 6) Each controller shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.
 - 7) Provide a door-mounted interface terminal to allow for direct-user access to the controller.
 - a) The terminal shall provide the user with the following functionality as a minimum:
 - View and set date and time
 - Modify and override time-of-day schedules
 - View points and alarms
 - Monitor points
 - Command and modify setpoints
 - Modify setpoints
 - LED display with scroll
 - b) Should the system controller be unable to interface to a door-mounted terminal, provide a laptop or similar terminal at the controller, or provide an SDC with a door-mounted or local terminal in lieu of the system controller in order to meet the specified minimum functionality.
- e. Spare wiring/cabling for each ASC, provide two (2) spare twisted, shielded pairs of wires to terminate at the ASC on one end and at the controlled unit at the other. Label both ends of spare wiring as "SPARE".
4. Automatic Control Valves:
- a. Control valves shall be two-way or three-way pattern as shown, constructed for tight shut off and shall operate satisfactorily against system pressures and differentials. Two-way control valves shall exhibit equal percentage characteristics. Valves with size up to and including 2" shall be screwed with 250 psi ANSI pressure body rating; 2 1/2" and larger valves shall be flanged configuration. Proportional control valves shall be sized for a maximum pressure drop of 4.0 psig at rated flow (except as noted). Two-position control valves shall be line size and shall be provided with a 250 psi static pressure body rating.

- b. All valves shall be capable of operating in sequence when required by the sequence of operation. All control valves shall be sized by the control manufacturer and shall be guaranteed to meet heating and cooling loads specified.
 - c. All control valves shall be suitable for the pressure conditions and shall close against the differential pressure involved. Valve operator connection type (screwed or flanged) shall conform to pipe schedule in this specification.
 - d. Hot water control valves shall be normally open, single seated type with equal percentage flow characteristics. The valve discs shall be composition type with bronze trim.
 - e. Chilled water control valves shall be single seated type with equal percentage flow characteristics, normally closed. The valve discs shall be composition type with bronze trim.
 - f. Valves shall be sized on the exact pressure drop for the equipment served to prevent over or under sizing the valves. Provide a separate submittal with all of this information included.
5. Damper:
- a. General:
 - 1) Automatic dampers, furnished by ATC Contractor, shall be single or multiple blade as required and/or shown on the drawings.
 - 2) Numerous references are made in this specification as to the responsibility of furnishing and installation of dampers and operators. The ATC Contractor shall closely coordinate his work with the HVAC Contractor to assure that all dampers are provided as required, and he shall examine all pertinent specification sections to assure that all dampers required but not provided by equipment manufacturers are provided under this contract.
 - 3) All blank-off plates and conversions necessary to install smaller than duct sized dampers are the responsibility of the HVAC Contractor.
 - 4) Dampers shall be installed by the HVAC Contractor under the supervision of the ATC Contractor.
 - 5) Operators shall be provided by the ATC Contractor for all types of dampers whether they are provided by equipment manufacturer or by the ATC Contractor.
 - b. Dampers:
 - 1) All damper frames shall be constructed of 13 gauge galvanized sheet metal and shall have flanges for duct mounting. Dampers installed in stainless steel and aluminum duct work shall be constructed of type 316L stainless steel (frame and blades).
 - 2) Damper blades shall not exceed six (6) inches in width. All blades shall be of corrugated type construction, fabricated from two (2) sheets of 22 gauge galvanized sheet steel, spot welded together, blades shall be suitable for high velocity performance. Damper leakage shall be 2% or less at 5 inches W.C.
 - 3) All damper bearings shall be made of nylon. Bushings that turn in the bearings shall be oil impregnated sintered metal.
 - 4) Leakage and flow characteristic charts must be submitted to the Engineer prior to installation.

6. Actuators And/Or Operators:
 - a. All damper actuators/operators shall be fully proportioning, unless otherwise specified. They shall be quiet in operation and shall have ample power to overcome friction for damper linkage and air pressure acting on louvers to position dampers accurately and smoothly. The damper actuator/ operator mounting arrangement shall be outside the airstream wherever possible, with a maximum of 16 square feet per actuator/operator.
 - b. The actuators/operators shall be capable of operating at varying rates of speed to correspond to the dictates of the controllers and variable load requirements. The actuators/ operators shall be capable of operating in sequence when required by the sequence of operation. The actuators/ operator shall have external adjustable stops to limit the stroke in either direction. The actuator/operator linkage arrangement shall be such as to permit normally open or normally closed positions of dampers as required.
 - c. All dampers sequenced with valves or dampers shall be furnished with pilot positioners or panel mounted positive positioning relays to ensure proper control sequencing.
 - d. For exact requirement and quantities of actuators/ operators, see plans and coordinate with the HVAC Contractor.

7. Valve And Damper Actuators (Electronic):
 - a. Actuators shall be of the gear train or hydraulic type.
 - b. Actuators shall have integral mechanical stroke limiting adjustments to prevent actuator overstroke and automatic load sensing to protect from motor burnout in stall condition.
 - c. All actuators shall be sized by the ATC Contractor and guaranteed to provide torque and stroke characteristics for the applied duty. Output shall be compatible with outputs of the controlling device. All actuators shall be of the spring return type, linked normally open or closed as applicable and common to the application.
 - d. All actuators shall be of the direct analog fully proportioning variety. Two position or floating type control actuators may be used only if specifically mentioned in the sequence of operation.

8. Temperature Sensors: Temperature sensors shall be RTDs or thermistors. Sensor Time Constant shall not exceed 5 seconds for a 60% response to a step change in temperature. Sensor repeatability shall be 0.1 Degrees F or better.
 - a. Space temperature sensor element shall be accurate within +0.5 Degrees F over a range from 40 Degrees F to 100 Degrees F. Sensors shall be housed in manufacturer standard miniature type thermostat cover and shall include exposed thermometer, setpoint adjustment and override button as specifically called for in the sequence of operation.
 - b. Outside air temperature sensor elements for each of the controllers shall be accurate within +0.5°F over a range from -20°F to 120°F.
 - c. Duct sensors shall be of the averaging type. Element length shall be adequate for sensing the average cross-sectional temperature over the full duct cross-section.

9. Pressure Switches: The pressure switches shall meet but not be limited to the following specifications:

- a. Sensing elements shall be capsule, diaphragm, bellow, bourdon tube, or solid state capable of withstanding 150% of rated pressure (sensor).
 - b. Switch actuation shall be adjustable for the specified application.
 - c. Switch shall have snap-action Form C contact rated for the application.
 - d. Gauge pressure switches shall have adjustable differential settings.
 - e. Accuracy of +1% of the switch setting.
 - f. Flow Switches: Flow switches shall meet but not be limited to the following specifications:
 - 1) Repetitive accuracy of +1% of operating range.
 - 2) Switch actuation adjustable over the operating flow range.
10. Low Limit Thermostat: Electric low temperature warning thermostats shall have low point sensitive elements installed to cover the entire duct area, with minimum coverage of (20 linear feet minimum). These thermostats shall be two-position manual reset type. Where coils are two-banks, two (2) sets of freezestats, wired in series, shall be provided and hard-wired to shut down the supply and return fans and show an alarm on the FMCS, as applicable and specified herein.
11. Smoke Detection System:
- a. Smoke detectors shall be furnished and wired to building alarm system by the Electrical Subcontractor. Smoke detector shall be installed by the Contractor. All hard-wired interlocking for shutdown of fans shall be by the ATC Contractor, with an alarm sent to the Network 8000 Host.
 - b. Except as otherwise specifically indicated, all supply, return and/or exhaust/ventilation systems 2000 cfm and larger that are interlocked with the air handling unit shall automatically stop when the in-duct smoke detectors are activated.
12. Miscellaneous Control Panels: Details of each panel shall be submitted for review prior to fabrication. Locations of each panel shall be convenient for adjustment and service. Provide engraved nameplate beneath each panel mounted control device clearly describing the function of said device and range of operation. All manual switches shall be flush mounted on the hinged door.
13. All electrical devices within the panels shall be factory pre-wired to a numbered terminal strip. All wiring within the panel shall be in accordance with NEMA and UL Standards and shall meet all Local Codes. All wiring in occupied spaces shall be concealed whenever possible. Any exposed wiring shall be enclosed in painted wiremold, color as selected by the Architect.
14. Sequences of Operation: Provide control components for each system as required for the sequence of operation indicated on the contract drawings.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all items specified under PART 2 - PRODUCTS, according to the applicable manufacturer's recommendations and shop drawings, the details shown on the drawings and as specified under this section. Provide all required hangers and supports.
- B. All welding done under this section shall be performed by experienced welders in a neat and workmanlike manner. All welding done on piping, pressure vessels and structural steel under this section shall be performed only by persons who are currently qualified in accordance with ANSI Code B31.1 for Pressure Piping and certified by the American

Welding Society, ASME or an approved independent testing laboratory; and each such welder shall present his certificate attesting his qualifications to the Engineer's representative whenever requested to do so on the job.

- C. All pipe welding shall be oxyacetylene or electric arc. High test welding rods suitable for the material to be welded shall be used throughout. All special fittings shall be carefully laid out and joints shall be accurately matched intersections. Care shall be exercised to prevent the occurrence of protruded weld metal into the pipe. All welds shall be of sound metal free from laps, cold shots, gas pockets, oxide inclusions and similar defects.
- D. All necessary precautions shall be taken to prevent fire or damage occurring as the result of welding operations.

3.2 HOISTING, SCAFFOLDING, STAGING AND PLANKING

- A. All hoisting of equipment to roof shall be performed in the off hours of school operation. Exact timing shall be coordinated with the owner.
- B. Provide, set up and maintain all required derricks, hoisting machinery, scaffolding, staging and planking. Perform all hoisting required to complete the work of this section as indicated and specified.
- C. Scaffolding is to have solid backs and flows to prevent dropping material therefrom to the floors or ground.
- D. All items of existing work indicated to be removed or are necessary to remove to permit proper installation of new work to be taken down and be immediately removed from the premises.

3.3 INSULATION

- A. All of the insulation work shall be done by contractors regularly engaged in this type of work in a neat and workmanlike manner. All insulation shall be completely sealed with no glass fibers exposed to the air.

3.4 EQUIPMENT

- A. Equipment shall be installed complete with all required hangers and supports in accordance with the manufacturer's recommendations.
- B. Furnish and install all steel structural support members for proper hanging and support of equipment. Provide vibration isolation on all hangers.

3.5 SHEET METAL WORK

- A. All of the sheet metal work shall be done by contractors regularly engaged in this type of work.
- B. Neatly erect all sheet metal work as shown on plans or as may be required to carry out the intent of these plans and specifications.
- C. All necessary allowances and provisions must be made by this contractor in the case of beams, posts, pipes, iron work or other obstructions in the construction of the building or the work of other trades whether or not the same is shown on plans.

- D. All ducts are to be rigid and are to be strongly and carefully supported with suitable braces or angles to keep them true to shape and to prevent buckling.
- E. All joints are to be made tight and all interior surfaces are to be made smooth.
- F. Protect all work under this section from injury during the progress of erection and until final acceptance by the Architect.
- G. All metal work in dead or furred down spaces is to be erected in time to occasion no delay in the work of other trades on the building.
- H. Supply collars to diffusers shall be installed inside the neck of the diffusers. Dampers on all registers and diffusers shall be installed in the open position.
- I. Joints in all ductwork throughout shall be sealed, Class-B. All ductwork shall be taped and sealed.
- J. During the progress of the work and after the completion of the same, this Contractor shall remove from the premises all dirt, debris, rubbish, waste materials, etc., cause by him in the performance of this work, together with all his tools and appliances.

3.6 AUTOMATIC TEMPERATURE CONTROLS

- A. System shall be complete with all control wiring, switches, relays, transformers, and other accessories.
- B. The Control System herein specified shall be free from defects in workmanship and material under normal use and service. After completion of the installation, regulate and adjust all thermostats, control valves, control motors, and other equipment provided and/or wired under this contract. If within twelve (12) months from the date of completion, any of the system herein described is proved to be defective in workmanship or materials, it will be replaced or repaired free of charge.
- C. Provide any service incidental to the proper performance of the Control System under guarantees outlined above for the period of one year. Normal maintenance of the system or adjustments of components is not to be considered part of the guarantee.

3.7 PLACING IN SERVICE

- A. At the completion of performance tests and following approval of test result, recheck all equipment to see that each item is adequately lubricated and functioning correctly.

3.8 VIBRATION ABSORPTION

- A. All equipment and piping shall operate without objectionable or unusual noise or vibration, as judged by the Engineer.
- B. Rotating equipment shall be fitted with such vibration-absorbing facilities as will be required to limit the transmission of vibration to the building and to the attached piping and breaching. The facilities shall be generally designed to limit this transmission to a maximum of 2%, but a greater amount will be allowed if it does not prove objectionable. The facilities shall also be designed to limit equipment floor loadings to 500 lb/sq. ft. or less. If, in order to accomplish this, the equipment requires the job installation of isolation

mountings, inertia blocks, special hangers or other arrangements, these shall be carefully and specifically selected for each piece of equipment.

- C. Motor driven equipment shall have the motor, equipment and drive mounted on a common base. Hollow bed plates shall be grouted with a rich cement mortar.
- D. Submit shop drawing data for approval by the Engineer showing the make, type, and size of isolation mountings, flexible pipe connectors, and other facilities to be provided, including any concrete inertia blocks that may be required. The data shall clearly indicate that the isolating arrangements can and will limit the transmission of vibration as specified.

3.9 MISCELLANEOUS IRON AND STEEL

- A. Provide steel supports and hangers required to support fans, tanks, air handling units, pipe, ductwork, and other equipment or materials. Submit details of steel supports and method of fabrication for approval.
- B. All work shall be cut, assembled, welded and finished by skilled mechanics. Welds shall be ground smooth. Stands, brackets, and framework shall be properly sized and strongly constructed.
- C. Measurements shall be taken on the job and worked out to suit adjoining and connecting work. All work shall be by experienced metal working mechanics. Members shall be straight and true and accurately fitted. Scale, rust, and burrs shall be removed. Welded joints shall be ground smooth where exposed. Drilling, cutting and fitting shall be done as required to properly install the work and accommodate the work of other trades as directed by them.
- D. Members shall be generally welded, except that bolting may be used for field assembly where welding would be impractical. Welders shall be skilled.
- E. All shop-fabricated iron and steel work shall be cleaned and dried and given a shop coat of paint on all surfaces and in all openings and crevices.

3.10 BALANCING, ADJUSTING, OPERATING, AND INSTRUCTIONS

- A. The HVAC contractor shall engage the services of an independent firm to perform testing, adjusting and balancing of the HVAC systems. The HVAC contractor shall submit to the owner at least qualified firms for the owner's review and acceptance in accordance Section 01750, start up and adjusting.
- B. Engage a balancing company to adjust, balance, and operate the heating, ventilating and air-conditioning system and thoroughly instruct the Owner's personnel in all phases of care and operation of the systems. The Balancing Company shall be certified by Associated Air Balance Council or by the National Environmental Balancing Bureau.
- C. Before the air systems are tested and balanced, ducts and equipment shall be thoroughly cleaned by the contractor so that no dirt, dust, or other foreign matter will be deposited in or carried through the systems. For this purpose, cheesecloth shall be placed over each opening for entraining such particles during the cleaning operation.

- D. The Balancing Company will not perform water systems balancing until after the systems have been cleaned and treated by the Contractor.
- E. Rooftop units shall not be operated without filters in place. All filters shall be replaced by the Contractor after rooftop units have been cleaned and ready for system balancing.
- F. The Contractor as a part of this contract shall provide all materials, labor, and service of all contractors for fulfillment of air and water balancing of all systems. The Balancing Company shall inform Contractor of all requirements ahead of time.
- G. All equipment shall be operated and adjusted and all air and water systems shall be adjusted and balanced, readings taken and recorded on an approved form submitted to the Engineer for approval, readjusted and rebalanced in accordance with the Engineer's review comments and resubmitted.
- H. Air Systems:
 - 1. Systems shall be adjusted and balanced so that air quantities at outlets are as indicated on the drawings and so that the distribution from supply outlets is free from drafts, and uniform over the face of each outlet.
 - 2. Adjustments shall be made by the Balancing Company to volume dampers at air outlets to produce the least pressure drop consistent with volume requirements.
 - 3. After completion of balancing and adjusting, settings of dampers, shall be permanently marked by the Balancing Company so that they can be restored if disturbed at any time.
 - 4. Direct reading velocity meters may be used by the Balancing Company for comparative adjustment of individual outlets, but air quantities in ducts have velocity of 1,000 feet per minute or greater, shall be measured by means of pitot tubes and inclined gauge manometers. Instrument test opening enclosures as specified shall be provided as required.
 - 5. Adjustment of the temperature controls shall be coordinated by the person in charge of the balancing and adjusting and shall be performed coincidental therewith. In conjunction with the Automatic Temperature Control System, simulate a complete cycle of operation for each system.
 - 6. After completion of the testing, balancing and adjusting of the air systems, six copies of a report showing the following information shall be submitted to the Engineer for review and approval. The report shall be arranged as follows:
 - a. Location of each air outlet or inlet.
 - b. Dimensions or size of each outlet or inlet.
 - c. Type: diffuser, grille, register, supply, return exhaust, and Ak value for each.
 - d. Cfm of air as indicated on drawings for each outlet or inlet.
 - e. Cfm of air as measured, after each complete system has been balanced and adjusted, for each outlet or inlet.
 - f. After each complete system has been balanced and adjusted, the total cfm at fan discharge, static pressure at fan outlet, total static pressure for apparatus, fan speed, motor amperage for each phase and voltage shall be listed.

3.11 TESTING

- A. All hot water piping in whole or in part, prior to insulating and being closed in, shall be subject to a hydrostatic test pressure of 100 psig for eight hours without a pressure drop at the end of the test period. All leaks that occur shall be repaired by removing the joints

in their entirety, rejoining, and test repeated as often as necessary until the piping system or systems are absolutely tight.

- B. Furnish all necessary equipment to conduct the testing of the piping system.
- C. Two pressure gauges shall be used whose range shall not exceed 0 to 150 psig, nor be less than 0 to 120 psig. Evidence of leakage or pressure drop shall be cause for rejection.
- D. A log of all tests shall be kept by the Contractor. The log shall provide a description of the test or inspection, the date performed, and the signatures of the responsible contractor's person performing the work and the witnessing engineer. This log shall form part of the final documentation. Failure to maintain this log will result in re-inspection or testing at the Contractor's expense.

END OF SECTION 230000

DIVISION 26

SECTION 260000

Electrical
(FILED SUB-BID REQUIRED)

PART 1 - GENERAL

1.00 RELATED DOCUMENTS

- A. Include GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS and applicable parts of Division 01 as part of this Section.
- B. Examine all Project Specifications and Drawings for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under Contract.
- D. The following definitions apply to the Drawings and Specifications
 - 1. Furnish: The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations."
 - 2. Install: The term "install" is used to describe operations at project site including actual "unloading, unpacking, rigging in place, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
 - 3. Provide: The term "provide" means to "furnish and install, complete and ready for intended use."
 - 4. Installer: An "installer" is the contractor or an entity engaged by the contractor, either as an employee, subcontractor, or sub-subcontractor for a performance of a particular construction activity, including installation, erection, application and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
 - 5. Contractor: The term "Contractor" shall mean Electrical Contractor.

1.01 TIME, MANNER AND REQUIREMENTS FOR SUBMITTING FILED SUB-BIDS

- A. The work of this Section pertains to a publicly-bid Filed Sub-Bid and includes the following requirements:
 - 1. Filed Sub-bids shall be submitted in accordance with provisions of the Massachusetts General Laws, Chapter 149, Section 44A to 44L inclusive, as amended. The time and place for submission of Filed Sub-Bids are set forth under the Advertisement. Procedures and requirements for submitted Filed Sub-Bids are set forth in the Instructions to Bidders.

2. Sub-bidders must be DCAMM certified in the listed trade and shall include a current DCAMM Sub-bidder Certificate of Eligibility and a signed DCAMM Sub-Bidder's Update Statement with the bid.
3. The Work of this Filed Sub-Bid is shown on the following listed Drawings & specifications, not just those pertaining particularly to this Filed Sub-Bid, unless specifically called out otherwise, regardless of where among the Drawings it appears:
 - a. E Series dwgs
Coordination with:
 - 1) All Trades.
4. The remaining Contract Drawings are included for reference and coordination.
5. Each Sub-Bid filed with the Awarding Authority must be accompanied by Bid Bond, Cash, or Certified Check, or by a Treasurer's Check or Cashier's Check, issued by a responsible bank or trust company in the amount stipulated in the "Instructions to Bidders." A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.
6. Each Sub-Bid submitted for the work under this Section shall be on a form furnished by the Awarding Authority, as required by Section 44 F of Chapter 149 of the Massachusetts General Laws, as amended.

1.02 SUBMITTALS

- A. Conform to the requirements of the submittals section for schedule and form of all submittals. Coordinate this submittal with submittals for all other finishes.
- B. Materials List: Before purchasing materials for the work, submit to the Architect/Engineer a complete list showing (1) the materials specified, and (2) the equivalent materials proposed for use, including description of product, if the Plumbing Contractor desires to use materials other than those specified.
 1. All materials shall be approved by the Architect/Engineer before commitment for materials is made. Intention of using specified materials shall not relieve the Contractor from submitting the items listed herein.
- C. Proposed Products List:
 1. Wire
 2. Disconnect Switch
 3. Conduit and Conductors
- D. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.
- E. Mark dimensions and values in units to match those specified.
- F. Submit Material Safety Data Sheets (MSD) on each product with submittal.

1.03 DEFINITIONS:

- A. Owner – Town of Bromfield

- B. Awarding Authority – Town of Bromfield
- C. Architect or Engineer – BLW Engineers, Inc.
- D. The HVAC Contractor shall be considered the General Contractor and General Bidder.
- E. The Contractor shall be considered the General Contractor and General Bidder.
- F. The Electrical Contractor shall be considered the Electrical Contractor.
- G. “Provide” shall mean furnish and install.
- H. “Disconnect” shall mean to electrically disconnect and otherwise make the equipment safe for removal and disposal by others. The Electrical Contractor shall remove conduit and wiring serving disconnected equipment, unless otherwise noted.
- I. “Remove” shall mean to “disconnect”, remove and dispose of the equipment indicated.
- J. “Relocate” shall mean to “disconnect” for relocation of the existing equipment.
- K. “Remain” shall mean the existing equipment is to remain in place, in operating condition.

1.04 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals necessary to provide complete electrical system as shown on the Drawings and as specified herein. The major items of work shall generally consist of:
 - 1. Electrical Demolition: Demolition/removal or extension of existing branch circuitry for the existing mechanical equipment as indicated on the electrical drawings.
 - 2. New Electrical Work in Building including providing new branch circuitry to power new mechanical equipment. The work shall generally consist of providing:
 - a. Raceways, Fittings and Supports
 - b. Wire and Cable
 - c. Disconnect Switches
 - d. Feeder Circuit Wiring and Connections for new mechanical equipment
 - e. Grounding
 - f. Electrical Identification (name plates and labeling)
 - g. All Fees and Permits
 - h. Testing
 - i. Operations and maintenance manuals.
 - j. Circuit breakers for existing panelboards.

- B. Furnish all labor and materials to perform demolition work as shown on the Drawings and as specified hereinafter.
- C. During final inspection, the electrical contractor shall be available to the mechanical and electrical engineers to open all electrical/control panels for inspectional purposes.

1.05 RELATED WORK PROVIDED BY THE GENERAL CONTRACTOR

- A. Carpentry Work
- B. Control Wiring

1.06 CODES, ORDINANCES, AND PERMITS

- A. Installation of systems and equipment provided under this section shall be done in strict accordance with Massachusetts Department of Public Safety Codes, Massachusetts Department of Environmental Protection, Massachusetts State Building Code, the Massachusetts Electrical Code, the National Electrical Code (most recent editions) and the Town of Wellesley Codes and Regulations having jurisdiction.
- B. All work, where applicable, shall conform to NFPA codes and all material shall be U.L. approved. Contractor shall be responsible for all coordination with the Fire Alarm Service Company and shall be responsible for payment on any service fees associated with Fire Alarm shutdowns. Contractor shall be responsible for any notifications or fees associated with Bromfield Fire Department for said shutdowns.
- C. All electrical apparatus furnished under this section shall be approved by the UL and shall be so labeled or listed where such is applicable. Where custom-built equipment is specified and the UL label or listing is not applicable to the completed product, all components used in the construction of such equipment shall be labeled or listed by UL where such is applicable to the component.
- D. Give notices, file plans, pay for and obtain permits and licenses, pay fees and obtain necessary approvals from authorities having jurisdiction. Deliver certificates of inspection and approval to the Engineer. Authorities having jurisdiction include, but are not necessarily limited to:
 - 1. Bromfield Wiring Inspector (Inspectional Services Department)
 - 2. Bromfield Fire Department's Fire Prevention Officer
- E. No work shall be covered before examination and approval by Engineer, inspectors, and authorities having jurisdiction. Replace imperfect or condemned work conforming to requirements, satisfactory to Engineer, and without extra cost to the Owner. If work is covered before due inspection and approval, the installing contractors shall pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.
- F. In the event local inspectors or codes require a change in the material, design, or involve additional labor, all such changes shall be submitted to the Engineer for approval before proceeding with the work. Comply with all local codes and inspections.

1.07 RECORD DRAWINGS

- A. Refer to Section 01 70 00, Project Closeout, of the Specifications for record drawings and procedures to be provided under this section.

1.08 CLEANING

- A. During the progress of the electrical work, the Electrical Contractor shall clean up and remove all scrap, demolition material, and other debris caused by the Contractor. At completion, the Electrical Contractor shall clean all electrical equipment, wiring and raceway systems and leave all work in perfect operating condition.

1.09 COORDINATION AND RESPONSIBILITY

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

1.10 PROTECTION OF MATERIALS, WORK, AND GROUNDS

- A. Materials, fixtures and equipment shall be properly protected and all raceway openings shall be temporarily closed so as to prevent obstruction and damage.
- B. Protect and preserve all materials, supplies and equipment of every description and all work performed. Protect all existing equipment and property of any kind from damage during the operations. Damage shall be repaired or replaced promptly by the Electrical Contractor at his expense.

1.11 DRAWINGS

- A. It is the intention of the Specifications and Drawings to call for finished work, tested and ready for operation. Any apparatus, appliance, material or work not shown on the Drawings, but mentioned in the Specifications or vice-versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by the Electrical Contractor without additional expense to the Owner.
- B. The Drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the project and shall have the approval of the Engineer before being installed. The Electrical Contractor shall follow Drawings, including his shop drawings, in laying out work and shall check the Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Engineer before proceeding with the installation. The Electrical Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

- C. Size of raceways and methods of running them are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the Drawings, all necessary parts to make complete approved working systems ready for use, shall be furnished without extra charge. All work shall be installed in such a manner as to avoid being unsightly.
- D. All measurements shall be taken at the building by the Electrical Contractor, prior to purchasing and installing the equipment and raceways.

1.12 APPROVAL OF MANUFACTURERS AND SHOP DRAWINGS

- A. Submit five (5) copies of the following;
 - 1. Disconnects and Safety Switches
 - 2. Wire and Cable
 - 3. Conduit and Raceways
 - 4. Circuit Breakers
- B. Individual information shall be submitted for each type of equipment. Where multiple products of various sizes, capacities or ratings are indicated on the same page of a submittal, the Electrical Contractor shall clearly identify which items are being submitted. Unmarked submittals will be returned without action. Additional requirements for shop drawings may be contained under individual items.

1.13 UNDERWRITERS' LABEL AND LISTING

- A. All electrical apparatus furnished under this Section shall be approved by the UL and shall be labeled or listed where such is applicable. Where custom-built equipment is specified and the UL label or listing is not applicable to the completed product, all components used in the construction of such equipment shall be labeled or listed by UL where such is applicable to the component.

1.14 CUTTING AND PATCHING

- A. All cutting and patching necessary for the proper installation of work to be performed under this Section shall be performed by the General Contractor.
- B. All work shall be fully coordinated with all phases of construction, in order to minimize the requirements for cutting and patching.
- C. All of this work shall be done by careful workmen competent to do such work and with the proper and smallest tools applicable.
- D. Any cost caused by defective or ill-timed work shall be borne by the contractor responsible.

1.15 GUARANTEE

- A. The Electrical Contractor shall guarantee, in writing, all work and all materials provided under this Section in accordance with the provisions of the printed form of Contract and the General Conditions.

1.16 ELECTRICAL

- A. All furnished electrical apparatus and controls shall conform to applicable requirements under DIVISION 26 - ELECTRICAL.
- B. The General Contractor shall furnish all magnetic starters for each and every motor furnished under other sections of the specification, except where otherwise indicated. The Electrical Contractor shall install and wire the starter.
- C. The General Contractor shall furnish and install all low voltage and/or line voltage control wiring for the HVAC equipment unless indicated otherwise.

1.17 VERIFYING EXISTING CONDITIONS

- A. Before commencing any work under this section, verify all governing dimensions and examine all adjoining work on which this work is in any way associated or connected. Failure to visit the jobsite will in no way relieve the Electrical Contractor from installing the work according to the intent of these specifications and at no additional cost to the Owner.
- B. Each bidder shall visit the site and inspect conditions affecting the proposed work. Failure to do so and misinterpretation of the Plans and Specifications shall be entirely the responsibility of the bidder, and will not be a basis for claim for extra compensation.
- C. Each bidder shall make note of the existing conditions affecting hauling, rigging transportation, installation, etc., in connection for his work and shall make all provisions for transportation such of all materials and equipment.
- D. Where field conditions require, the Electrical Contractor shall arrange for equipment to be shipped to the job, dismantled and assembled in place.

1.18 CONCRETE WORK

- A. All masonry and concrete pads shall be provided by the General Contractor.

1.19 PAINTING

- A. All finish field painting shall be provided by the General Contractor.

1.20 REFERENCE STANDARDS

- A. The latest published issue of the standards, recommendations, or requirements of the following listed societies, associations, or institutes in effect at the date of Contract are part of this Specification. These shall be considered as minimum requirements; specific requirements of this specification and/or associated drawings shall have precedence. In case of conflict between published requirements, the Engineer and/or Owner's representative shall determine which is to be followed.
- B. Electrical equipment, installation and workmanship shall conform to the latest editions of the applicable codes and standards of the following organizations.

1. Institute of Electrical and Electronic Engineers (IEEE)
2. American National Standards Institute (ANSI)
3. National Fire Protection Association (NFPA)
4. Massachusetts and National Electrical Code (MEC/NEC)
5. Underwriters' Laboratories (UL)
6. National Bureau of Standards (NBS)
 - a. H33-Safety Rules-Electrical Utilization Equipment.
 - b. H51-Safety Rules-Installation and Maintenance of Electric Supply and Communication Lines.
7. National Electrical Manufacturers Association (NEMA)
8. American Society for Testing and Materials (ASTM)
9. Insulated Power Cable Engineers Association (IPCEA)
10. Occupational Safety and Health Act (OSHA)

1.21 COOPERATION WITH OTHER TRADES

- A. The work shall be so performed that the progress of the entire building construction, including all other trades, shall not be delayed or interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as desired.
- B. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other Sections. Any conflicts shall be referred immediately to the Engineer for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Engineer's satisfaction, at no expense to the Owner.
- C. Where work of this section will be installed in close proximity to work of other sections or where there is evidence that the work of this section will interfere with work of other sections, assist in working out space conditions to make satisfactory adjustment. If so directed by the Engineer, prepare and submit for approval 1/8 inch scale or larger working drawings and sections, clearly showing how this work is to be installed in relation to the work of other sections. If the work of this section is installed before coordinating with other trades or so as to cause interference with work of other trades, make changes necessary to protect conditions without extra charge.

1.22 WORKING CONDITIONS AND SAFETY

- A. Whereas the building may be occupied during the construction period, it is of utmost importance that student and faculty safety and the educational process be maintained. The Electrical Contractor shall not disrupt the normal operations of the building and shall be required to cease work during occupied hours if, in the opinion of the Owner's

Representative or the Engineer, the work creates a disruption to education. The Electrical Contractor will then be required to perform such disruptive work during unoccupied business hours. No work shall commence until the site has been properly prepared.

1.23 MATERIAL AND WORKMANSHIP

- A. All material provided shall be new and approved for the intended service.
- B. Defective equipment or equipment damaged in the course of installation or testing shall be replaced by the Electrical Contractor at no cost to the District.
- C. All work shall be executed in the best and most thorough manner known to each trade. Employ careful, competent, experienced journeymen, and insofar as possible, keep the same foreman and workmen from the beginning to the completion of the job.

1.24 PRODUCT HANDLING AND STORAGE

- A. Arrange for, and provide, a storage space or area at the job site for all electrical equipment and materials to be installed or reinstalled in the project. The exact location of portable storage vans at the job site or protected storage areas within the building construction, conditions permitting, shall be arranged with the Engineer.
- B. All electrical equipment and materials, upon receipt at the job site shall be thoroughly inspected as to their type and condition and the quantity received.
- C. After inspection, all electrical equipment and materials shall be moved to the storage area designated.

1.25 TEMPORARY FACILITIES

- A. The Electrical Contractor shall be responsible for maintaining all temporary power and lighting throughout the project. Existing light and power shall be utilized for temporary lighting and power usage. The Electrical Contractor shall coordinate with the General Contractor regarding requirements for light and power.

1.26 OUTAGES

- A. The Electrical Contractor shall coordinate all power outages with Owner's Representative.
- B. Outages confined to the new Mechanical Room shall be coordinated with the general contractor.

1.27 HOISTING, SCAFFOLDING, STAGING AND PLANKING

- A. Provide, set up and maintain all required derricks, hoisting, machinery, scaffolding, staging and planting for the work of this section.
- B. Scaffolding is to have solid backs and floors to prevent dropping materials to the floors or ground.

PART 2 - MATERIALS

2.00 RACEWAYS AND FITTINGS

- A. General:
 - 1. All wiring shall be installed in conduit or wireways, unless otherwise indicated. All conduit shall be minimum 3/4" commercial trade size, unless otherwise specified or indicated on the drawings. Metallic conduit fittings shall be made of steel or malleable iron only. Die-cast zinc-alloy fittings and fitting made of inferior materials, such as "pot metal", shall not be used.
- B. Rigid Steel Conduit:
 - 1. Rigid Steel, Galvanized
 - a. Full weight galvanized steel conforming with UL 6 and ANSI C80.1.
 - 2. Terminations
 - a. Double locknuttred with insulated throat bushings in dry locations.
 - b. Insulated, gasketed hub connectors in damp/wet locations.
 - 3. Fittings and Conduit Bodies
 - a. Fittings and conduit bodies: ANSI/NEMA FB 1; threaded type, material to match conduit.
- C. Metal Clad Cable (MC)
 - 1. Where indicated on the drawings, type MC Cable shall be provided.
- D. Liquid-Tight Flexible Metal Conduit
 - 1. Flexible galvanized steel tubing over which is extruded a liquid-tight jacket of polyvinyl chloride (PVC). 1-1/4" size and smaller shall be provided with a continuous copper bonding conductor.
 - 2. Connectors shall be steel or malleable iron with insulated throats.
- E. Wireways
 - 1. Wireways, auxiliary gutters, and associated fittings shall comply with UL 870.
 - 2. Wireways shall be of the screw-cover type, and of sizes indicated or as required by NEC.
 - 3. Wireways shall be of raintight construction in wet locations.
 - 4. Finish shall be paint, manufacturer's standard.

2.01 PULL BOXES AND CHANNELS

- A. Pull boxes shall be code gauge galvanized steel with screw covers to match. Where pull boxes are larger than 18"x18", hinged covers shall be provided. Pull boxes and wireways

shall be as shown on Drawings and/or as required by NEC and/or job conditions, with steel barriers separating systems.

- B. Steel channel supports shall be minimum 1-5/8-inch mold strip steel with minimum 105-inch wall thickness, Unistrut P1000, Kindorf, Husky Products, or equal.
- C. Steel support rods or support bolts for conduits shall be 1/8-inch diameter for each inch or fraction thereof of diameter of conduit size, but no rod or bolt shall be less than 1/4-inch in diameter.
- D. Metal conduit fittings shall be of cast malleable iron, cadmium plated with neoprene gaskets and cast malleable iron covers. Fitting for use with conduit 1-1/4-inch diameter and smaller shall be "Form 35", those for use with conduit 1/1/2-inch diameter and larger shall be Mogol. Fitting shall be as manufactured by Appleton Electrical Co., Steel City, Crouse-Hinds, or approved equal.
- E. Expansion fitting shall be as manufactured by O. Z. Gedney, Electrical Manufacturing Co., Inc., or approved equal as manufactured by Crouse-Hinds or Appleton.

2.02 WIRE AND CABLE

- A. Wire and cable of sizes, quantities and types shown on drawings, schedules or specified herein shall be provided by the Electrical Contractor. All wire and cable shall be installed in raceways, unless otherwise indicated.
- B. Wire and cable work shall be in strict accordance with requirements of National Electrical Code and its latest revisions, both with respect to material and workmanship, except where insulation thickness and covering are required by these Specifications in excess of Code requirements.
- C. Minimum size wiring, unless otherwise indicated, for power branch circuit shall be #12 AWG.
- D. Branch circuit power, and control wiring, except as otherwise noted, shall have type THWN-THHN, 600 volts insulation. Unless otherwise noted, feeder wiring and branch circuit wiring sizes #6 AWG AND LARGER shall be Type XHHW, #8 AWG and smaller type shall be THWN-THHN.
- E. Wires and cables shall be single conductor. Conductors of sizes #8 AWG and larger shall be stranded; wires smaller than #8 AWG shall be solid. Conductors shall be soft drawn copper and have a conductivity of not less than 98% of ASTM standards for annealed copper. Aluminum conductors will not be accepted.
- F. Sizes 12 and 10 AWG wire and cable shall be factory color-coded with a separate color for each phase of each system voltage used consistently throughout power systems. Size 8 AWG and larger shall be completely colored with vinyl tape wherever accessible. Colors shall be in accordance with those listed in Part 3.03 of this specification.
- G. Grounding conductors and equipment grounds unless bare, shall have a GREEN covering or shall be completely marked with green tape at boxes, conduit bodies or where otherwise accessible.

- H. Cables ties and straps shall be self-clinching types of one piece molded construction. Bodies shall be of nylon and clinching clips shall be spring bronze. Ties and straps shall be Thomas & Betts Company, Types TY-25 and TY-35 or approved equal.
- I. Splices and taps in wires #8 and larger shall be made with solderless mechanical compression connectors designated for the purpose. Splices and taps shall be taped with approved tapes providing insulation not less than that of the conductors. Joints for wires #10 AWG and smaller shall be made with spring type screw-on connectors.
- J. Splicing tape shall be vinyl plastic tape 8.5 mils minimum thickness, flame retardant, abrasion, ultra-violet, moisture, alkali, acid, and corrosion resistant.

2.03 WIRE PULLING EQUIPMENT

- A. Provide polyethylene ropes for pulling wire.

2.04 DISCONNECT SWITCHES

- A. All safety switches shall be NEMA type "HD", heavy duty and shall meet or exceed NEMA Standard KS-1 for type HD switches, and meet or exceed Federal Specification W-S-865C for HD switches.
- B. Enclosed disconnect switches shall have the following features:
 - 1. Quick-make, Quick-break Switch Mechanism
 - 2. Padlockable Door and Handle
 - 3. Positive Type Interlocked Door
 - 4. 250 volt AC Rating
 - 5. Visible On-off Indication
 - 6. NEMA I Surface Enclosure in Dry Locations
 - 7. CO/ALR Cable Lugs
 - 8. Horsepower Rated (note that HP rating of switch must be equal to or greater than HP rating of motor or equivalent equipment loads.

2.05 GROUNDING

- A. Cables shall be of solid or stranded copper size as specified on the drawings. Cables shall be bare when installed in soil or in open air, and shall be insulated with 600 volt green jackets in all runs installed in conduit.

- B. The grounding conductor bonding jumper shall be attached to the circuits, conduits, cabinets, equipment and the like, which are to be grounded by means of suitable lugs, pressure connectors and clamps.
- C. All feeder and three phase motor circuits shall be provided with an appropriately sized grounding conductor. Sizes shall be based on NEC Table 250-95. Grounding conductors shall also be provided wherever the raceway is not a suitable grounding conductor.

2.06 CIRCUIT BREAKERS

- A. Shall be bolt on type compatible with existing GE Spectra series distribution board.
- B. Thermomagnetic trip.
- C. UL Listed compatible with existing.

2.07 IDENTIFICATION

- A. Wire and Cable Identification
 - 1. Conductor labels shall be white, adhesive self-laminating type. All text shall be typed. String tags shall not be accepted. Temporary tagging during construction shall be allowed, but all permanent adhesive tags shall be in place prior to requesting final acceptance.

PART 3 - EXECUTION

3.00 RACEWAYS AND FITTINGS

- A. Conduits usage shall be as follows:

<u>LOCATION</u>	<u>EXPOSED/ CONCEALED</u>	<u>SUBJECT TO DAMAGE, Y/N</u>	<u>WET/DAMP OR DRY</u>	<u>PERMITTED CONDUITS</u>
Interior	Exposed	No	Dry	RGS
Interior	Exposed	No	Wet	RGS
Interior	Exposed	Yes	Dry	RGS
Interior	Exposed	Yes	Wet	RGS

*RGS - Rigid Galvanized Steel

- B. The following areas shall be considered damp/wet locations, and raceways installed according to NEC requirements for such locations:
 - 1. Mechanical Room Exterior Locations.
- C. All conduit shall be cut square and reamed at the ends. All joints shall be drawn tight. Exposed conduit shall be run parallel to or at right angles to the lines of the building. Right angle bends in exposed conduit shall be made with standard elbows, conduit body fittings, or conduit bent to radii not less than those of standard elbows. All bends shall be free from dents or flattening.
- D. Conduit shall be made mechanically and electrically continuous from service entrance to all outlets

- E. Conduit connected to wall outlets shall be run in such a manner that they will not cross water, steam or waste pipes wherever possible. Overhead conduits shall be run above water, steam or waste lines wherever possible.
- F. Liquid-tight flexible conduits shall be used for connection to motors and other electrical equipment when it is subject to movement, vibration, misalignment or cramped quarters or where noise transmission is to be eliminated or reduced. Proper angle connectors (straight, 45 degree, 90 degree) shall be used for the installation. Improperly installed connectors are not allowed.
- G. Pipe straps and hanger rods shall be fastened to concrete by means of inserts or expansion bolts, to brickwork by means of expansion bolts and to hollow masonry by means of toggle bolts. Hanger rods shall be fastened to beams and joists by means of swivel type beam clamps. Wooden plugs and shields and powder driven fasteners shall not be used.
- H. Individual horizontal conduits shall be supported by one hole pipe straps or separate pipe hangers for sizes 1-1/2" and smaller. Spring steel fasteners may be used for sizes 1-1/2" and smaller in dry locations only. Hanger rods used with spring steel fasteners shall be minimum 1/4" diameter.
- I. Where two or more horizontal conduits run parallel and at the same elevation, they shall be supported on multiple pipe hangers. Conduit shall be secured to the horizontal hanger member.
- J. Pullboxes shall not be utilized for the vertical support of conduits.
- K. Every conduit system shall be installed complete and blown through and swabbed before conductors are installed.
- L. Wireways shall be used for mounting groups of disconnects and/or starters, or where shown on the drawings.

3.01 DEVICE, PULL AND JUNCTION BOXES

- A. Boxes shall be installed in rigid and satisfactory manner supported by bar hangers in frame constructions or fastened directly with wood screws on wood; bolts to hollow expansion shields on concrete or brick, toggle bolts on hollow masonry units and machine screws or welded threaded studs on metal. Threaded studs provided with lock washers and nuts are acceptable for mounting of outlets on concrete construction.
- B. Location of devices shown on the Drawings is approximate. When necessary, devices shall be relocated at no extra cost within a 10'-0" radius to avoid conflicts with structural conditions or equipment of other trades. Outlets shall be symmetrically located according to room layouts.
- C. Boxes shall be secure to conduit by means of double steel locknuts (inside and outside) and malleable iron or steel insulated throat bushings.

3.02 WIRE AND CABLE

- A. 208 Volt Systems:

1. Conductors shall not be installed in a manner which will injure their insulation or covering. Conduit system shall be complete before any conductors are installed. Conductors shall not be installed until such time that the conductors can be suitably protected against the elements and damage.
2. Provide and use suitable cable pulling winches or equipment of adequate capacity in order to insure a steady, continuous pull. Before any wires or cables are drawn into conduits, the conduit shall be cleaned out by pulling a swab through the conduit with fish tape, and wires shall be pulled through conduit in such a manner as to avoid kinking or injuring the insulation. Only non-metallic approved cable lubricants shall be used when necessary. Cable lubricants shall be completely removed at panelboards, pull and junction boxes and other accessible locations.
3. All feeder cables shall be continuous from origin to panel or equipment terminations without running splices in intermediate pull or splice boxes. Where taps and splices are deemed necessary by job conditions, they shall first be approved by the Engineer and shall be made in approved splice boxes with suitable connectors as noted herein. Special note is to be made when extending existing feeders.
4. No splices or joints shall be permitted in branch circuits except within accessible junction boxes. Splices in junction boxes shall be with enough spare wire to enable two or more splices to be remade with the same wire in event of a fault. When a bolted splice or connection presents an irregular surface, duct seal compound shall be molded around the joint. It shall make a smooth taping surface and prevent the formation of air pockets.
5. Use solderless pressure connectors on conductors of No. 8 AWG and larger and tape to provide insulation not less than that of the conductor. Solderless connectors shall be of rugged construction with multi-point contact on cable, ground contact surfaces for low resistance and low temperature rise, and with high pull-out strength. On conductors of 250 MCM or larger provide not less than 2 pressure connectors.
6. On conductor sizes No. 10 or smaller, connectors shall be molded composition with metal thread-on core.
7. At panelboards, junction boxes, conductors shall be identified with circuit numbers by applying suitable marking.
8. Neatly train all wiring within equipment boxes and panelboards.
9. Inspect all wire and cable for damage after installation. Replace all damaged conductors or insulation. Megger test all feeder conductors and record results in accordance with Section 01 70 00 of this specification. Verify all phasing of conductors and equipment.

10. Conductor color coding for power circuits shall be as follows:

<u>Phase</u>	<u>120/208 volts</u>	<u>277/480 volts</u>
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

3.03 DISCONNECT SWITCHES

- A. Provide manufacturer's nameplates for front cover indicating the following information:
1. Switch Type
 2. Catalog Number
 3. H.P. Rating
 4. Voltage Rating
 5. Current Rating
- B. Provide safety disconnect switches at all locations as shown on drawings. Disconnects shall be mounted within sight, and proximate to the load served. Disconnects are to be mounted 48" AFF, unless otherwise noted.
- C. Provide engraved phenolic (white lettering/black field) nameplate indicating load being fed.

3.04 GROUNDING

- A. The entire electrical wiring raceway system of this project shall be made to form a continuous, permanent and effective equipment grounding circuit which shall be installed as follows:
1. All metallic threaded couplings and conduits shall be wrench-tight.
 2. All termination of rigid conduits at all boxes, cabinets, and other enclosures shall be made with double locknut arrangement and a bushing. Bushings shall be insulating type.
 3. All flexible metallic conduit and liquid-tight flexible conduits over 6' long or with conductors carrying over 20 amps shall have proper size ground conductor jumper bonded to the rigid conduit system and to the electrical equipment.
 4. All electrical, metallic enclosures shall be effectively bonded by a separate green colored bonding screw. The use of a mounting screw for grounding will not be accepted.
 5. All sections of wiring gutters and wireways, all outlet boxes and receptacle grounding terminals, all metal sections of continuous rigid cable supports and fittings and cable bus, and other built-up enclosures with bolted joining of sections

ELECTRICAL

shall be firmly bonded and effectively grounded. Conduit expansion fittings shall have factory furnished bonding jumpers.

END OF SECTION