

SECTION 02.41.00

SELECTIVE DEMOLITION

I. PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. The General Conditions, Supplementary General Conditions, and applicable parts of Division I as part of this Section.
- B. This Contractor must be familiar with all other Divisions and Sections which affect this Work.

1.02 DESCRIPTION OF WORK

- A. **Work included:** Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Protecting existing exterior elements to remain such as envelope items, audio/visual, fire alarm beacons, exterior wires, etc..
 - 2. Protection of interior items / elements to remain in and around the work areas.
 - 3. Removal of select existing bituminous areas in preparation for the new equipment slab.
 - 4. Select removal of existing Plumbing chase.
 - 5. Select removal of the existing concrete slab in preparation for the new grease trap / Plumbing scope.
 - 6. Temporary support of all items to remain while new work is being completed.
 - 7. All other demolition work as indicated on drawings.
 - 8. Legal disposal off site of all demolished materials for all trades.
- B. **Items to Be Installed Only:** Install the following items as furnished by the designated Sections:
 - 1. None. All items to be installed by this trade, shall be furnished by this trade.
- C. **Items to Be Furnished Only:** Furnish the following items for installation by the designated Sections:
 - 1. None.
- D. **Related Work Specified Elsewhere:** The following items are not included in this Section, and will be performed under the designated Section:
 - 1. Section 01.50.00 - TEMPORARY FACILITIES AND CONTROLS
 - 2. Section 01.73.29 - CUTTING AND PATCHING for demolition work affecting interior finishes
 - 3. Section 03.30.00 - CAST IN PLACE CONCRETE for new work and prep of patching / repairs at existing

1.03 WORK BY OTHERS

- A. **WPS** to coordinate the removal of the existing items in the work areas, interior and exterior items. Refer to Section 01.01.00 - Summary of Work and Section 01.31.00 - Project Management and Coordination.

1.04 SUBMITTALS

- A. Refer to Section 01.33.00 - Submittals for submittal provisions and procedures.
- B. Schedule: Provide detailed sequence of demolition and removal work. The schedule shall interface to the overall project schedule and shall be approved by **WPS** prior to the start of any demolition.
- C. Prepare and submit the Comprehensive Waste Management form. Submit records of recycling and/or disposal as appropriate, including waste manifests for hazardous materials.

1.05 JOB CONDITIONS

- A. Condition of Structures: Owner assumes no responsibility for actual condition of items or structures to be demolished.
- B. Access and Sequencing: Provide **WPS** with adequate time to issue tenant notices prior to the start of work on any given building, as specified in Division 1. Prior to demolition each day, advise **WPS** staff of the areas to receive work, and allow sufficient time for relocation of tenants or items if required.
- C. Protections: Provide temporary barricades and other forms of protection as required to protect Owner's personnel, tenants and the general public from injury due to selective demolition work.
 - 1. Provide protective measures as required to provide free and safe passage in and out of the building, and around the site.
 - 2. Protect from damage existing finish work that is to remain in place and becomes exposed during demolition operations. Protect site with suitable coverings when necessary.
 - 3. Remove protections at completion of work.
- D. Damages: Promptly repair all damages caused by demolition work at no cost to Owner.
- E. Traffic: Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
- F. Do not close, block or otherwise obstruct streets, walks or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- G. Utility Services: Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.

1.06 EXISTING UTILITIES

- A. The Contractor is responsible for coordinating the locations of all existing utilities with the

utility provider and "DIGSAFE".

- B. The Contractor shall take every precaution to limit disruption to existing utilities. Any existing utilities disrupted or affected by the Contractor as a result of his/her work shall be repaired at least to the condition that existed prior to construction. The Contractor shall coordinate repair of any utilities with the utility providers and any costs associated with the repair shall be borne by the Contractor.

II. PART 2 - PRODUCTS (Not Applicable).

III. PART 3 - EXECUTION

3.01 PRE-WORK INSPECTION

- A. Prior to commencement of selective demolition work, inspect areas in which work will be performed. Photograph existing conditions to structure surfaces, equipment or to surrounding properties which could be misconstrued as damage resulting from selective demolition work; file with Architect prior to starting work.
- B. The functionality of all accessories affected by the scope of work owned by the General Contractor, shall be verified prior to the start of construction. If any items are found to not be in working order or damaged, the contractor shall notify the owner and provide a written list of all items / locations prior to the start of work. Once the list is received **WPS** will provide formal direction on their repair. Any items found to be not be in working order or damaged after the project is complete, that were not on the submitted list, shall be the responsibility of the contractor to replace or restore proper function at no additional cost to the owner.

3.02 COORDINATION

- A. Coordinate the work of all trades on site and what can be completed that day for safety reasons.

3.03 PREPARATION

- A. Submit schedules with proper advance notice, as required by Section 01.33.00.
- B. Provide temporary protections as specified in Section 01.50.00.
- C. Coordinate the removal or disconnection of any plumbing items if required, by a licensed Plumber, though such work is not anticipated for this project.
- D. Coordinate the removal or disconnection of any MEP items required, by a licensed Contractor in that field. All effected feeds shall be made safe prior to the start of work.

3.04 GENERAL DEMOLITION

- A. Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.

- B. Demolish materials in a careful manner, so as not to disturb or damage materials scheduled to remain, or not scheduled for demolition. Provide test cuts or inspectional demolition of small areas as required to verify the presence of hidden materials that could be damaged by demolition operations. Repair or make good any materials not scheduled for demolition that become damaged by construction operations.
- C. Do not perform more demolition than can be made weather-tight that same day.
- D. If unanticipated mechanical, electrical or structural elements which conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to Designer in written, accurate detail. Pending receipt of directive from Designer, rearrange selective demolition schedule as necessary to continue overall job progress without delay.
- E. Notify Architect immediately if materials scheduled to remain are found to be unsuitable for the installation of the new work, or if existing conditions deviate substantially from those shown on the drawings. Remove and replace, or make good, any existing materials unsuitable for installation of new work.
- F. The Contractor shall have at least one person in charge of operations on the ground, this person shall be cognizant of residents and other persons in the work area and shall remove debris that may obstruct passage or otherwise present a danger to residents.
- G. Segregate and recycle demolished materials where possible, and in accordance with the Waste Management section and the standard City of Worcester Protocol.

3.05 DEMOLITION BITUMINOUS AREA

- A. Coordinate the final HVAC equipment size, requirements and location with all parties prior to the start demolition.
- B. Saw-cut and remove existing bituminous material as required for new concrete slab.
- C. Remove / re-grade sub-straight material as required for the new base material and new concrete slab.

3.06 DEMOLITION OF THE EXISTING PLUMBING CHASE

- A. Install new supports as required to remove select areas of the soap stone plumbing enclosure.
- B. Coordinate fixture removal with the Plumbing Contractor.
- C. Removal of select portions on the soap stone plumbing case (top / front wall) as required to perform the new project scope.

3.07 DEMOLITION IF THE INTERIOR FLOOR SLAB

- A. Coordinate final plumbing equipment, requirements and location with all parties prior to the start of demolition.
- B. Saw-cut and remove existing interior concrete slab as required for the plumber to install the grease trap and piping.
- C. Remove sub-straight material to the depth required for the new equipment.

3.08 DISPOSAL OF DEMOLISHED MATERIALS

- A. Segregate and recycle per the Construction Waste Management requirements.
- B. Remove debris, rubbish and other materials resulting from demolition operations from building site. Transport and legally dispose of materials off site.
- C. Dispose of hazardous materials as required by applicable regulations, laws, and ordinances concerning removal, handling and protection against exposure or environmental pollution.
- D. If hazardous materials beyond those identified for removal are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling and protection against exposure or environmental pollution.
- E. Burning of removed materials is not permitted on project site.

3.09 CLEAN-UP AND REPAIR

- A. Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protections and leave area broom clean and ready for new work.
- B. Repair demolition performed in excess of that required at no cost to the Owner. Return structures and surfaces to remain to condition existing prior to commencement of selective demolition work. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.
- C. Any damages to existing furnishings and/or equipment, shall be reimbursed by the general contractor, who shall recoup costs from other contractors as appropriate.
- D. Repair any utilities damaged by demolition procedures, in a manner as directed by the Owner.

3.10 CLOSE-OUT

- A. Record on the as-built drawing set, all areas which received new framing or sheathing, and any utilities which were cut back or abandoned.

END OF SECTION
02.41.00

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1- GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the documents identified in Division 00 Procurement and Contracting Requirements and Division 01 General Requirements.

1.2 SUMMARY

- A. Work Included: This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes. Cast-in-place concrete shall include, but not be limited to the following:
 - 1. Exterior concrete slab.
- B. Related Sections include the following:
 - 1. Section 01 45 00, QUALITY CONTROL.
 - 2. Section 23 00 00, HVAC for equipment coordination.
- C. **Alternates: N/A**
- D. Items To Be Installed Only: Not Applicable.
- E. Items To Be Furnished Only: Not Applicable.

1.3 SUBMITTALS

- A. Refer to Section 01 33 00, SUBMITTAL PROCEDURES for submittal provisions and procedures.
- B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, water-stops, joint systems, curing compounds, dry-shake finish materials, and others if requested by the Architect or SER.
- C. Shop drawings for reinforcement detailing, fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement.
 - 1. All reinforcing shop drawings for concrete and masonry walls shall be shown on walls elevations with a scale of 1/4 in. = 1 ft. - 0 in.
 - 2. Include special reinforcing required for openings through concrete structures.
 - 3. Submit shop drawings of formwork for Architecturally Exposed Concrete showing cone tie patterns and form liner layout.

- D. Electronic Submittals: Refer to Section 01 33 00 for Submittal Procedure. In addition, provide Engineer (1) fullsize paper print of each shop drawing, in addition to the electronic submittal. Paper copy will be retained by the Engineer and electronic copy will be returned. Review cycle will not commence until paper copy of shop drawing has been received.
- E. Concrete mix design for each mix specified. Supporting test data shall be submitted if requested.
- F. Proposed method of curing concrete and associated products.
- G. Proposed precautions for hot weather and cold weather concreting.
- H. Samples of materials as requested by Architect, including names, sources, and descriptions.
- I. Laboratory test reports for concrete materials and mix design test.
- J. Description of Methods and Sequence of Placement. For each type of specially-finished concrete provide description of methods and sequence of placement.
- K. Material certificates in lieu of material laboratory test reports when permitted by Architect. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where requirements that are more stringent are shown or specified:
 - 1. Massachusetts State Building Code, Current Edition.
 - 2. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings".
 - 3. ACI 318, "Building Code Requirements for Reinforced Concrete".
 - 4. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice".
 - 5. Manual of Standard Practice for Detailing Reinforced Concrete Structures ACI 315.
 - 6. ACI 308, "Recommended Practice for curing Concrete"
 - 7. ASTM C 94, Ready-Mixed Concrete.
- B. Inspection, Testing, and Quality Control
 - 1. A Program of Inspection and Testing of cast-in-place concrete work will be established by the Structural Engineer of Record (SER) who will direct the implementation of tests as carried out by an Independent Testing Agency, under a separate contract with the Owner. Materials and workmanship shall be subjected to inspection and testing in mill, shop, and/or field by the SER and/or Testing Agency. Such inspection and testing shall not relieve the Contractor of his responsibility to provide his own inspection, testing, and quality control as necessary to furnish materials and workmanship in accordance with the requirements of Contract Documents.
 - 2. The General Contractor shall notify the SER and the Testing Agency prior to start of any phase of concrete work so as to afford them reasonable opportunity to inspect the work. Such notification shall be made at least 24 hours in advance.
- C. Project Data:
 - 1. Concrete Curing and Protection: Submit to the Architect/SER in accordance with the requirements of Contract Documents, detailed methods proposed for use for curing and protection prior to commencement of concrete work. This shall include winter protection and hot weather concrete methods.

- D. Preconstruction Conference. Attend a preconstruction conference prior to the start of architectural concrete construction as directed by the Owner's Representative and the Architect. Discussion will include the following:
1. The Contractor's program to obtain the specified quality of architectural concrete.
 2. The procedures and methods for construction of preconstruction mock-ups specified herein.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products in accordance with Section 01 60 00, PRODUCT REQUIREMENTS.
1. Reinforcing steel and other items to be embedded in cast-in place concrete which are stored at the project site shall be above ground on platforms, skids or other supports, protected from the elements by a waterproof covering ventilated to prevent condensation.
- B. General Contractor shall provide and pay for all dumpster services during the entire construction period. Suppliers and Sub-Contractors to bring all rubbish and debris to the dumpster location daily. No costs are to be assessed to the suppliers or Sub-Contractors by the General Contractor for this service.
- C. General Contractor, Sub-Contractors, and suppliers are all individually to furnish their own staging, scaffolding, and hoisting equipment necessary to get workers, material, and equipment from the point of delivery at the project site to the point of use or installation within the building and project site. All crane and rigging services required are the responsibility of each individual trade.

PART – 2 PRODUCTS

2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two (2) edges and one (1) side for tight fit.
- C. Chamfer strips shall be wood, PVC or rubber strips.
- D. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
1. Formulate form release agent with rust inhibitor for steel form-facing materials.
- E. Form Ties for Concrete Below Grade or Areas Not Exposed to View: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal.

1. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.

2.2 METAL REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Steel Wire: ASTM A 82, plain, cold-drawn steel, Refer to “Special Requirements for Architecturally Exposed Concrete” for required stainless steel wire.
- C. Welded Wire Fabric: ASTM A 185, welded steel wire fabric. All welded wire fabric shall be supplied in flat sheets.
- D. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.
 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs. Concrete bricks may be used to support reinforcing steel where application allows.

2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II.
- B. Normal-Weight Aggregates: ASTM C 33 and as specified.
- C. Natural sand: ASTM C33.
- D. Water: Potable, clean and free from oils, acids, alkali, and other deleterious material.
- E. Admixtures, General: Provide concrete admixtures that contain not more than 0.1 percent chloride ions.
- F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- G. Water-Reducing Admixture: ASTM C 494, Type A.
- H. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.
- I. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
- J. Water-Reducing, Accelerating Admixture: ASTM C494, Type E.

2.4 RELATED MATERIALS

- A. Sand Cushion: Clean, manufactured, or natural sand.
- B. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- C. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
 1. Water proof paper.
 2. Polyethylene film.
 3. Polyethylene coated burlap.

- D. Liquid Membrane-Forming Curing Compound: Liquid-type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.55 kg/sq. meter when applied at 200 sq. ft./gal.
- E. Evaporation Control: Mono-molecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
- F. Bonding Agent: Polyvinyl acetate or acrylic base.
- G. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.
- H. Epoxy Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.
- I. Preformed Expansion Joint Filler: Resilient, flexible, non-extruding, expansion-contraction joint filler. Cellular fibers securely bonded together, uniformly saturated with asphalt. Joint filler shall conform to the following standards and have the following requirements:
 - 1. ASTM D1751.
 - 2. Resilience: When compressed to half its original thickness, recover to a minimum of 70 percent of its original thickness.
 - 3. Thickness: 1/2".

2.5 PROPORTIONING AND DESIGNING MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- B. Submit written reports to the Architect of each proposed mix for each class of concrete at least fifteen (15) days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Architect/SER
- C. Exterior Walks, Aprons, Stairs, Ramps, and Miscellaneous Exterior Structures: Proportion normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 4,500 psi
 - 2. Maximum Slump: 4 inches.
 - 3. Slump may be increased to 6 inches with use of Mid-Range Water Reducing Admixture.
 - 4. Air-entrained
 - 5. Corrosion inhibitor (DCI or approved equal)
 - 6. Maximum water-cement ratio: 0.42
- D. Under no conditions shall water be added to the concrete mixes at the site.
- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by SER. Laboratory test data for revised mix design and strength results must be submitted to and accepted by SER before using in Work.
- F. All pumped concrete shall contain mid-range water reducing admixture or high range water reducing admixture (superplasticizer) added at the site. Maintain slumps as specified above

2.6 ADMIXTURES

- A. Use mid-range water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for pumping, placement and workability.
- B. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees F.
- C. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:
 - 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure: 5.0 percent (moderate exposure); 6.0 percent (severe exposure) for 3/4-inch maximum aggregate.
- D. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.
- E. Use corrosion inhibitor complying with ASTM C1582 for all exterior concrete containing reinforcing steel.

2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.
 - 1. When air temperature is between 85 degrees F and 90 degrees F, reduce mixing and delivery time from 1-1/2 hours to seventy-five 75 minutes, and when air temperature is above 90 degrees F, reduce mixing and delivery time to sixty (60) minutes.

PART 3- EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

3.2 FORMS

- A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347.
- B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.
- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf

wood inserts for forming keyways, reglets, recesses, and the like for easy removal. Use 6 mil poly to cover rustication keyways to ensure easy removal without chipping concrete.

- D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.3 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports and as specified.
 - 1. Avoid cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect.
- D. Place reinforcement to maintain minimum coverage as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install flat welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one (1) full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.4 INSTALLING EMBEDDED ITEMS

- A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.
- B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.5 PREPARING FORM SURFACES

- A. General: Coat contact surfaces of forms with an approved, non-residual, low-VOC, form-coating compound before placing reinforcement.

- B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.
 - 1. Coat steel forms with a non-staining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete", and as specified.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.
- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than twenty-four (24) inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
 - 1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least six (6) inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
- E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
 - 1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
 - 2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 - 3. Maintain reinforcing in proper position on chairs during concrete placement.
- F. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of placement.
 - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
 - 3. Cover walls and slabs with thermal blankets. Provide poly tents with heat for twenty-four (24) hours when temperature is 40 degrees F or below.

- G. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 degrees F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.
- H. Re-tempering of concrete which has partially hardened, that is, mixing with or without additional cement, aggregates, or water, shall not be permitted.

3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction (other than waterproofing systems). This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. Smooth-Rubbed Finish: Provide smooth-rubbed finish on scheduled concrete surfaces to receive smooth-formed finish treatment not later than one (1) day after form removal.
1. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Grout-Cleaned Finish: Provide grout-cleaned finish on scheduled concrete surfaces to receive grout-cleaned finish treatment.
1. Combine one part portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard Portland cement and white Portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.
 2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least thirty-six (36) hours after rubbing.
- E. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

- F. Non-slip Broom Finish: Apply a non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- G. Non-slip Aggregate Finish: Apply non-slip aggregate finish to concrete stair treads, platforms, ramps, sloped walks.
 - 1. After completing float finishing and before starting trowel finish, uniformly spread 25 lbs. of dampened non-slip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as specified.
 - 2. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose non-slip aggregate.

3.8 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

3.9 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than seven (7) days.
- C. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.
- D. Provide moisture curing by the following methods:
 - 1. Use continuous water-fog spray.
 - 2. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a four (4) inch lap over adjacent absorptive covers.
- E. Provide moisture-retaining cover curing as follows:
 - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least three (3) inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

- F. Apply curing compound on exterior slabs, walks, stairs, and curbs as follows:

1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within two (2) hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within three (3) hours after initial application. Maintain continuity of coating and repair damage during curing period.
 2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
- G. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- H. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.
1. Cure concrete slabs and surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

3.10 REMOVING FORMS

- A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 degrees F for twenty-four (24) hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

3.11 REUSING FORMS

- A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Architect.

3.12 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.
1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than one (1) inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
 2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- B. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie

holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.
- C. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least fourteen (14) days.
 3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Architect.
 4. Repair defective areas, except random cracks and single holes not exceeding one (1) inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- D. Perform structural repairs with prior approval of Architect for method and procedure, using specified epoxy adhesive and mortar.
- E. Repair methods not specified above may be used, subject to acceptance of Architect.

3.13 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. An independent Testing Laboratory, chosen by the Owner, will be retained for this project to perform such laboratory services as are required. The engagement of this laboratory will in no way relieve the Contractor of his responsibility to furnish materials and construction in conformance with the drawings and specifications.
- B. Sampling and testing for quality control during concrete placement may include the following, as directed by Architect.
1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - a. Slump: ASTM C 143; one (1) test at point of discharge (at the truck before adding plasticizers) for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one (1) for each day's pour of each type of air-entrained concrete.
 - c. Concrete Temperature: ASTM C 1064; one (1) test hourly when air temperature is 40 degrees F and below, when 80 degrees F and above, and one (1) test for each set of compressive-strength specimens

- d. Compression Test Specimen: ASTM C 31; one (1) set of four (4) standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - e. Compressive-Strength Tests: ASTM C 39; one (1) set for each day's pour exceeding five (5) cu. yds. plus additional sets for each fifty (50) cu. yds. more than the first twenty-five (25) cu. yds. of each concrete class placed in any one (1) day; one specimen tested at seven (7) days, two specimens tested at twenty-eight (28) days, and one specimen retained in reserve for later testing if required.
- 2. When frequency of testing will provide fewer than five (5) strength tests for a given class of concrete, conduct testing from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used. When total quantity of a given class of concrete is less than fifty (50) cu. yds., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
 - 3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 - 4. Strength level of concrete will be considered satisfactory if averages of sets of three (3) consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- C. Test results will be reported in writing to Architect, Structural Engineer, ready-mix producer, and Contractor within twenty-four (24) hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at twenty-eight (28) days, concrete mix proportions and materials, compressive breaking strength, and type of break for both seven (7) day tests and twenty-eight (28) day tests.
- D. Any material or workmanship that is rejected by the SER and/or the Testing Agency either at the plant or at the job site, shall be replaced promptly by the Contractor to the satisfaction of the SER at no expense of the Owner.
- E. Non-destructive Testing: Impact hammer, sonoscope, or other non-destructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- F. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics that have not been attained in the structure, as directed by Architect. Testing agencies may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION

03 30 00

SECTION 22.00.00 – PLUMBING

(Filed Sub-Bid Required)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All of the Contract Documents, including General and Supplementary Conditions and Division 1, General Requirements, are hereby made a part of the work of this Section. Where paragraphs of this Section conflict with Division 1, the more stringent requirements shall govern.
- B. All work shall comply with all federal, state and local codes and any other authorities having jurisdiction including any special requirements of the Owner or Architect.

1.2 TIME, MANNER AND REQUIREMENTS FOR SUBMITTING SUB-BIDS:

- A. Sub-bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the City of Worcester, Department of Public Works and Parks, Architectural Division, 50 Skyline Drive, Worcester, MA 01605 at time and place stipulated in the "invitation to Bid/Notice to Contractors". The following shall appear on the upper left hand of the envelope:

Name of Sub-Bidder: **Print Name of Sub-bidder**

Project: **Vernon Hill School Kitchen Relocation for Worcester Public Schools**

Sub-Bid for Section: **22 00 00**

- B. Each sub-bid submitted for work under this Section shall be on forms furnished by the City of Worcester as required by Section 44F of Chapter 149 of the General Laws, as amended. Sub-Bid forms may be obtained at the Department of Public Works and Parks, Architectural Division, 50 Skyline Drive, Worcester, MA 01605 in person, or by written request.
- C. Sub-bids filed with the City of Worcester shall be accompanied by a BID BOND or CASH or CERTIFIED CHECK or a TREASURER'S or CASHIER'S CHECK issued by a responsible bank or trust company payable to the City of Worcester in the amount of five (5) percent of the bid. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.
- D. Filed Sub-Subs: None Required.

1.3 SCOPE

- A. The scope of work consists of the installation of all materials to be furnished under Section 22.00.00, and without limiting the generality thereof, consists of furnishing all labor, materials, equipment, plant, transportation, rigging, staging up to eight (8) feet, appurtenances, and services necessary and/or incidental to properly complete all work as shown on the Plumbing drawings, as described in the Specifications, or as reasonably inferred from either, in the opinion of the Architect.
- B. Perform work and provide material and equipment as required for a complete and operational plumbing system as specified in this Section. Completely coordinate with work of other trades and provide for complete and fully functional installation.
- C. The work shall include, but is not limited to, the following major items of work:
 - 1. Demolition of plumbing fixtures and piping for new space configuration and use. Verify existing piping in the toilet wet walls for connection to new, including overhead piping and sanitary venting.

2. Sanitary, waste, and vent systems within the project area connecting to existing waste and vent piping above grade, installed with all incidentals necessary for a complete operational system. The system shall include all piping, traps, flanges, seals, cleanouts, structural support (carriers, hangers), fixtures, and such other standard accessories as are necessary for a complete approved system.
3. Grease waste system within the project area connecting to installed kitchen equipment and piped to an interior grease interceptor. The system shall include all piping, traps, flanges, seals, cleanouts, structural support (carriers, hangers), equipment, and such other standard accessories as are necessary for a complete approved system.
4. Cold water system connecting each and every fixture, device, and item of equipment requiring cold water within the project area and connecting to existing water piping in adjacent spaces. The system shall be installed with all incidentals necessary for a complete operational system and shall include all piping, insulation, valves, stops, vacuum breakers, gauges, structural support (hangers), water hammer arresters, and such other standard or specified accessories as are necessary for a complete approved system.
5. Hot water system connecting each and every fixture, device, and item of equipment requiring hot water within the project area. The system shall be installed with all incidentals necessary for a complete operational system and shall include all piping, insulation, valves, stops, vacuum breakers, gauges, structural support (hangers, etc.), water hammer arrester, electric water heater (alternate) and such other standard or specified accessories as are necessary for a complete approved system. Note that the electric water heater would be dedicated to the proposed kitchen equipment in case the existing domestic hot water supply from the building is insufficient.
6. Provide all plumbing fixtures and equipment as required and indicated on the drawings and as specified herein. This shall include all necessary waste, vent, cold water & hot water services.
7. Obtain all permits and approvals required for work under this Section.

1.4 COORDINATION

- A. Before starting work, visit site and examine conditions under which work shall be performed including preparatory work by others. Report conditions which might adversely affect the work in writing to the Architect. Do not proceed with the work until the defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as acceptance of preparatory work and existing conditions.
- B. Completely coordinate with work of other trades and provide for complete and fully functional installation. Although not specifically shown, provide supplementary or miscellaneous items, devices, appurtenances and materials incidental to or necessary for sound, secure and complete installation.

1.5 RELATED WORK

- A. Carefully examine all of the Contract Documents for requirements which affect work of this Section.
- B. Other specification sections which directly relate to the work of this Section include, but are not limited to, the following:

Section 23.00.00 – MECHANICAL

- C. The following related work will be performed by other Divisions of the specifications:

1. Painting, except as specified herein.
2. Electric power wiring for all equipment. Control wiring shall be performed by this Section.
3. Structural supports except as specified herein.
4. Temporary light, power, water, heat, gas and sanitary facilities for use during construction and testing, unless required by the Architect elsewhere.

1.6 ALTERNATES - NONE

1.7 CODES, STANDARDS AND AUTHORITIES

- A. Perform all work in strict accordance with all rules, regulations, standards, codes, ordinances and laws of local, state and Federal governments, and other authorities having lawful jurisdiction, and be responsible for compliance therewith. Such authorities include but are not limited to the following: NFPA, OSHA, AGA, & EPA.
- B. Give notices, file plans, obtain licenses and permits, pay fees and backcharges and obtain necessary approvals from authorities having jurisdiction.
- C. Material and equipment shall be Underwriters' Laboratories (UL) listed for the service for which it is being used.
- D. Whenever two or more codes, regulations, etc., conflict with each other or with the Contract Documents, the more severe requirements shall govern the conduct of the work.

1.8 GUARANTEE

- A. Notwithstanding any other requirements of this contract, the **Plumbing** Subcontractor shall guarantee the performance of the installation and equipment included in this Section for one year from the date of Substantial Completion as defined in Article 9.6 of the General Conditions. Should any defects in materials or workmanship appear during this period, they shall be corrected or replaced by the Plumbing Subcontractor to the satisfaction of the Architect, and at no expense to the Owner.

1.9 DISCREPANCIES IN DOCUMENTS

- A. Where Drawings or Specifications indicate discrepancies or are unclear, advise Architect in writing before award of Contract. Otherwise, Architect's interpretation of documents shall be final and no additional compensation shall be permitted due to discrepancies or unclear items.
- B. Where Drawings or Specifications do not coincide with recommendations of the manufacturer of a material or piece of equipment, this shall be brought to the attention of the Architect in writing before installation of item in question. Otherwise, make changes in installation as Architect requires without additional cost to the Owner.

1.10 RECORD DRAWINGS

- A. Refer to Specification Section RECORD DRAWINGS for requirements of this section.
- B. The marked up As Built Drawings required to be maintained under this section are of Drawing P-1.
- C. Availability of marked up As Built drawings shall be a prerequisite to scheduling final inspection of this contract and said drawings and original contract documents will be used in checking completion of the work..
- D. Non-availability of marked up As Built drawings or inaccuracies therein may be grounds for cancellation and postponement of any scheduled final inspection by the Architect until the discrepancy has been corrected.

1.11 SUBMITTALS

- A. Submit five copies of shop drawings and product data to Architect for approval. Any deviation from the Contract Documents, or proposed substitution of materials or equipment for those specified, must be requested by the Contractor in a separate letter, whether the deviations are due to field conditions, standard shop practices or other cause. Where any deviation or substitution is permitted, the Contractor shall fully coordinate all related changes to Architectural, Structural, Fire Protection, HVAC, Electrical or other work, and shall accomplish these related changes at no additional cost to the Owner.
- B. Submit shop drawing or product data for the following:
 - 1. Plumbing fixtures, faucets and accessories.
 - 2. Piping, valves, and accessories.
 - 3. Pipe insulation.
 - 4. Interior Grease Interceptor.
 - 5. Electric Water Heater (Alt. Add).

1.12 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Prior to the final inspection, the Plumbing Contractor shall provide to the Architect three (3) sets of operating and maintenance instructions. The Architect shall review the instructions for completeness prior to turning them over to the Owner.
- B. Instructions: The Contractor shall provide qualified, factory-trained manufacturers' representative to give detailed instruction to assigned Owner personnel in the operation and complete maintenance for all equipment. All such training will be at the job site.

PART 2 - PRODUCTS

2.1 PRODUCTS CRITERIA

- A. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.
- B. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- C. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
- D. Asbestos products or equipment or materials containing asbestos shall not be used.
- E. Plumbing fixtures, valves, piping & fittings (i.e. anything in contact with potable water systems) must be lead-free or meet the requirements of NSF61G. The model numbers given may not indicate this, but any submitted valve will be reviewed based on meeting the Lead Free law and NSF 61G.

2.2 PLUMBING FIXTURES – No New Plumbing Fixtures are Proposed

2.3 KITCHEN EQUIPMENT

- A. Kitchen equipment is currently set in place but they are partially installed. They need to be secured and the installation completed including faucet and accessory installation and all piping

- B. The Plumbing Contractor shall provide hot and cold water, drainage, waste and vent to each of these fixtures as required and make final connections to same.
- C. The Plumbing Contractor shall furnish and install shut-off valves at each fixture and, where required, shall provide unions to permit the removal of fixtures for repairs. All hot and cold water piping, valves, waste and vent piping to Kitchen Equipment exposed to normal view, including piping under exposed counters, shall be chrome-plated brass pipe or chrome-plated copper tubing after fabrication.
- D. The Kitchen Equipment layout plans show the approximate size, number, and locations of connections for each item of Kitchen Equipment. The Plumbing Contractor is advised that the size, number, and arrangement of connections may vary with different manufacturers. This Contractor shall make the connections no smaller than those provided at the fixture and shall vary the arrangement to suit the equipment furnished. The Kitchen Equipment Contractor shall furnish certified roughing-in drawings to the Plumbing Contractor before proceeding with the work.
- E. The following items and those indicated on the Drawings shall be furnished and installed by others, but the Plumbing Contractor shall make all connections, hot and cold water, gas, waste (direct or indirect), and vent piping, thereto and provide necessary traps, shut-offs, thereof.
Note that there are multiples of many of these pieces of equipment listed.

3-Compartment Pot Sink	Hand Sinks x 2	Dishwahser	1-Bay Pre-Rinse Sink
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- A. The Kitchen Equipment Contractor (K.E.C.) shall furnish all faucets, strainers, lever handle wastes and waste outlets required on equipment; all furnished equipment shall be installed by the Plumbing Contractor. All other specialty items such as tailpieces, traps, valves, mixing valves for hand sinks and shut-offs, shall be furnished and installed by the Plumbing Contractor. The K.E.C. will also furnish any water filters or water softeners required to the Plumbing Trade Contractor for installation.

2.4 PIPE MATERIALS

- A. All sanitary, soil, waste, and vent lines in accessible areas 2 in. and larger shall be cast-iron "no-hub," ASA group 022 pipe and fittings joined with "Clamp-All," or equal; on pipe sizes 3 in. and larger, use four (4) band clamps, two (2) band clamps will only be allowed on 2 in. pipe. Where it is impractical to install cast-iron pipe, as in tight partition work or where the sizes of lines are smaller than 2 in., Type "L" copper tubing shall be used conforming to ASTM Specification with sweat type fitting using lead free solder and non-corrosive flux, "Non-Korrode," or approved equal, conforming to ASTM Specification B-32 alloy 50A.
- B. All vent lines 2 in. and smaller shall be Type "L" copper, or DWV, except minimum size below ground shall be 2 in.
- C. All hot water and cold water piping within the building shall be hard copper Type "L" seamless drawn tubing assembled with sweat fittings. All solder used shall be lead free, cadmium free, "Silverbrite - 100," or approved equal, complying with the latest issue of ANSI A-5.8 publication. All exposed runs to all toilet fixtures and sinks shall be chrome plated.
 - 1. Mechanical grooved pipe couplings, fittings, Mechanical T's, and other products are acceptable to be used on piping systems and mechanical equipment connections 2-1/2" diameter and larger (in lieu of welded/flanged and threaded methods) in systems specified. Operating conditions not to exceed -30°F to 230°F temperature range according to the gasket lining selected and working pressures as shown in the coupling manufacturer's current product specifications.
 - 2. Press Fitting: Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-Rings for copper press fittings shall be EPDM.

Manufacturers of Copper Press Fittings:

Viega, 17545 Daleview Dr., Lakewood, OH 44107, (877) 620-0016

Rigid Tool Company, 400 Clark Street, Elyria, OH 44035, (800) 519-3456

Elkhart Products Corporation "Xpress Press-Connect Fittings", 1255 Oak Street, Elkhart, Indiana 46515, (800) 284-4851

Nibco Press System, 1516 Middlebury Street, Elkhart, IN 46516-4740, (800)234-0227

Conex Banninger >B< Press, IBP Group, LLC, (904) 217-4970

3. Solder Standard: Solder metal shall conform to the requirements of ASTM B32. Soldering fluxes shall conform to ASTM B813. Solder and fluxes used in drinking water systems shall have a maximum of 0.20-percent lead (Pb) content.

2.4 VALVES

A. Ball Valves:

1. On water lines inside the building, ball valves 3 in. and smaller shall be as manufactured by Consolidated Valve Industries, Inc.'s "Apollo" 95-200-03 Series stop and drain with 1-1/4 in. extended stems for piping 1/2 in. to 1 in. size; 70-100/200 Series with 1-1/4 in. extended stems for piping 1-1/4 in. to 3 in. size. Valves shall be provided with stainless steel ball, reinforced Teflon seats and seals, bronze body, 400 PSI WOG, positive 100 percent shutoff. Valves 4 in. in size shall be equal to "Apollo" 82-20A with extended stem. All ball valves shall be full port style.
2. Drain valves at all low points shall be "Apollo" 78-100 or 78-200 Series, 1/2 in. or 3/4 in. solder by 3/4 in. hose end with attached cap and chain.
3. Ball valves shall be of one (1) manufacturer, Conbraco Industries, Inc., "Apollo," Watts Regulator, Nibco/Scott, or approved equal.

2.5 TRAPS

- A. Provide separate traps with integral cleanouts on fixtures and equipment requiring connections to sanitary system. Exceptions are fixtures with integral traps. Traps exposed to view, including connecting drain lines, shall be chrome plated. No trap shall be less than 1-1/2 inch and shall be sized as required by Code.

2.6 INSULATION

- A. All hot water and cold water piping shall be insulated with Manville FLAME-SAFE fiberglass pipe insulation, Owens-Corning Fiberglass 25, or approved equal. The insulation shall have an average thermal conductivity not to exceed .25 BTU in. per sq. ft. per F. per hour at a mean temperature of 75 degrees F. Thickness of the insulation shall be 1/2 in. for cold water piping up to and including 2 in., 1 in. thick for cold water piping 2-1/2 in. and above, and 1 in. thick for hot water piping. Jacket shall be FLAME-SAFE AP. The insulation shall be applied over clean dry pipe with all joints butted firmly together. Longitudinal jacket laps and the butt strips shall be smoothly secured with Benjamin Foster 85-20 adhesive.
- B. All fittings and valves shall be insulated with the proper factory pre-cut fiberglass insulation and covered using the factory, pre-molded, one-piece PVC fitting covers secured with flexible off-white 10 mil polyvinyl chloride film bonded with a specially formulated adhesive that can be installed indoors and out with a strong permanent bond conforming to MIL Spec. No. 7798-A.
- C. Insulation shall be Manville, Owens-Corning, CertainTeed Corp., Armstrong, or approved equal.

2.7 PIPE SLEEVES, HANGERS AND SUPPORTS

- A. Pipe sleeves, pipe hangers, pipe anchors, auxiliary steel, fire treated wood blocking and fixture supports shall be furnished and set by this Contractor, and he shall be responsible for the proper and permanent location. This Contractor shall be responsible for all core drilling.
- B. Pipe sleeves shall be installed and properly secured at all points where pipes pass through masonry, concrete or wood. Pipe sleeves shall be of sufficient diameter to provide approximately $\frac{1}{4}$ " clearance around insulation. Pipe sleeves through masonry partitions and floors shall be Schedule 40 galvanized steel pipe. Wall sleeves shall have chromium plated escutcheons with set screws or clips for firmly holding in place. Sleeves through wall shall end flush with surface of walls. Sleeves in floors shall extend 1" above the floor and after installation of piping shall be packed and made water tight. Provide core drilling. Core openings shall have Link-Seal fire rated penetration closures. Sleeves in exterior walls shall have water stop plates, shall end flush with the surface of the walls and shall have Link-Seal penetration closures.
- C. Where pipes penetrate fire rated floors and partitions, the openings shall be packed with material which will maintain the integrity of the fire rating.
- D. All piping shall be rigidly supported from the building structure by means of approved hangers and supports. This Contractor shall furnish and install all required auxiliary steel required for hanging of piping
- E. All horizontal piping shall be hung with approved adjustable malleable iron pipe hangers. Cast iron soil pipe shall be supported at 5' intervals except where 10' lengths of piping are used, then 10' intervals are acceptable. Supports shall be placed directly beneath horizontal fittings that connect to the stack. Copper tubing 1-1/2" and larger shall be supported at 10' intervals. Copper tubing 1-1/4" and smaller shall be supported at 6' intervals. Steel piping shall be supported at 6' intervals for piping 1/2" and smaller, at 8' intervals for $\frac{3}{4}$ " and 1" piping and at 10' intervals for piping 1-1/4" and larger.
- F. Vertical cast iron piping shall be supported at base, at each story height and at 10' intervals. Vertical steel piping and copper tubing shall be supported at each story height and at no more than 10' intervals.
- G. Hangers for piping sizes 4" and smaller shall be Carpenter & Paterson, No. 1A band type, Grinnell Company, Calco Steel Products Company or equal, black steel with hanger rods with machine threads; for uninsulated copper tubing, the hangers shall be copper plated. Hangers for piping larger than 4" shall be the adjustable clevis hanger type, malleable iron and extension rod. Chain, strap, perforated bar or wire hangers will not be approved. Approved gang hangers may be used in lieu of separate hangers on pipes running parallel to each other and close together. Where used for uninsulated copper tubing, all hangers shall be copper plated. Insulation shields shall be provided on all horizontal insulated piping at each hanger or supported location. Insulation shields shall be galvanized steel, 180 degrees arc and centered in the hanger or support. On diameters 4" and smaller, shield shall be 12" long, 18 gauge steel. On diameters 5" and 6", shield shall be 18" long, 16 gauge steel. On diameters 8" and 10", shield shall be 24" long, 14 gauge steel. On diameters greater than 10", shield shall 24" long 12 gauge steel. This Contractor shall furnish and install steel insulation shields at each hanger location on piping to be installed. Structure attachments shall be as manufactured by Carpenter & Patterson and shall be suitable to carry the weight. Pipe alignment guides shall be split-sleeve type as manufactured by Broat Manufacturing, Inc. and suitable for copper tubing.

2.8 CLEANOUTS

- A. Cleanouts shall be provided in soil and waste pipes at changes in direction, where shown on Drawings, and at other points required by Code so that lines will be readily accessible for cleaning or rodding out; provide a minimum of 24 inch clearance for rodding. Cleanouts shall be same size as pipe in which they are installed but not larger than four inches.

- B. Cleanouts shall be installed so that cleanout opens in direction of flow of drainage line served or at right angles thereto. Cleanout plug shall be kept free of dirt and construction materials and shall not be covered with cement, plaster or other permanent finishing materials.
- C. Provide cleanouts a base of vertical stacks with cleanout plug located approximately 30 inches above floor. Extend cleanouts to wall with access covers. Cleanout shall consist of sanitary tees. Furnish nickel-bronze square frame and cover with minimum opening 6 x 6 inches at each wall cleanout.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass screw plug in fitting or in caulked cast iron ferrule.
- E. Wall cleanouts shall be brass, recessed head plugs with Zurn ZN-1441 with round cover.

2.9 JOINTING COMPOUNDS

- A. Provide pipe dope, Teflon tape, wax rings, neoprene gaskets and other jointing compounds as required by best standard practice and only on service as recommended by the manufacturer. Work shall conform to manufacturer's recommendations with regard to use of putties, jointing compounds or both in installing plumbing fixtures and trim.

2.10 INTERIOR GREASE INTERCEPTORS

- A. Furnish and install GI-1 in Boys Restroom serving the 3-bay sink, dishwasher and 1-bay pre-rinse sink similar to Schier Great Basin™ grease interceptor model #GB-50. It shall be lifetime guaranteed and made in USA of seamless, molded polyethylene with minimum 3/8" uniform wall thickness. Interceptor shall be furnished for above or below grade installation with adjustable cover adapter, Safety Star® access restrictor built into each cover adapter, and three outlet options. This unit is certified for hydromechanical performance ASME A112.14.3 (type D) and CSA B481. Interceptor flow rate shall be 50 GPM or 75 GPM. Interceptor grease capacity shall be 439 lbs.
- B. Alternate grease interceptors shall be by Canplas Endura, Mifab, Zurn, Ashland PolyTrap or John Boos.

2.11 PIPE IDENTIFICATION AND VALVE TAGS

- A. All piping, except that piping which is within inaccessible chases, shall be identified with semi-rigid plastic identification markers equal to Seton or approved equal Setmark pipe markers. Directions of flow arrows are to be included on each marker. Each marker background shall be appropriately color coded with clearly printed legend to identify the contents of the pipe in conformance with the "Scheme for the Identification of Piping Systems" (ANSI 13.1-1981). Setmark snap-around markers shall be used above six inch overall diameters up to six inches and strap-around markers shall be used above six inch overall diameters. Markers shall be located adjacent to each valve, at each branch, at each cap for future, at each riser take off, at each passage through wall, at each pipe passage through floors, at each pipe passage to underground and on vertical and horizontal piping at 20 foot intervals maximum. All non-portable water lines and outlets shall be identified in accordance with the requirements of the Massachusetts Uniform State Plumbing Code.
- B. All valves shall be designated by distinguishing numbers and letters carefully coordinated with a valve chart. Valve tags shall be 19 gauge polished brass, 1-1/2 inch diameter with stamped black filled letters similar to Seton S type 250-BL or approved equal. Lettering shall be 1/4 inch high for type service and 1/2 inch for valve number. Tag shall be attached to valves with approved brass "S" hooks, or brass jack chin. Whenever a valve is above a hung ceiling, the valve tag shall be located immediately above the hung ceiling.

2.11 ELECTRIC WATER HEATER (ADD ALTERNATE #1)

- A. Electric Water Heater is being suggested in case the hot water for the relocated kitchen is insufficient to handle the kitchen fixtures including the 3-bay sink, dishwasher and pre-rinse sink. It shall be located in the adjacent Boys Restrooms and set out of the way of foot-traffic. The electric water heater shall be sized at a minimum as follows:
1. The heater shall be Gold Series Commercial Electric Model Number DRE-52-30 as manufactured by A. O. Smith. Heater(s) shall be rated at 30 kW, 208 volts, 3 phase, 60 cycle AC, and listed by Underwriters' Laboratories and approved to the NSF Standard 5 by UL. Tank(s) shall 50 gallon capacity. Tanks shall have 150 psi working pressure and be equipped with extruded high density anode. All internal surfaces of the heater(s) exposed to water shall be glasslined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature range of 1400°F to 1600°F. Electric heating elements shall be low watt density Goldenrod 1" screw-in type. Each element shall be controlled by an individually mounted thermostat and high temperature cut-off switch. All internal circuits shall be fused. The outer jacket shall be of baked enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panel and shall enclose the tank with foam insulation. Electrical junction box with heavy duty terminal block shall be provided. The drain valve shall be located in the front for ease of servicing. Heater tank shall have a three year limited warranty as outlined in the written warranty. Manufacturer shall supply ASME rated temperature and pressure relief valve. Fully illustrated instruction manual to be included. Meets standby loss requirements of the U. S. Department of Energy and current edition of ASHRAE/IES 90.1.
 2. Alternate electric water heater manufacturers are American Water Heaters, Bradford, White, PVI and Lochinvar.

PART 3 - EXECUTION

3.1 SPECIAL RESPONSIBILITIES

- A. Cooperate and coordinate with other trades in executing work of this Section. Perform work such that progress of entire project including work of other trades shall not be interfered with or delayed. Provide information on items furnished under this Section to be installed by other Sections.
1. Obtain detailed information from manufacturers of equipment as to proper method of installation. Give full information so that openings required for work of this Section might be coordinated with other work and other openings and many be provided for in advance. In case of failure to provide information, cutting and patching will be done at the expense of this Section to the satisfaction of the Architect.
 2. Notify Architect of location and extent of existing piping and equipment not shown on the Drawings which interferes with new construction. With approval of Architect, relocate existing equipment to permit new work to be installed as required by Contract Documents. With approval of Architect, remove non-functioning or abandoned piping and equipment.
- B. During progress of work, remove and properly dispose of resultant dirt and debris and keep premises reasonably clean. Upon completion of work, remove equipment and unused material provided for work.
- C. Conduct work so as not to interfere with functioning of existing sewer, water and gas mains. Extreme care shall be observed to prevent debris from entering piping. Confer with Architect as to disruption of water service or their utilities due to testing or connection of new work to existing.
- D. All piping and equipment running within trusses must be supported from top chord of truss at panel point. For any alternate configurations or for heavy pieces of equipment coordinate fully with structural engineer for support location before installation.

3.2 MATERIALS AND WORKMANSHIP

- A. Work shall be executed in a workmanlike manner and shall present neat appearance when completed. Piping shall run concealed except in mechanical rooms and areas where no hung ceiling exists. Material and equipment shall be installed according to manufacturer's recommended best practice.
- B. Materials and equipment shall be new, unless otherwise noted.

3.3 ESCUTCHEONS

- A. Escutcheons shall be installed around exposed pipe passing through finished floor, wall or ceiling. Escutcheons shall be heavy cast brass, chrome-plated, adjustable, of sufficient outside diameter to cover sleeve opening and to fit snugly around pipe or insulation.

3.4 SLEEVES AND INSERTS

- A. Sleeves for piping between floors and through firewalls or smoke partitions shall be installed with approved packing between sleeves and piping to provide firestop. Coordinate with G.C. requirements.
- B. This contractor is responsible for sleeving all pipe penetrations before pouring of slab. If additional holes are required this contractor shall core drill such holes in coordination with the general contractor and with prior consent of the Architect.

3.5 INTERIOR WATER SUPPLY SYSTEM

- A. Water supply piping shall be run as indicated on the Drawings, including new connections to mains and supplies to fixtures. Connections to fixtures shall be from top of mains and piping shall be pitched at least 1 inch in 40 feet in the direction of flow so that it can be drained completely at low points. Provide drain valves where necessary. Piping shall be pitched up towards fixtures for proper air relief.
- B. Provide water hammer arrestors of proper size and type at end of each water branch with flush valves as shown on the drawings.
- C. Provide ball type shut-off valves on water branches to individual areas and to each bathroom group.

3.6 SANITARY, WASTE AND VENT PIPING

- A. Interior horizontal sanitary and waste piping shall be installed in practical alignment at uniform grade of 1/8 inch per foot minimum up to 1/4 inch per foot if possible or if required by code such as for waste piping smaller than 4". Coordinate invert of tie-ins to site piping with site contractor. Piping within building shall be coordinated closely with the work of other trades, in particular the HVAC ductwork.

3.7 VENTS THROUGH ROOF – EXISTING TO REMAIN

3.8 VALVES

- A. All valves shall be furnished and installed under this Section shall be located in a manner to allow proper access for service and repair.
- B. In no case shall valve stem and handle on a gate or globe valve be installed below the center-line of the pipe it serves.

3.9 JOINTS AND CONNECTIONS

- A. Joints and connections of piping shall be made permanently gas and water tight.
- B. Dielectric couplings or unions shall be used where dissimilar piping materials are joined.
- C. Final plumbing and gas connections to all equipment furnished or installed by others shall be by this Section.

3.10 INSULATION

- A. Insulation shall be applied over clean dry pipe with all joints butted firmly together and sealed with butt strips. Insulation shall run through all hangers and sleeves and have an 18 gauge sheet metal saddle equal to three (3) times the pipe diameter in length, on all pipes over 2 in. in diameter.
- B. All fittings, valves, and exposed supply and waste piping to the handicapped lavatories, etc., shall be insulated as specified. The ends of the insulation shall be tucked snugly into the throat of the fitting and the edge adjacent to the pipe covering tufted and tucked in fully insulating the pipe fitting. The one-piece PVC fitting cover shall then be secured by taping the ends to the adjacent covering.
- C. In addition to the regular insulation specified, all exposed piping from floor up to 10 ft. 0 in. shall have a PVC jacket cover applied over the insulation from finish to 10 ft. 0 in. above. All joints shall be sealed with tape.

3.11 FIXTURES – Not Required

3.12 ADJUSTMENT

- A. Adjust all flush valves, pressure reducing valves, meter faucets, and water temperature controllers, water heater, and recirculation pumps for proper outlet temperatures and pressure.
- B. The Plumbing Contractor shall be responsible for adjusting and balancing the entire domestic hot water recirculation system. Provide recirculation pump balance report.

3.13 DISINFECTION

- A. The domestic water distribution piping system shall be thoroughly disinfected with solution containing not less than 50 parts per million of available chlorine. Solution shall be introduced into system for period of eight hours, during which time valves and faucets shall be opened and closed several times. After disinfection, solution shall be flushed from system with clean water until residual chlorine content is not greater than 0.2 parts per million.

3.14 CLEANING

- A. Upon completion of work but prior to final system testing, all parts of installation shall be thoroughly cleaned. Fixtures, pipe, valves and fittings shall be completely cleaned of grease, metal cuttings, dirt, etc. Protective covers shall be removed and fixtures shall be cleaned and ready for use.

3.15 TESTING

- A. Provide testing of plumbing systems as required by authorities having jurisdiction, including Owner and Architect. Tests shall be conducted as part of work of this Section and shall include labor, equipment, apparatus and services required to perform tests.

- B. Prior to final acceptance, furnish Architect with certificates of testing and inspection for plumbing systems indicating approval of authorities having jurisdiction and conformance with requirements of Contract Documents.
- C. Notify Architect and authorities involved at least 48 hours prior to testing and inspection. Do not paint, cover or conceal work prior to testing, inspecting and obtaining approval.
- D. Provide temporary piping and connections for testing, flushing or draining systems to be tested. Leaks, damage or defects discovered or resulting from test shall be repaired or replaced to like-new condition. Piping must be absolutely tight before it will be accepted and joints shall be made tight without caulking.
- E. Tests for Plumbing Systems: Soil, waste, vent, gas, and water piping shall be tested by the Plumbing Contractor and approved before acceptance. Underground soil, rain conductor, and waste piping shall be tested prior to backfilling. Equipment required for tests shall be furnished by the Plumbing Contractor at no additional cost to the Owner. All tests shall be witnessed and approved by the Plumbing Inspector.
- F. Drainage And Venting System Piping: All vent, soil, waste, acid waste, acid vent, and rain conductor shall be tested with water or air before the fixtures are installed.
 - 1. Water Test: Water test shall be applied to the drainage and venting system in their entirety or in sections. If the entire system is tested, all openings in the pipe shall be tightly closed, except the highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening, except the highest opening of the section under test, shall be tightly plugged and each section shall be filled with water and tested with at least a 10 ft. head of water. In testing successive sections, at least the upper 10 ft. of the next preceding section shall be tested so that each joint of pipe in the building, except the uppermost 10 ft. of the system, has been submitted to a test of at least 10 ft. head of water. The water shall be kept in the system, or in the portion under test, for at least two (2) hours before the inspection starts. The system shall be tight at all joints.
 - 2. Air Test: If tests are made with air, a pressure of not less than 5 lbs. per sq. in. shall be applied with a force pump and maintained at least one (1) hour without leakage.
- G. Water System: When the roughing-in is complete, and before fixtures are set, the entire hot water recirculation and cold water piping system shall be tested at a hydrostatic pressure of not less than 125 PSI gauge and proved tight at this pressure for not less than four (4) hours in order to permit inspection of all joints. Where a portion of the water piping system is to be concealed before completion, this portion shall be tested separately as specified for the entire system. All water entrance piping up to PRV-station shall be tested at 50 PSI in excess of the street pressure, but not to exceed 200 PSI.
- H. Defective Work: If inspection or test indicates defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests repeated. Repairs to piping shall be made with new materials. No caulking of screwed joints or holes will be acceptable.

3.16 LUBRICATION

- A. After complete installation by the Contractor of any equipment which depends on lubrication for efficient operation, the Contractor shall properly lubricate per instructions of the manufacturer. This shall be done before any test runs or final operation.

END OF SECTION 22.00.00

SECTION 23.00.00 - MECHANICAL

(Filed Sub-Bid Required)

PART I - GENERAL

1.1 RELATED DOCUMENTS

- A. All of the Contract Documents, including General and Supplementary Conditions and Division 1 General Requirements, are hereby made a part of the work of this Section. Where paragraphs of this Section conflict with Division 1, the more stringent requirements shall govern.
- B. All work shall comply with all federal, state and local codes and any other authorities having jurisdiction.

1.2 TIME, MANNER AND REQUIREMENTS FOR SUBMITTING SUB-BIDS:

- A. Sub-bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the City of Worcester, Department of Public Works and Parks, Architectural Division, 50 Skyline Drive, Worcester, MA 01605 at time and place stipulated in the "invitation to Bid/Notice to Contractors". The following shall appear on the upper left hand of the envelope:

Name of Sub-Bidder: **Print Name of Sub-bidder**

Project: **Vernon Hill School Kitchen Relocation for Worcester Public Schools**

Sub-Bid for Section: **23 00 00**

- B. Each sub-bid submitted for work under this Section shall be on forms furnished by the City of Worcester as required by Section 44F of Chapter 149 of the General Laws, as amended. Sub-Bid forms may be obtained at the Department of Public Works and Parks, Architectural Division, 50 Skyline Drive, Worcester, MA 01605 in person, or by written request.
- C. Sub-bids filed with the City of Worcester shall be accompanied by a BID BOND or CASH or CERTIFIED CHECK or a TREASURER'S or CASHIER'S CHECK issued by a responsible blank or trust company payable to the City of Worcester in the amount of five (5) percent of the bid. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.
- D. Filed Sub-Subs Required

- 1. Filed Sub-bidder's attention is directed to Massachusetts G.L. Chapter 149 §44H, as amended, which provides in part as follows:
- 2. Each filed Sub-bidder shall list in Paragraph E of the "Form for Sub-Bid" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which the Section of the Specifications for that sub-subtrade requires such listing, provided that, in the absence of a contrary provision in the Specifications, any sub-bidder may, without listing any bid price, list his own name or part thereof and perform that work with persons on his own payroll, if such sub-bidders, after sub-bid openings, shows to the satisfaction of the Awarding Authority that he does customarily perform such class of work with persons on his own payroll and is qualified to do so. This Section of the Specifications requires that the following classes of work shall be listed in Paragraph E under the conditions indicated herein.

Class of Work	Reference Specification	Paragraphs
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Sheet Metal	23 00 00	2.1
Insulation	23 00 00	2.2
Auto. Temperature Control	23 00 00	2.7

3. If the Filed Sub-Bidder customarily performs the above Work with its own workforce, the Sub-Bidder should list its own name and trade and leave the dollar amount blank.

1.3 SUMMARY

- A. Provide all materials, labor and equipment required to perform the work of this section, as shown on the Contract Drawings and as specified herein, to include:
1. Demolition and removal of existing abandoned ductwork within the proposed cafeteria spaces. Existing ductwork should be capped. Also, there are pneumatic tubes mounted high on the wall between the two cafeterias that may need to be reworked rather than the electrical conduits,
 2. Complete Heating & Ventilation duct system including supply registers, exhaust grilles, dampers, etc.
 3. Miscellaneous steel, dunnage, supports, hangers, pads, etc., as shown, and as required.
 4. Insulation for ductwork: internal lining and exterior insulation protected from the elements. Interior ductwork is exposed within the space and does not require duct insulation.
 5. Heat Only Energy Recovery Ventilator mounted on grade.
 6. Automatic Temperature Controls – Verify with owner that electronic controls and unit monitoring should be included for owner remote control.
 7. Testing and balancing.
 8. Equipment bases and supports.
 9. All rigging and hoisting of equipment as required.
- B. Related Work Specified Under Other Divisions
1. Power circuiting.
 2. Plumbing.
 3. Cutting and sealing openings in window in-fill for new ductwork penetrations.
- C. Where the specifications and/or plans conflict, the more stringent (costly) requirement shall control. Clarification from Engineer shall be obtained before proceeding.
- D. The work of this section is shown on drawings DH-1, H-1 and H-2.

1.4 SUBMITTALS

- A. Submit in accordance with Section SUBMITTALS.
- B. Product data: within 30 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
1. Coordinated shop drawings, showing proposed layout of equipment and other components of the system.
 2. Manufacturers catalogs, samples and other items needed to fully demonstrate the quality of the proposed materials and equipment including product data on the following.
 - Heat Only Energy Recovery Ventilator
 - Supply Registers
 - Exhaust Grilles
 - Ductwork and Duct Hangers
 - Automatic Temperature Controls

C. Record Drawings:

1. Submit one reproducible and three blue line copies of As-Built drawings at completion of project.

D. Testing and Balancing Reports:

1. Prior to the completion of all work and the final inspection of the installation by the owner, three (3) copies of a complete Instruction Manual, bound in booklet form and suitably indexed, shall be submitted to the Architect for review and approval. All written material contained in the manual shall be typewritten or printed.

1.5 INSTRUCTION OF OWNER'S PERSONNEL

- A. After completion of all work and all tests and at such time as designated by the owner, fully instruct the owner's representative in the complete operation, adjustment and maintenance of the entire installation

1.6 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. The Contractor's superintendent shall conduct all coordination between the Contractor, the Architect, the Engineers, etc., and shall fully represent the Contractor's position in his absence. All decisions by the superintendent shall become the responsibility of the Contractor and binding to the Contract. The Contractor shall be responsible for the drawings, and that which is written or implied in the specifications.
- C. Without additional cost to the Owner, provide such other labor and materials as are required to complete the work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.
- D. Before submitting the final proposal examine the site of the proposed work to determine existing conditions that may effect the work, as this section will be help responsible for any assumption in regard thereto.

1.7 GUARANTEE

- A. The Contractor shall guarantee every component part of each system for a minimum of one year parts and labor. The contractor shall also provide the Owner with factory warranties for all equipment.

1.8 DRAWINGS

- A. The Contractor shall examine the requirements and provisions of the Contract Documents and ascertain the extent of work and materials required or reasonably implied. The drawings pertaining to the work of this section are DH-1, H-1 and H-2.

1.9 PAYMENT

- A. Payment for work of the Section will be made for the quoted Contract Price and will constitute payment in full for all costs for furnishing all labor, materials and equipment necessary to complete the work as required. Payment under this contract shall be made in partial payments as approved by the Architect as the work progresses.

PART 2 - PRODUCTS

2.1 DUCTWORK

- A. For the Heating and Ventilating systems, provide galvanized sheet metal ducts fabricated and installed to pertinent ASHRAE and SMACNA standards, except as otherwise indicated.
Galvanized ductwork shall conform to ASTM A527 (G-90) having not less than 1.25 oz. of zinc on each side of each square foot of sheet. Duct systems shall comply with the pressure velocity classification in compliance with the SMACNA HVAC Duct Construction Standards, 2020 fourth edition. Minimum pressure classification shall be 2" w.g.
- B. Furnish and install the size, connections and run of ducts as indicated on the drawings. Drawings indicate inside clear dimensions.
- C. The sheet metal ductwork shall, whether indicated or not, rise and drop and change in shape to clear lighting fixtures, plumbing and structural framing etc., to maintain the desired clearances within the spaces.
- D. The ductwork shall be continuous, with airtight joints and seams presenting a smooth surface on the inside and neatly finished on the outside. Ducts shall be constructed with curves and bends so as to effect an easy flow of air. Unless otherwise shown on the Drawings, the inside radius of all curves and bends shall be not less than width of ducts in plane of bend.
- E. All ductwork, unless otherwise noted, shall be built from galvanized sheet steel and thoroughly braced and stiffened. All ductwork shall be of the gauge recommended by SMACNA except that the minimum gauge thickness for any duct shall be no less than 24.
- F. Duct sizes change in shape or dimensions and offset as required to clear structural members and to coordinate with other trades. All changes must maintain the same friction loss as the original duct (i.e. similar free area) and must meet the latest ASHRAE and SMACNA standards.
- G. The centerline radius of all duct elbows where shown on Drawings shall be at least one and one-half the width of the duct. Where building conditions do not allow for this radius, provide double wall airfoil turning vanes or, if in a sound attenuated duct, provide acoustical attenuating turns.
- H. Duct sections 1 ft. 6 in. wide or less shall be butted together and jointed with flat drive cleats 2-1/8 in. wide. Top and bottom cleats shall be cut flush with duct and side cleats bent over to make a tight joint. Standing bar slips as specified for ducts over 18 in. may be used at the HVAC Trade contractor's option.
- I. Sheet metal screws 3/4 in. No. 10 may be used to attach stiffener angles to ductwork to secure seams, spaced not over 12 in. on centers and not less than two (2) per side of 12 in. or more, except where specified otherwise. Button punching shall not be used, except for pre-erection attachment of fittings.
- J. Hangers for all rectangular ducts 4 sq. ft. in area or above shall be round bar type fastened to 1-1/4 in. by 1-1/4 in. by 1/8 in. angles under the ducts.
 - 1. Ducts less than 4 sq. ft. in area shall be hung with black 1 in. by 1/8 in. strap iron bent 1 in. under bottom side of the duct and fastened to the duct with sheet metal screws, using not less than two (2) screws per side and as many more so that they are not greater than 6 in. centers.
- K. Hangers are to be placed on not greater than 8 ft. 0 in. centers or closer where required so that the ductwork can support the weight of a 200-pound man at any point.
- L. Wherever sound insulation lining is called for, the sheet metal duct size shown on the Drawings must be increased to provide the clear inside dimensions or cross-sectional area shown on the Drawings. Dimensions shown on the drawings are clear inside.

- M. Seal all duct seams, transverse and longitudinal, air tight with 3M “ED800” or equal duct sealing compound.
- N. At branch ducts, provide manually operated dampers of the type and arrangement shown on the Drawings, two gages heavier than the duct in which installed and equipped with locking quadrants. All branch take-offs shall be made with 45° or full Bellmouth type fittings.
- O. Volume dampers, provide single and multi blade manually adjustable dampers as shown on drawings in all duct splits and branch connection of supply and exhaust air systems.
- P. Turning vanes, provide and install air foil vanes at square duct elbows and as noted on drawings. Vane length not to exceed 36 in. Provide separate equal size sections for greater lengths.
- Q. Refer to paragraph entitled ‘INSULATION’ for internal lining requirements.

2.2 INSULATION

A. General

- 1. Provide materials complying with NFPA Bulletin 90-A, as determined by UL method NFPA 225-ASTM E 84, and complying with the governing code, with flame spread rating under 25 and smoke developed rating under 50.
- 2. Insulation properties must meet or exceed the minimum R-values required by the IMC 2012, the applicable Stretch Energy Code adopted by the City/Town as applicable and those indicated herein.
- 3. Where vapor barriers are used, provide intact and continuous throughout.
- 4. Acceptable manufacturers:
 - Owes/Corning Fiberglass
 - Knauf
 - Manville
 - Certainteed

- B. Interior Ductwork: All interior ductwork is exposed within the spaces they serve so inside duct liner or outside duct insulation is not required.

C. Exterior Ductwork

- 1. Exterior Supply & Return Air Ductwork: All supply air and return/exhaust air ductwork located outside the heated building envelope shall be insulated with 2” thick polyisocyanurate closed-cell rigid duct insulation, ASTM C 591, type IV, K=0.19), with R-12 insulating value for use at temperatures up to 149 degree C (300 degree F) regardless of whether internal lining is present. Insulation shall be sloped so as to pitch water towards edge of ductwork.
- 2. Provide covering on all exterior insulated ductwork and equipment. Product shall be field-applied or pre-applied protective finishing and/or vapor sealing, operating within the range of -94°F (-70°C) and 300°F (149°C), jacketed with laminated, flexible, self-adhering, protective jacketing, vapor barrier and weather proofing membrane, having a high performance acrylic adhesive capable of installation with no additional mechanical attachment. Material is to be VentureClad 1577CW (5ply) Natural, White (White Membrane “WM”), or approved equal finish selected based on availability and desired final appearance of insulated system. Jacketing material is to have a maximum flame spread/smoke developed index of 10/20 per UL 723 test, a .000 water vapor permeance rating per ASTM E-96, and mold inhibitors incorporated. All products are UV stable. Fabrication and installation shall conform to the manufacturer’s installation instructions and Midwest Insulation Contractors Association National Insulation Standards Manual. If there is conflicting information, manufacturer’s installation instructions are to be followed.

- D. Acoustic insulation: All supply and return air ducts within 10 feet of air moving equipment shall be lined internally with 1-inch-thick liner with fiberglass reinforced facing. Liner shall comply with NFPA 90A requirements and current IAQ standards, be listed for hospital grade use and have a microbial resistant coating. Duct dimensions noted on drawings are clear inside dimensions, metal size shall be increased and transitioned to accommodate liner. Internal liner does not engage the need for specified exterior duct insulation.

2.3 AIR INLETS/OUTLETS

- A. Supply registers and exhaust grilles shall be installed where shown on the drawings and shall be of the type, sizes and quantities as indicated on drawings. Manufacturer's shall be Price, Titus, Krueger or MetalAire.
- B. All supply registers and exhaust grilles shall be constructed out of steel as scheduled on the drawings. Final color selection shall be by Engineer & Owner. Submit color chart for review and selection.
- C. Air quantities shall be handled at velocities not exceeding 600 fpm, with maximum diffusion within the space, without objectionable air movement and with sound pressure level not exceeding NC-32.
- D. All registers and grilles shall be shipped with protective film on face and connections to prevent dust from entering.
- E. Furnish and install supply registers of the sizes and mounting types indicated on the plans and outlet schedule. Registers shall be double deflection type with two sets of fully adjustable airfoil shaped deflection blades spaced 3 /4 in. on center. The front set of blades shall run parallel to the (long / short) dimension of the register. Both blades and border shall be of heavy extruded aluminum construction. The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel (optional aluminum construction 22DAL). The damper shall be operable from the register face. The damper shall be coated steel (mill finish aluminum 22DAL). The grille shall be finished in (B12 White Powder Coat / B15 Aluminum Powder Coat). Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering as per ASTM D610 and ASTM D714.
- F. Furnish and install exhaust grilles of the sizes and mounting types indicated on the plans and outlet schedule. Registers shall be 45 degree deflection fixed louver type with blades spaced 3 /4 in. on center. The blades shall run parallel to the (long/short) dimension of the register, as indicated in the outlet schedule. Both blades and border shall be of heavy extruded aluminum construction. The optional integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel. The damper shall be operable from the register face. The optional damper shall be coated steel. The grille shall be finished in B12 White Powder Coat. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering as per ASTM D610 and ASTM D714.

2.4 VIBRATION ISOLATION AND FLEXIBLE CONNECTIONS

- A. At duct connections to energy recovery ventilator, provide glass-fabric flexible neoprene connections with a minimum of 6 inch full length and approved by the governmental agencies having jurisdiction.

2.5 PACKAGED ROOFTOP VENTILATOR WITH OPTIONAL ENERGY RECOVERY WHEEL AND ELECTRIC HEATER

- A. This section includes a unit with integral heating for outdoor installation. Integral energy recovery device shall be a rotary air-to-air total enthalpy wheel. Integral heating source shall be electric heat. Airflow arrangement shall be outdoor air only with no recirculation. The unit shall be

construction in a horizontal configuration and shall incorporate additional product requirements as listed.

- B. Manufacturers: Available Manufacturers - Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include but are not limited to:
 - 1. Greenheck Fan Corporation.
 - 2. Valent.
 - 3. Daikin.
- C. Manufactured Units: Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, exhaust air blower, Energy wheel, electric post-heater, phase and brownout protection, motorized dampers, sensors, curb assembly, service receptacle, filter assembly for intake air, supply air blower assembly and an electrical control center. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection except with electric post heat and exhaust fan only power which have dual point power.
- D. Cabinet:
 - 1. Materials – Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - a. Outside casing: 22 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Unit's exterior shall be supplied from the manufacturer using G60 galvaneal steel with proprietary pre-painted material in the following finish color; Concrete Gray-RAL 70023. This has been subjected to a salt spray test per ASTM-B117 and evaluated using ASTM-D714 and ASTM-D610 showing no observable signs of rust or blistering until reaching 2,500 hours.
 - b. Internal assemblies: 24 gauge, galvanized (G90) steel] except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
 - 2. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - a. Materials: Rigid urethane foam
 - 1) Thickness: 2 inch (50.8 mm)
 - 2) Thermal Resistance: R13
 - 3) Meets UL94HF-1 flame requirements
 - 4) Location and application: Full coverage of entire exterior to include walls, roof of unit, unit base and doors
 - 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 22 gauge galvanized G90 steel or painted galvanealed steel.
 - 4. Supply Air blower assemblies: Blower assembly shall consist of an electric motor and direct-drive fan(s). Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motor(s) shall be capable of continuous speed modulation and controlled by a VFD.
 - 5. Exhaust Air blower assemblies: Blower assembly shall consist of an electric motor and a direct-drive fan. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motor shall be capable of continuous speed modulation and controlled by a VFD
 - 6. Control panel / connections: Rooftop Ventilator units 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. RTU shall be equipped with a Unit Disconnect Switch. Electric heater shall have a separate electrical control center and separate high voltage power circuit as shown on the plans. Electric heater shall have single point power.

7. Energy wheel: Unit energy wheel shall handle the full volume of outdoor and exhaust air without an energy wheel bypass damper(s). 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 or a link style 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. Silica gel desiccant shall be permanently bonded to the polymer film and is 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.
8. Wheel Frost Control: Modulating Wheel: Shall be provided for frost control of the energy wheel. Control system shall include an energy wheel VFD, outdoor air thermostat, and pressure sensor on the wheel assembly to initiate frost control sequence.
9. Electric Post-heater: Post-heater shall be SCR control and shall include a temperature sensor with field adjustable set point through the BMS, located in the outdoor air stream. Heat output of the post-heater shall be infinitely variable.
10. Phase and brownout protection: RTU shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.
11. Motorized dampers Outdoor Air & Recirculation Air: AMCA Class 1A certified motorized damper of low leakage type and a leakage rate of 3 CFM/ft² @ 1 in. wg. shall be factory installed. Exhaust air damper shall be barometric type.
12. Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed as specified.
13. Curb Assembly: A curb assembly made of 14 gauge galvanized steel shall be provided by the factory for assembly and installation as part of this division. The curb assembly shall provide perimeter support of the entire unit. Curb assembly shall enclose the underside of the unit and shall be sized to fit into a recess in the bottom of the unit. Contractor shall be responsible for coordinating with GC to ensure curb anchors to slab. The curb shall be the height of 14".
14. Service receptacle: 120 VAC GFCI service outlet shall be factory-provided and installed

E. Blower

1. Blower section construction Supply Air: direct drive motor(s) and blower(s) shall be assembled on a 14 gauge galvanized steel platform and shall be equipped with 1.125 inch thick 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. Fan: Direct drive, airfoil plenum fan with steel wheels statically and dynamically balanced and AMCA certified for air and sound performance.
 4. 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."
- F. Motors: General: Blower motors greater than ¾ horsepower shall be "NEMA Premium™" unless otherwise indicated. Compliance with EPA's 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. Motors shall be 60 cycle, 3 phase 208 volts.

G. Unit Controls

1. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors. In addition, it can be operated as a heating and cooling system controlled by a Building Management System (BMS). This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors. Unit must have a BACnet interface card for communication with the building BMS.
 2. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of push buttons.
 3. RTU supply fan shall be configured for Constant Volume (ON / OFF).
 4. Exhaust fan shall be configured for Constant Volume (ON /OFF).
 5. Economizer control shall be temperature based. A recirculation damper shall be provided for occupied/unoccupied use.
 6. Dirty filter sensor shall be factory-installed.
 7. Operating protocol: The DDC shall be factory-programmed for BACnet IP
 8. Variable Frequency Drive (VFD) [unit shall have factory installed variable frequency drive for modulation of the supply air blower assembly & exhaust air blower assembly. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
 9. BMS shall control enable/disable, occupied/unoccupied and supply air reset.
- H. Filters: Unit shall have permanent 2-inch aluminum mesh moisture eliminator filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the OA supply air stream upstream of the energy wheel and MERV 13 disposable pleated filters provided in the supply final air stream. MERV 8 filters shall also be provided in the exhaust air stream ahead of the energy recovery wheel. Provide three (3) spare replacement sets for all filters.

2.6 ELECTRICAL WORK

- A. The Heating, Ventilating and Air Conditioning Contractor shall provide all wiring for the Automatic Temperature Controls, air handlers, duct smoke detectors (fan interlock and control loop power), condensers, etc.. except as otherwise specified herein.
- B. The HVAC contractor shall hire a licensed electrician to perform all control wiring as required by code. Minimum gauge of all control wiring is 18 AWG and shall be plenum rated.
- C. The Electrical Contractor shall install and do all power wiring for all motor starters and unmounted motors, furnished to him at the job site by other trades.
- D. For all low voltage motors, temperature control wiring and motor control wiring, including wiring for interlocking, shall be provided by the Section providing the motors, including the installation of all control devices.

- E. Furnish all starters and all other motor control devices for motor driven equipment required for the work. The Electrical Contractor shall provide all code required disconnect switches for all motors, except where otherwise noted. The setting of all motors required for mechanical equipment shall be included as part of the mechanical work.
- F. Equipment which includes a number of correlated electrical control devices mounted in a single enclosure or on a common base with equipment, shall be supplied for installation completely wired as a unit with terminal boxes and ample leads ready for external wiring.
- G. All electrical items called for as part of the mechanical work shall conform to NEMA Standards, to the requirements of the National Fire Protection Association and to the requirements of any local electrical code authority having jurisdiction, any field modifications required to ensure such conformance shall be included as part of the mechanical work.

2.7 AUTOMATIC TEMPERATURE CONTROLS

- A. Furnish and install all control components necessary to obtain a fully functional control system as described herein. The contractor is responsible for providing all controls, relays, etc. necessary to accomplish the Sequence of Operations and performance specified, whether or not the items are specifically identified herein. This shall include all the points shown in the control diagrams and on the drawings. Wherever a setpoint is referred to, this implies that the setting is adjustable by the user. Contractor shall hire the project electrician to provide additional power supplies to support the control devices as required. All controls operating equipment and systems configured to run off emergency stand-by power must be wired to the emergency stand-by power circuit. Any controls supporting the stair tower pressurization fans or other life safety components shall be wired to life safety emergency power circuit. This shall include but not be limited to the following systems along with all associated control devices:
 - 1) front-end work station
 - 2) network controllers and interface
 - 3) boiler plant (boilers, pumps, ventilation, CO system)
 - 4) domestic water heaters and associated, boiler, tank and recirculation pumps
 - 5) IDF and MDF fan coil units
 - 6) Data center systems CRAC-1 & 2 and ACCU-1 & 2
 - 7) Emergency electric room fan coil units
 - 8) Chiller/Heater module, chiller heat and cool pumps and chilled water system pumps
 - 9) cabinet unit heaters & unit heaters
 - 10) RTU-6, 7, 8, 12, 12, 14, 18, 20, 21, 22, 23, 24 systems (DX cooling and dehum. disabled if on emergency power)
 - 11) Anti-stratification fans.
 - 12) Administration & Health Clinic systems RTU-10 and all associated ACHP's (ACHP-8) and fan coils;
 - 13) Kitchen MAU and Hood Exhaust Systems and associated devices;

Provide battery UPS power supplies for the front-end and network interface controls to insure no interruption of the power supply. As indicated in section 01.60.00 Product Requirements, 1.6 Owner's Proprietary Products, the Alerton control system by ABS is a proprietary product and no alternates shall be allowed.

- C. The specified DDC system shall be based the most recent generation of products by Alerton, as provided by Automated Building Systems, Inc. the Owners current energy management system provider. No alternates shall be allowed. Owner's front-end graphics must be updated to include this building with link to associated systems. The project graphics and software must be programmed into the existing city-wide Alerton server. New controls installed must seamlessly integrate into the existing Alerton system front-end graphics for trending and alarm reporting. The control system shall operate on a central network bus and shall web based access via password protection to any remote computer. This control system shall be referred to as the DDC, BMS, EMS or ATC system throughout this specification. BMS system must be BACnet and Open Protocol compatibility for direct communication with boilers, VFD's & RTU's, etc... to obtain operation status of systems including real time energy consumption.

It is the intent of this project that most of the HVAC equipment such as ERV shall come with many factory controls. Although equipment may come with many local devices and sensors provided by the equipment manufacturer the BMS contractor must still provide external sensors and devices (i.e. duct smoke detector and damper connections, duct static and space static sensors, return and/or space temp., CO2 and humidity sensors, etc...) as required to achieve the sequence of operation and comply with the bid documents. Controls subcontractor must review specifications and clarify with respective mechanical sub-bidders to verify mechanical contractor is proposing to provide the equipment specified with communication interface specified

- D. The entire system, materials & devices as well as installing contractor and associated work shall comply with all current governing codes, ordinances and regulations including UL, NFPA, NEC, IBC, IMC, local AHJ, etc...
- E. The system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability for any existing control system component including but not limited to Primary Control Panels, Secondary Control Panels, personal operator workstations, and portable operator's terminals, to be connected and directly communicate with any new BMS system equipment without bridges, routers or protocol converters.
- F. All control wiring shall be shielded plenum rated minimum 18 AWG (unless lighter gauge or heavier gauge is required due to impedance or current demands) and shall be run concealed above ceilings or within walls. When the wiring must run exposed it shall be run in EMT conduit in unfinished service spaces and in Wiremold® or equal conduit system product in finished occupiable spaces.
- G. It shall be division 23 00 00 responsibility to provide all personnel as required to fully coordinate with the commissioning agent as applicable.
- H. General
 - 1. The automatic temperature control system shall include, but not be limited to, the following components:
 - Front-end computer with graphic software showing all building HVAC systems. Real-time interface with controlled components.
 - Several stand-alone DDC control unit(s) networked together on a local LAN to control the environment in the entire building
 - Expansion modules for the controllers, if required, shall provide for the capability of additional DDC points.
 - End devices such as sensors, actuators, dampers and valves.
 - Control transformers and relays.
 - Control wiring between duct smoke detectors and the respective fan starters.
 - 2. The failure of any single component shall not interrupt the control strategies of other operational devices.

I. OPERATOR INTERFACE / STATION

- 1. Update existing building and central BMS graphics and controllers to reflect the new systems.

J. INPUT/OUTPUT INTERFACE

- 1. Digital Inputs (DI) shall allow the monitoring of on/off signals from remote devices. The digital inputs shall provide a wetting current of 12mA at 12 vdc to be compatible with commonly available control devices.
- 2. Analog Inputs (AI) shall allow the monitoring of low voltage current or resistance signals and shall have a minimum resolution of 0.1% of the sensing range. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

3. Digital Outputs (DO) shall provide a continuous low voltage signal for on/off control of remote devices. Where specified in the sequences of operations or indicated on the points list, digital outputs shall have 3-position (on/off/auto) override switches, status lights, and shall be selectable for either normally open or normally closed positions.
4. Analog Outputs (AO) shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10vdc or a 4 to 20 mA signal as required to provide proper control of the output device.

K. AUXILIARY CONTROL DEVICES

1. Dampers and Actuators

- a. Dampers shall be opposed blade type except where installed in round ductwork where single blade type is acceptable. All damper blades shall be low leakage type with neoprene gasketed edge seals rated for no more than 3 CFM/SF leakage at 1" w.g.. Actuators shall be electronic, spring return, low voltage (24v) and properly selected for the required torque and speed. Actuators shall be fully proportioning with the exception of those dampers specified as being 2-position open & closed. All actuators shall include end switches. Those dampers for the stair tower pressurization system shall include end switches for both full open and full closed positions.
- b. Dampers exposed to the area served shall be double wall insulated ultra-low leakage type.

2. Temperature Sensors

- a. Temperature sensors shall be Resistance Temperature Detector (RTD) type or thermistors, as dictated by the requirements of this specification. Final location of all space sensors shall be coordinated with the Owner and Engineer. Space sensors in café shall be wall mounted type with lockable user adjustable access allowing deviation of +/- 3 deg. of computer defined setpoint and push button occupied override. Alerton school standard space sensor such as #MS4-THC style shall be used.
- b. Duct sensors shall be rigid or averaging as specified in the sequence of operations. Averaging sensors shall be a minimum of 20 feet in length. Freeze protection sensor shall have a 20-foot sensor crossing back and forth across the air exit face of the water heating coil. Immersion sensors shall be provided with a separable stainless steel well
- c. Sensor accuracy's and operating ranges shall be as follows:
 - Space temp. +/- 1 deg. F, 0 to 130 deg. F range
 - Duct temp. +/- 1 deg. F, 30 to 160 deg. F range
 - O.A. Duct temp. +/- 1 deg. F, -30 to 160 deg. F range
 - Water +/- 1 deg. F, 0 to 200 deg. F range

3. Relative Humidity Sensors

- a. Relative humidity sensors shall be thin film capacitor type with an accuracy of +/- 2% with a range of 10% to 90%. For enthalpy calculations provide on North wall for outdoor air sensing and one in each ERV main return air duct and elsewhere as shown on the control drawings or indicated herein. Final location of all space sensors shall be coordinated with the Owner and Engineer. Space sensors shall be wall-mounted type.

4. CO2 sensors: Shall be self-calibrating duct or wall-mounting type as specified capable of measuring a CO2 range between 100 and 2000 PPM as manufactured by Mamac or approved equal.

5. Flow Switches

- a. Differential pressure switches shall be provided at filters and fans. Paddle type switch shall be provided at boilers unless otherwise noted or if boiler flow turn down is below range of paddle sensor. Current sensing run indicators shall be provided at each fan and pump. Sensor shall be able to differentiate between belt loss and motor failure and report to the workstation as such.

L. OPERATOR INTERFACE SOFTWARE

1. Alarms

- a. The stand-alone DDC unit shall provide visual notification of equipment failures, program failures, hardware failures or sensor failures. In addition, each sensor and point shall be individual alarmed for values in excess of their respective high/low limits or status. When an alarm is detected, it shall be automatically stored and the user notified by displaying a message on the front display panel.
- b. High-level alarm conditions shall report out via email or text to facility personnel as follows:
 - Fan failure
 - Freeze stat protection alarm
 - Low space temperature (lower than 50°F)
 - High space alarm (greater than 100°F)

c. Filter Alarms:

If filter differential static pressure sensor detects a filter pressure drop of greater than a setpoint of 0.7" a dirty filter maintenance alarm shall be reported by the front-end. Typical for all system with filter monitoring as indicated on the control drawings.

2. Scheduling

- a. The scheduling program in the stand-alone DDC unit shall provide daily, weekly and calendar scheduling capability. The master schedule shall be capable of being individually edited for each day of the week and holidays.

3. Communications

- a. The controller shall communicate on a network bus. In addition, the system shall communicate to the internet via a Ethernet connection. Coordinate with Owner for Ethernet interface port. Contractor shall program system to dial out and email alarms to predefined parties and send alarms to the Owner's security monitoring company.

4. Fault Detection and Diagnostics:

The EMS shall include analytical software to support fault detection and diagnostics of the EMS system. Software shall be similar to Niagra WEBs-N4 Analytics, current version. Software shall include an algorithm library editable to match the current applications within the building and shall be set up to monitor, trend and report on operation issues.

P. SEQUENCE OF OPERATION – ENERGY RECOVERY UNIT (ERV- 1):

1. General

- a. ERV- 1 is a constant volume energy recovery unit which provides year-round ventilation to the two Café areas and associated adjoining spaces. The unit comes with integral factory controls as well however, full interface and control as specified herein is the responsibility of the mechanical and controls contractor.

2. Supply and Exhaust Fan Control

- a. The BMS shall index from the occupied mode to the unoccupied mode based on a time schedule furnished by the owner. This schedule may be temporary overridden for a predetermined time period by push button override switches on the space thermostats served by the respective system. When overridden, the system will run in occupied mode for a 2-hour (adj.) time period. Enable/disable control and status of fans shall be reported by the EMS.

3. Occupied Mode

- a. The outdoor air damper shall open, the recirculation damper shall close when system is in occupied mode as determined by system schedule or occupied override switch.
- b. Supply and exhaust fans shall run continuously during occupied periods.
- c. The BMS shall modulate wheel speed and output of electric heater as required to maintain the supply air temperature at a setpoint reset between a low of 55°F and a high of 75°F based on average space temperature. Supply air shall be at its minimum of 55°F when the average space temperatures are at or above 75°F and 75°F when the average space temperatures are at or below 70°F
- d. If discharge air temperature falls below 45°F for longer than 60 seconds the ERV unit shall be disabled, dampers shall close and a freeze warning shall be reported by the EMS.
- e. Unit shall modulate wheel as required to achieve discharge air setpoint when economizer cooling is viable such as when outdoor enthalpy is lower than indoor air enthalpy.
- f. Unit shall modulate wheel based on a factory provided defrost sequence. In general, defrost should not need to occur until OA temperatures are below 5°F.
- g. Wheel bypass dampers, where applicable, shall open once the wheel is disabled.

4. Unoccupied Mode

- a. If the system goes into an unoccupied mode the ERV shall be disabled and its respective outdoor air damper shall close and recirculation damper shall open.
- b. If space cools below unoccupied heating setpoint as defined by BMS, (initially set for 62F), the unit shall cycle on recirculation mode using electric heater to bring space up to space unoccupied heating setpoint.
- c. If space warms above unoccupied cooling setpoint as defined by BMS, (initially set for 85F) and the OA temperature is below the unoccupied space cooling setpoint, the unit shall cycle on in economizer ventilation mode to bring space up to space unoccupied cooling setpoint.

5. DDC Point List – Energy Recovery Unit ERV-1

- a. Refer to the plans and these sequences of operation and provide all points required and inferred to make for a fully functional and operation system. Many of the unitary points may be available through the units factory controllers. Coordinant with unit vendor. As a minimum the following points being monitored and controlled for each unit:

<u>Inputs</u>	<u>Outputs</u>
O.A. temperature AI (global)	Unit Enable/Disable DO
O.A. humidity AI (global)	Unit Occupied/Unoccupied Mode
Supply fan status amp. switch DI	Recirc. damper DO
Exhaust fan status amp. switch DI	O.A. damper DO
Return Air CO2 AI	Supply Air Temp Setpoint AO
Supply Air Temperature AI	Supply fan S/S DO (or 0-10Vdc)
Return/Exhaust Air Humidity AI	Exhaust fan S/S DO (or 0-10Vdc)
Return/Exhaust Air Temperature AI	Wheel bypass Dampers DO

SA Filter DP DI
EA Filter DP DI
Wheel Speed AO
Wheel Rotation Alarm DI
Space Temperature Café #1 AI (adj)
Space Temperature Café #2 AI (adj)

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of heating, ventilating and air conditioning system will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install equipment ductwork, piping and controls where shown with recognized industry standards and practices, to ensure that installation complies with requirements and serves intended purposes.
- B. Coordinate with other work as necessary to interface installation of ductwork, piping and equipment with other components of systems.
- C. Installation of Ductwork:
 - 1. Installation of ductwork shall be coordinated with other work as necessary to interface installation or ductwork with other components of systems. Duct sizes shown on the drawings at connection to fans or other equipment may vary in actual installation. The HVAC Contractor shall provide transition pieces as required. Ducts, casings and hangers shall be installed straight and level and shall be free of vibration and noise when fans are operating.
 - 2. Provide safing to close wall (where fire rated) openings around ductwork - pack annular space with rockwool and 18 gauge sheet metal safing.
 - 3. Seal the ductwork at joists with suitable sealers 3M EC-800 or approved equal.
- D. Installation of Equipment:
 - 1. The HVAC Contractor shall examine location where equipment is to be installed and determine space conditions and notify Architect, in writing, of conditions detrimental to proper and timely completion of work.
 - 2. Install equipment where shown in accordance with manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of the automatic temperature control system and after motors have been energized with normal power source, test system to demonstrate compliance with requirements. When possible, field correct malfunctioning controls then retest to demonstrate compliance. Replace controls which cannot be satisfactorily corrected. Refer to Section - Test and Balancing.

3.4 SERVICE

- A. After completion of the control system installation, the Controls Contractor shall regulate and adjust all thermostats, control valves, damper motors, etc., and place in complete operating condition, subject to the approval of the Owner. Complete instructions shall be given to the

operating personnel. There shall be one day of instruction given on the operation of the entire system.

3.5 TESTING, ADJUSTING AND BALANCING

- A. All piping and equipment shall be tested. Test shall be performed in the presence of and to the satisfaction of the Owner and such other parties as may have legal jurisdiction.
- B. In no case shall piping, equipment or accessories be subjected to pressure exceeding their ratings.
- C. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Architect.
- D. All fans and duct systems shall be completely balanced by the adjustment of sheaves, dampers, registers and other volume and diverting control devices, to obtain the air quantities indicated on the design drawings. Replace sheaves if required to meet design conditions. Systems must balance to within 10% on individual terminals and 5% as a system whole. Pitot traverse of main supply ducts is required.
- E. Air System Procedures:
Adjustments:
Adjust air handling systems to provide the required design air quantity to, or through, each component.
- F. Certified Reports:
 - 1. For the reports required to be submitted under Article 1.3 of this Section, provide certification by an independent Balancing and Testing Contractor who is versed in the field of air balancing and who is not affiliated with any firm involved in the design or construction phases of this work.
 - 2. Identify in the reports each item not complying with the Contract requirements, or obvious misoperation or design deficiencies of equipment or controls.

3.6 CLEANING

- A. Clean all ductwork and equipment at completion of work for turnover to Owner.

END OF SECTION 23.00.00