SECTION 23 00 01
**HVAC**

# GENERAL

## GENERAL CONDITIONS

* + 1. Work to be done under this SECTION is shown on drawings numbered: H1 to H7 and E1
		2. The HVAC Work is covered by Specification Sections:
			1. Division 1.
			2. Section 23 00 01 – HVAC

## SCOPE OF WORK

* + 1. Demolition
			1. Remove all existing cast-iron steam radiators and surrounding wooden enclosures on 1st and 2nd floors. Remove pipe stubs thru floor, and seal holes.
			2. Existing systems in basement (boilers and accessories, steam pipe and accessories, condensate pipe and accessories) shall be abandoned in place.
		2. Heating and Cooling:
			1. Provide hyper-heat, high-efficiency heat pump outdoor units, branch boxes, and indoor units with interconnecting refrigerant piping, wiring and controls per the drawing schedules. All units sized for cooling.
			2. Provide a new oil-fired boiler, oil tank, oil piping, boiler accessories and controls, HW pump, and pressure bypass per the drawing schedule. Sized to meet the heating load not met by the heat pumps.
			3. Provide HW baseboard radiation, HWS-HWR piping, pipe hangers, dielectric fittings. pipe insulation, zone valves, and thermostats.
			4. Provide all required accessories and controls for complete and operating systems.
		3. Ventilation and Exhaust
			1. Provide a ducted energy recovery ventilator (ERV) for code-required exhaust and fresh air. Provide HW coil and modulating control valve to maintain constant discharge temperature in heating mode. Provide ducted indoor unit to provide tempered fresh-air in cooling mode.
			2. Provide sealed, galvanized steel fresh-air and exhaust ducts. 2” Uni-duct for 20 cfm and under. Duct penetrations thru exterior walls shall have code-compliant low-leakage motorized dampers, and 45-down terminations with ¼” mesh, galvanized-steel or aluminum screens.
			3. Provide duct insulation: 2” duct wrap (R5-installed) on all ERV OA intake, and all SA outlet and RA inlet ducts. No insulation required on ERV Exhaust discharge-to-outside ducts.
			4. Provide all required accessories and controls for complete and operating systems per the piping schematics and the sequence of operations.
		4. Controls: Provide all control components required for the drawing sequences of operation. Make all control wiring terminations.
			1. All control wiring shall be pulled by a licensed electrician in the employ of the HVAC Sub-contractor.
			2. All power wiring and terminations by the electrician
		5. General Requirements:
			1. Provide permanent ID signs on all new equipment, corresponding to equipment schedule "names".
			2. Fire-stop all floor penetrations used by by this contractor for any work under this contract.
			3. Seal and water-proof all exterior-wall penetrations on both sides of wall.
			4. Obtain all energy-efficiency rebates for qualified equipment – checks made out to Community Action of Pioneer Valley
			5. Proof all equipment and controls operation in the presence of the engineer. Repair all defects
		6. Documentation and close-out
			1. Obtain all permits and inspections. Submit signed off permits to the owner
			2. Provide all required submittals, accurate as-bult drawings, and a 1 year written warranty.
			3. Provide operating and maintenance manuals, and a summary schedule of all reqular maintenance required once a year or more.
			4. Provide a video-taped, minimum 2 hour training to owners personnel, in systems operations, and routine maintenance.

## RELATED WORK SPECIFIED ELSEWHERE

* + 1. Carefully examine all of the Contract Documents for requirements which affect the work of this Section.
		2. The following related work is detailed under the designated Sections:
		3. Cutting and patching: refer to Section 01 73 29.

## SUBMITTALS

* + 1. Close-out submittals
			1. For each boiler: start-up and combustion efficiency reports on manufacturer’s forms. Hand-written acceptable
				1. Leave one completed copy and 3 blank forms on site in a plastic cover,
				2. leave one copy in each O&M manual
			2. As-built drawings, Warranty and O&M Manuals – per Basic Mechanical Requirements Section 20 00 01.
		2. Submittals are required for all equipment, including but not limited to:
			1. Hyper-Heat, High-efficiency heat pump systems
				1. Outdoor units
				2. Branch boxes
				3. Indoor units

Wall-mounted

Ducted

* + - 1. Refrigerant Piping line-sets
			2. Refrigerant specialties
			3. Oil-fired Boiler System
				1. Boiler
				2. Oil-tank
				3. Oil-piping
				4. Boiler controls and specialties
				5. Expansion tank,
				6. air eliminator with auto-air-vent
				7. strainers or dirt traps,
				8. back-flow preventor,
				9. Pressure reducing valve
				10. Valved Pressure gages
				11. Thermometers
				12. Building-loop Heating pumps
			4. Heating Distribution
				1. Zone-valves
				2. Radiation
				3. Isolation Valves and drains,
				4. Pipe
				5. Pipe Hangers
				6. Pipe Insulation
				7. Pipe Specialties
				8. dielectric nipples,
				9. auto circuit setters,
		1. An O&M manual is required for the following:
			1. Oil-fired Boiler
			2. Building loop pumps
			3. pressure reducing valve,
			4. back-flow preventor,)
			5. Combustion efficiency reports shall be included in the O&M manual, as well as at the boiler under plastic slip-on cover.
			6. Electrical wiring diagrams and instructions , including field wiring as-built drawings

## RECORD DRAWINGS

* + 1. The marked- up "As-Built" Drawing(s) required to be maintained under this section are H-1to H-7, and E1.

# PRODUCTS

## CONTROLS

* + 1. This controls specification is performance based. The contractor shall provide all components, wiring, and installation, required to implement the drawing sequence of operations.
		2. All control wire shall be copper, minimum 18 g, under 100’, 16 g. over 100’.per run.
		3. All control wiring connections shall be at screw-type terminal strips. – no wire nuts permitted.

## MULTI-SPLIT SYSTEMS

* + 1. Acceptable manufacturers – Mitsubishi, Daikin, Fujitsu, Panasonic or approved equal
		2. Quality Assurance:
			1. The system components shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.
			2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
			3. The units shall be rated in accordance with Air-conditioning Refrigeration Institute’s (ARI) Standard 240 and bear the ARI Certification label.
			4. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to product and manufacturing quality and environmental management and protection set by the International Standard Organization (ISO).
			5. A dry air holding charge shall be provided in the indoor section.
			6. System efficiency shall meet or exceed 17 SEER when part of a multi system (2:1 / 3:1 / 4:1).
		3. Warranty
			1. The units shall have a manufacturer’s parts and defects warranty for a period five (5) years from date of installation. The compressor shall have an extended warranty of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty will not include labor.
			2. Manufacturer shall have over 25 years of continuous experience in the U.S. market
				1. Outdoor Unit
			3. General: R410A, variable capacity multi-zone systems. Outdoor unit sound level shall not exceed 54 dB(A)
				1. Unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory prior to shipment.
				2. Refrigerant flow from the outdoor unit to the indoor units shall be independently controlled by means of individual electronic linear expansion valves for each indoor unit.
				3. Outdoor unit shall be pre-charged with sufficient R-410a refrigerant for up to one hundred and thirty-one (131) feet of refrigerant piping.
				4. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements,
			4. Unit Cabinet:
				1. The casing shall be fabricated of galvanized steel, Bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.
				2. Assembly hardware shall be cadmium plated for weather resistance.
			5. Steel mounting feet, shall withstand lateral wind gust up to 155 MPH to meet applicable weather codes.
			6. Fan:
				1. the unit shall be furnished with a direct drive, high performance propeller type fan.
				2. The condenser fan motor shall be a variable speed, direct current (DC) motor and shall have permanently lubricated bearings.
				3. Fan speed shall be switch automatically according to the number of operating indoor units and the compressor operating frequency.
				4. The fan motor shall be mounted with vibration isolation for quiet operation.
				5. The fan shall be provided with a raised guard to prevent contact with moving parts.
				6. Coil:
				7. The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
				8. The coil shall be protected with an integral guard.
			7. Compressor:
				1. The compressor shall be a high performance, hermetic, inverter driven, variable speed, dual rotary type manufactured by Mitsubishi Electric Corporation.
				2. The compressor motor shall be direct current (DC) type equipped with a factory supplied and installed inverter drive package.
				3. The outdoor unit shall be equipped with a suction side refrigerant accumulator.
				4. The compressor will be equipped with an internal thermal overload.
				5. The compressor shall be mounted to avoid the transmission of vibration.
			8. Electrical:
				1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
				2. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
				3. The outdoor unit shall be controlled by the microprocessors located in the indoor unit and in the outdoor unit communicating system status, operation, and instructions digitally over A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire, 14 ga. AWG connection plus ground.
				4. The outdoor unit shall be equipped with Pulse Amplitude Modulation (PAM) compressor inverter drive control for maximum efficiency with minimum power consumption.
		4. Branch Boxes: The branch boxes shall have manifold connections providing a separate set of flared fittings for each indoor unit
		5. Wall Mounted Indoor Units:
			1. The indoor unit shall be fully factory assembled, wired and run tested prior to shipment. Contained within the indoor unit shall be all factory wiring, piping, control circuit board, fan, and fan motor. The unit shall have a self-diagnostic function, 3-minute restart time delay mechanism, an auto restart function, an emergency / test operation. Indoor unit shall be charged with dry air before shipment from factory.
			2. Unit Cabinet:
				1. Multi directional drain and refrigerant piping, Secure indoor unit mounting to the wall.
			3. Fan:
				1. The indoor unit fan shall be an assembly with a line-flow fan direct driven by a single motor.
				2. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearing.
				3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
				4. All speeds shall be selected from the remote controller.
				5. indoor unit sound level shall not exceed 43 dBA
			4. Filter:
				1. Return air shall be filtered by means of an easily removed, washable, Catechin, Antioxidant Pre-filter and a separate Anti-allergy blue enzyme filter – blue bellows type.
			5. Coil:
				1. The indoor unit coil shall be of nonferrous construction with smooth plate fins on copper tubing.
				2. The refrigerant tubing shall have inner groves for high efficiency heat exchange.
				3. All tube joints shall be brazed with PhosCopper or silver alloy.
				4. The coils shall be pressure tested at the factory.
				5. A sloped, corrosion resistant condensate pan with drain shall be provided under the coil.
				6. An optional drain pan level switch (DPLS1), designed to connect to the control board, shall be provided if required, and installed on the condensate pan to prevent condensate from overflowing.
			6. Electrical:

indoor unit electrical power shall be 208 / 230 volts, 1-phase, 60 hertz.

* + - * 1. The system shall be equipped with A-Control – a system allowing each indoor unit to be powered and controlled directly from the outdoor unit using a 14 gauge (AWG) 3-wire connection plus ground providing both primary power and integrated, by-directional, digital control signal without additional connections.
				2. The indoor units shall not have any supplemental or “back-up” electrical heating elements.
			1. Control:
				1. The unit shall have a wireless controller to perform input functions necessary to operate the system.
				2. The wireless controller shall have a Power On/Off switch, Mode Selector – Cool, Dry, Heat, Auto Modes - Temperature Setting, Timer Control, Fan Speed Select and Auto Vane selector.
				3. The indoor unit shall perform Self-diagnostic Function and Check Mode switching.
				4. Temperature changes shall be by 1ºF increments with a range of 61 - 88ºF.
				5. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wireless or a wired controller, providing emergency operation and controlling the outdoor unit.
				6. The system shall be capable of automatically restarting and operating at the previously selected conditions when the power is restored after power interruption.
				7. The indoor units shall be capable of working with single-zone or multi-zone outdoor units

## OIL-FIRED BOILER

* + 1. Acceptable Manufacturers include Peerless, Burnham, Smith or approved equal.
		2. Specification is based on the Peerless WBV-04.
			1. Cast-iron sectional boiler, factory tested and assembled with steel push-nipples.
			2. High-efficiency, flame-retention burners – choice of Beckett, Carlin, or Riello – 1.25 gph, with 131 MBH net output, and 85.4 AFUE
			3. 14.75 gallons water volume
			4. 2” supply, 1-1/4” return connections
			5. Full-plate swing-out door for easy cleaning
			6. Powder coated steel jacket
			7. ETL certified for U.S. and Canada
			8. Standard: Boiler Reset control with Low-water-cut-out, temperature-pressure gage, drain valve,
		3. Sealed combustion air: Provide sealed combustion air kit – Field Controls or equal.
		4. Venting: Minimum draft required: - .04”. Provide new, 6” Type B stainless steel vent. Run new vent inside existing chimney, terminating with rain cap.

## HYDRONIC RADIATION

* + 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering radiation that may be incorporated into the work include, but are not limited to, the following:
			1. Slant Fin
			2. Heating Edge
			3. Sterling
			4. Burnham Hydronics
		2. Capacity Ratings: All heating terminal units shall be sized based on 68 deg. F entering air temperature, 170 deg F entering water temperature, and 20 degree Temperature drop thru the unit.
		3. HW Base-board – specification is based on Slant-fin HD850, with H-3 element, and ¾” copper tubing.
			1. Copper tubing and aluminum fins, one tube end belled; with polypropylene element glides: NPS  3/4”
			2. Enclosures: 16 g. steel cover and 20 g. full back-plate, slope-top style with sloped grille and return pipe support. Telescopic cover accessories to absorb slight misalignments from uneven floors or walls.
			3. Cover secured with screws at each bracket.
			4. Provide all end panels, end caps, corners, and joiner pieces required to finish all ends and joints.
			5. Finish: Galvanized.
			6. Element Brackets: Galvanized steel.

## ZONE VALVES

* + 1. Acceptable Manufacturer’s include Honeywell, Johnson Controls, Taco or approved equal.
		2. Specification is based on Honeywell 8043F1036
			1. 2-position, 2-way, straight-thru
			2. Normally closed, spring-return-fail-open,
			3. With N.O. end-switch, - SPST, 4.4 A-running / 26.4 A in-rush, 120 V-rated
			4. Screw-terminal block connections.
			5. Brass body and seat, Stainless steel stem, Buna-N Ball, EPDM packing
			6. With emergency manual opener
			7. Powerhead and motor may be replaced without drain-down or valve removal
			8. Bronze body and seat, stainless steel stem, and brass plug.
			9. Sized for maximum 2 psi pressure drop.
			10. CV = 3.5, 24 V, 7.7 VA

## THERMOSTATS

* + 1. Acceptable Manufacturers: Honeywell, Johnson Controls, White-Rogers, or approved equal
		2. Heat pump indoor units factory provided with wireless remote controllers. Mount controllers to the wall, so they are not lost.
		3. Modulating operation: will maintain constant discharge temperature from the ERV supply air Hot Water (HW) coil, by modulating the 3-way control valve.

## DOUBLE-WALL OIL TANKS

* + 1. Acceptable Manufacturers: Granby, Roth, or approved equal.
		2. Specification is based on Granby 961226.
			1. UL listed, 25-year limited warranty
			2. Provide 2, minimum 265 gallon, horizontal, double-wall oil tanks.
			3. Primary tank of seamless (blow-molded) high-density polyethylene.
			4. Galvanized steel secondary containment, with galvanized legs
			5. Visual leak detection of primary tank
			6. Oil-burner supply duplex bushing with tube adapters.
			7. 2” NPT galvanized steel Fill piping adapter. Provide fill and vent piping of – wrought iron, or schedule 40 steel.
			8. Low-pressure vent and over-fill alarm
			9. With direct-reading, float-type level gage.

## OIL PIPING

* + 1. Stainless-steel tubing, or copper / copper-alloy tubing within a plastic oil-containment sleeve.
		2. With welded (steel) or brazed (copper), mechanical, or press-connect fittings.
		3. Provide an approved, shut-off valve at the fuel-tank outlet

## HYDRONIC PUMPS

* + 1. Acceptable manufacturers include Bell and Gossett, Grundfoss, and Taco. Specification is based on the B&G 20-18. Refer to pump schedule on drawings for ratings and capacity
		2. Variable-speed, ECM motor, max. power 70W. 3-speeds available – set up for medium-speed (curve B) operation.
		3. Cast-iron body, with automatic air-purge, and dry-run protection.

##  HYDRONIC SPECIALTIES

* + 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
			1. Amtrol, Inc.
			2. Spiro-therm
			3. Nexus
			4. Taco Inc.
			5. Watts Regulator Co.
			6. Ametek
			7. Flexcon
			8. or Approved Equal
		2. Expansion Tank
			1. 100% butyl rubber Diaphragm type – 4.2 gallons acceptance.
			2. 16 g. cold-rolled steel – stainless steel connections
			3. Brass air-valve with O-ring.
			4. 5 year warranty
			5. Flexcon – HTX60 or approved equal.
		3. Air eliminator:
			1. Brass construction, with fill-air-release valve,
			2. micro-air-bubble separator,
			3. rated for less than 2 foot pressure drop at design flow. See pump schedule for design flows
			4. threaded connections – Boiler HWS header line size.
			5. SpiroVent or approved equal.
		4. Pressure gages: 3” diameter, shall be selected to read mid-scale at normal operating pressures. Provide complete with petcock and brass connections. Ametek, U.S. Gage figure P500 or approved equal.
		5. Thermometers: bimetal, with 1/2” NPT brass thermowell and set-screw. Select dial to read mid-scale at normal operating temperatures. Self-sealing test connections not permitted. Watts Series TB or approved equal.
		6. Automatic Air Vent: Spirotherm Spiro-top or equal. Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure, 240 deg F operating temperature; with 1/4 inch NPS (DN8) discharge connection and 1/2 inch NPS (DN15) inlet connection.
		7. Strainers: Line size, bronze, Y-type with 304 stainless steel strainer –Provide 20 mesh at substantial completion. Kackley or approved equal. Provide ball-valve with cap and chain on all strainer cleaning ports.
		8. Automatic circuit setters: Nexus Ultramatic or approved equal.
			1. Bronze in sizes ½” to 1-1/2”
			2. Removable, non-clogging flow cartridge
			3. Cartridge exchange available for up to 1 year for flow-rate changes in same valve body
			4. Accuracy +/- 5%
		9. Back-flow preventor – Watts Reduced pressure zone or approved equal.
			1. Bronze body,
			2. Replaceable seats.
		10. Dielectric Fittings: Insulating material that isolates joined dissimilar metals to prevent galvanic corrosion. Dielectric Unions NOT PERMITTED. Acceptable fitting types include:
			1. Insulating flange gaskets – minimum 1/8” thick, electrically insulating. M&P phenolic Type E with single washers or approved equal.
			2. Dielectric Nipples: Electroplated steel nipple, having inert and noncorrosive thermoplastic lining. 300-psig working pressure at 225 deg. F. temperature. Victaulic “Clearflow” or approved equal.

##  PIPING

* + 1. Hydronic Systems:
			1. 3” and smaller, B88. CopperType L seamless.
			2. With wrought copper sweat or Pro-Press fittings.
			3. 95-5 lead-free solder.
		2. Refrigerant
			1. For R410A – 450 psi.
			2. Type ACR copper,
			3. with silver-brazed, wrought-copper fittings
			4. Line sets acceptable in sizes specified by the heat pump manufacturer
		3. Condensate Drain Piping
			1. Schedule 40 PVC, ASTM D1785 pipe and fittings. Provide 45 fitting down at termination outside exterior walls.
			2. ASTM D2564 primer and cement
			3. Starter-Flex tube shall attach to PVC with a barbed fitting. Max. 1’ of flex.

##  VALVES

* + 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include but are not limited to the following:
			1. Hammond Valve Corporation.
			2. NIBCO Inc.
			3. Conbraco Industries, Inc.; Apollo Division.
			4. or Approved Equal
		2. Valves - General
			1. Rated pressure 125 psi, rated temperature 190 degrees F.
			2. Sizes: Full-port, same size as up stream pipe, unless otherwise indicated.
			3. Ball Valves: 400-psi WOG, 100% positive shut-off, ASTM B 584 bronze body and bonnet, chrome steel ball and stem; reinforced teflon seats and seals; soldered end connections, vinyl-covered steel lever handle with memory stop.
			4. Provide 1-1/4” extended stem for valves in insulated piping.
			5. 1/2” to 2” size: Watts FBV or approved equal.

##  INSULATION

* + 1. Manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
			1. Certain Teed corporation.
			2. Johns Manville.
			3. Owens-Corning Fiberglas Corporation
			4. Knauf Fiberglas
			5. USG Industries - ThermaFiber Division
		2. All piping systems:
			1. All Insulation shall be continuous thru hangers and building structure.
			2. Conductivity .27 or less.
		3. Hydronic Pipe Insulation - standard Fiberglass wraps:
			1. Molded glass-fiber with All-Purpose white jacket and PVC Zeston (or equal) fittings covers. Density: 6 lb/cu.ft. average
			2. 1-1/2” thick wall on HWS and HWR 1-1/4” and smaller pipe size
			3. 2” thick wall on HWS and HWR – 1-1/2” and larger pipe size.
			4. Insulate fittings with 2 layers of pre-cut fiberglass wrap, and PVC covers.
		4. Refrigerant Line Sets:
			1. Closed-cell foam insulation with vapor barrier.
			2. All foam insulation outside the building shall be PVC jacketed.
			3. ½” wall on units under 5 ton.
		5. Condensate piping:
			1. ½” closed cell foam – including within equipment.

##  HANGERS

* + 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
			1. Allied Piping Products
			2. Thomas & Betts
			3. Allied Tube & Conduit
		2. Steel, adjustable band hangers on threaded rod for all insulated pipe
			1. Size hangers for insulation O.D.
			2. Provide insulation shield on pipe 1-1/2” O.D. and larger.

##  ENERGY RECOVERY VENTILATOR (ERV)

* + 1. Renew-Aire EV300 or approved equal
			1. Type - –static plate with heat and humidity transfer
			2. Air flow range 150-300 cfm
			3. 1, .2 HP motor - 120V Line cord.
			4. On-board, 24 V transformer / relay package
			5. 2” MERV 8 pleated filters on OA intake.
			6. Optional 2”, MERV 13, filters on RA intake
			7. 4, Optional rectangular to 8” round duct transitions
			8. 2, Optional galvanized, 8” hooded, wall-vent.
			9. 2, Optional, 8” back-draft dampers.
			10. Optional digital time-clock.
			11. Minimum total winter efficiency – 65% at design conditions
			12. Minimum total summer efficiency – 50% at design conditions.

##  DUCTWORK

* + 1. All ductwork shall be rigid galvanized steel, except as specifically noted below. Duct shapes maybe modified (i.e. round, oval, rectangular) if equivalent air velocity and pressure drop are maintained.
		2. Provide all required fittings, transitions, and flexible connections.
		3. Provide flexible connectors at each Ducted fan inlet and outlet. Provide a straight run of duct at all fan outlets – minimum lengths before the 1st branch, elbow, or size transition as follows:
			1. Under 1000 cfm – 2 ft.
		4. Duct Joints:
			1. Duct transverse joints may be slip-fit type, securely screwed, and sealed with approved sealant.
			2. All duct turns to be rigid, smooth-radius bends. Turning radius shall be 1.5 x the turning dimension. Use 45-offsets where possible.
		5. No standard flexible duct. Unico, 2”x12” rigid sound-insulators with 2” round outlets may be used for stubs with airflows under 25 cfm.
			1. Provide “half-flow” balancing orifice for outlets with cfm under 15

##  AIR SYSTEM ACCESSORIES

* + 1. Motorized dampers and actuators
			1. Opposed blade dampers, with maximum permitted leakage = 3 cfm/sqft at 1” w.g.
			2. Actuators shall be power-open, spring-return-closed, shaft-mounted, double-insulated, with SPDT end-switches and position indicator.
			3. Minimum actuator capacity – 35 in-lbs.
			4. 5-year warranty
			5. Belimo NF series or approved equal.
		2. Registers
			1. Provide Unico, 2” outlets for all outlets under 25 cfm.
			2. Steel, white, with opposed blade face damper on all other FA, RA, and EA registers.
			3. Wall registers: Hart and Cooley 94A-HOV or approved equal

##  FIRE-STOPPING

* + 1. Materials shall be asbestos-free, complying with UL 1470 and UL Fire Resistance Directory.
		2. On insulated pipe, the fire-rating classifications must not require the removal of the insulation.
		3. 3M Construction Markets No Sag Caulk, Self-Leveling Caulk, Penetration Sealing Systems, or approved equal

# EXECUTION

## MULTI-SPLIT HEAT PUMPS

* + 1. During handling, keep unit upright to avoid compressor damage.
		2. Install on a level concrete pad, positioned so ice and snow will not fall on unit in winter.
		3. Where refrigerant piping line-sets pass thru exterior walls, seal both sides of wall with 50-year silicone caulk, or EIFS sealant.
			1. Holes thru walls shall be minimum ½” larger and maximum 1” larger than line-set.
			2. Provide backer-rod or mineral-wool backer to support caulk, leaving a ¼” open depth for caulk.
		4. Do not let electrician test HP units prior to their being fully charged with refrigerant. Operation without refrigerant can break the compressor.

## BOILER

* + 1. Set Boiler level on 4” solid concrete blocks. Locate appliance minimum of 3’ from any electrical panels, and 5’ from any oil tank.
		2. Chimney Connectors:
			1. Install so they are as short as possible, with as few bends as practical
			2. Provide a vent thimble cemented in place, extending to the inner face of the chimney liner, but not beyond.
			3. Chimney connector shall be flue collar size, minimum 24 g galvanized steel
			4. The crimped end of each section of smoke pipe shall be on the down-stream side of the pipe.
			5. Install connectors with a minimum ¼” per foot rise towards the chimney.
			6. Securely support the chimney connector, and fasten each joint with a minimum of 3 screws, located a minimum of ½” for the pipe ends.
			7. Make sure connector is well sealed to chimney, and clean-out door is tight fitting.
		3. Install fill connection at the same point as expansion tank connection to system, on return side of building-loop pumps.
		4. Prior to filling boiler, provide water-pH and quality test.
			1. pH should be between should be between 7.5 and 11
			2. Hardness should be less than 9 grains per gallon
			3. Chloride should be less than 30 ppm
			4. As required, provide chemical treatment to meet these requirements, and re-test.
		5. Fill to 12 psi. Confirm that pressure remains under 25 psi at maximum boiler temperature (190 F)
		6. Do not add cold water to a hot boiler – thermal shock may crack the heat exchanger.
		7. HWS and HWR Piping - connect hot-water piping to supply-and-return-boiler tappings with shutoff valve and union at each connection.
			1. Use a wrench on both field and boiler-integral piping or internal damage to boiler may occur.
		8. Pipe relief valve vertically – with tee and street elbow off the HWS riser. Plug the un-used relief valve port.
		9. System Pump –
			1. Shall be on the HWS piping, with the expansion tank and air-eliminator on the intake side of pump.
			2. Shall be wired through a field-provided 120 V circulator relay to cycle on a call for heat. From one of the 4-zone thermostats. (continuous run is not acceptable)
		10. Provide Combustion Test. Results must be within burner manufacturer’s recommendations.
		11. Test boiler operation and correct all defects.

## OIL TANK

* + 1. Locate tanks inside the building, on the lowest floor, as shown.
		2. Locate new tanks a minimum of 5’ from any fire or flame. Tanks shall not obstruct quick and safe access to any utility meters, switch panels, or shut-off valves.
		3. Install new tanks pitched towards the outlet end – minimum ¼” per 5’ of tank length.
		4. Provide new 1-1/4” vent piping. Adjust as require to pitch to drain into tank, without sags or low-points.
			1. Vent pipe shall extend into the top of the tank not more than 1”, and shall terminate with a weather proof cap or hood outside the building. Vent caps shall have a free area equal to the vent piping free area, and a screen no finer than 4 mesh.
			2. Vent shall terminate a minimum of 3’ above grade and a minimum of 2’ (horizontally and vertically) from any building opening.
		5. Provide new 1-1/4” fill pipe, with permanent label, tag, or nameplate. Adjust as required to terminate a minimum of 3’ above grade and a minimum of 2’ (horizontally and vertically) from any building opening.
		6. Check and make all fill, and vent pipe joints tight with suitable pipe compound.
			1. No Teflon tape permitted.
			2. No unions with gaskets or packings.

## OIL PIPING

* + 1. Provide new, sleeved oil piping – non-metallic sleeve must be continuous where pipe passes thru concrete or earth.
		2. Ream all re-connection joints, use flare fittings, and make leak-tight. No not conceal any joints with in walls, floor, or ceiling.
			1. No compression fittings permitted, except flare, 2-ferrule, swage type.
			2. No solder with melting point less than 500 F on oil lines.
		3. Provide new, flexible connections at each end.
		4. Provide a new, listed oil filter that will remove down to 40-micron particles, and filter holder – capacity suitable for the appliance served.
		5. Provide a readily accessible, fusible, spring-loaded, listed oil safety valve at the burner end of the oil line. Install per manufacturer’s instructions.
		6. Provide readily accessible, manual shut-off valves at each end (appliance and tank). Valves shall be capable of closing against the maximum supply pressure with a full oil-tank.

## PUMPS

* + 1. Hydronic Pumps Installation
			1. Support in-line pumps independent from piping. Fabricate brackets or supports as required.
			2. Use continuous-thread hanger rods and vibration isolation hangers of sufficient size to support weight of pumps.
			3. Install union, valved pressure gage, line-size shutoff valve and strainer on suction side of circulating pumps.
			4. Install union, valved pressure gage, and line-size throttling valve on discharge side of circulating pumps. ).

## HW RADIATION

* + 1. Provide continuous baseboard enclosure along the exterior walls from HWS rise to HWR drop. Approximately center the finned-tube section of baseboard on the wall. Run bare copper pipe thru the remainder of the enclosure.
		2. Operate Boiler supply temperature at a maximum of 170 F. The intent is to keep the exterior wall warmer by running lower temperature water for longer periods. This will minimize the “cold-wall-effect” which makes people uncomfortable even with the room at 70 F.

## HYDRONIC SPECIALTIES INSTALLATION

* + 1. Pressure gages:
			1. Install on both sides of all pumps
			2. Install on both sides of strainers.
			3. Install on both sides of pressure reducing valves
		2. Temperature gages
			1. Install on both sides of boiler
			2. Install on building loop HWS and HWR
		3. Dielectric fittings: Provide wherever steel or cast iron specialties are used with copper pipe, or copper/bronze/brass specialties are used with steel pipe.
		4. Reduced pressure zone backflow preventor
			1. Applications – install on the boiler feed line.
			2. Install:
				1. Owner’s side of the water meter, located with easy access for testing and maintenance
				2. Horizontally, 3’ to 4’ AFF
				3. A minimum of 12” from any wall
				4. On dedicated branch line,
		5. Automatic Air vents: Install at high points in system
		6. Strainers – install with easy access to cleaning port. Install with hose-thread, ball valve and threaded cap on cleaning port. Install upstream of pumps, and boiler.

## PIPING

* + 1. All pipe hangers shall be sized to fit over the insulation, with insulation shields on pipe 2” and larger. Insulation shall be continuous thru all walls and floor penetrations.
		2. Pipe Applications:
			1. Copper type L for heating system piping.
			2. PVC for condensate
			3. Pre-insulated line-sets sized per manufacturer’s specifications for refrigerant.
		3. Hydronic Piping Installations
			1. Pitch piping to drains located at low-points Minimum pitch, 1” per 10 ft.
			2. Provide new auto-air vents at all high points of HWS and HWR lines.
			3. Provide isolation valves and unions on each piping connection to equipment. Full-port bronze ball valves, with 1-1/4” extended stems for insulated pipe.
			4. All hangers shall be sized to fit over the insulation, with insulation shields on pipe 2” and larger. Insulation shall be continuous thru all walls and floor penetrations.
		4. Condensate Piping Installations
			1. Provide starter flex tube from heat pump indoor units – connecting to PVC drain thru a barbed fitting.
			2. Provide 3/4” PVC drain out thru exterior wall, terminating with a 45 down. Air and water seal exterior wall penetration on both sides. Minimum pitch 1/4” per foot.
		5. Refrigerant Piping Installation
			1. Any presence of air, refrigerants other than R410A, or other foreign substances in the refrigerant circuit causes an abnormal pressure rise and possible rupture. To avoid this:
			2. Use a dedicated R410A gauge manifold, charge hose, gas leak detector, reverse flow check valve, refrigerant charge base, vacuum gauge, and refrigerant recovery equipment.
			3. R410A is a mix of several other refrigerants. It is essential to add extra charge in the liquid state. Use a siphon to take refrigerant off the bottom or turn the canister upside down.
			4. Pressure test to be witnessed by the engineer
				1. Air-tight test: pressurize the liquid pipe, suction gas pipe, HP/LP gas pipes to 250 psi, from the service ports of each shutoff valve. If pressure does not drop in 24 hours, system passes this test.
				2. Vacuum test: evacuate the system from the service ports to -14.6 psi. Let system “sit” for 1 hour or more, then check for pressure rise. If pressure is constant, it passes.

## VALVES

* + 1. Installation
			1. Install shut-off duty valves at each supply and return connection to each piece of equipment, and elsewhere as indicated.
		2. Application Schedule
			1. Ball valves for shutoff duty;
			2. Ball valves with hose thread end at strainer cleaning ports
			3. Tee with ball valve for low-point drains.

## INSULATION

* + 1. Insulate all new piping
		2. Apply pre-molded, removable insulation with PVC covers to items requiring maintenance, including unions, strainers, valves, and flow regulators.
		3. Apply insulation with integral jackets as follows:
			- 1. Pull jacket tight and smooth.
				2. Cover circumferential joints with butt strips, at least 3-inches wide, and of same material as insulation jacket.
				3. Apply insulation with longitudinal seams at top of pipe.
				4. Clean and dry surface to receive self-sealing lap.
				5. Overlap seams at least 11/2 -inches.
				6. Repair damaged insulation jackets by applying jacket material around damaged jacket. Adhere and seal. Extend patch around the entire circumference of the pipe and at least 2 inches in both directions beyond the damaged area.

## ENERGY RECOVERY VENTILATOR

* + 1. Install ERV unit level in both directions. Support from building structure on optional vibration isolators,
		2. Provide minimum 2’ straight duct at the ERV fan outlets, and minimum 18” straight duct at the ERV inlets.

## DUCTWORK

* + 1. All ductwork shall be neat, accurate, and mechanically tight.
		2. Hang with galvanized duct hangers, and galvanized hardware. Attach to building structure.
		3. Pitch exhaust ducts to drain any condensed moisture outside the building.
		4. Max. duct hanger spacing – 10’ o.c. for round duct, 8’ o.c. for rectangular duct.
		5. Duct Sealing: Seal all transverse duct seams with reinforced, water-based duct sealant, to pressure class 3, Seal Class C
		6. Support and connect metal ducts according to SMACNA's "HVAC Duct Construction Standard."

## FIRE-STOPPING

* + 1. Fire stop all pipes or ducts that enter or leave the boiler room:
		2. Fire-stop all floor penetrations
		3. Fire-stop rating shall be equal or greater than the rating of the floor or wall assembly penetrated.

## HANGERS & SUPPORTS

* + 1. General: In addition to the maximum o.c. hanger spacing listed below, provide 1 hanger within 1’ of each horizontal elbow or branch.
		2. Install hangers for drawn-temper copper piping with the following minimum rod sizes and maximum spacing:
			1. 1-1/4” and smaller: Maximum span 6 feet; minimum rod size 1/4 inch.
			2. 1-1/2” and larger: Maximum span 10 ft. minimum rod size 3/8”
		3. Install hangers for PVC, ABS, and CPVC pipe:
			1. All sizes: maximum 4’ o.c. on 1/4” threaded rod.
			2. Adjust for uniform, minimum 1/4” / ft. pitch
			3. Install supports for vertical plastic piping every 48 inches, and at the base of each riser.
		4. Support pipes sufficiently clear of all structure and equipment to allow for a full thickness of insulation.

## HYDRONIC SYSTEM PRESSURE TEST

* + 1. Prepare piping according to ASME B31.9 and as follows:
		2. Leave joints, un-insulated and exposed for examination during test.
		3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated.
		4. Examine test equipment to ensure that it is tight and that low-pressure filling lines are disconnected.
		5. Testing:
			1. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure, nor less than 50 psi.
			2. After hydrostatic test pressure has been applied for, at least 10 minutes examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
			3. Engineer to witness test.

## ADJUSTING AND CLEANING

* + 1. Flush and clean boilers according to manufacturer’s written instructions.
		2. Flush new piping systems as follows:
			1. Before placing any new piping systems into service, flush first with fresh water, then with detergent solution to remove any oils.
			2. Submit method of flushing for approval by Engineer.
			3. When flushing piping, isolate all equipment and coils, flushing only bypass piping and valves.
			4. After flushing, clean all strainer screens and dirt traps..
			5. Fill the hydronic system with fresh-water,

## COMMISSIONING

* + 1. Start-up of all heat pumps shall be by the manufacturer’s rep.
		2. Start-up of the boiler shall be by the manufacturer’s rep.
		3. Provide combustion performance test on the boiler – recorded on manufacturer’s report sheet.. Leave 1 completed form and 3 blank forms inside a slip-on plastic cover – at the equipment tested. Include completed forms in the O&M manual also.
		4. Ensure N.O. shut-off valves are fully open
		5. Fill hydronic systems and set automatic fill valves for required system pressure. Ensure system pressure is a minimum of 4 psig at the high point in the system.
		6. Check expansion tanks to determine that they are not air bound and that system is completely full of water.
		7. Check air vents at high points of systems and determine if all are installed and operating freely. Bleed air completely out of all hydronic systems.
		8. For all equipment, complete the manufacturer’s installation checklist. Verify the following:
		9. Test and adjust all equipment, controls and safeties.
		10. Ensure that all controls are properly calibrated and providing the specified sequences of operation.
		11. Replace damaged and malfunctioning controls devices and equipment and re-test
		12. Performance testing of all controls to be witnessed by the Engineer
		13. Check all systems for excessive vibration or noise, and correct all such conditions.

END OF SECTION