SECTION 23 05 48

VIBRATION ISOLATION FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this Section:
   1. American National Standards Institute (ANSI).
   2. American Society of Testing and Materials (ASTM).
      a. A36/A36M, Specification for Carbon Structural Steel.
      b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
   3. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code—Steel.
   4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): Seismic Restraint Manual: Guidelines for Mechanical Systems.
   5. Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

1.2 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. EPDM: Ethylene-Propylene-Diene Monomer.

C. Withstand: Unit will remain in place without separation of any parts from the device when subjected to seismic forces specified and unit will be fully operational after the seismic event.

1.3 DESIGN REQUIREMENTS

A. Seismic Control:
   1. Provide seismic control as required to maintain integrity of mechanical ductwork, and equipment installed in this Project, so they will "withstand" seismic forces.
   2. Design shall comply with requirements of this Specification, applicable codes, and requirements of Section 01 61 00, Common Product Requirements.
   3. Design, size, and install for piping and equipment throughout facility, whether shown or not.
   4. Designed by a registered Professional Engineer registered in the Province of Manitoba.
   5. Seismic restraints shall conform to requirements of SMACNA's Seismic Restraint Manual: Guidelines for Mechanical Systems.

1.4 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings, Vibration Isolators:
      a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.

b. Product Data:
   1) Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
   2) Schedule of vibration isolator type with location and static and dynamic load on each.
   3) Vibration Isolation Base Details:
      a) Detail fabrication, including anchorages and attachments to structure and to supported equipment.
      b) Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

2. Shop Drawings, Seismic Control Components:
   a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.
   b. Signed and sealed by a registered Professional Engineer registered in the Province of Manitoba.
   c. Include, as a minimum, a tabulation of design data for each snubber, including specific anchorage details.
   d. Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
   e. Product Data:
      1) Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
      2) Schedule of seismic control component type with location and static and dynamic load on each.
      3) Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.

B. Informational Submittals:
   1. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
   2. Certifications:
      a. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Contractor Field Services.
      b. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Contractor Field Services.
      c. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Isolation materials, flexible connectors, and seismic restraints shall be same manufacturer, Select and certify using published or factory certified data.

C. Vibration isolation and seismic restraint manufacturer shall be a member of the Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

D. Seismic Control:
   1. Designer Qualifications:
      a. Professional Engineer registered in the Province of Manitoba.
      b. Minimum of 5 years' work experience certifying seismic snubber and anchorage details.
   2. Components shall bear anchorage pre-approval "R" number, from agency acceptable to AHJ, showing maximum seismic restraint ratings.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATION

A. General:
   1. Provide for mechanical piping, ductwork, and equipment as identified by this Specification.
   2. Select in accordance with equipment, pipe, or duct weight distribution to produce reasonably uniform deflections.
   3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 30 percent and 60 percent of maximum deflection.

B. Elastomeric Pad:
   1. Oil-resistant and water-resistant elastomer or natural rubber waffle pads, arranged in single or multiple layers, molded with a nonslip pattern.
   2. Waffle pads bonded each side of minimum 6 mm-thick galvanized steel separator plate.
   3. Height of waffle ribs shall not exceed 0.7 times width.
   4. Maximum Loading: 413 kPa.
   5. Minimum Single Layer Thickness: 6 mm.
   6. Separator plate of sufficient stiffness for uniform loading over pad area.
   7. Factory cut to size that matches requirements of supported equipment.
   8. Waffle Pad Material: Standard neoprene.
   9. Number of Layers: As required to support equipment load; refer to manufacturer's data for load capacities.

C. Elastomeric Mount:
   1. Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements.
   2. Factory-drilled, encapsulated top plate for bolting to equipment.
   3. Baseplate for bolting to structure.

D. Open Spring Isolator:
   1. Freestanding, laterally stable, open-spring isolators.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of required deflection at rated load.
   4. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Baseplate:
   a. Factory drilled for bolting to structure and bonded to 6 mm-thick rubber isolator pad attached to baseplate underside.
   b. Limit floor load to 690 kPag.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolator:
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 6 mm-thick elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: 80 percent minimum of the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Elastomeric Hanger:
1. Double-deflection type.
2. Molded, oil-resistant rubber or neoprene isolator elements bonded to steel housing.
3. Threaded connections for hanger rods.

G. Spring Hanger:
1. Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
4. Minimum Additional Travel: 50 percent of required deflection at rated load.
5. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element:
   a. Molded, oil-resistant rubber or neoprene.
   b. Steel washer-reinforced cup to support spring and bushing projecting through bottom of frame.

H. Thrust Limit:
1. Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop.
2. Rod and angle-iron brackets for attaching to equipment.
3. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

4. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
5. Minimum Additional Travel: 50 percent of required deflection at rated load.
6. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
9. Coil Spring: Factory set and field adjustable for a maximum of 6 mm movement at start and stop.

I. Manufacturers:
1. Mason Industries, Inc.
2. Peabody Noise Control, Inc.
3. Kinetics Noise Control, Inc.
4. California Dynamics Corp.
5. M.W. Sausse & Co., Inc. (VIBREX).
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation Co., Inc.
8. The VMC Group.

2.2 EQUIPMENT BASES

A. Structural Steel Base:
1. Factory-fabricated, welded, structural steel base and rail.
2. Design Requirements:
   a. Lowest possible mounting height with not less than 25 mm clearance above floor.
   b. Provide equipment anchor bolts and auxiliary motor slide bases or rails.
   c. Provide supports for suction and discharge elbows for pumps.
3. Structural Steel:
   a. Steel shapes, plates, and bars complying with ASTM A36/A36M.
   b. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

B. Concrete Inertia Base:
1. Factory-fabricated, welded, structural steel base and rail ready for cast-in-place concrete.
2. Design Requirements:
   a. Lowest possible mounting height with not less than 25 mm clearance above floor.
   b. Provide equipment anchor bolts and auxiliary motor slide bases or rails.
   c. Provide supports for suction and discharge elbows for pumps.
3. Structural Steel:
   a. Steel shapes, plates, and bars complying with ASTM A36/A36M.
   b. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

5. Fabrication:
   a. Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete.
   b. Obtain anchor-bolt templates from supported equipment manufacturer.
6. Concrete: 20685 kPa.

C. Rooftop Isolation Rails:
1. Factory-assembled, fully enclosed, insulated, airtight, and watertight curb rail designed to resiliently support equipment.
2. Lower Support Assembly:
   a. Sheet metal “Z” section containing adjustable and removable steel springs that support upper floating frame.
   b. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind and seismic forces.
   c. Provide means for attaching to building structure and a wood nailer for attaching roof materials.
   d. Insulated with a minimum of 50 mm of rigid, glass-fiber insulation on inside of assembly.
3. Isolators:
   a. Adjustable, restrained spring type, mounted on elastomeric vibration isolation pads.
   b. Provide access ports, for level adjustment, with removable waterproof covers at isolator locations.
   c. Locate so they are accessible for adjustment during the life of the installation without interfering with the integrity of the roof.
   d. Restrained Spring Isolators:
      1) Freestanding, steel, open-spring isolators with seismic restraint.
      2) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
      3) Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
      4) Minimum Additional Travel: 50 percent of required deflection at rated load.
      5) Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
      6) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   e. Elastomeric Isolator Pads:
      1) Oil-resistant and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern.
      2) Single Layer Thickness: Minimum 6 mm.
      3) Galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to size that match requirements of supported equipment.
      4) Material: Standard neoprene.
      5) Number of Layers: As required to support equipment load; refer to manufacturer’s data for load capacities.
4. Snubber Bushings: All-directional, elastomeric snubber bushings at least 6 mm thick.
5. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter-flashed over roof materials.

D. Manufacturers:
   1. Mason Industries, Inc.
   2. Peabody Noise Control, Inc.
   3. BDR Noise and Vibration Control, Inc.
   4. Kinetics Noise Control, Inc.
   5. Amber/Booth Company, Inc.
   6. California Dynamics Corp.
   7. Isolation Technology, Inc.
   8. M.W. Sausse & Co., Inc. (VIBREX).
   9. Thybar Inc.
   10. Vibration Eliminator Co., Inc.
   11. Vibration Isolation Co., Inc.
   12. The VMC Group.

2.3 FLEXIBLE CONNECTORS

A. Flexible Pipe Connectors:
   1. Braided Nonferrous: For nonferrous piping systems, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose.
   2. Braided Stainless Steel: For ferrous piping, provide stainless steel hose covered with Type 304 stainless steel wire braid with NPT steel nipples or 150-psi ANSI flanges, welded to hose.
   3. Rubber:
      a. Neoprene or EDPM construction consisting of multiple piles of nylon tire cord fabric and elastomer, molded and cured in hydraulic rubber presses.
      b. Straight or elbow connector as indicated on Drawings, rated at 827 kPa at 104 degrees C.
   4. Manufacturers:
      a. Mason Industries, Inc.
      b. Peabody Noise Control, Inc.
      c. Kinetics Noise Control, Inc.

B. Flexible Duct Connectors: Refer to Section 23 31 13, Metal Ducts and Accessories.

2.4 SEISMIC RESTRAINTS

A. Resilient Isolation Washers and Bushings: One-piece, molded neoprene with a flat washer face.

B. Seismic Snubbers: Factory fabricated using welded structural steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

C. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

D. Anchor Bolts:
   1. Seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

E. Manufacturers:
1. California Dynamics Corp.
2. Kinetics Noise Control, Inc.
3. Loos & Co., Inc.; Cableware Technology Division.
4. Mason Industries, Inc.
5. M.W. Sausse & Co., Inc. (VIBREX).
6. TOLCO Incorporated.
7. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
8. Vibration Eliminator Co., Inc.
9. Vibration Isolation Co., Inc.
10. The VMC Group.

2.5 SHOP/FACTORY FINISHING

A. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment, before shipping.
1. Powder coating on springs and housings.
2. Electro-galvanize hardware.
3. Hot-dip galvanize metal components for exterior use.
4. Baked enamel coat metal components for interior use.

B. Color-code or otherwise mark vibration isolation and seismic control devices to indicate capacity range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
1. Install products in accordance with manufacturers' written instructions.
2. Connect wiring to isolated equipment with flexible hanging loop.
3. Install roof curbs, equipment supports, and roof penetrations as specified in Section 07 70 01, Roof Specialties and Accessories.
4. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.
5. Locate isolation hangers as near overhead support structure as possible.

B. Vibration Isolators:
   1. Install spring hangers without binding.
   2. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

C. Equipment Bases:
   1. Adjust equipment level.
   2. Bases with seismic snubbers shall have snubbers located close to isolators.
   3. Structural Steel Bases: Set steel bases for 25 mm clearance between housekeeping pad and base.
   4. Concrete Inertial Bases:
      a. Set concrete inertia bases for 50 mm clearance between housekeeping pad and base.
      b. Fill concrete inertia bases, after installing base frame, with concrete; trowel to a smooth finish.

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

E. Seismic Restraint Devices:
   1. Notify local representative of seismic restraint materials manufacturer prior to installing seismic restraint devices.
   2. No rigid connections between equipment and building structure shall be made which degrades seismic restraint system herein specified.
   3. Electrical conduit to restrained equipment shall be looped to allow free motion of equipment without damage to electrical wiring.
   4. Install seismic snubbers on isolated equipment.
   5. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   6. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.
   7. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers.
   8. At trapeze anchor locations, shackle piping and equipment to trapeze.
   9. Install resilient bolt isolation washers on equipment anchor bolts.
   10. Upon completion of seismic restraint material installation and before startup of restrained equipment, clean debris from beneath protected equipment, leaving equipment free to contact snubbers.

3.3 FIELD QUALITY CONTROL

A. Testing:
   1. Conduct the following field quality-control testing:
      a. Isolator deflection.
      b. Isolator seismic-restraint clearance.
      c. Snubber minimum clearances.

B. Seismic Control Component Inspection:
   1. Conduct periodic inspections of material installation with assistance of manufacturer's representative. Report in writing deviations from good installation practice.
   2. Upon completion of seismic restraint device installation inspect completed system with assistance of manufacturer's representative. Report in writing installation errors, improperly selected snubber devices, or other fault in the system that could affect performance of the system.

3.4 MANUFACTURER'S SERVICES:

A. Manufacturer's Representative present at Site or classroom designate by the City, for minimum person-days listed below, travel time excluded:
   1. One person-days for installation assistance and inspection.
   2. One person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   3. One person-days for facility startup.

3.5 ADJUSTING

A. Vibration Isolation Devices:
   1. Adjust isolators after piping systems have been filled and equipment is at operating weight.
   2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height.
   3. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
   4. Attach thrust limits at centerline of thrust and adjust to a maximum of 6 mm movement during start and stop.
   5. Adjust isolators to ensure units do not exceed rated operating deflections or bottom out under loading, and are not short circuited by other contacts or bearing points.
   6. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

B. Seismic Control Components:
   1. Adjust snubbers according to manufacturer's written recommendations.
   2. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
   3. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.6 CLEANING

A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.
   3. Canadian Associated Air Balance Council (CAABC): National Standards for Field Management and Instrumentation Total System Balance.
   4. National Environmental Balancing Bureau of Canada (NEBBC):
      a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
      b. Procedural Standards for Measuring Sound and Vibration.
   5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

1.2 SUBMITTALS

A. Informational Submittals:
   1. Documentation of experience record of testing authority.
   2. Documentation of current CAABC or NEBBC certifications for those technicians in responsible charge of the work under this Contract.
   3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
   4. Written verification of calibration of testing and balancing equipment.
   5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.3 QUALITY ASSURANCE

A. Air Balancing and Test Agency Qualifications:
   1. Certification by CAABC of NEBBC for testing, adjusting and balancing of HVAC systems.
   2. Corporately and financially independent organization functioning as an unbiased testing authority.
   3. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.
   4. Have a proven record of at least five similar projects.
   5. Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.

B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

C. Drives for Belt-Driven Fans:
   1. Furnish cast iron or flanged steel sheaves.
   2. Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

PART 3 EXECUTION

3.1 GENERAL

A. Adjust and balance air and water systems in accordance with standard procedures and recognized practices of the CAABC, NEBBC or SMACNA.

B. Adjust and balance the following systems:
   1. Supply, return and exhaust air systems.
   2. Boiler heating systems (existing).
   3. HRC heating system.
   4. Four Air (FOA) systems related to the biofilter and the bioreactor. The applicable air flows will be provided to the Contractor during construction.

3.2 ADJUSTING AND BALANCING AIR SIDE

A. Preparation:
   1. Prior to beginning the Work, perform the following activities:
      a. Review shop drawings and installed system for adequate and accessible balancing devices and test points.
      b. Recommend to Contract Administrator dampers that need to be added or replaced in order to obtain proper air control.
      c. Verify proper startup procedures have been completed on the system
      d. Verify controls installation is complete and system is in stable operation under automatic control.
      e. Verify test instruments have been calibrated to a recognized standard and are within manufacturer’s recommended calibration interval before beginning the Work.

B. General:
   1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
   2. Lock and mark final positions of balancing dampers with permanent felt pen.

3. Correct fan and airflow measurements for Site elevation.
4. For neutral rooms, the allowable variations are plus 5 percent /minus 5 percent for supply and plus 5 percent/minus 5 percent for exhaust.
5. For positive rooms, the allowable variations are plus 5 percent/minus 0 percent for supply and plus 0 percent/minus 5 percent for exhaust.
6. For negative rooms, the allowable variations are plus 5 percent/minus 0 percent for exhaust and plus 0 percent/minus 5 percent for supply.

C. Equipment Data:
1. Collect the following data and included in final report:
   a. Type of unit.
   b. Equipment identification number.
   c. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
   d. Motor data (frame, kW, volts, FLA rpm, and service factor).
   e. Sheave manufacturer, size, and bore.
   f. Belt size and number.
   g. Sheave centerline distance and adjustment limits.
   h. Starter and motor overload protection data.
   i. Include changes made during the course of system balancing.

D. Fan Systems:
1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
   a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation aforementioned.
   b. After final adjustments, do not operate motor above nameplate amperage on any phase.
   c. After final adjustments, do not operate fan above maximum rated speed.
   d. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
   e. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall be able to deliver 150 percent of motor horsepower. Provide written notice to air handling unit manufacturer and Contract Administrator if drive or belt changes were made.
4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.
5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.
6. Read and record motor amperage on all phases for each test condition.

E. Air Terminal Devices:
   1. Terminal Airflow Calibration: Calibrate and set the flow coefficients in terminal controller units to ensure controller readings are identical to measured values. This shall be a one-point calibration at maximum flow conditions. Record coefficient values.
   2. Test each terminal flow device at minimum and maximum flow conditions. Ensure terminal controller is under control at time of each test.
   3. If airflow of terminal device is derived from two or more flow streams, the individual air streams shall be measured and recorded independently for each test.
   4. In each terminal system at least one airpath from terminal to final duct termination shall have dampers fully open.
   5. Adjust air volumes on each terminal to quantity shown, with allowable variation aforementioned.

F. Air Outlets and Inlets:
   1. In each system at least one air path from fan to final branch duct termination shall have dampers fully open.
   2. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation aforementioned.
   3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.
   4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

G. Zone Differential Pressure:
   1. Test and adjust differential pressures by setting design flows to meet required flow direction and pressure differential during worst case conditions of systems serving zone being adjusted and of adjacent zones.
   2. Zone differentials for this project include:
      a. All electrical rooms, automation rooms and control rooms shall be under positive pressure with respect the adjacent rooms
      b. The following rooms shall be under negative pressure with respect to adjacent rooms
         1) Grit Pump Room
         2) Loading Bay and Grit and Screening Platform in Grit and Screening building
         3) Screen Room
         4) Grit Tanks Room
         5) Pump Room and Clarifier Room in the High Rate Clarification building
         6) RAS Pump Room in the Bioreactors / Blower building
         7) Chemical Loading Platform and Chemical Containment Room in the Chemical / Electrical building
         8) Pump Room in the Secondary Clarifiers 4 & 5 building.
         9) RDT Room
         10) Humidifier Room in the Biofilter Facility
   3. Provide written notice to Contract Administrator of zone leakage conditions preventing design differential requirements to be met.

3.3 ADJUSTING AND BALANCING WATER SIDE

A. Preparation: Prior to beginning the Work, perform the following activities:
   1. Review shop drawings and installed system for adequate and accessible balancing devices and test ports.
   2. Recommend to Contract Administrator devices needed to be added or replaced in order to obtain proper water control.
   3. Verify proper startup procedures have been completed on system.
   4. Verify controls installation is complete and system is in stable operation under automatic control.
   5. Verify hydronic systems have been filled and are clean. Examine a sample of strainers to ensure cleanliness.
   6. Verify manual air vents have been bled and expansion tanks and automatic air vents are functioning.
   7. Verify control valves and coil connections are complete and properly installed.

B. General:
   1. In addition to the new equipment and sub-systems provided under this contract, the balancing work shall include the hot water side of the existing plant-wide hydronic heating system.
   2. Refer to drawing 1-0102-MGAD-A002 for the system schematic of the existing plant-wide hydronic heating system complete with the design flow rates to be achieved.
   3. When adjustments are made to a portion of a water system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
   4. Correctly adjust water flow readings for mixtures other than pure water.
   5. Throttling of butterfly and other nonbalancing device valves shall not be allowed.
   6. Lock and mark final positions of balancing devices with a centerpunch or permanent felt pen.

C. Equipment Data:
   1. Collect the following data and include in final report:
      a. Type of pump.
      b. Equipment identification number.
      c. Equipment nameplate data (including manufacturer, model, size, type, impeller size and serial number).
      d. Pump capacity (flow rate and differential pressure).
      e. Drive data.
      f. Motor data (frame, kW, volts, FLA rpm, and service factor).
      g. Starter and motor overload protection data.
      h. Include changes made during course of system balancing.

D. Pumps:
   1. Verify impeller size through a “dead-head” test. Do not perform on positive displacement pumps.
   2. Adjust water to achieve design flows at all modes of operation during single and multiple pump operation.
   3. Test redundant and stand-by pumps.

4. After final adjustments, do not operate motor above nameplate amperage on any phase.
5. Read and record pressures at pump inlet and discharge for each test condition.
6. Read and record motor amperage on all phases for each test condition.
7. Record and mark final position of balancing cocks, valves, and operators with a permanent felt pen or centerpunch.

E. Terminal Flow Devices:
1. Adjust water systems for required flow rates at each coil, connection, and terminal device.
2. Provide proper flow through individual fin tube sections, evaporator and condenser circuits, each boiler loop, each pump, and recirculation loops.
3. Measure and adjust flow through valves and valve bypass lines.
4. Record and mark final position of balancing cocks, valves, and operators with a permanent felt pen or centerpunch.
5. Read and record differential pressures across coils, control valves, chiller bundles, boilers, and heat exchanges.

F. Tolerances:
1. Heating Water Flow Rate: Plus 10 percent to minus 10 percent.

3.4 FIELD QUALITY CONTROL

A. General: Perform functional tests as required by Section 01 91 14, Equipment Testing and Facility Startup.

B. Performance Testing:
1. Electric Heating Coil Testing:
   a. Adjust system as required to achieve full output from coil.
   b. Read and record amperages and voltages for all phases.
2. Vibration Testing:
   a. Upon completion of air and water system balance, perform vibration testing as specified below for the following rotating or reciprocating equipment:
      1) Heating hot water pumps.
   b. Vibration Test Procedures:
      1) Take measurements at each bearing housing, using a calibrated electronic analyzer.
      2) Record log shall include equipment symbol, location, identification, and peak-to-peak displacement in a direction parallel to shaft in a horizontal plane, and in a direction perpendicular to shaft in both horizontal and vertical planes.
      3) Maximum Peak-to-Peak Amplitude Levels:

Rotational Speed (rpm)	Vibration Amplitude (mils)
250	3.5
500	2.0
750	1.5
1,000	1.0

Rotational Speed (rpm)	Vibration Amplitude (mils)
1,500	0.75

4) Notify Contract Administrator if amplitude exceeds upper limit specified.
5) After readjustment for vibration, measure and record only the readjusted equipment to determine its conformance with design.

C. Balancing Log Report Requirements:
1. Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control setpoint.
2. Log and record operational information from every test for each system, as necessary to accomplish services described.
3. Include equipment data for units tested.
4. Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.
5. Indicate recorded Site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
6. Include separate section in log, if necessary, describing operating difficulties in air or water systems that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of condition and its effect on building, and describe corrective actions attempted and recommended.

D. Quality Control Verification:
1. After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:
   a. Air and water balancing procedures, vibration tests, and verification of test results.
   b. Perform spot tests on a maximum of 20 percent of total diffusers and grilles, on two air handling fan devices per building, and on 10 percent of total water balance fittings, with measuring equipment used in original tests, at random points selected by Contract Administrator.
   c. Results of these spot tests shall agree with balance logs within percentage tolerances specified. Where this accuracy cannot be verified, rebalance portions of system as requested by Contract Administrator.
   d. At completion of rebalance procedures, perform another spot test if required to verify results.

END OF SECTION

SECTION 23 07 00

HVAC INSULATION

PART 1 GENERAL

1.1 REFERENCES

A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
   1. American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE): 90.1, Energy-Efficient Design of New Buildings Except Low-Rise Residential Buildings.
   2. ASTM International (ASTM):
      a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      b. C533, Standard Specification for Calcium Silicate Block and Pipe Insulation.
      c. C534, Standard Specification for Preformed Flexible Elastometric Cellular Thermal Insulation in Sheet and Tabular form.
      d. C547, Standard Specification for Mineral Fiber Pipe Insulation.
      e. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
      f. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
      g. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
      h. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      i. G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
      j. G22, Standard Practice for Determining Resistance of Plastics to Bacteria.
   3. Association of the Nonwoven Fabric Industry (INDA), IST 80.6, Water Resistant (Hydrostatic Pressure)
   4. National Fire Protection Association (NFPA):
      a. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
      b. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
      c. 259, Standard Test Method for Potential Heat of Building Materials.
   5. Underwriters' Laboratories, Inc. (UL): 723, UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.
   6. TIAC, Thermal Insulation Association of Canada – Standards Manual for Mechanical Insulation.
   7. CAN/ULC-S102, Standard Method & Test for Surface Burning Characteristics of Building Materials and Assemblies.
   8. CAN/CGSB-51.40 M80, Thermal Insulation, Flexible, Unicellullar, Polyolefin Foan Sheet and Pipe Covering.

1.2 DEFINITIONS

A. Cold Air Ductwork: Designed to convey mechanically cooled air or return ducts in such systems.

B. Warm Air Ductwork: Designed to convey mechanically heated air or return ducts in such systems.

C. Piping: Includes fittings, flanges, valves, appurtenances, drains, vents and similar items, both indoors and outdoors.

D. Appurtenances: Special pipe fittings such as strainers, but not common pipe fittings such as tees, reducers and elbows.

E. Ducting: Includes fittings, drains, accessories and similar items.

F. Concealed: Insulated mechanical services and equipment above suspended ceilings and non-accessible chases and furred spaces.

G. Exposed: Not concealed.

H. Thermal Conductivity: The ability of a given substance to conduct heat.

I. Vapour Permeance: Resistance to water vapor transmission.

1.3 SUBMITTALS

A. Action Submittals: Product description, list of materials and thickness for each service or equipment scheduled, locations, and manufacturer’s installation instructions.

B. Informational Submittals:
   1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
   2. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Materials furnished under this Specification shall be standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.

C. ULC Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Stamp or Label:
   1. Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Project Site for use must have manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
   2. Insulation packages and containers shall be marked "asbestos-free."

PART 2 PRODUCTS

2.1 GENERAL

A. Insulation exterior shall be cleanable, grease-resistant, nonflaking, and nonpeeling.

B. Insulation shall conform to referenced publications and specified temperature ranges and densities in kg/m^3.

C. Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

D. Fire Resistance:
   1. Insulation, adhesives, vapor barrier materials and other accessories, except as specified herein, shall be noncombustible.
   2. Use no fugitive or corrosive treatments to impart flame resistance.
   3. Flame proofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.
   4. Materials including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with ASTM E84 (NFPA 255) methods.

E. Materials exempt from fire-resistant rating:
   1. Nylon anchors.
   2. Treated wood inserts.

F. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
   1. Polyurethane insulation.
   2. PVC casing.
   3. Fiberglass-reinforced plastic casing.

2.2 PIPE INSULATION

A. Refer to Section 40 42 13, Process Piping Insulation.

2.3 DUCT INSULATION

A. Type D1—Blanket (ASTM C553, Type 1, Class B3):
   1. Fiberglass, nominal 16 kg/m^3 density blanket, K factor 0.045 W/m degrees C maximum at 24 degrees C mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures to 121 degrees C.
   2. Manufacturers and Products:
      a. CertainTeed; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Owens/Corning Fiberglass; Soft R.
      d. Knauf; Ductwrap.

B. Type D2—Board:
   1. Fiberglass, minimum 44 kg/m^3 density board, K factor 0.033 W/m degrees C maximum at 24 degrees C mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures from 38 degrees C to 454 degrees C.
   2. Manufacturers and Products:
      a. CertainTeed; Certa Pro Commercial Board.
      b. Knauf; Duct Slab.
      c. Owens/Corning Fiberglass; TIW.
      d. Johns Manville; Ductboard.

C. Type D5 – Flexible Elastometric (ASTM 534, Type I for tubular material and Type II for sheet materials):
   1. Closed-cell, sponge or expansion rubber materials.
   2. Manufacturers and Products:
      a. Aeroflex USA Inc., Aerocell.
      b. Armacell LLC, AP Armaflex.
      c. RBX Corporation, Insul-sheet 1800 and Insul-Tube 180.

2.4 INSULATION FINISH SYSTEMS

A. Type F1—PVC:
   1. Polyvinyl chloride (PVC) jacketing, white, for straight run piping and fitting locations, temperatures to 70 degrees C.
   2. Manufacturers and Products:
      a. Knauf; Proto.
      b. Johns Manville; Zeston.

B. Type F3—Aluminum:
   1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.4 mm thickness, with smooth mill finish.
   2. Moisture Barrier: Provide factory applied moisture barrier, consisting of 18 kg kraft paper with 1 mil thick low density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.

3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, etc.
4. Manufacturer:
   a. Permaclad.
   b. Childers.
   c. Insul-Coustic.
   d. RPR Products.

PART 3 EXECUTION

3.1 INSTALLATION OF DUCTWORK INSULATION

A. Install insulation products in accordance with the manufacturer's written instructions and in accordance with recognized industry practices.

B. Install insulation materials with smooth and even surfaces.

C. Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

E. Maintain integrity of vapor-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.

F. Seal longitudinal and circumferential joints with FSK tape, and finish with fiberglass mesh fabric embedded in vapor barrier mastic.

G. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

H. Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

I. Refer to Section 23 31 13, Metal Ducts and Accessories, for installation of internal duct liner.

3.2 INSTALLATION OF INSULATION FINISH SYSTEMS

A. Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.

B. Secure circumferential joints with preformed snap straps containing weatherproof sealant.

C. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

D. Do not use screws or rivets to fasten the fitting covers.

E. Install removable prefabricated aluminum covers on exterior flanges and unions.

F. Caulk and seal all exterior joints to make watertight.

3.3 DUCTWORK INSULATION REQUIREMENTS

A. Mechanically Cooled and Heated Supply and Return Air and Outside Air; (Concealed):
   1. Type D1, blanket.
   2. 50 mm thickness.

B. Mechanically Cooled and Heated Supply and Return Air, and Outside Air (Exposed to View):
   1. Type D2, board.
   2. 40 mm thickness.

C. Mechanically Heated Supply Air; (Outdoors):
   1. Type D5, flexible elastomeric.
   2. 50 mm thickness.

D. Mechanically Heated Supply Air; (In spaces not served by the duct):
   1. Type D2, board.
   2. 40 mm thickness.

E. Outside Air Intake Plenum and Exhaust Air Plenum:
   1. Type D2, board.
   2. 40 mm thickness.

F. Exhaust Air 1.2 m from Exhaust Air Plenum:
   1. Type D2, board.
   2. 40 mm thickness.

G. Exhaust Air, including odour air ducts (Outdoor):
   1. Type D5, flexible elastomeric.
   2. 50 mm thickness.

H. Air Distribution Devices: Refer to Section 23 37 00, Air Inlets and Outlets, for requirements.

3.4 INSULATION FINISH REQUIREMENTS

A. Duct Insulation (Indoor): Factory finish.

B. Ductwork Insulation (Outdoors): Type F3, aluminum.

C. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.5 FIELD QUALITY CONTROL

A. Test factory-applied materials assembled. Field-applied materials may be tested individually.

END OF SECTION

SECTION 23 11 10

GENERATOR FUEL OIL SYSTEM

PART 1 GENERAL

1.1 RELATED SECTIONS

A. Section 26 32 10, Diesel Electric Generating Units (Liquid Cooled).

1.2 SUMMARY OF WORK

A. This Section covers the work necessary to design, furnish, install and commission the fuel oil system for the standby generators specified in Section 26 32 10, complete.

B. The system is composed of a double wall above ground storage tank, dual fuel transfer pumps within an enclosure, two double wall day tanks, fuel filtration system, fuel oil piping, manual valves, automatic valves, solenoid valves, instrumentation and controls, and all other necessary and related miscellaneous appurtenances required to produce satisfactory and properly operating system.

C. Unit Responsibility: The Work requires that the fuel oil system complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment, which (supplier) shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified or required features and functions without altering or modifying the Contactor’s responsibilities under the Contract Documents. The Contractor is responsible to the City for providing the equipment systems as specified herein.

1.3 REFERENCE CODES AND STANDARDS

A. All Work and materials shall comply with Canadian Standard Association (CSA) or the Underwriter Laboratories of Canada (ULC or cUL).

B. The following is a list of standards and standards organizations which may be referenced in this section:
   1. Institute of Electrical and Electronics Engineers (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   2. Hydraulic Institute Standards.
   3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
   4. American Society of Mechanical Engineers (ASME):
      a. B31.1, Power Piping
      b. B31.3, Process Piping
   5. Canadian Electrical Code (CEC).
   6. Nationally Recognized Testing Laboratories (NRTL).
   7. Occupational Safety and Health Administration (OSHA).

8. The Canadian Standards Association (CSA).
9. Underwriters Laboratories Inc. of Canada (ULC).
10. Manitoba Building Code (MBC).
11. Electrical Equipment Manufacturer's Association of Canada (EEMAC).
12. Environmental Code of Practice for above ground and underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products (CCME)

C. Inspection and Technical Services Manitoba.

D. All electrical components shall be CSA or cUL approved.

1.4 SUBMITTALS

A. Shop Drawings and Product Data:
1. List of proposed system components.
2. Make, model, weight and horsepower of each equipment assembly.
3. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
4. Standard and specialized equipment assembly cuts.
5. Performance data showing compliance with specification requirements. Include: Pump curves showing head pressure capacity, horsepower demand, and efficiency over the entire operating range and from shutoff to maximum capacity.
6. Detailed structural, mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of equipment associated therewith.
7. Tank data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, corrosion allowance thickness, and details of nozzle designs.
8. Fuel filtration system details including the following: dimensional drawing, connections details, operating instructions, expected performance, detail calculations and letter of SAE J1488_201010 certification.
9. Outside utility requirements such as air, water, power, etc., for each component.
10. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
11. Control panel elevation drawings showing component layout, construction, placement of operator interface devices and other elements.
12. Schematic control diagrams.
13. Description of system sequence of operation.
14. Power and control wiring diagrams, including terminal numbers.
15. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
16. Shop and Field Painting Systems Proposed: Include manufacturer's descriptive technical catalog literature and specifications, hazardous communication data sheets, and written certification that the factory-applied coating system(s) is identical to the requirements specified.
17. Where system proposed is different from that specified or where, in the manufacturer's opinion, the coating system exceeds the requirements specified, submit complete technical literature of the proposed system to the Contract Administrator for review.
18. Warranty card.

B. Quality Control Submittals:
   1. Manufacturer’s Certificate of Compliance: Applicable OSHA requirements, Underwriters’ Laboratory (UL) requirements, Province of Manitoba basic safety code requirements, and other materials requirements of these Specifications.
   2. Certified copies of short commercial test results for actual motors being supplied.
   3. Factory test results, reports, and certifications. Include:
      a. Functional Test Certificates.
      b. Performance Test Report and Certificates.
   4. Test results of control panels for proper operation, electrical connection, and function.
   5. Copies of fabrication, quality control, and testing records for actual tank.
   6. Special shipping, storage and protection, and handling instructions.
   7. Manufacturer’s written/printed installation instructions.
   8. Routine maintenance requirements prior to plant startup.
   9. Manufacturer’s Field Service Report and Certificates in accordance with Section 01 43 33, Contractor Field Services. Include:
      a. Manufacturer’s Certification of Proper Installation.
      b. Field Functional Test Certificates.
      c. Field Performance Test Certificates.
   10. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools, materials, and supplies required for checking, testing, parts replacement, and maintenance with current price information.
   11. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
   12. Operation and Maintenance Manuals: As specified in Section 01 78 23, Operation and Maintenance Data.

1.5 SPECIAL GUARANTEE

A. Furnish manufacturer's extended guarantee or warranty, with the City named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the City, removal or replacement if any material or labor is found defective during a period of 3 years after the date of Substantial Performance. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

1.6 CONDITIONS OF SERVICE

A. Provide equipment compatible for use with Diesel Fuel Oil (No.2) for outdoor use.

1.7 ACCEPTABLE INSTALLATION CONTRACTORS

A. Only Contractors licensed in the Province of Manitoba to install diesel fuel equipment/piping are allowed as acceptable contractors to install this system (i.e. Licensed Petroleum contractors).

1.8 CERTIFICATION

A. Installation contractor shall obtain Inspection and Technical Services Manitoba permit to install the system and obtain certification that installed system meet the Inspection and Technical Services Manitoba requirements.

B. System design and installation shall meet the requirements of CSA B139 and CSA C282-15.

C. All equipment, piping, instruments and wiring provided in this section must meet all relevant Federal and Provincial codes, and be in accordance with all local authorities.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.

B. Equipment manufacturer shall be capable of demonstrating at least 10 consecutive years of successful experience in production of like equipment. Equipment must be similar in size, design, and application required for this Project.

C. Regulatory Requirements:
   1. Provide equipment and materials in compliance with applicable Federal and Provincial safety codes, NFPA, UL, ULC, CEC, ASME, MBC, and OSHA requirements.
   2. Equipment and tanks shall meet or exceed local, city, and fire code requirements.
   3. Entire fuel oil system shall meet Inspection and Technical Services Manitoba requirements.

D. Materials: Manufacturer's standard for the intended service, unless otherwise specified herein.

E. Modify standard products to meet or exceed specified component or system requirements.

2.2 MANUFACTURER

A. Components and accessories specified in this section shall be complete system supplied by:
   1. Clemmer Technologies Inc.
   2. Westeel
   3. Or approved equal in accordance with B8.

2.3 EQUIPMENT DESCRIPTION

A. Above ground Fuel Oil Storage Tank
   1. Tank storage capacity shall be 25,000 liters.
   2. Tank shall be completely shop fabricated, horizontal, cylindrical, above ground, protected type, with integral secondary containment.
   3. Tank shall be suitable for receiving, storing, and discharge of No. 2 diesel fuel oil in an exterior ambient environment with temperature range of -50 to 50 degrees C.
   4. Tank shall consist of an inner steel wall and an outer steel wall with interstitial vacuum sensor.
   5. Integral secondary containment shall be testable and provide access for interstitial leak detection monitoring. Provide a voltage free fail-safe contact for a "leak detected" signal to the Plant Control System.

6. Primary and secondary tank to have vent and emergency vent.
7. Marking:
   a. Identify tank with an Identification Plate: Identify each tank with fabricator's name, capacity in liters, service, maximum temperature, design pressure/vacuum, tank number, tank name, and date of manufacture.
   b. Provide permanent marking. Seal decals, labels, etc., to exterior.
   c. Mark tanks on all sides with warning signs: “Flammable” or “Combustible”, “No Smoking”, and other signs as required by applicable codes.
8. Nozzles:
   a. Provide tank with and design all required nozzles for all vents, spares, fill lines, supply lines and required appurtenances such as level switches, level instruments, etc. Spare nozzle to be minimum of 100 mm dia.
   b. Gusset 100 mm and larger nozzles or smaller nozzles with conical or plate type gussets. Larger nozzles shall be gusseted as required.
   c. Finish flush with the inside surface of the tank unless otherwise indicated in the Contract Documents.
   d. Gaskets:
      1) Provide two per nozzle, 3 mm thick full face elastomeric material having a hardness of Shore A60 plus or minus 5.
      2) Material shall be suitable for the intended service.
   e. All Flanged Nozzles: Rated at 700 kPa with other dimensions and bolting corresponding to ANSI B16.5 for 1035 kPa steel flanges.
   f. The back face of all flanges shall be spot faced, flat and parallel to the flange face of sufficient diameter to accept an SAE metal washer under the bolt head or nut.
9. Tank Appurtenances
   a. Supports: Tank shall have integral leg supports ULC approved designed to support the full load of tank and contents. Supports shall be bolted to tank base, provide a minimum 150 mm clearance between tank and concrete pad (to be provided by the installation contractor) for complete visual inspection. The tank support system shall be anchored to concrete pad. Galvanized concrete anchors shall be as provided by tank manufacturer.
   b. Access Stairs and Platform: Tank shall be equipped with access stairs and platform for access to the transfer pumps. Stairs and platform shall be of welded steel construction hot dip galvanized after fabrication. Stair shall include non-skid tread surfaces and handrails.
   c. Manway: Provide flanged access manways of manufacturer’s standard design and top mounting location. Provide complete with necessary gaskets and stainless steel bolts.
   d. Venting: Provide properly sized ULC listed approved emergency and standard vents. Standard vent shall terminate a minimum of 3.6 metres above the adjacent ground level. Vents shall terminate a minimum of 1.6 metres from any instrumentation to allow for instrumentation to be located in a Class I, Zone 2 area.
   e. Grounding: Provide (2) grounding locations suitable for connection of 4/0 AWG copper cable connections (one at either end of the tank). System shall be electrically grounded in full compliance with Canadian Electrical Code standards for static electricity build up. Co-ordinate with grounding grid installation.

f. Exterior Finish: The complete fuel centre shall be blast cleaned to SSPC-SP6 primed and finished painted with an epoxy based high gloss white for the tank and yellow for the base.
g. Provide all required lifting lugs.
h. Provide UL label: Include name of manufacturer and location of factory.
i. Provide tank with OPW 61 F stop overfill prevention valve compatible with direct fill coupler. . Provide Tank Fill monitor RFLM-1 from Clemmer, complete with audio/visual alarms.
j. Provide Pomeco/OPW 332-ASTW74 or approved equal in accordance with B8 direct-fill aboveground storage tank spill container with welded hinge, lockable hatch including provision for padlock.
k. Provide the tank with a direct read gauge that shall be readable from ground level. OPW Model 200TG or approved equal in accordance with B8.
l. Provide the tank with level and leak monitoring instruments as described under Section 2.8 of this document.

B. Fuel Oil Transfer Pump Package:
1. Provide a complete pre-engineered automatic fuel transfer pump system suitable for withdrawal of fuel oil from the storage tank and discharging the fuel to two day tanks situated indoor. Units shall operate intermittently in an ON/OFF mode manually and automatically and shall be activated by level switches in the day tank.
2. The fuel transfer pump assembly shall include the following:
   a. Duplex submersible turbine pumps, each rated for 95 L/m at 215 kPa for pumping fuel oil with a maximum viscosity of 70 SSU.
   b. Pump motor: 0.6 kW fixed speed, 3450 rpm, two-stage centrifugal type pump motor with integral, automatic thermal overload protection. Motor suitable for 208V, single phase, 60 Hz power supply.
   c. Each pump system to include the following devices and valves:
      1) Check valve, fluorocarbon Viton seal constructed on cast aluminum body and steel backing washer.
      2) Pressure relief valve with four pressure relief settings, integral to check valve.
      3) Venturi type siphon primer, siphon check valve and secondary siphon.
      4) Air eliminator
      5) Discharge shutoff valve.
      6) Solenoid valve
      7) Discharge pressure gauge.
      8) Electrical disconnect; electrical yoke for positive contractor disconnect during service.
   d. Pump control system as specified under paragraph Controls.
   e. Sensor to detect pump flow and indicate failure of pump.
3. The pump package shall be supplied with a weather-proof and insulated enclosure covering the entire pumps package including valves and piping. The insulated enclosure must be designed for easy inspection and maintenance of all pump package components. Panels shall be made of galvanized steel sheet, internally and externally powder coated in a light reflecting, light colour. The enclosure shall provide suitable protection for outdoor installation under wind load and snow load. Two hinged access doors and quick release panels each less than 20 kg should be provided for easy and quick access in routine maintenance of the pumps and the package components. Should the panels be

heavier than 20 kgs, additional hinged doors must be supplied with the appropriate frame, reinforcements and supporting elements. Provide weather-proof side louvers for cross ventilation. Electrical components, instrumentation and connections shall not be mounted or interface with moving panels of the insulated enclosure. Provide a level switch with a voltage free fail-safe contact inside the enclosure for detection of leaks within the enclosure for connection to the Plant Control System.

C. Day Tank Skids:
   1. General: Provide two packaged design fuel oil day tanks complete in all respects for use with storage tank and transfer pumps system described above in order to provide an automatic, self-refilling fuel supply system.
   2. Each day tank shall be designed and supplied as a package engineered system by the manufacturer, and shall include all inlet flow control devices, other valves, level controls, leak alarms, and all other devices as required to form an integrated, functional system such that field installation is restricted largely to external piping, wiring, and such intermediate devices that are required by code and/or good engineering practice to interconnect the storage tank to each of the day tank, and the day tank to the generator.
   3. The system shall be for use with fuel oil as described by NFPA 321, “Basic Classification of Flammable and Combustible Liquids.” As defined by this standard, the fuel supply system shall be for use with “combustible liquids,” those having a flash point at or above 38 degrees C and further defined as Class II or Class III liquids. In no case shall a liquid defined as “flammable,” or as “Class I” or as having a flash point less than 38 degrees C be used. In every case, the system shall not be used or applied at a temperature in excess of the flash point of the contents. Electrical equipment used in the system shall be in accordance with NFPA 30, Section 5-7, wherein it states “For areas where class II or class III liquids only are stored or handled at a temperature below their flash points, the electrical equipment may be installed in accordance with provisions of NFPA 70, National Electric Code, for ordinary locations…”
   4. The system shall be designed and installed in accordance with applicable sections of NFPA 30, NFPA 31, NFPA 37, UL 80, and UL 142. The day tank shall bear the label of Underwriters Laboratories standard 142 and UL 508.
   5. Day Tanks Ratings:
      a. Capacity: 2200 liters.
      b. Day Tanks Construction:
         1) Double wall, all welded steel atmospheric tank of cylindrical construction built in accordance with codes and standards noted above for indoor use with fuel oil.
         2) Provide pipe thread connections for:
            a) Fuel Oil Supply from Transfer Pump: 50 mm.
            b) Supply to Generator: 50 mm
            c) Return from Generator: 50 mm.
            d) Vent: 50 mm.
            e) Emergency Vent: 75 mm.
            f) Drain: 19 mm, with drain valve.
         3) Provide an inspection port in the top.
         4) Equip the tank with a welded steel channel base suitable for bolt attachment to a concrete pad.
         5) Provide interior epoxy corrosion protection.

6) Provide a heavy-duty industrial anti-corrosion coating on exterior of the day tanks and provide a painted finish coating.
7) Day tanks shall be factory leak tested at 35 kPa.

6. Tank Appurtenances:
   a. Provide the tank with level and leak monitoring instruments as described under Section 2.8 of this document.

2.4 FUEL OIL AND VENT PIPING:

A. Vent Piping: As specified in Section 40 27 00.02, Carbon Steel Pipe and Fittings - Special Service.

B. Fuel Oil Piping:
   1. General: Pipe and fittings shall be UL listed for conveying flammable liquids.
   2. Carbon Steel Double Wall Pipe: As specified in Section 40 27 00.15, Double Wall Containment Piping.
   3. Provide fittings as required for installation of leak detection elements.
   4. Provide UL listed leak detection system.

2.5 FUEL OIL SYSTEM MANUAL VALVES:

A. Ball valves: Type 305 per Section 40 27 02, Process Valves and Operators.

2.6 FUEL FILTRATION SYSTEM:

A. Fuel filtration system with capabilities of removing emulsified water and cleansing fuel of particulates to SAE J1488_201010 certification levels.

B. Provide voltage free contacts for “Run Status” and “Fault Status” (fail-safe) signals to the Plant Control System.

C. Supply loose, four isolation ball valves and one check valve to be installed by the contractor as follows:
   1. One isolation ball valve shall be installed on the diesel fuel supply line at the tank (outside) with check valve.
   2. One isolation ball valve shall be installed on the diesel fuel return line at the filtration system (indoor).
   3. One isolation ball valve shall be installed on the diesel fuel return line at the tank (outdoor).
   4. One isolation ball valve shall be installed on the drain line from the filter.

D. Manufacturer: Diesel Pure.

2.7 FUEL OIL SUPPLY

A. Contractor is responsible to provide sufficient volume of fuel for all testing and commissioning. Fuel oil storage tank shall be filled to 100 percent capacity after SAT.

2.8 CONTROLS AND INSTRUMENTATION:

A. Process and Instrumentation Diagrams and these Specifications depict the minimum functional requirements of the systems and controls to be provided under this Section. System supplier shall provide all components, instrumentation, and controls necessary to provide a complete, safe, and properly operating system. Specific systems and controls proposed shall be subject to the approval of the Contract Administrator.

B. The area 3m surrounding the Above Ground Fuel Oil Storage Tank is considered to be a Class I, Zone 2 location. The area 1.5m surrounding vent outlets is considered to be a Class I, Zone 1 location. The area within the Above Ground Fuel Oil Storage Tank is considered to be a Class I, Zone 0 location. All equipment and installation shall comply with these area classifications.

C. Instrumentation provided under this Section shall comply with the requirements of Section 40 91 01, Instrumentation and Controls Components, unless otherwise specified herein.

D. Panels: Provide NEMA 4X stainless steel control panels to accommodate the required control and monitoring functions. The panels will be located outside of the hazardous rated areas. Control panels' construction shall comply with the requirements of Section 40 99 91, Package Control Systems.
   1. Transfer Pump Control Panel: LCP-C563
   2. Storage Tank Fill Control Panel: LCP-C560
   3. LCP-C563 (Transfer Pump Control Panel) Requirements:
      a. Provide, at minimum, the following pilot devices:
         1) LOCAL/OFF/AUTO selector switch for pumping system.
         2) START and STOP pushbuttons for each pump.
         3) E-STOP for entire diesel fuel transfer system.
         4) OPEN/CLOSE selector switch for each pump solenoid valve.
         5) Pump status RUN indication lights for each pump (Green).
         6) Pump FAULT indication lights for each pump (Amber).
         7) TEST pushbutton (for testing pilot lights)
         8) SILENCE pushbutton
         9) Audible Alarm Horn
         10) Storage Tank LOW LOW/LOW/HIGH/HIGH HIGH indication lights
         11) Day tank SELECT pushbuttons for each day tank
         12) Day tank SELECTED indication lights for each day tank (Green)
         13) OPEN/CLOSE selector switch for each day tank solenoid valve
         14) Day Tank LOW LOW/LOW/HIGH/HIGH HIGH indication lights for each day tank
      b. Disconnect switch with door interlock for main power inlet connections equipped with guarded terminals and padlockable handle mechanism interlocked to prevent door opening unless switch is OFF.
      c. Provide Transfer Pump Control Panel to include, but not be limited to Circuit Breakers, Magnetic Motor Starters, pilot devices, relays, and terminal strips with marked terminals for external connection.
      d. Provide control for the entire system, including but not limited to:
         1) Fuel delivery

2) Automatic fuel transfer to day tanks based on day tank low level and high level
3) Local day tank selection
4) Interlocks required between day tank levels and transfer pumps
5) Interlocks required for leak detection
6) Fuel filtration

e. All controls and interlocks required for the safe and reliable operation of the fuel transfer system shall be included within the system control.

f. Provide dry contacts for alarms and status signals for the Plant Control System, including but not limited to, the following:
1) Pumps Run and Fault (fail-safe) status.
2) LOCAL/OFF/AUTO switch Auto status.
3) Common Fault alarm (fail-safe) and common Warning alarm (fail-safe)
4) Day tank Active status.

g. Provide terminals for wiring of a system shutdown from the plant fire alarm panel. The fire alarm panel will switch a 120 VAC relay coil.

4. LCP-C560 (Storage Tank Fill Control Panel) Requirements
a. Provide, at minimum, the following pilot devices:
1) Storage Tank HIGH Alarm light (Amber)
2) Storage Tank HIGH HIGH Alarm light (Amber)
3) Storage Tank HIGH HIGH Alarm horn
4) TEST pushbutton (for testing pilot lights and horn)
5) SILENCE pushbutton E-STOP for entire diesel fuel transfer system.

E. Fuel Tank Level /Leak monitoring instruments: Provide level sensors, switches, and relays in the panels as required to meet the system operations, alarms, and external interfaces specified herein. Instruments on the Storage Tank to be hazardous area Class I, Zone 2 rated. Provide the following instruments for both Storage Tank and Day Tanks.

1. Continuous Level Measurement:
a. Enclosure: NEMA 4X
b. Power: 24 V dc loop powered.
c. Output: 4-20 mA dc.
d. Manufacturer and Model: Siemens Sitrans Probe LU or approved equal in accordance with B8.
e. Control system will connect directly to instrument.

2. Point Level Measurement:
a. Provide level sensor with four floats adjustable over the length of the stem and having a connection head at the top of the tank for the four dry contacts.
b. Flanged process connection from top of the tank.

3. Level Gauge:
a. Provide a level gauge to for local indication of tank fuel level.

4. Integral leak detection in the respective tanks and signals to the Plant Control System. Leak detection system shall comply with Environmental Code of Practice for above ground and underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products (CCME). Provide a voltage free fail-safe contact for signal to the Plant Control System.

2.9 ELECTRICAL

A. Provide for a single point 600V, three-phase, 15A power supply connection to the control panels.

2.10 ACCESSORIES

A. Equipment Anchor Bolts: In accordance with Section 05 50 00, Metal Fabrications (Basic). Provide Type 316 stainless steel bolts, sized by equipment manufacturer and at least 12.5 mm in diameter. Coordinate required bolt size with approved Shop Drawings.

B. Equipment Identification Plates: Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component and control panel(s) in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification.

2.11 SHOP FABRICATION

A. Shop/Factory Finishing: Factory prepare, prime, and finish coat exposed metal surfaces of equipment and accessories in accordance with Section 09 90 00, Painting and Coating, System No. 5.

2.12 SOURCE QUALITY CONTROL

A. Perform manufacturer’s standard functional and performance tests on equipment, components, accessories and as follows:
   1. Gather and furnish test information necessary to show conformance to specified requirements.
   2. Manufacturer’s test representative shall certify test results.
   3. Perform tests on equipment and control panels actually furnished.
   4. Test control panels for proper construction, electrical connection, and function.

B. Make short commercial motor tests, including running light current at rated voltage, rated speed, high potential, and locked rotor current. Provide certified copies of test reports on motor(s) identical to those being furnished.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment at location indicated and in conformance with the manufacturer’s recommendations. Assemble piping so there is no strain placed on the enclosures or pump casings.

B. Coordinate all piping installations between tanks and equipment.

C. Install complete system in accordance with CSA B139.

D. Wiring:
   1. Electrical wiring and conduits between equipment, field devices, and panels provided under this Section are NOT necessarily shown on the Drawings.
   2. The Contractor shall coordinate with the systems supplier regarding the power, control wiring, and conduits required between the equipment, field devices, panels, and other devices. The Contractor shall furnish and install all necessary items to provide a safe and properly operating system.

3.2 PAINTING

A. The Contractor shall prepare and finish coat in accordance with Section 09 90 00, Painting and Coating, System No. 5.

3.3 FIELD QUALITY CONTROL

A. Tests: Conduct on all equipment provided, assisted by manufacturer's representative.
   1. Functional Test: Perform on all complete assemblies prior to plant startup. Inspect and test installed equipment for correct rotation, proper alignment and connection, quiet operation, and satisfactory specified performance.
   2. Performance Test:
   3. Perform prior to plant startup on all equipment under actual or approved simulated operating conditions.
   4. Perform tests on all completed assemblies, to demonstrate their conformance to these Specifications to the satisfaction of the Contract Administrator. Furnish all labor and instruments required for procedures. During tests, record data.
   5. Perform with the manufacturer's authorized representative, in the presence of and schedule with the Contract Administrator.
   6. Submit test log to the Contract Administrator upon completion of each test.
   7. Furnish and install, and subsequently remove, all temporary piping and accessories necessary to permit full and proper recirculation of testing liquid utilized during the field tests.
   8. Continue testing on each pump for a continuous 3-hour period without malfunction or sign of apparent weakness in the equipment.
   9. If units apparently fail to meet these Specifications to the satisfaction of the Contract Administrator, test more accurately. If unit fails first performance test, adjust, realign, or repair as necessary and retest. If the system fails second test, unit will be rejected and a new unit that will perform as specified, shall be provided.

3.4 MANUFACTURER'S SERVICES

A. Manufacturer's Authorized Representative: Present at Work site or classroom designated by the City for the minimum person-days listed below, travel time excluded:
   1. 2 person-days for installation assistance, inspection, and certification of installation.
   2. 1-1/2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   3. 1/2 person-day for prestartup classroom or Jobsite training of the City's personnel.
   4. 1 person-day for facility startup.
   5. 1 person-day for post-startup training of the City's personnel.

B. Furnish assistance, inspection, testing, and certification services at such times as requested by the Contractor.

C. Furnish training of the City's personnel at such times as requested by the City.

D. See Section 01 43 33, Contractors Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING—GENERAL

PART 1 GENERAL

1.1 REFERENCES

A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
   1. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
   2. American Society of Mechanical Engineer's (ASME):
      a. B1.20.1, Pipe Threads General Purpose (Inch).
      b. B16.3, Malleable Iron Threaded Fittings.
      c. B16.4, Gray Iron Threaded Fittings.
      d. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24.
      e. B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
      f. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
      g. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
      h. B16.24, Cast Copper Alloy Pipe Flanges, and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500.
      i. B31.9, Building Services Piping.
      j. Boiler and Pressure Vessel Code (BPVC), Section I, Rules for Construction of Power Boilers.
      k. Boiler and Pressure Vessel Code (BPVC), Section IX, Welding and Brazing Qualifications.
   3. American Water Works Association (AWWA):
      a. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   4. American Welding Society (AWS):
      a. Brazing Handbook.
      b. Soldering Handbook.
      c. A5.8, Specification for Filler Metals for Brazing and Braze Welding.
      d. D1.1/D1.1M, Structural Welding Code—Steel.
   5. ASTM International (ASTM):
      a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
      b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
      d. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
      e. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
      f. A197/A197M, Standard Specification for Cupola Malleable Iron.
      g. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      h. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

i. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
j. A536, Standard Specification for Ductile Iron Castings.
k. A563, Standard Specification for Carbon and Alloy Steel Nuts.
l. A733, Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Nipples.
m. B32, Standard Specification for Solder Metal.
n. B88, Standard Specification for Seamless Copper Water Tube.
o. B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
p. B813, Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
q. D2000, Standard Classification System for Rubber Products in Automotive Applications.
r. F402, Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.

6. Copper Development Association (CDA): Copper Tube Handbook.
7. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   a. SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
   b. SP-95, Swage (d) Nipples and Bull Plugs.
   c. SP-97, Integrally Reinforced Forged Branch Outlet Fittings—Socket Welding, Threaded, and Buttwelding Ends.
8. National Electrical Manufacturers Association (NEMA).
9. Underwriters Laboratories of Canada (ULC).

1.2 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:
   1. ID: Inside Diameter.
   2. WOG: Water, Oil, Gas.

1.3 SUBMITTALS

A. Action Submittals: Shop Drawings to include the following:
   1. Coordination Drawings: Provide 1:50 scale drawings of mechanical rooms, showing relationship between piping and other trades.
   2. Name of system.
   3. Pipe: ASTM number, grade if known, type, wall thickness, and material.
   4. Fittings: ASTM number, grade if known, class, type, wall thickness, and material.
   5. Joint type.
   6. Flanges: ASTM number, grade, class, type, and material.
   7. Bolt and nut material.
   8. Thread joint sealant material.
   9. Flange gasket material and rating.
   10. Unions: ASTM number, type, material, and rating.
   11. Type of welding.
   12. Paint data sheets.

B. Informational Submittals:
   1. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Contractor Field Services.
   2. Piping Certificates:
      a. Provide manufacturer's piping material certificates (Mill Test Report) for piping systems.
      b. Material certificates shall include dimensions, heat numbers, chemical analysis, and tensile test results for pipe shipped to Site.
   3. Welding Certificates: Copies of Certificates for welding procedures and personnel.
   4. Field test reports; test pressure and media for each piping system.
   5. Cleaning:
      a. Piping system flushing procedures.
      b. Piping system cleaning method.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Piping materials, products and installation shall comply with ASME B31.9, and local codes.
   2. Boiler external piping shall comply with ASME BPVC, Section I.

B. Qualifications:
   1. Welding: Welding processes and operators shall be qualified in accordance with ASME BPVC, Section IX.
   2. Mechanical Grooved Pipe Connections: Field grooving shall be performed by qualified operator, having demonstrated manufacturer's recommended grooving procedures.

C. Manufacturer, pressure class, size, and heat code of each fitting and flange shall be permanently identified on its body in accordance with MSS SP-25.

1.5 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements.

B. Piping:
   1. Free of rust and scale.
   2. Install plastic end caps/plugs on each end of pipe.
   3. Maintain end caps/plugs through shipping, storage, and handling to prevent pipe end damage, and to eliminate dirt and construction debris from accumulating inside of pipe.
      a. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
      b. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
      c. Linings and Coatings: Prevent excessive drying.
      d. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
      e. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

C. Storage:
   1. Where possible, store materials inside and protect from weather.

2. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

PART 2 PRODUCTS

2.1 MATERIALS

A. Piping and Fittings:
1. Refer to Pipe Data Sheet(s), Article Supplements.
2. In accordance with ASME B31.9, as applicable.
3. Unless otherwise indicated, fittings and accessories connected to pipe shall be of same material as pipe.
4. Bullhead tees are not permitted.

B. Piping System Cleaner:
1. Detergent cleaning compound similar to Nalco 2567.
2. Suitable for removal of organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor.
3. Suitable for system metals without deleterious effects.
4. Cleaner shall not contain phosphate.

2.2 COMPONENTS

A. Supports: In accordance with Section 40 05 15, Piping and Cable Tray Support Systems.

B. Insulation: In accordance with Section 40 42 13, Piping Insulation.

C. Heat Tracing: In accordance with Section 40 41 13, Pipe Heat Tracing.

D. Valves: Gate, globe, check, ball, and butterfly valves as specified in Section 40 27 02, Process Valves and Operators.

E. Hydronic Specialties: In accordance with Section 23 21 14, Hydronic Specialties.

F. Grooved Mechanical Pipe Connections:
1. General:
a. Grooved mechanical pipe joint system consisting of pipe couplings, fittings, valves, and other grooved components.
b. Grooved components shall be product of one manufacturer.
2. Application:
a. Pipe Joints: Grooved mechanical joint system may be used as option to pipe welding, threading, or flanged methods where indicated on Piping Data Sheets.
b. Pump Flexible Connectors:
1) Grooved mechanical pipe flexible couplings may be used in lieu of piping flexible connectors.
2) Locate couplings at first three points at pump connection.
3) Not acceptable for in-line pump applications.

3. Components:
   a. Refer to Piping Data Sheet(s) for coupling, fitting and other grooved component requirements.
   b. Refer to Section 40 27 02, Process Valves and Operators, for grooved end valve requirements.
   c. Couplings and fittings shall have enamel coating.
   d. Use full-flow fittings; fabricated or mitered fittings not acceptable.
4. Manufacturers:
   a. Victaulic Co.
   b. Grinnell.
   c. Star Pipe Products.

2.3 ACCESSORIES

A. Vent and Drain Valves:
   1. Pipeline, 50 mm Diameter and Smaller: 12 mm vent, 25 mm drain, unless shown otherwise.
   2. Pipeline, 65 mm Diameter and Larger: 20 mm vent, 25 mm drain, unless shown otherwise.

B. Wells and Tappings:
   1. Pipeline, 50 mm Diameter and Smaller: Use piping tee fitting.
   2. Pipeline, 65 mm Diameter and Larger: Use threadolets or sockolets.

C. Leak Plates:
   1. Provide leak plate welded to pipe at building walls for moisture barrier; consisting of steel plate flange 100 mm larger in outside diameter than pipe.
   2. Locate leak plate at mid-point of pipe passing through wall.
   3. See Section 40 27 01, Process Piping Specialties, for link seal.

D. Threaded Joint Sealants:
   1. Nontoxic, chemically inert, nonhardening rated for minus 45 degrees C to plus 260 degrees C, bearing UL, ULC, CGA, and NSF approvals.
   2. Teflon tapes are not allowed.

E. Flange Gaskets:
   1. Asbestos free and suitable for pressure temperatures and fluid of piping system.
   2. Nonmetallic gaskets in accordance with ASME B16.21.

F. Heat Shrink Wrap:
   1. Type: Cross-linked polyolefin wrap or sleeve with mastic sealant.
   2. Manufacturer and Product: Raychem; WPC or TPS.

G. Corrosion Protection Coatings: Refer to Section 09 90 00, Painting and Coating, for details of coating requirements.

H. Polyethylene Sheet Encasement:
   1. Material: Polyethylene sheet, minimum 8 mils thickness, conforming to AWWA C105.

2. Adhesive Tape:
   a. 50 mm-wide plastic adhesive tape.
   b. Manufacturers and Products:
      1) Clapico Vinyle Tape.
      2) Polyken 900.

2.4 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of pipelines to be connected to new equipment or existing pipe.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

C. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and that coating is undamaged.

3.2 PREPARATION

A. Notify Contract Administrator at least 2 weeks prior to field fabrication of pipe or fittings.

B. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

C. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer’s instructions.

D. Refer to Piping Schedule and Section 09 90 00, Painting and Coating for additional requirements.

3.3 INSTALLATION

A. In accordance with ASME B31.9, and these Specifications.

B. General:
   1. Install piping to allow adequate service space for equipment.
   2. Install vertical piping plumb.
   3. Where interferences develop in field, offset or reroute piping as required to clear such interferences.
   4. Install valves, control valves and piping specialties, including items furnished by others, as specified and detailed.

5. Make connections to equipment installed by others where that equipment requires piping services indicated in this Section.
6. Protect piping from weather and paint promptly to prevent corrosion.
7. Pitch horizontal mains up at 25 mm per 12 m in direction of flow.
8. Provide straight lengths of pipe upstream and downstream of flow measuring devices as required for accurate flow measurement.

C. Piping Expansion: Provide anchors, expansion joints, swing joints and expansion loops so piping may expand and contract without damage to itself, equipment, or building.

D. Aboveground Piping:
1. Group piping wherever practical at common elevations.
2. Install piping to conserve building space and to not interfere with use of space and other work.
3. Run piping parallel to building or column lines and perpendicular to floor, unless shown otherwise.
4. Install piping at such heights not to obstruct any portion of window, doorway, stairway, or passageway.
5. Install piping so no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection.
6. Nonmetallic piping shall not be installed in occupied spaces and ventilation plenum spaces.
7. Piping Clearance (unless otherwise shown):
   a. Over Walkway and Stairs: Minimum of 2.3 m, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   b. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 1 m, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   c. From Adjacent Work: Minimum 25 mm from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   d. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
8. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
9. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

E. Grooved Mechanical Pipe Connections:
1. Use factory grooved pipe in accordance with coupling manufacturer’s specifications or field grooved pipe in accordance with same specifications using specially designed tools available for application.
2. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with coupling manufacturer’s specifications.
3. Support pipe as indicated in Article Hangers and Supports, except as modified below.
4. Support each horizontal pipe section at least once between couplings and whenever change in flow direction takes place.

5. Support vertical pipe at every other floor or every other pipe length, whichever is most frequent.
6. Set base of riser or base fitting on pedestal or foundation.
7. Follow coupling manufacturer's installation recommendations if they are more stringent than above requirements.

F. Fittings:
1. Mitered ells, welded branch connections, notched tees and "orange peel" reducers are not allowed.
2. Unless specifically indicated, reducing flanges and reducing bushings are not allowed, except reducing bushings may be used for air vents and instrumentation connections.
3. Unless otherwise indicated, for upfeed risers use top or top 45-degree connection to main, and for downfeed risers use side or bottom 45-degree connection to main.
4. Do not use mechanically formed tee fittings.

G. Joints:
1. General:
   a. Refer to Piping Data Sheet(s) for acceptable joint methods for each piping system.
   b. Make piping joints in accordance with ASME B31.9 and these Specifications.
2. Preparation:
   a. Ream ends of pipes and tubes and remove burrs.
   b. Bevel plain ends of steel pipe.
   c. Remove scale, slag, dirt and debris from inside and outside of pipe and fittings before assembly.
3. Threaded Joints:
   a. Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.
   b. Cut threads full and clean using sharp dies.
   c. Cut threads so no more than three threads remain exposed after joint is made.
   d. Ream threaded pipe ends to remove burrs and restore full ID.
   e. Apply thread sealants to cleaned male threads.
   f. Assemble joint to appropriate depth and remove excess pipe joint compound from tightened joint.
4. Flanged Joints:
   a. Clean flange surfaces and align flange surfaces parallel.
   b. Select appropriate gasket material, size, type and thickness for service application.
   c. Bolt holes of gaskets shall be cut slightly larger than bolt diameter and gasket ID shall be slightly larger than flange ID.
   d. Position gasket concentrically so compression is equally distributed over entire gasket surface.
   e. Lubricate bolts and run nuts down by hand.
   f. Tighten nuts in proper sequence so gasket is compressed evenly, and to torque specified by bolt manufacturer.
   g. Retorque bolts 12 hours to 24 hours after startup.
5. Welded Joints: Construct joints in accordance with ASME B31.9, using qualified processes and welding operators according to Article Quality Assurance.
6. Soldered Joints:
   a. Construct joints in accordance with AWS, Soldering Handbook or CDA, Copper Tube Handbook.

b. Clean fitting and tube with emery or sand cloth.
c. Remove residue from cleaning operation, apply flux and assemble joint.
d. Use solder to secure joint as specified for specific piping service.

7. Brazed Joints:
   a. Construct joints according to AWS, Brazing Handbook.
   b. Clean fitting and tube with emery or sand cloth.
   c. Remove residue from cleaning operation, apply flux and assemble joint.
   d. Use brazing material to secure joint as specified for specific piping service.
8. Solvent Welded Joints:
   a. Comply with ASTM F402 for safe handling practices of cleaners, primers, and solvent cements.
   b. Clean and dry joining surfaces by wiping with clean cloth and applying primer.
   c. PVC Pressure Piping: Join piping and fittings in accordance with ASTM D2672.

H. Unions and Flanges:
1. Provide at each equipment connection or instrumentation connection to facilitate installation and removal without cutting of piping.
2. Install at each automatic control valve and at each piping specialty or piece of equipment that requires tube pull or removal for maintenance, repair, or replacement.
3. If required, provide additional unions or flanges in order to facilitate removal of piping sections that interfere with tube pulls or equipment removal.
4. Required for line sizes 25 mm and larger.
5. Not required on copper piping with soldered joints for 12 mm and 20 mm line sizes.
6. Where valve is located at piece of equipment, provide flange or union connection on equipment side of valve.
7. Concealed unions or flanges are not allowed.

I. Vents and Drains:
1. Vents and drains that are required for completed piping system may or may not be shown on Drawings.
2. Install vents and drains throughout piping systems to permit complete venting and drainage of entire system.
3. Install drains on low points of pipelines.
4. Install vents on high points of pipelines.
5. If vent is not in accessible location, extend air vent piping to nearest code acceptable drain location with vent valve located at nearest accessible location to pipe.

J. Pipe Size Changes:
1. For proper air venting, use eccentric fittings (top of pipe straight) for changes in horizontal pipe sizes with fittings.
2. Concentric fittings may be used for changes in vertical pipe sizes.
3. Where size of pipe segment is not indicated, pipe segment size shall be equal to largest pipe segment to which it is connected. Transition to smaller size shall occur on side of fitting where smaller size is indicated.

K. Piping Branch Connections:
1. Refer to Piping Data Sheet(s) for branch connection applications.

2. Do not install branch connections smaller than 12 mm nominal pipe size, including instrument connections, unless shown otherwise.
3. Threaded taps in pipe barrel are unacceptable.
4. Materials of branch connections shall match material of piping.

L. Terminal Equipment Connections:
1. Use minimum of three elbows in each pipeline to terminal equipment to provide flexibility for expansion and contraction of piping systems.
2. Main branches and runouts to terminal equipment may be made at top, side, or bottom of main provided there are drain valves located for complete system drainage, and manual air vents are located as described in these Specifications.
3. Size for supply and return piping connections shall be same as for equipment connections.
4. Install control valves in accessible locations close to connected equipment.
5. Install bypass piping with globe valves around control valve. If multiple, parallel control valves are installed, only one bypass is required.
6. Install ports for pressure and temperature gauges at coil inlet connections.

M. Slab, Floor, Wall, and Roof Penetrations: In accordance with Section 40 27 01, Process Piping Specialties.

N. Hangers and Supports: In accordance with Section 40 05 15, Piping and Cable Tray Support Systems.

O. Insulation: In accordance with Section 40 42 13, Piping Insulation.

P. Heat Tracing: Refer Section 40 41 13, Pipe Heat Tracing.

Q. Replacement of existing hot water circulating pumps
1. Refer to drawing SEP-897 for the general location of the existing pumps to be replaced.
2. New pumps shall be installed in approximate location of the corresponding removed pumps, on existing concrete house keeping pad
3. Remove all existing shut off valves, check valves, strainers, balancing valves and fittings associated with each pump and provide new corresponding components meeting the requirements of the specification.
4. Cut back existing pipes and provide new pipe reducers as required for the installation of new pumps, without modifying the configuration of the existing piping layout.

R. Connection to existing piping system
1. Refer to demolition drawings for the scope of demolition work affecting the existing hydronic heating piping system.
2. Coordinate with plant staff and provide labour and materials as required to make provisions for system draining and isolations to facilitate the connections of new piping.
3. Cut back existing insulation at the points of connection and repair all affected existing insulation to match new work after work is complete.

3.4 APPLICATION

A. Piping and Fittings:
   1. Refer to Piping Schedule, Section 40 27 00, Process Piping—General.
   2. When piping of lower pressure connects to piping of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first isolation valve in line carrying the lower pressure, unless otherwise shown.

B. Valves:
   1. In accordance with Section 40 27 02, Process Valves and Operators.
   2. Refer to Drawings for application of each valve type.

3.5 FIELD FINISHING

A. Notify Contract Administrator at least 3 days prior to start of surface preparation or coating application work.

B. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

C. Carbon Steel Pipe:
   1. Above Ground: As specified in Section 09 90 00, Painting and Coatings.
   2. Buried:
      a. Pipe: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coatings.
      b. Joints: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coatings or heat shrink wrap as specified herein.
   3. Submerged or Embedded: Shop coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coatings.

D. Copper Pipe:
   1. Above Ground: As specified in Section 09 90 00, Painting and Coatings.

E. Accessories:
   1. Above Ground:
      a. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
      b. Field paint galvanized and black steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coatings, as applicable for base metal material.

3.6 IDENTIFICATION

A. Aboveground Piping: As specified in Section 09 90 00, Painting and Coatings.

3.7 CLEANING

A. Piping System:
   1. General:
      a. Before installation of piping insulation, wash piping exterior surfaces to remove construction dirt, loose scale, and flux.
      b. Internally clean piping systems before they are used, except conduct pressure test before cleaning.
   2. System Flush:
      a. Flush piping systems with water thoroughly, for 15 minutes or longer, as required to ensure removal of dirt and foreign matter from piping system.
      b. Bypass pumps and equipment, and remove strainers from strainer bodies.
      c. Provide temporary piping or hose to bypass coils, control valves, other factory cleaned equipment, and any component which may be damaged, unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place.
      d. Sectionalize system to obtain minimum velocity of 1.8 meter per second.
      e. Provide temporary piping to connect dead-end supply and return headers as necessary.
      f. Flush bottoms of risers.
   3. System Cleaning:
      a. After initial flushing of system, use portable pumping apparatus for continuous 24-hour, minimum, circulation of cold water detergent.
      b. Add cleaner to closed systems at concentrations as recommended by cleaner manufacturer.
      c. Flush detergent clear with continuous draining and raw water fill for additional 12 hours or until cleaner is removed from system.
      d. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed.
      e. Replace strainers and reconnect permanent pumping apparatus and bypassed apparatus.
      f. Drain cleaning water to sanitary sewer.

B. Water Treatment: Fill and vent systems with proper working fluids, as specified in Section 23 25 00, HVAC Water Treatment.

3.8 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: In accordance with Section 40 80 01, Process Piping Leakage Testing.

B. Required Weld Examinations:
   1. Perform examinations in accordance with ASME B31.9, except that additionally, 5 percent of circumferential butt welds shall be randomly radiographed.
   2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this section.
   3. Examine at least one of each type and position of weld made by each welder or welding operator.

4. Defects:
   a. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in applicable piping standards, examine two additional welds made by same welder that produced defective weld.
   b. Such additional examinations are in addition to the minimum required above.
   c. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

C. Weld Inspection: In accordance with Section 05 05 23, Welding-Quality Assurance.

D. The supplements listed below, following "End of Section," are part of this Specification.
   1. Pipe Data Sheets.
   2. Branch Connection Table.

Section Number	Title
23 21 13.01	Hydronic Piping Schedule.
23 21 13.02	Carbon Steel Pipe and Fittings–Hydronic Water Service

END OF SECTION

SECTION 23 21 13.01

HYDRONIC PIPING SCHEDULE

Legend	Service	Size(s) (mm)	Exposure	Piping Material	Specification Section	Maximum Operating Pressure (kPag)	Test Type	Test Pressure (kPag)	Pipe Colors and Labels	Notes
GS/GR	GLYCOL, SUPPLY/RETURN	ALL	EXP	CS21	23 21 13.02	414	H	1034		
HWS/HWR	HOT WATER, RETURN/SUPPLY	ALL	EXP	CS21	23 21 13.02	414	H	1034		
NG	NATURAL GAS	ALL	EXP	CS02	40 27 00.03	34.5	P	340		
R	REFRIGERANT	ALL	EXP	CU02	23 23 00	NOTE 1	NOTE 1	NOTE 1		

NOTES:
1. REFER TO SECTION 23 23 00, REFRIGERANT PIPING FOR TESTING REQUIREMENT

LEGEND:

Exposure	Pressure Test	Material
BUR Buried	H Hydrostatic	CU01 Copper
EXP Exposed	I In Service	CU02 Copper, Air Conditioning and Refrigeration
SUB Submerged	P Pneumatic	CPVC Chlorinated PVC
ENC Concrete Encased	NA Not Applicable	DI Ductile Iron
		CS02 Carbon Steel

END OF SECTION

SECTION 23 21 13.02 CARBON STEEL PIPE AND FITTINGS–HYDRONIC WATER SERVICE (CS21)		
Item	Size	Description
General	All	Maximum Pressure: 860 kPa; systems with threaded joints. 1206 kPa; systems with Class 125 flanged fittings. 1720 kPa; systems with Class 150 flanged fittings. 2757 kPa; systems with Class 250 flanged fittings or welded joints.
		Maximum Temperature: 121 degrees C.
		Not for steam or steam condensate service.
Pipe	All	Do not use Type F ASTM A53 carbon steel.
	All	Pipe with threaded joints, pressure greater than 690 kPa and temperature greater than 104 degrees C: Carbon steel, ASTM A106 (seamless), Grade B; XS weight (Schedule 80).
	50 mm & smaller	Carbon steel, ASTM A106 (seamless), Grade B or ASTM A53/A53M, Grade B, Type E or Type S; STD weight (Schedule 40).
	65 mm through 250 mm	Carbon steel, ASTM A53/A53M, Grade B, Type E or Type S; STD weight (Schedule 40).
	300 mm through 600 mm	Carbon steel, ASTM A53/A53M, Grade B, Type E or Type S; STD weight (10 mm wall thickness).
Pipe Nipples	50 mm & smaller	Carbon steel, ASTM A106 (seamless), Grade B. Dimensions to ASTM A733. Wall thickness to match adjoining pipe.
Swage Nipples	12 mm – 100 mm	Carbon steel, ASTM A234/A234M Grade WPB. Dimensions to MSS SP-95. Wall thickness to match adjoining pipe. Threaded ends not to exceed 50 mm NPS.
Joints	50 mm & smaller	Threaded: General Purpose (American), ASME B1.20.1. Socket Welded; AWS D1.1/D1.1M and ASME BPVC, Section IX. Flanged/Union: At valves and equipment, as required.

SECTION 23 21 13.02 CARBON STEEL PIPE AND FITTINGS–HYDRONIC WATER SERVICE (CS21)		
Item	Size	Description
	65 mm & larger	Butt welded; AWS D1.1/D1.1M and ASME BPVC, Section IX. Flanged: At valves and equipment.
Fittings	50 mm & smaller	Threaded: Malleable Iron Class 150 or Class 300, ASME B16.3, or Cast Iron Class 125 or Class 250, ASME B16.4.
	65 mm & larger	Butt Welded: Wrought carbon steel, ASTM A234/A234M, Grade WPB; meeting requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
Unions	50 mm & smaller	Threaded: Malleable iron, ASTM A197/A197M or ASTM A47/A47M, Class 150, Class 250, or Class 300, meeting requirements of ASME B16.3.
Flanges	50 mm & smaller	Socket-Weld or Threaded: Forged carbon steel, ASTM A105/A105M, Grade II, ASME B16.5, Class 150 or Class 300, 1.5 mm raised face.
	65 mm & larger	Butt-Welded: Forged carbon steel, ASTM A105/A105M, ASME B16.5, Class 150 or Class 300 slip-on or welding neck, 1.5 mm raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings.
Branch Connections	All	Full sized Fittings or Branch Connection Forgings, as indicated in Branch Connection Table. Fittings: See Fittings, this table. Branch Connection Forgings: Forged carbon steel, same material and weight/schedule as adjoining pipe, ASME B16.9 and MSS SP-97.
Couplings	50 mm & smaller	Threaded: Malleable iron, ASTM A197/A197M or ASTM A47/A47M.
	65 mm & larger	Grooved End: Rigid joint malleable iron, ASTM A47/A47M or ductile iron, ASTM A536 Grade 65-45-12 and ASTM A395 Grade 65-45-15.
Bolting	All	Flanges: Carbon steel ASTM A307, Grade A hex head bolts, and ASTM A563 Grade A hex head nuts.

SECTION 23 21 13.02 CARBON STEEL PIPE AND FITTINGS–HYDRONIC WATER SERVICE (CS21)		
Item	Size	Description
Gaskets	All	Flanges: 1.5 mm thick, compressed inorganic fiber with nitrile binder, rated to 371 degrees C and 6900 kPa.
Thread Sealant	50 mm & smaller	Teflon based paste type; tapes are not allowed.

BRANCH CONNECTION TABLE

	HEADER NOMINAL SIZE																	
SIZE	12	80	25	40	50	65	75	100	150	200	250	300	350	400	450	500	600	SIZE
	T	TR	TR	TR	TR	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	13
		T	TR	TR	TR	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	20
			T	TR	TR	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	25
				T	TR	TR	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	40
					T	TR	TR	TH	TH	TH	TH	TH	TH	TH	TH	TH	TH	50
						T	TR	TR	W	W	W	W	W	W	W	W	W	65
							T	TR	TR	W	W	W	W	W	W	W	W	75
								T	TR	TR	W	W	W	W	W	W	W	100
									T	TR	TR	W	W	W	W	W	W	150
										T	TR	TR	TR	W	W	W	W	200
											T	TR	TR	TR	TR	W	W	250
												T	TR	TR	TR	TR	W	300
													T	TR	TR	TR	TR	350
														T	TR	TR	TR	400
															T	TR	TR	450
																T	TR	500
																	T	600

BRANCH NOMINAL SIZE

LEGEND

S = STUB-ON, PLAIN

SO = SOCKOLET (NOTE 2)

TH = THREDOLET

T = FULL SIZED TEE

TR = REDUCING TEE, W/ SWAGE OR REDUCER IF REQUIRED

W = WELDOLET

NOTES

1. REINFORCE AS REQUIRED BY ASME B31.1
2. THREADOLETS ARE REQUIRED FOR TEMPERATURE, INSTRUMENT, AND SAMPLE CONNECTIONS

END OF SECTION

SECTION 23 21 14

HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 REFERENCES

A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
   1. American National Standards Institute (ANSI).
   2. American Society of Mechanical Engineers (ASME).
      a. B15.1, Safety Standard for Mechanical Standard Transmission Apparatus.
      b. B40.100 Pressure Gauges and Gauge Instruments
      c. B40.200, Thermometers, Direct Reading and Remote Reading.
      d. BPVC Section VIII, Rule for Construction of Pressure Vessels.
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   4. National Electrical Manufacturers Association (NEMA):
      a. MG 1-12.53a, Motors and Generators.
      b. NEMA 250.
   5. Occupational Safety and Health Act (OSHA).
   6. Canadian Standard Association: CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
   7. Underwriters Laboratories of Canada (ULC).

1.2 SUBMITTALS

A. Action Submittals:
   1. Provide for products specified, as follows:
      a. Identify as referenced in Contract Documents.
      b. Manufacturer’s name and model number.
      c. Descriptive specifications, literature and drawings.
      d. Dimensions and weights.
      e. Pump Curves:
         1) Performance Curves Indicating:
            a) Relationship of flow rate to static pressure for various pump speeds.
            b) Brake horsepower curves.
            c) Acceptable selection range.
            d) Static pressure, capacity, horsepower demand and overall efficiency required at the duty point.
      f. Capacities and ratings.
      g. Construction materials.
      h. Pump type, size, drive arrangement, and bearings.
      i. Impeller type, diameter.
      j. Motor data.
      k. Power and control wiring diagrams, including terminals and numbers.

l. Vibration isolation.
m. Factory finish system.
n. Color selection charts where applicable.
o. Corrosion protection coating product data.

2. Where submitted equipment results in change to piping and equipment configuration shown on Drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

B. Informational Submittals:
1. Recommended procedures for protection and handling of equipment and materials prior to installation.
2. Manufacturer's installation instructions.
3. Manufacturer's Certificate of Compliance in accordance with Section 01 43 33, Contractor Field Services, for energy efficient motors.
4. Test reports.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data ; including as-built version of equipment schedules.
6. Certification of concentration of glycol solution.

1.3 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, and materials:

Item		Quantity
Pressure gauge		Two in appropriate range
Temperature gauge		Two in appropriate range

PART 2 PRODUCTS

2.1 EQUIPMENT SCHEDULES

A. Refer to Article Supplements.

2.2 EQUIPMENT

A. Expansion Tank:
1. Heavy-duty butyl rubber diaphragm type.
2. Steel tank designed and constructed per ASME Section VIII, Division 1 rated for 115 degrees C working temperature and 860 kPa working pressure.
3. Performance and Capacities: Refer to Equipment Schedule.
4. Manufacturers and Product:
a. Amtrol; Extrol Diaphragm Series.
b. ITT/Bell & Gossett; Series, Diaphragm.
c. Taco; CX Diaphragm Series.

B. Balance Fitting and Flow Indicator, Lines 100 mm and Smaller:
1. Bronze body, brass ball, and carbon filled TFE seat rings.
2. Screwdriver or hand adjusted ball valve.

3. Graduated dial indicator.
4. Line size.
5. Integral valved readout ports.
6. Adjustable memory stop.
7. Drain connection.
8. Manufacturers and Products:
   a. ITT/Bell & Gossett; Type CB Circuit Setter Plus.
   b. Taco; ACUF Series Accu-Flo.
   c. S.A. Armstrong; Type CBV.

C. Balance Valve With Pressure Taps, Lines Greater than 100 mm:
1. Eccentric plug valves.
2. Nonlubricated type.
3. Wrench lever manual operators for valves 150 mm and smaller.
4. Totally enclosed, geared, manual handwheel operators for valves 200 mm and larger.
5. Class 150 WOG minimum rating.
6. Cast iron body with flanged ends.
7. Balanced plug coated with EPDM elastomer.
8. Buna-Vee packing or Teflon-Graphite.
9. Stainless steel bearings.
10. Nickel- or epoxy-coated seats.
11. Gauge connections (for flow balancing and measurement) equipped with shutoff cocks.
12. Flanges to meet Class 125 ANSI Standard.
13. Manufacturers and Products:
   a. ITT/Bell & Gossett; Type CB Circuit Setter.
   b. DeZurik; Series 100, Figure 118.
   c. S.A. Armstrong; Type CBV.

D. Pressure and Temperature Test Plug:
1. Brass body.
2. 6 mm NPT.
3. Removable threaded brass protective cap.
4. Dual Nordel core rated for 93 degrees C.
5. Manufacturers and Products:
   a. Sisco; Model BNO.
   b. MG Piping Products; Model PT.
   c. Peterson Equipment Co.; Pete’s Plugs.

E. Bimetallic Industrial Thermometer:
1. Precision calibrated bimetallic sensing element.
2. Silicone dampened coil.
3. Adjustable angle type with swivel union connection.
4. 125mm diameter face.
5. Hermetically sealed stainless steel case.
6. Weatherproof case when thermometer will be located in exterior location.
7. Double strength glass window.
8. External recalibrator.

9. Stem:
    a. Stainless steel.
    b. Length as recommended by manufacturer for pipe or duct size and insulation thickness at installed thermometer location.
10. When installed in piping, install with thermowell furnished by same manufacturer as thermometer.
11. When installed in ductwork, install with mounting flange and adapter hub furnished by same manufacturer as thermometer.
12. Maximum 1 degree per scale division of Celsius scale.
13. Accurate to plus or minus 1 percent of full scale in accordance with ASME B40.200.
14. Fahrenheit and Celsius scales.
15. Heating Hot Water System Range: minus 10 degrees C to 115 degrees C
16. Potable Hot Water System Range: minus 20 degrees C to 95 degrees C
17. Ranges for other uses not listed shall be selected so system operating temperature range falls approximately in the middle of the scale range
18. Manufacturers and Products:
    a. H. O. Trerice; B8.
    b. Ashcroft.
    c. Weksler Glass Thermometer Company.

F. Pressure Gauge:
1. Bourdon tube sensing element.
2. Range:
    a. 0 to 693 kPa
    b. Indelibly mark ranges with black figures on a white background.
3. Connection: 0.25 inch male NPT.
4. Case:
    a. Painted steel, stainless steel, fiberglass reinforced polypropylene, or aluminum.
    b. Weatherproof case when gauge will be located in exterior location.
5. Wetted Parts: Bronze, brass, stainless steel, or monel.
6. Ring: Stainless steel or fiberglass reinforced polypropylene.
7. Window: Acrylic or glass.
8. Dial Face:
    a. 100mm diameter, minimum.
    b. White with black figures.
9. Accuracy: Plus or minus 1 percent of full scale in accordance with ASME B40.100.
10. Temperature Rating: 121 degrees C, minimum.
11. Manufacturers:
    a. H. O. Trerice.
    b. Ashcroft.
    c. Weksler.

G. Air Separator, 40 mm and Smaller:
1. Full-line size.
2. Cast iron body.
3. Integral weir design.
4. Manufacturers and Products:
    a. ITT/Bell & Gossett; IAS in-line air separator.

b. Taco; VorTech.

H. Air Separator, 50 mm and Larger:
1. Full-line size, without strainer.
2. Tangential construction.
3. Steel tank with stainless steel collector tube.
4. ASME constructed for 860 kPa operating pressure.
5. Blowdown connection.
6. Manufacturers and Products:
   a. ITT/Bell & Gossett; Rolairtrol.
   b. Taco; Air Separator.
   c. Spirotherm; Spirovent.

I. Automatic Air Vent: Brass body with nonferrous internals.
1. Manufacturers and Products: For 1034 kPa maximum operating pressure and 115 degrees C maximum operating temperature.
   a. ITT/Hoffman Specialty; No. 78.
   b. ITT/Bell & Gossett; No. 87.
2. Manufacturers and Products: For 240 kPa maximum working pressure and 110 degrees C maximum operating temperature.
   a. ITT/Hoffman Specialty; No. 79.
   b. ITT/Bell & Gossett; No. 67.

J. Manual Air Vents: Brass body with nonferrous internals.
1. Maximum Operating Pressure: 1034 kPa.
2. Maximum Operating Temperature: 107 degrees C.
3. Manufacturer and Product: ITT/Bell & Gossett; No. 4V.

K. Pressure Relief Valve:
1. ASME rated.
2. Bronze body.
3. EPDM diaphragm.
4. Maximum Operating Temperature: 121 degrees C.
5. Maximum Operating Pressure: 860 kPag.
6. Relief Pressure: 207 kPag.
7. Manufacturers and Products: ITT/Bell & Gossett; Type 790 or 1170.

L. Radiator Valves:
1. Manufacturers:
   a. ITT/Hoffman Specialty.
   b. Danfoss.

M. Pressure Reducing Valve:
1. 20 mm cast iron body.
2. Brass mounted.
3. Integral strainer and antisiphon check valve.
4. Factory Pressure Setting: 83 kPa with adjustable range of 55 kPag to 170 kPag.

5. Manufacturers and Products:
    a. Taco; No. 329 or No. 335.
    b. Armstrong; Model RD.

N. Strainers:
1. Y-type.
2. Body: Class 125 cast iron.
3. 50 mm and Smaller: Screwed ends and screwed face cap.
4. 65 mm and Larger: Flanged ends with bolted end cover and blowdown connection.
5. Screen:
    a. Type 316 stainless steel.
    b. Free Area: Minimum of 2-1/2 times inlet area with 5 mm perforations.
6. Manufacturers:
    a. Armstrong.
    b. Keckley.
    c. Spirax Sarco.

O. Suction Diffuser:
1. Body: 1206 kPag working pressure, cast iron.
2. Inlet straightening vanes with length no less than 2-1/2 times pump suction diameter.
3. Stainless steel combination diffuser-strainer-orifice cylinder with total free area equal to or greater than five times the cross-sectional area of pump suction; designed to withstand pressure differential equal to pump shutoff head.
4. Disposable 16-mesh start-up strainer.
5. Permanent magnet located in flow stream, removable for cleaning.
6. Adjustable foot support designed to carry weight of suction piping.
7. Blowdown tapping in bottom, gauge tapping in side.
8. Manufacturers and Products:
    a. ITT/Bell & Gossett; Suction Diffuser.
    b. Taco; SD.

P. Piping Flexible Connectors:
1. Spherical connector.
2. Twin sphere.
3. Precision molded of multiple layers of Kevlar cord and EPDM cover.
4. Rated 1206 kPa at 93 degrees C.
5. 50 mm and Smaller: Threaded union end connections.
6. 65 mm Inches and Larger: Steel or cast iron flanges.
7. Manufacturers and Products:
    a. Mason; Safeflex.
    b. Metraflex; Metrasphere.

Q. Dielectric Isolators:
1. Isolators:
    a. Glass fiber reinforced nylon insulating bushings where size reduction is required.
    b. Two insulating bushing in oversized couplings where size reduction is not required.
2. Unions: Nylon insulated metal unions.

3. Insulating Sets:
   a. Combination sleeve, washer, and full-face neoprene gasket flange at flange joints.
   b. Drill flange holes oversize and use standard size bolts, with double insulation on bolts so each bolt is insulated from both flanges.
4. Temperature Rating: 98 degrees C.

R. Automatic Glycol Feed System:
1. General:
   a. Monitor hydronic system pressure. When hydronic system pressure drops below a set pressure indicating loss of fluid, feed system shall pump glycol solution into hydronic system as required to bring hydronic system pressure back to pressure setpoint.
   b. System shall be fully automatic with one pump for each hydronic loop served, controls, glycol tank, stand and all other devices as required for a complete and functional stand alone system.
2. Single loop system.
3. Tank:
   a. Industrial grade polyethylene storage tank with cover.
   b. Size: 189 litres, minimum.
4. Stand: Painted steel.
5. Pump: One for each hydronic system served, each rated at minimum 0.08 L/s at 690 kPa.
6. Drain valve.
7. Y-type strainer at each pump inlet and check valve at each pump outlet.
8. Pump isolation valves.
9. Pressure gauge for each hydronic system served.
10. Pressure Relief Valve:
    a. Provide with recirculation piping for each hydronic system served.
    b. Relief Pressure: 200 kPa.
11. System working pressure at glycol makeup connection 100 kPag.
12. Controls:
    a. NEMA 4X control panel enclosure.
    b. Factory prewired.
    c. Low tank level cutoff switch that prevents pump operation when tank level is low with dry contact for low tank level alarm.
    d. Adjustable pressure switch for each hydronic system served. Cut in, cut out, and pressure differential as required for system to function effectively at system pressure specified.
    e. Main power switch and ON light.
    f. HAND/OFF/AUTO switch for each pump.
    g. Low level alarm indicating light.
13. Single point power connection.
14. Voltage: 115 volt, 60 Hz.
15. Manufacturers and Products:
    a. Advantage Controls; Model AGF.
    b. Neptune; Model G-50.
    c. J. L. Wingert; Model GL50.

S. Glycol Fluid:
   1. Premix 50 percent solution of propylene glycol and water, with corrosion inhibitors.
   2. Dilution water per manufacturer's recommendations.
   3. Manufacturers and Products:
      a. DOW; Dowfrost HD.
      b. STA-Clean Products; STA-Clean Antifreeze.

T. Hydronic Pumps, In-Line Mounted:
   1. Centrifugal type.
   2. Resiliently mounted horizontal or vertical motor, as scheduled.
   3. Cast iron pump casing fitted with companion flanges for line mounting.
   4. Gauge tappings.
   5. Cast iron construction.
   6. Shaft Seal: Mechanical seal.
   7. Rating: 1206 kPag working pressure.
   8. Performance and Capacities: Refer to Equipment Schedule.
   9. Manufacturers and Products:
      a. ITT/Bell & Gossett; Series 80.
      b. Taco.
      c. Paco.

U. Hydronic Pumps, Base Mounted:
   1. Centrifugal type.
   2. Flexible coupling drive.
   3. Steel base mounted, with anchor bolts and template.
   4. Vertical split-case end suction construction.
   5. Bronze fitted. Cast iron construction.
   6. Renewable bronze wear rings.
   7. Mechanical shaft seal.
   8. Oil-lubricated ball bearings.
   9. Bearings and impeller removable without disturbing piping.
   10. Bearing assembly interchangeable with several pump sizes.
   11. Removable coupling shield compliant with ASME B15.1, Section 8.
   12. Rating: 860 kPag working pressure.
   13. For pumps controlled through a variable speed drive, select pump with no natural frequency between 50 percent and 100 percent of operating range.
   14. Performance and Capacities: Refer to Equipment Schedule.
   15. Manufacturers and Products:
      a. ITT/Bell & Gossett; Series 1510.
      b. Armstrong; Series 4030.
      c. Taco; Model FE.
      d. Paco; Type L.

2.3 MOTORS

A. General:
   1. Pump motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction Motors.
   2. Provide integral self-resetting overload protection on single-phase motors.
   3. Motors for pumps specified for use with variable frequency drives shall be inverter-duty type.
   4. Motors shall not operate into service factor.

B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:
   1. Horsepower, Voltage, and Phase: As scheduled.
   2. Enclosure: As scheduled.
   3. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
   4. Winding Thermal Protection: None.
   5. Space Heater: None.
   6. Number of Speeds: Single.
   7. Number of Windings: One.
   8. Motor Efficiency: Premium efficient.
   9. Shaft Type: Solid, carbon steel.
   10. Oil-lubricated ball bearings.
   11. Mounting: As required for pump arrangement.
   12. Service Factor: 1.15.

2.4 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 13 mm minimum diameter, and as specified in Section 05 50 00, Metal Fabrications (Basic). Coat in accordance with Section 09 90 00, Painting and Coating.

2.5 FINISHES

A. Manufacturers' standard.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Expansion Tank:
   1. Secure tank to structure.

2. Charge to required system pressure.

B. Balancing Devices:
1. Install balancing devices with unrestricted flow and straight pipe for four pipe diameters up and downstream.
2. Provide balancing devices as shown on the drawings.

C. Instrumentation furnished under other sections:
1. Install well tappings and fittings for control sensors furnished under other sections.

D. Pressure and temperature test plugs:
1. Provide pressure and temperature test plugs at the following locations, unless pressure gauges and thermometers are provided:
   a. Inlet and outlet to hydronic coils.
   b. Both sides of pumps.
   c. Both sides of control valves.
   d. Both sides of heat exchangers.
   e. Expansion tanks.

E. Air Vents:
1. Automatic Air Vents:
   a. Install at air separators.
   b. With 20 mm shutoff valve with 12 mm Type L copper drain line to nearest receptor.
2. Manual Air Vents: Install at high side of coils and at high points of chilled water, condenser water, heating hot water piping system.

F. Separators:
1. Install as indicated on Drawings.
2. Secure to structure.
3. Remove and clean system strainer after 24 hours of operation and after 30 days of operation.

G. Valves:
1. Locate and orient so handles are readily accessible.
2. Orient stems vertically in horizontal runs of pipe having centerline elevations 1.4 m or less above finished floor, unless otherwise noted.
3. Orient stems horizontally in horizontal runs of pipe having centerline elevations above 1.4 m above finished floor, unless otherwise noted.

H. Strainers:
1. Install on upstream side of automatic valves, pressure-reducing valves, suction side of pumps, and elsewhere as indicated.
2. Where installed in equipment rooms, provide valved blowout connection piped to nearest drain.
3. Where installed at pump mains, provide 16-gauge bronze start-up strainer. Remove start-up strainer after system flush and prior to balancing.
4. Remove and clean system strainers after 24 hours of operation and after 30 days of operation.

I. Suction Diffusers: Provide 16-gauge bronze startup strainer. Remove startup strainer after system flush and prior to balancing.

J. Flexible Connectors: Install at pumps, chillers, air-handling units, equipment on vibration isolators, and at building seismic joints.

K. Dielectric Isolators: Install where incompatible piping materials, except for bronze valves and strainers, come into contact with each other.

L. Automatic Glycol Feed Systems:
   1. Install in compliance with manufacturer's written instructions.
   2. Coordinate with other trades as required for power and control wiring.
   3. Install with access as required for normal operation and as required to service parts.

M. Glycol Fluid:
   1. Fill the following hydronic systems:
      a. Heating water.
      b. Heat recovery runaround loop.
   2. After hydronic systems have been completely filled with specified glycol solution, provide full tank of gylcol solution specified.

N. In-Line Mounted Pumps: Support pumps separately from piping.

O. Base Mounted Pumps:
   1. Install in accordance with manufacturer's written instructions.
   2. Concrete Bases:
      a. Mount pump and driver on existing concrete base.
      b. Anchor securely in place.
   3. Leveling Pump Base:
      a. Level base using steel wedges (steel plates and steel shims).
      b. Wedge Taper: Maximum 1:50.
      c. Use double wedges to provide level bearing surface for pump and driver base.
      d. Secure each pair of wedges in their final positions with one tack weld on each side after leveling is complete.
      e. Prevent change of level or springing of baseplate when anchor bolts are tightened.
   4. Pump Assembly Adjustments:
      a. Align, plumb, and level driving units with driven units and interconnecting shafts and couplings.
      b. Flexible couplings shall not compensate for misalignment.
      c. Eliminate strain from attaching piping to pumps.
      d. Correct pump or driver misalignment, noisy operation, or other signs of improper setting.
   5. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation.
   6. Connection to existing piping system:
      a. Location pumps to align with existing pipes
      b. Provide labour and materials as required for complete installation of pumps into the existing pipes

c. Provide new insulation and jacketing to match existing.

P. Thermometer:
1. Install in strict accordance with manufacturer's recommendations.
2. Install in location that allows easy access for reading thermometer in safe fashion.
3. When located in piping install with a thermowell and heat transfer gel.

Q. Pressure Gauge:
1. Install in strict accordance with manufacturer's recommendations.
2. Install in location that allows easy access for reading gauge in safe fashion.

3.2 ACCESS AND CLEARANCE CONSIDERATIONS

A. Obstructions: Drawings do not attempt to show exact details of piping. Anticipate and work around obstructions.

B. Cover piping installed across aisles or other main access walkways with a protective checkered plate steel ramp, pitched a maximum of 2:12 to allow safe wheeled or foot traffic, and paint with a prime coat and two finish coats of Safety Yellow. Support ramp from floor and do not rest ramp directly on pipe.

C. Install specialties with suitable access clearances for maintenance or removal of replaceable components. Provide necessary couplings or flanges to maintain or remove specialties without removing connecting appurtenances.

D. Do not install water or steam piping immediately over or within a 900 mm horizontal clearance of any electrical panel, motor starter, or environmental control panel (ECP). Where piping is located within these zones, install piping inside a PVC conduit or shield electrical device to protect it from direct water access.

E. Provide an alternate safe means of access where equipment requiring periodic maintenance cannot be reached by walkways because of substitution of equipment or interference with ductwork, piping, or other mechanical conflicts resulting from construction. These may include:
1. Overhead platform with stairway or ladder access and safety railings or handholds.
2. Walk-through duct plenums with hinged access doors.
3. Other means as necessary to meet OSHA standards for safe maintenance procedures.

3.3 CLEANING AND ADJUSTING

A. Cleanup:
1. Thoroughly clean parts of the installation and remove refuse material at completion of the Work.
2. Check belt-drive tensions and alignments.
3. Lubricate motors and bearings in accordance with manufacturer's service manuals prior to equipment startup.

B. Repair Work: Perform repair work of existing facilities affected by mechanical work performed under this Section. Include such items as:
   1. Replacement of ceiling tiles or plaster removed or damaged for access to ceiling.
   2. Patching walls and ceilings for piping and ductwork penetrations.
   3. Repair of concrete or asphalt paving removed for pipe access.
   4. Other repairs due to extension and remodeling of existing mechanical systems.

3.4 SUPPLEMENTS

A. The supplements listed below following “End of Section” are a part of this Specification.
   1. 23 21 14.01, Hydronic Pumps.
   2. 23 21 14.02, Hydronic Expansion Tank

END OF SECTION

HYDRONIC PUMPS							**23 21 14.01**
SYMBOL				P-G660	P-G661	P-G655	P-G666
SERVICE				GRIT & SCRN. FACIL HTG. CIRC. PUMP	GRIT & SCRN. FACIL HTG. CIRC. PUMP	GLYCOL HTG. CIRC. PUMP	GLYCOL HTG. CIRC. PUMP
TYPE				INLINE MOUNTED	INLINE MOUNTED	INLINE MOUNTED	INLINE MOUNTED
PUMP DATA	CAPACITY		L/s	31.87	31.87	32.05	32.05
	HEAD		m	15.24	15.24	23.47	23.47
	MAXIMUM POWER		kW	6.96	6.96	11.69	11.69
	FLUID	TYPE		WATER	WATER	PROPYLENE GLYCOL	PROPYLENE GLYCOL
		CONC.	%	100	100	50	50
	MIN. EFF.		%	73.6	73.6	68.9	68.9
	NPSH		m	-	-	-	-
MOTOR DATA	RATED POWER		kW	7.46	7.46	14.92	14.92
	SPEED		RPM	1800	1800	1800	1800
	VOLT			575	575	575	575
	PH			3	3	3	3
	ENCLOSURE			TEFC	TEFC	TEFC	TEFC
MAX WEIGHT	kg			218	218	306.0	306.0
MANUFACTURER				ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT
MODEL NO.				4x4x9.5B Series e-80SC	4x4x9.5B Series e-80SC	4x4x11B Series e-80SC	4x4x11B Series e-80SC
APPLICABLE REMARKS:				A/E	A/E	A/E	A/E

REMARKS:

A: MOTOR CONTROL: MAGNETIC MOTOR STARTER, INSTALLED IN DIV 26 MOTOR CONTROL CENTER (MCC)
B: MOTOR CONTROL: MAGNETIC MOTOR STARTER, WALL MOUNTED
C: MOTOR CONTROL: ADJUSTABLE FREQUENCY DRIVE, INSTALLED IN DIVISION 26 MCC
D: MOTOR CONTROL: ADJUSTABLE FREQUENCY DRIVE, WALL MOUNTED
E: BRONZE FITTED

HYDRONIC PUMPS							**23 21 14.01**
SYMBOL				P-G674	P-G677	P-G678	P-S664
SERVICE				HEAT RECOVERY CIRC. PUMP	ELEC. RM. CLG. CONDENSER WATER PUMP	ELEC. RM. CLG. CONDENSER WATER PUMP	HEAT RECOVERY CIRC. PUMP
TYPE				INLINE MOUNTED	INLINE MOUNTED	INLINE MOUNTED	INLINE MOUNTED
PUMP DATA	CAPACITY		L/s	10.35	4.81	4.81	10.02
	HEAD		m	20.12	6.40	6.40	25.91
	MAXIMUM POWER		kW	4.48	0.59	0.59	5.75
	FLUID	TYPE		PROPYLENE GLYCOL	WATER	WATER	PROPYLENE GLYCOL
		CONC.	%	50	100	100	50
	MIN. EFF.		%	65.33	72.1	72.1	62.38
	NPSH		m	-	-	-	-
MOTOR DATA	RATED POWER		kW	5.60	1.12	1.12	7.46
	SPEED		RPM	1800	1800	1800	1800
	VOLT			575	575	575	575
	PH			3	3	3	3
	ENCLOSURE			TEFC	TEFC	TEFC	TEFC
MAX WEIGHT	kg			145	27	27.0	195.0
MANUFACTURER				ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT
MODEL NO.				2.5x2.5x9.5C Series e-80SC	2AAB Series e-90	2AAB Series e-90	3x3x11B 80-SC
APPLICABLE REMARKS:				A/E	A/E	A/E	A./E.

REMARKS:

A: MOTOR CONTROL: MAGNETIC MOTOR STARTER, INSTALLED IN DIV 26 MOTOR CONTROL CENTER (MCC)
B: MOTOR CONTROL: MAGNETIC MOTOR STARTER, WALL MOUNTED
C: MOTOR CONTROL: ADJUSTABLE FREQUENCY DRIVE, INSTALLED IN DIVISION 26 MCC
D: MOTOR CONTROL: ADJUSTABLE FREQUENCY DRIVE, WALL MOUNTED
E: BRONZE FITTED

HYDRONIC PUMPS							**23 21 14.01**
SYMBOL				P-K660	P-K661	P-K665	P-K666
SERVICE				HRC FACIL SECONDARY	HRC FACIL SECONDARY	GLYCOL HEATING CIRC. PUMP	AHUs HEATING COILS
TYPE				INLINE MOUNTED	INLINE MOUNTED	INLINE MOUNTED	INLINE MOUNTED
PUMP DATA	CAPACITY		L/s	16.66	16.66	15.08	15.08
	HEAD		m	18.29	18.29	15.85	15.85
	MAXIMUM POWER		kW	4.93	4.93	4.0284	4.03
	FLUID	TYPE		WATER	WATER	PROPYLENE GLYCOL	PROPYLENE GLYCOL
		CONC.	%	100	100	50	50
	MIN. EFF.		%	70.97	70.97	69.04	69.04
	NPSH		m	-	-	-	-
MOTOR DATA	RATED POWER		kW	5.60	5.60	5.60	5.60
	SPEED		RPM	1800	1800	1800	1800
	VOLT			575	575	575	575
	PH			3	3	3	3
	ENCLOSURE			TEFC	TEFC	TEFC	TEFC
MAX WEIGHT	kg			157	157	156.8	156.8
MANUFACTURER				ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT
MODEL NO.				3x3x9-1/2B Series e-80SC	3x3x9-1/2B Series e-80SC	3x3x9-1/2B Series e-80SC	3x3x9-1/2B Series e-80SC
APPLICABLE REMARKS:				A./E.	A./E.	A./E.	A./E.

REMARKS:

A: MOTOR CONTROL: MAGNETIC MOTOR STARTER, INSTALLED IN DIV 26 MOTOR CONTROL CENTER (MCC)
B: MOTOR CONTROL: MAGNETIC MOTOR STARTER, WALL MOUNTED
C: MOTOR CONTROL: ADJUSTABLE FREQUENCY DRIVE, INSTALLED IN DIVISION 26 MCC
D: MOTOR CONTROL: ADJUSTABLE FREQUENCY DRIVE, WALL MOUNTED
E BRONZE FITTED

HYDRONIC PUMPS							**23 21 14.01**
SYMBOL				P-B671	P-B672	P-B673	P-B674
SERVICE				PRIMARY LOOP CIRCULATING PUMP	PRIMARY LOOP CIRCULATING PUMP	PRIMARY LOOP CIRCULATING PUMP	PRIMARY LOOP CIRCULATING PUMP
TYPE				BASE MOUNTED	BASE MOUNTED	BASE MOUNTED	BASE MOUNTED
PUMP DATA	CAPACITY		L/s	64.98	64.98	43.03	43.03
	HEAD		m	18.29	18.29	12.20	12.20
	MAXIMUM POWER		kW	13.52	13.52	13.47	13.47
	FLUID	TYPE		WATER	WATER	WATER	WATER
		CONC.	%	100	100	100	100
	MIN. EFF.		%	86.94	86.94	83.67	83.67
	NPSHR		m	-	-	-	-
MOTOR DATA	RATED POWER		kW	14.92	14.92	14.92	14.92
	SPEED		RPM	1800	1800	1800	1800
	VOLT			575	575	575	575
	PH			3	3	3	3
	ENCLOSURE			TEFC	TEFC	TEFC	TEFC
MAX WEIGHT	kg			304	304	304	304
MANUFACTURER				BELL & GOSSETT	BELL & GOSSETT	BELL & GOSSETT	BELL & GOSSETT
MODEL NO.				5BD e-1510, 256T	5BD e-1510, 256T	5BD e-1510, 256T	5BD e-1510, 256T
APPLICABLE REMARKS:				A./E.	A./E.	A./E.	A./E.

REMARKS:

A: MOTOR CONTROL: MAGNETIC MOTOR STARTER, INSTALLED IN DIV 16 MOTOR CONTROL CENTER (MCC)
B: MOTOR CONTROL: MAGNETIC MOTOR STARTER, WALL MOUNTED
C: MOTOR CONTROL: ADJUSTABLE FREQUENCY DRIVE, INSTALLED IN DIVISION 16 MCC
D: MOTOR CONTROL: ADJUSTABLE FREQUENCY DRIVE, WALL MOUNTED
E: BRONZE FITTED

HYDRONIC EXPANSION TANK						**23 21 14.02**
SYMBOL			V-G674	V-G663	V-K663	V-S663
TYPE			DIAPHRAGM	DIAPHRAGM	DIAPHRAGM	DIAPHRAGM
SERVICE			GLYCOL HEATING	GLYCOL HEATING	GLYCOL HEATING	GLYCOL HEATING
MINIMUM TANK VOLUME		L	30.3	340.7	82.1	30.3
MINIMUM ACCEPTANCE VOLUME		L	9.1	128.7	42.8	9.1
AIR PRESSURE CHARGE		kPa	83	83	83	83
FLUID	TYPE		PROPYLENE GLYCOL	PROPYLENE GLYCOL	PROPYLENE GLYCOL	PROPYLENE GLYCOL
	CONC.	%	50	50	50	50
DIMENSIONS	DIAMETER	mm	305	610	413	305
	HEIGHT	mm	495	1426	749	495
	MAXIMUM WEIGHT	kg	50	443	123	50
MANUFACTURER			ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT
SERIES			D	D	D	D
MODEL NO.			D-15V	D-180V	D-40V	D-15V
APPLICABLE REMARKS						
REMARKS:						

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 760, Performance Rating of Solenoid Valves for Use with Volatile Refrigerants.
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): 15, Safety Standard for Refrigeration Systems.
   3. American Society of Mechanical Engineers (ASME):
      a. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
      b. B31.5, Refrigeration Piping and Heat Transfer Components.
   4. American Welding Society (AWS):
      a. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
      b. BRH, Brazing Handbook.
   5. ASTM International (ASTM): B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   6. National Electrical Manufacturers Association (NEMA).
   7. Underwriters Laboratories of Canada. (ULC).

1.2 DEFINITIONS

A. ACR: Air conditioning and refrigeration.

B. NRTL: National Recognized Testing Laboratory.

1.3 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings in 1/100 scale for refrigerant piping showing pipe and tube sizes, flow capacities location, elevations, fittings, accessories, and piping connections.
   2. Manufacturer’s data on refrigerant piping, piping products, thermostatic expansion valves, solenoid valves, hot-gas bypass valves, filter dryers, strainers, pressure regulating valves and accessories.

B. Informational Submittals:
   1. Welding certificates.
   2. Field quality control; test report.
   3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Safety Code Compliance: Comply with applicable portions of ASHRAE 15.

B. Brazing: Comply with applicable requirements of ASME B31.5 pertaining to brazing of refrigerant piping for shop and Project Site locations.

C. Installer: A firm with at least 5 years of successful installation experience on projects with refrigerant piping similar to that required for this Project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refrigerant piping shall be cleaned, dehydrated, and sealed when delivered.

B. Store piping in clean and protected area with end caps in place.

PART 2 PRODUCTS

2.1 MATERIALS

A. Material and dimensional requirements for field assembled refrigerant piping, valves, fittings and accessories shall conform to ASHRAE 15 and ASME B31.5, except as hereinafter specified.

B. Piping, 3 Inches and Smaller: Copper, Type ACR tube, ASTM B280, copper No. 122, hard-drawn temper. Brazed joints required.

C. Fittings for Copper Tube: Wrought-copper/bronze solder-joint fittings in accordance with ASME B16.22.

2.2 MISCELLANEOUS PIPING PRODUCTS

A. Brazing Materials:
   1. Except as otherwise indicated, provide 15 percent silver alloy brazing material for copper to copper and copper to brass fittings.
   2. Comply with AWS A5.8M/A5.8 for brazing filler materials.

B. Refrigerant Specialties:
   1. Refrigerant Suction Line Filter-Dryer:
      a. Provide steel shell, corrosion-resistant finish filter-dryer, with molded felt core with 10-micron particle retention, in size and working pressure indicated, with copper connectors, and access valve (not applicable for heat pump system).
      b. Operating Temperature Rating: 115 degrees C.
      c. Working Pressure: 3448 kPa.
      d. Provide size recommended by refrigeration equipment manufacturer.
   2. Refrigerant Liquid Line Dryer:
      a. Provide refrigerant liquid line filter-dryer for all units.
      b. Operating Temperature Rating: 115 degrees C.
      c. Working Pressure: 3448 kPa.
      d. For heat pumps, provide biflow directional types (not required if included with air-conditioning equipment).
      e. Provide size recommended by refrigeration equipment manufacturer.

C. Refrigerant Valves:
   1. Globe and Check Valves: Listed and labeled by an NRTL.
      a. Shutoff Valves:
         1) Forged brass, packed, back seating winged seal cap, 140 degrees C temperature rating 3448 kPa working pressure.
         2) Maximum Opening Pressure: 3.45 kPag.
         3) Valve required only if shutoff service valves are not included with package air-conditioning equipment.
      b. Manufacturers:
         1) Henry Technologies.
         2) Parker Hannifin Corp.
   2. Solenoid Valve: Listed and labeled by an NRTL.
      a. Two-Way Solenoid Valves: Forged brass, designed to conform to AHRI 760, normally closed, Teflon valve seat, NEMA 1 solenoid enclosure, 24 volts, 60-Hz, UL Listed, 13 mm conduit adapter, 121 degrees C temperature rating 3448 kPa working pressure.
      b. Provide valve only if recommended by air-conditioning equipment manufacturer.
      c. Manual Operator: Provide optional manual operator to open valve.
      d. Manufacturers:
         1) Alco Controls Div.; Emerson Electric Co.
         2) Automatic Switch Co.
         3) Parker Hannifin Corp.
   3. Thermostatic Expansion Valve:
      a. Body Bonnet and Seal Cap: Forged brass or steel.
      b. Diaphragm, Piston, Closing Spring and Seat Insert: Stainless steel.
      c. Capillary and Bulb: Copper tubing filled with refrigerant.
      d. Suction Temperature: 4.4 degrees C.
      e. End Connections: Socket or flare.
      f. Working Pressure: 4826 kPag.
      g. Manufacturers:
         1) Henry Technologies.
         2) Parker Hannifin Corp.
         3) Danfoss Group Global.
   4. Safety Relief Valve:
      a. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
      b. Seat Disk: Polytetrafluoroethylene.
      c. Working Pressure: 3448 kPag.
      d. Operating Temperature: 115 degrees C, maximum.
      e. Manufacturers:
         1) Henry Technologies.
         2) Parker Hannifin Corp.
         3) Danfoss Group Global.

D. Refer to Section 40 05 15, Piping and Cable Tray Support Systems, for piping shields and piping support requirements.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPING SYSTEM

A. Install piping products in accordance with manufacturer's written instructions, applicable requirements of ASME B31.5, ASHRAE 15, and in accordance with recognized industry practices to ensure products serve intended function.

B. Install dryers on liquid and suction lines.

C. Refrigerant Piping:
1. Cut pipe accurately to measurements established at Site and work into place without springing or forcing.
2. Install piping with sufficient flexibility to adequately provide for expansion and contraction as a result of temperature fluctuation inherent in its operation.
3. Where pipe passes through building structure, pipe joints shall not be concealed, but located where they may be readily inspected.
4. Run pipe to be insulated as shown and as required with sufficient clearance to permit application of insulation.
5. Run piping as shown on Drawings, taking care to avoid interference with other piping, conduit or equipment. Except where specifically indicated otherwise, run piping plumb, and straight and parallel to walls and ceilings.
6. Trapping of lines shall not be permitted, except where indicated.
7. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
8. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.
11. Install refrigerant piping in protective conduit where installed belowground.
12. Install accumulator in suction line near condensing unit.
13. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
14. Slope refrigerant piping as follows:
    a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
    b. Install horizontal suction lines with a uniform slope downward to compressor.
    c. Install traps and double risers to entrain oil in vertical runs.
    d. Liquid lines may be installed level.

D. Pipe Sleeves:
1. Provide pipe sleeves of suitable size for pipe and tubing that penetrate building structure.
2. Secure sleeves in position and location before and during construction. Space between pipe and sleeves, or between insulation and pipe sleeves, shall be not less than 6 mm between outside of pipe or insulation, and inside wall of sleeves.
3. Sleeves for uninsulated pipes shall have ends flush with finished wall surfaces; provide pipe or tubing as above with outside perimeter of pipe caulked to sleeve.
4. Extend sleeves for insulated pipes 13 mm from wall faces and caulk to sleeve on both sides.
5. Seal terminal ends of pipe insulation with mastic.

6. Extend sleeves for lines passing through floors 75 mm above finished floor slab and caulk to slab.
7. Seal penetrations through fire and smoke barriers according to Section 07 84 00, Firestopping.

E. Braze cap (seal) ends of piping when not connected to mechanical equipment.

3.2 SOLDER JOINTS

A. Solder joints shall not be used for joining refrigerant piping systems.

3.3 BRAZED JOINTS

A. Braze copper piping with silver solder complying with AWS A5.8M/A5.8.

B. Brazed Joints:
1. Construct joints according to AWS *Brazing Handbook* Chapter “Pipe and Tube”.
2. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
3. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

C. Inside of tubing and fittings shall be free of flux.

D. Clean parts to be joined with emery cloth and keep hot until solder has penetrated full depth of fitting and extra flux has been expelled.

E. Cool joints in air and remove flame marks and traces of flux.

F. During brazing operation, prevent an oxide film from forming on inside of tubing by slowly flowing dry nitrogen to expel air.

G. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

3.4 PIPE HANGERS

A. Refer to Section 40 05 15, Piping and Cable Tray Support Systems, for piping shields and piping support requirements.

3.5 EQUIPMENT CONNECTIONS

A. Connect refrigerant piping to mechanical equipment in the manner shown, and comply with equipment manufacturer’s instructions where not otherwise indicated.

3.6 FIELD QUALITY CONTROL

A. General:
1. Notify Contract Administrator at least 48 hours before testing is performed.
2. Furnish equipment required for tests.

3. Group as many systems together as possible when testing in order to consolidate number of test inspections.

B. Leak Test:
1. Prior to initial operation, clean and test refrigerant piping in accordance with ASME B31.5.
2. Perform initial test with dry nitrogen to 2068 kPag minimum using soap solution to test joints.
3. Evacuate system after initial test and charge system with refrigerant or dry nitrogen, 20 percent refrigeration mixture to 4137 kPag minimum.
4. Upon completion of initial system test, test factory, as well as field, refrigerant piping joints with electronic-type leak detector to acquire a leak-tight refrigerant system.
   a. If leaks are detected, remove entire refrigerant charge for the system, replace defective pipe or fitting, and retest entire system as specified above.

C. Evacuation, Dehydration, and Charging:
1. After system is found to be without leaks, evacuate system using reliable gauge and vacuum pump capable of pulling a vacuum of at least 1-mm Hg absolute.
2. Evacuate system with vacuum pump until temperature of 2 degrees C is indicated on vacuum dehydration indicator.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
4. Maintain vacuum on system for minimum of 12 hours after closing valve between vacuum pump and system. If system holds vacuum for 12 hours it is ready for charging.
5. Break vacuum with refrigerant gas or dry nitrogen gas, allowing pressure to build up to 15 kPa.
6. Install new filter-dryer core in charging line.
7. Repeat evacuation procedure and complete charging of system; provide full operating charge.

3.7 ADJUSTING

A. General:
1. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
2. Adjust high-pressure and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
3. Adjust setpoint temperature of air-conditioning or chilled-water controllers to system design temperature.
4. Perform following adjustments according to manufacturer’s written instructions before operating refrigeration system:
   a. Open shutoff valves in condenser water circuit.
   b. Verify compressor oil level is correct.
   c. Open compressor suction and discharge valves.
   d. Open refrigerant valves, except bypass valves that are used for other purposes.
   e. Check open compressor-motor alignment and verify lubrication for motors and bearings.

B. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13

METAL DUCTS AND ACCESSORIES

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Air Movement and Control Association (AMCA): 500, Test Methods for Louvers, Dampers and Shutters.
   2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook.
   3. Association of the Nonwoven Fabrics Industry (INDA): IST 80.6, Water Resistance (Hydrostatic Pressure Test).
   4. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
      c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      d. A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.
      e. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
      f. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
      g. A568/A568M, Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
      h. A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      i. A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment.
      j. A924/A924M, Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Process.
      k. A1008/A1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
      l. A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
      m. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      n. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      o. C916, Standard Specification for Adhesives for Duct Thermal Insulation.
      p. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

q. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
r. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
s. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

5. National Air Duct Cleaners Association (NADCA): General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.
6. National Fire Protection Association (NFPA):
   a. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   b. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
   c. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   d. 259, Standard Test Method for Potential Heat of Building Materials.
   e. 701, Standard Method of Fire Test for Flame Propagation of Textiles and Films.
7. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Duct Construction Standards.
   b. Guidelines for Seismic Restraints of Mechanical Systems.
   c. Fibrous Glass Duct Construction Standards.
   d. Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
   e. HVAC Air Duct Leakage Test Manual.
8. Underwriters Laboratories Inc. (UL):
   a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.
   b. 214, Tests for Flame-Propagation of Fabrics and Films.
   c. 555, Standard for Safety Fire Dampers.
   d. 555S, Standard for Safety Smoke Dampers.
   e. Underwriters Laboratories of Canada (ULC).
   f. National Fire Code of Canada.
   g. National Building Code of Canada.

1.2 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:
   1. L/s: litre per second.
   2. m/s: m per second.
   3. kg/m^3: kg per cubic metre.

B. Sealing Requirements: For the purpose of duct systems sealing requirements specified in this Section, the following definitions apply:
   1. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.
   2. Joints, duct surface connections including:
      a. Girth joints.
      b. Branch and subbranch intersections.
      c. Duct collar tap-ins.
      d. Fitting subsections.
      e. Louver and air terminal connections to ducts.

f. Access door, and access panel frames and jambs.
g. Duct, plenum, and casing abutments to building structures.

1.3 SUBMITTALS

A. Action Submittals:
1. Seismic Control: As required by Section 23 05 48, Vibration Isolation and Seismic Controls for HVAC
2. Product Data:
   a. Rectangular and Rigid Round Ductwork:
      1) Schedules of duct systems, materials, joints, sealing, gage and reinforcement.
      2) SMACNA Figure Numbers for each shop fabricated item.
      3) Reinforcing details and spacing.
      4) Seam and joint construction details.
      5) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
   b. Ductwork Accessories:
      1) Manufacturer's product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, and finishes, including the following items:
         a) Fittings and volume control damper installation (both manual and automatic) details.
         b) Sealing materials.
         c) Dampers; include leakage, pressure drop, and maximum back pressure data.
         d) Duct-mounted access panels and doors.
         e) Flexible ducts.
         f) Sheet metal fasteners.
3. Duct Fabrication Drawings:
   a. Drawn after actual job measurements are obtained.
   b. Drawn to a scale not smaller than 6 mm equals 300 mm, on drawing sheets same size as Contract Drawings.
   c. Include the following features:
      1) Fabrication, assembly, and installation details including plans, elevations, sections, details of components, and attachments to other work.
      2) Duct layout, indicating pressure classifications, and sizes in plan view.
      3) Duct material and thickness.
      4) Fittings and volume control damper installation (both manual and automatic) details.
      5) Reinforcing details and spacing.
      6) Seam and joint construction details.
      7) Penetrations through fire-rated and other partitions.
      8) Duct accessories and control devices such as automatic dampers, airflow monitors, terminal units, smoke detectors, regulators, air distribution devices, etc.
      9) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

10) Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installation.
11) Coordination with ceiling suspension members.
12) Spatial coordination with other systems installed in same space with duct systems.
13) Coordination of ceiling- and wall-mounted access doors and panels required for access to dampers and other operating devices.
14) Coordination with ceiling-mounted lighting fixtures, air outlets, and inlets.
15) Coordination of ductwork with sprinkler piping and other mechanical and electrical services, and equipment installed under Division 23, Heating, Ventilating, and Air-Conditioning (HVAC), Division 40, Process Integration, and Division 26, Electrical.

B. Informational Submittals:
1. Seismic Control: As required by Section 23 05 48, Vibration Isolation and Seismic Controls for HVAC
2. Sound Attenuators Certified Test Data:
a. Dynamic insertion loss.
b. Self-noise power levels.
c. Static pressure loss.
d. Dimensions and weights.
3. Record Drawings: Include duct systems routing, fittings details, and installed accessories and devices.

1.4 QUALITY ASSURANCE

A. Industry Standards:
1. Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA duct construction standard relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.
2. Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.
3. NFPA Compliance: NFPA 90A and NFPA 90B.

B. Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

C. Suppliers of duct and fitting components shall provide on request the following information:
1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
2. Laboratory performance data for fittings, including zero-length dynamic losses.

D. Installer shall be a firm with at least 3 years' experience of successful installation on ductwork systems similar to that required for this Project.

E. Changes or alterations to layout or configuration of duct system shall be:
   1. Specifically approved in writing by Contract Administrator.
   2. Proposed layout shall provide original design results, without increasing system total pressure.

1.5 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:]

Item		Quantity
Fusible Links		10% of amount installed

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork from dirt, water, and debris. During storage on Jobsite, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

B. Deliver sealant materials to Site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

C. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

D. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 PRODUCTS

2.1 SCHEDULES

A. Ductwork Schedule: Refer to Articles Supplements.

B. Sound Attenuator Schedule: Refer to Article Supplements.

2.2 GENERAL

A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

C. Ductwork thinner than 26 gauge will not be allowed.

D. Ductwork Interior Surfaces:
   1. Smooth.
   2. No sheet metal parts, tabs, angles, screws, or other items may project into air ducts, unless otherwise specified.
   3. Seams and joints shall be external.
   4. For ductwork that is required to be reinforced. Contractor may use either external or internal reinforcing.

2.3 SHEET METAL MATERIALS

A. Construct metal duct systems from materials as indicated in Article, Ductwork Schedule.

B. Where no specific ductwork materials are indicated in Specifications or on Drawings, galvanized steel sheet metal shall be basis of Contract.

C. Galvanized Steel Ductwork (GS61):
   1. Comply with ASTM A653/A653M and ASTM A924/924M.
   2. Product Name: Steel Sheet, Zinc Coated (Galvanized Steel).
   3. Sheet Designation: CS Type B.
   4. Applicable Specification: ASTM A653/A653M.
   5. (Zinc) Coating Designation: G90.
   6. Coating designation in accordance with Test Method A, ASTM A90/A90M. and ASTM A924/A924M.
   7. Provide mill-phosphatized finish for ducts which are scheduled to be painted.
   8. Provide sheet metal packaged and marked as specified in ASTM A700.

D. Aluminum Ductwork (AL61):
   1. Comply with ASTM B209.
   2. Aluminum Sheet: Alloy 3003-H14, unless indicated otherwise.
   3. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or approved equal in accordance with B8.

E. Stainless Steel Ductwork (SS64):
   1. Comply with ASTM A167, A176, A240/A240M, and ASTM A480.
   2. Stainless Steel Sheet: Type 304, unless indicated otherwise.
   3. Gauge shall comply with SMACNA manual, unless specified otherwise.
   4. Finish: No. 2 B (cold-rolled, bright) finish, except as otherwise noted.
   5. With No.4 finish on exposed surface for ducts exposed to view.

F. Stainless Steel Ductwork (Odorous Air) (SS66):
   1. Comply with ASTM A167, ASTM A176, ASTM A240/A240M, and ASTM A480/A480M.
   2. Stainless Steel Sheet: Type 316/316L, unless indicated otherwise.
   3. Duct construction, including sheet metal gauge and reinforcements, shall comply with SMACNA Round Industrial Duct Construction Standards and SMACNA Rectangular Industrial Duct Construction Standards as applicable, unless specified otherwise.

4. Finish: No. 2 B (cold-rolled, bright) finish. Welds shall be grinded smooth and passivated.
5. Longitudinal fusion welded butt seam, flanged fittings, and joints with all seams welded.
6. Elbows: Provide centerline equal to radius 1.5 times elbow diameter.
7. Fittings: Continuously welded along seams.
8. Duct Classification: Class 5 (Corrosive Fumes).
9. Maintenance load provision: 113 kg.
10. Duct support spacing shall not exceed a maximum of 4.5 m.

G. Exposed Ductwork: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

H. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

2.4 DUCT SEALING MATERIALS

A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

C. Water-Based Sealants:
1. Listed by manufacturer as nonflammable in wet and dry state.
2. Manufacturers and Products:
   a. Foster; Series 32.
   b. Childers; CP-145A, 146.
   c. Rectorseal; Airlok 181.

2.5 FIRESTOPPING

A. Refer to Section 07 84 00, Firestopping.

2.6 DUCTWORK FASTENERS

A. General:
1. Rivets, bolts, or sheet metal screws.
2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

B. Self-Drilling Screws:
1. Galvanized Steel Ductwork System: Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated carbon steel with zinc electroplated finish.
2. Aluminum Ductwork System:
   a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Marutex® stainless steel with strength of Type 410

stainless steel and corrosion resistance of Type 304 stainless steel, complete with bonded metal and fiber washer for dielectric separation.

b. Manufacturers:
   1) DB Building Fasteners Inc., Santa Fe Springs, CA.
   2) Clark Craft Fasteners, Tonawanda, NY.

3. Stainless Steel Ductwork System:
   a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Marutex® stainless steel with strength of Type 410 stainless steel and corrosion resistance of Type 304 stainless steel.
   b. Manufacturers:
      1) DB Building Fasteners Inc., Santa Fe Springs, CA.
      2) Clark Craft Fasteners, Tonawanda, NY.
      3) UCAN Fastening Products.

2.7 DUCTWORK PRESSURE CLASS

A. Construct duct systems to pressure classifications indicated in Ductwork Schedule

B. Where no specific duct pressure designations are indicated in Specifications or on Drawings, 500 Pa pressure class shall be basis of Contract.

2.8 RECTANGULAR DUCTWORK

A. Fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 480 mm and larger and are 20-gauge or less, with more than 1.0 square meter of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

C. Air Handling Unit Discharge Ductwork: Ductwork extending from variable air volume air handling units up to and including first elbow or terminal tap outside air handling unit room shall be constructed of 16-gauge, minimum.

2.9 RECTANGULAR DUCTWORK FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. Elbows:
   1. Fit square-turn elbows with vane side rails.
   2. Shop fabricate double-blade turning vanes of same material as ductwork.
   3. Fabricate with equal inlet and outlet.
   4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.
   5. Manufacturers and Products:
      a. Elgen; All-Tight.
      b. Duro-Dyne; Type TR.

2.10 RECTANGULAR DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections to rectangular duct mains shall be made using factory fabricated fittings with spot welded tap to main duct connections. Field installed taps are not acceptable.

2.11 RIGID ROUND DUCTWORK

A. Construct rigid round ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Basic Round Diameter: As used in this Article, is diameter of size of round duct that has circumference equal to perimeter of a given size of flat oval duct.

C. Where space limitations prevent use of round duct or where shown on Drawings, provide ductwork of flat oval construction.

D. Fabricate round ducts with spiral seam construction, except where diameters exceed 1800 mm. Fabricate ducts having diameters greater than 1800 mm with longitudinal butt-welded seams.

2.12 RIGID ROUND DUCTWORK FITTINGS

A. Construct rigid round ductwork fittings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless otherwise specified.

B. 90-Degree Tees, Laterals, and Conical Tees: Fabricate to conform to SMACNA manual with metal thicknesses specified for longitudinal seam straight duct.

C. Diverging Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

D. Elbows:
   1. Fabricate in stamped (die-formed), pleated, or segmented (gored) construction 1.5 times elbow diameter. Two piece segment elbows are not allowed, except with turning vanes.
   2. Segmented Elbows: Fabricate with welded construction.
   3. Round Elbows 200 mm and Smaller:
      a. Stamped elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees configuration.
      b. Fabricate nonstandard bend angle configurations or nonstandard sized (e.g., 90 and 115 mm) elbows with segmented construction.
   4. Round Elbows 225 mm Through 350 mm:
      a. Segmented or pleated elbows for 30, 45, 60, and 90 degrees.
      b. Fabricate nonstandard bend angle configurations or nonstandard sized (e.g., 240 and 265 mm) elbows with segmented construction.

2.13 ROUND DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections (taps) to round duct mains shall be made using factory fabricated fittings.

2.14 INSULATED FLEXIBLE DUCT

A. Fabricate in accordance with:
   1. UL 181, Class 1.
   2. NFPA 90A and NFPA 90B.

B. Construction:
   1. Outer Jacket: Fire retardant reinforced aluminum vapor barrier jacket with reinforced cross-hatched scrim having a permeance of not greater than 0.1 perm when tested in accordance with ASTM E96, Procedure A.
   2. Inner Liner: Tri-laminate of aluminum foil, fiberglass, and aluminized polyester.
   3. Reinforcing: Galvanized steel wire helix, mechanically locked to and encapsulated by inner liner fabric.
   4. Insulation:
      a. Factory insulated with fiberglass insulation.
      b. R-value: 1.05 m^2 k/w minimum at a mean temperature of 24 degrees C.
   5. Internal Working Pressure: Rating shall be minimum 1500 Pa positive and 1000 Pa negative, with bursting pressure of at least 2-1/2 times working pressure.
   6. Air Velocity Rating: 20 m/s, minimum.

C. Environment: Suitable for continuous operation at temperature range of minus 29 degrees C to plus 121 degrees C.

D. Manufacturers and Products:
   1. Flexmaster; Type 5M.
   2. Thermaflex Type M-KC.

2.15 HIGH TEMPERATURE FLEXIBLE DUCTWORK

A. Metal flexible ductwork for high heat applications.

B. Fully interlocked, stainless steel, 0.305 mm thickness.

C. Manufacturer and Product:
   1. Flexmaster; RT-6.

2.16 DUCTWORK HANGERS AND SUPPORTS

A. General:
   1. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.
   2. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.
   3. Wire hangers are not acceptable.
   4. Hanger Spacing:
      a. Ducts Up to 1500 mm in Largest Dimension: 3.0 m, maximum.
      b. Ducts Over 1525 mm in Largest Dimension: 2.4 m, maximum.

B. Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:
   1. Galvanized Steel Ductwork:
      a. Indoors: Carbon steel, zinc electroplated.
      b. Outdoors: Carbon steel, hot-dipped galvanized after fabrication.
   2. Aluminum Ductwork Indoors and Outdoors: Carbon steel, hot-dipped galvanized after fabrication.
   3. Stainless Steel Ductwork Indoor and Outdoors: Stainless steel, same ASTM Grade as ductwork.

C. Building Attachments:
   1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
   2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 100 mm thick.
   3. Upper Attachment (Concrete):
      a. Drive pin fastener and expansion nail anchor may be used for ducts up to 450 mm maximum dimension.
      b. Threaded stud fastener may be used for ducts up to 900 mm maximum dimension.
      c. Concrete attachments shall be made of steel.

D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fastener.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.17 DUCTWORK FLEXIBLE CONNECTIONS

A. General:
   1. Factory fabricated metal-edged fabric flexible connectors for commercial or industrial applications.
   2. Sheet metal permanently secured to fabric with double fabric fold, double metal crimp.
   3. Comply with NFPA 90A and 90B requirements.
   4. Airtight and waterproof.

B. Materials:
   1. Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
   2. Metal Edges: Construct from same material as ductwork, unless otherwise noted.
   3. Fabric:
      a. Comply with UL 214 (except teflon coated).
      b. Woven polyester or nylon for most applications.
      c. Woven fiberglass for high temperature applications.
      d. Coating: Vinyl.

C. Construction:
   1. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA Manual.

2. Standard Metal Edged Connectors: Strip of fabric 90 mm wide attached to two strips of 70 mm wide sheet metal.
3. Extra Wide Metal Edged Connectors: Strip of fabric 145 mm wide attached to two strips of 70 mm wide sheet metal.
4. Transverse Metal Edged Connectors: Strip of fabric 90 mm wide attached to two strips of 110 mm wide sheet metal.

D. Manufacturers:
1. Ductmate; PROflex, Commercial.
2. Ventfabrics.
3. Duro-Dyne.

2.18 CEILING ACCESS DOORS

A. Size: 750 mm by 750 mm.

B. Finish in baked white enamel.

C. Manufacturers:
1. Inryco Milcor.
2. Krueger.

2.19 DUCT INSPECTION DOORS

A. General:
1. Insulated, gasketed, and at least 375 mm by 375 mm when duct dimensions are large enough.
2. On ductwork where largest side dimension is less then 400 mm, furnish inspection doors at least 200 mm by 200 mm.
3. Complete with necessary hardware.
4. Fabricated of same material as ductwork.

B. Round Spin-in Type Access Doors:
1. Size: 450 mm and 600 mm diameter will be acceptable in lieu of comparable size square or rectangular access doors specified herein.
2. Complete with insulation, spin-in frame, inner door, attachment cable, gaskets, three latches, and pull ring.
3. Manufacturers:
a. Flexmaster, Inspector Series.

C. Casing and Plenum Access Doors:
1. Size: 1425 mm high by 600 mm wide minimum where possible.
2. Complete with hardware, hinges, seals, and latch handles.
3. Latch Handles: Ventlock, Series No. 260.
4. Hinges: Venlock, Series No. 200 and No. 300.

D. Manufacturers:
   1. Ventlock.
   2. Flexmaster.
   3. Duro-Dyne.

2.20 MANUAL DAMPERS

A. Butterfly Manual Dampers:
   1. Fabricate from two gauges heavier than duct in which installed, of same material as ductwork.
   2. Align operating handle with damper blade.
   3. Provide 50 mm standoff bracket for insulated duct systems.
   4. Damper Manufacturers:
      a. Ruskin.
      b. American Warming and Ventilating.
   5. Operator Manufacturers:
      a. Accessible Ductwork: Ventlok; Type 620 or 635.
      b. Accessible Insulated Ductwork: Ventlok; Type 639.
      c. Concealed Ductwork: Ventlok; Type 677 with extended operating rod and concealed regulator with plain cover.

B. Manual Opposed-Blade Balancing Dampers:
   1. Externally operated gang airfoil, damper blades.
   2. Fabricate from same material as ductwork.
   3. Stainless steel or nylon sleeve bearings.
   4. Construction shall have interlocking edges and maximum 250 mm blade width.
   5. Manufacturers and Products:
      a. Ruskin; CD102.
      b. American Warming & Ventilating; Model VC-31.

2.21 BACK DRAFT DAMPERS

A. General:
   1. Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.

B. Steel Frame, Nonmetallic Blades:
   1. Fabrication:
      a. Frame: 2 inches by minimum 51 mm by minimum 1.6 mm galvanized steel with windstops to reduce backflow.
      b. Blades:
         1) Style: Single piece, independent.
         2) Action: Parallel.
         3) Material: Noncombustible, neoprene coated fiberglass.
         4) Orientation: Horizontal.
         5) Width: Maximum 152 mm.
      c. Rear Bird Screen: Galvanized expanded metal.

d. Mounting:
   1) Suitable for mounting in vertical or horizontal airflow up positions.
   2) Configured for positions as shown on Drawings.
e. Finish: Factory applied air-dried epoxy paint on steel damper parts.

2. Performance Data:
   a. Temperature Rating: Withstand minus minus 34 degrees to 93 degrees C.
   b. Maximum Back Pressure: 1.0 kPa.
   c. Maximum System Air Velocity: 5.1 m/s.
   d. Maximum Spot Air Velocity: 6.1 m/s.
3. Manufacturers and Products:
   a. Ruskin; Model NMS2.
   b. Vent Products, Co.

C. Aluminum, Counterbalanced, Heavy Duty:
1. Fabrication:
   a. Frame: 57 mm by minimum 3.2 mm 6063-T5 extruded aluminum channel with front flange and rear flange and galvanized steel braces at mitered corners.
   b. Blades:
      1) Style: Single piece, overlap frame.
      2) Action: Parallel.
      3) Orientation: Horizontal.
      4) Material: Minimum 1.8 mm 6063-T5 extruded aluminum.
      5) Width: Maximum 152 mm.
   c. Bearings: Corrosion-resistant, long-life, synthetic, formed as single piece with axles.
   d. Blade Seals: Extruded vinyl, mechanically attached to blade edge.
   e. Linkage: Minimum 13 mm aluminum tie bar with stainless steel pivot pins mounted on blades.
   f. Axles: Corrosion-resistant, long-life, synthetic, locked to blade and formed as single piece with bearings.
   g. Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade enabling damper to operate over wide range of pressures.
   h. Mounting:
      1) Suitable for mounting in vertical, horizontal airflow up, and horizontal airflow down positions.
      2) Configured for positions as shown on Drawings.
   i. Finish: Factory applied air-dried epoxy paint on all damper parts.
2. Performance Data:
   a. Temperature Rating: Withstand minus 40 to 93 degrees C.
   b. Maximum Back Pressure: 4 kPa.
   c. Maximum Air Velocity: 12.7 m/s.
   d. Operation of Blades:
      1) Start to Open: 2.5 Pa.
      2) Fully Open: 12.5 Pa.
   e. Pressure Drop: Maximum 38 Pa at 7.6 m/s through 600 mm by 600 mm damper.
3. Manufacturer and Product: Ruskin; Model CBD6.

2.22 FIRE DAMPERS

A. Duct Mounted Fire Dampers in Fire Walls with Rating of 2 Hours or Less:
   1. NFPA 90A rated for 1-1/2-hour service.
   2. Blades, frame, and mounting angles same material as ductwork.
   3. Accordion style folded blades.
   4. 74 degrees C fusible link.
   5. Approved for installation with 2-hour fire rating.
   6. Rated, manufactured, tested, and approved in accordance with UL 555.
   7. Blades out of airstream when open (Type B or CR) except as noted on the drawings.
   8. Furnish with sleeved frame for duct connections.
   9. Labeled for use in static mode.
   10. Furnish dynamic and horizontal mounted dampers with springs for proper closure.
   11. Corrosive Service Dampers: Type 316 stainless steel.
   12. Manufacturers and Products:
      a. Ruskin; DIBD20, Type B.
      b. Nailor-Hart;Model 0130, Type B.

B. Duct Mounted Fire Dampers in Walls with 3-Hour or Greater Fire Rating:
   1. NFPA 90A rated for 3-hour service.
   2. Blades, frame, and mounting angles.
   3. Accordion style folding blades. Air foil type blades for multiblade dampers.
   4. 74 degrees C fusible link.
   5. Approved for installation in 4-hour wall.
   6. Rated, manufactured, tested, and approved in accordance with UL 555.
   7. Blades out of airstream when open (Type B).
   8. Furnish with sleeved frame for duct connection.
   9. Labeled for use in static mode.
   10. Furnish dynamic and horizontal mounted dampers with springs for proper closure.
   11. Corrosive Service Dampers: Type 316 stainless steel.
   12. Manufacturers and Products:
      a. Ruskin; DIBD23, Type B.
      b. Nailor-Hart; Model 0530, Type B

C. Ceiling Grille and Diffuser Fire Dampers:
   1. UL Listed assembly with frame.
   2. Butterfly type blades.
   3. 74 degrees C fusible link.
   4. Radiation type damper.
   5. Manufacturers and Products:
      a. Ruskin; Type CFD Series.
      b. Nailor-Hart; Model 0722 or 0716.

2.23 MOTORIZED DAMPERS

A. General:
   1. Specification applies to motorized dampers, except those specified to be furnished with equipment.

2. Furnish opposed-blade type for proportional action and parallel-blade type for two-position action, except where indicated otherwise.

B. Standard Duty Motorized Dampers:
1. Frame:
   a. Nominal 127 mm deep, minimum 1.6 mm thick roll formed, hat-shaped channel, reinforced at corners. Structurally equivalent to 2.3 mm U-channel.
   b. Material: As scheduled in Motorized damper Schedule, Article Supplements.
2. Blades:
   a. Style: Single skin with three longitudinal grooves, minimum.
   b. Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.
   c. Minimum 2 mm equivalent thickness.
   d. Material: As scheduled in Motorized damper Schedule, Article Supplements.
   e. Width: Nominal 152 mm.
3. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
4. Seals:
   a. Blade Seals: Inflatable PVC-coated fiberglass material and galvanized steel. Mechanically attached to blade edge.
   b. Jamb Seals: Flexible metal compression type.
5. Linkage: Concealed in frame.
6. Axles:
   a. Minimum 13 mm diameter, hex-shaped, mechanically attached to blade.
   b. Material: As scheduled in Motorized damper Schedule, Article Supplements.
7. Performance Data: As scheduled in Motorized damper Schedule, Article Supplements.
8. Accessories: As follows:
   a. Actuator: Refer to Article Motorized damper Actuators, for requirements.
   b. Switch Package: Two-position indicator switches linked directly to damper blade to remotely indicate damper blade position.
   c. T-Flange Frame:
      1) Minimum 152 by 35 by 3.2 mm aluminum, bolt holes in corners.
      2) Mates to: TDC, TDF, Ductmate, Nexus, Ward, and other T-flange duct connections.
9. Manufacturers and Products:
   a. Ruskin; Model CD-35.
   b. American Warming and Ventilating.
   c. TAMCO.

C. High Performance Motorized Dampers:

1. Frame: Frame: 127 mm by 25 mm by minimum 3.2 mm 6063-T5 extruded aluminum hat-shaped channel, mounting flanges on both sides of frame, reinforced at corners.
2. Blades:
   a. Style: Airfoil-shaped, single-piece.
   b. Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.
   c. Material: Heavy duty 6063-T5 extruded aluminum.
   d. Width: Nominal 152 mm.
3. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.

4. Seals:
    a. Blade Seals: Extruded neoprene type for ultra-low leakage from minus 58 to 135 degrees C). Mechanically attached to blade edge.
    b. Jamb Seals: Flexible metal compression type.
5. Linkage: Concealed in frame.
6. Axles:
    a. Minimum 13 mm diameter, hex-shaped, mechanically attached to blade.
    b. Material: As scheduled in Motorized damper Schedule, Article Supplements.
7. Performance Data: As follows:
    a. Temperature Rating: Withstand minus 58 to 135 degrees C.
    b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
    c. Closed Position: Maximum pressure of 3.2 kPa at 305mm blade length.
    d. Open Position: Maximum air velocity of 1,829 meter per minute.
    e. Leakage: Maximum 0.6 cubic meter per minute per square meter at 1 kPa for size 1219 by 1219 mm.
    f. Pressure Drop: Maximum 0.01 kPa at 457 meters per minute across 610 by 610 mm damper.
8. Accessories: As follows:
    a. Actuator: Refer to Article Motorized damper Actuators, for requirements.
    b. Switch Package: Two-position indicator switches linked directly to damper blade to remotely indicate damper blade position.
    c. T-Flange Frame:
        1) Minimum 152 by 35 by 3.2 mm aluminum, bolt holes in corners.
        2) Mates to TDC, TDF, Ductmate, Nexus, Ward, and other T-flange duct connections.
9. Manufacturers and Products:
    a. Ruskin; Model CD-50.
    b. American Warming and Ventilating.
    c. TAMCO.

D. Heavy Duty Motorized Dampers:
1. Frame:
    a. 203 mm by 51 mm by minimum 2 mm channel.
    b. Bolt Holes: Both flanges.
    c. Material: As scheduled in Motorized damper Schedule, Article Supplements.
2. Blades:
    a. Style: Airfoil-shaped, double-skin.
    b. Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.
    c. Minimum 2 mm equivalent thickness.
    d. Material: As scheduled in Motorized damper Schedule, Article Supplements.
    e. Width: 127 mm to 203 mm maximum.
3. Bearings: Stainless steel sleeve pressed into frame.
4. Seals:
    a. Blade Seals: EPDM blade seals, maximum 121 degrees C. Mechanically attached to blade edge.
    b. Jamb Seals: Compressible stainless steel located between blade edge and jamb.

5. Linkage:
    a. Side linkage out of airstream.
    b. Constructed of minimum 3.5-mm galvanized steel clevis arms with minimum 4.8 mm by 19 mm plated steel tie bars pivoting on minimum 9.5-mm diameter stainless steel pivot pins with lock-type retainers.
6. Axles:
    a. Minimum 12 mm diameter, hex-shaped, mechanically attached to blade.
    b. Material: As scheduled in Motorized damper Schedule, Article Supplements.
7. Performance Data: As follows:
    a. Maximum Operating Temperature: 121 degrees C.
    b. Maximum System Pressure: 2.5 kPa.
    c. Maximum System Velocity: 1,219 meter per minute.
    d. Leakage with Seals: Based on pressure differential of 0.25 kPa.
        1) Percent of Maximum Flow: 0.10.
        2) Leakage: 1.2 cubic meters per minute per square meters.
8. Accessories: As follows:
    a. Actuator: Refer to Article Motorized damper Actuators, for requirements.
    b. Switch Package: Two-position indicator switches linked directly to damper blade to remotely indicate damper blade position.
9. Manufacturers and Products:
    a. Ruskin; Model CD-80AF.
    b. American Warming and Ventilating.
    c. TAMCO.

E. Odour Ductwork Motorized Dampers:
1. General:
    a. Dampers to be AMCA certified low leak per standard 500-D-97.
2. Construction:
    a. Damper frame to be constructed of 200 mm by 50 mm by 14 gauge 316 stainless steel.
    b. Blades are to be 16 gauge airfoil profile with a maximum blade with 200 mm. The blade to be injected with a two part polyurethane (CFC) free foam, and debridged for thermal isolation.
    c. Blade frame to have a mill finish.
3. Linkage:
    a. Linkage to be concealed in 316 stainless steel 16 gauge cover to be mounted on the exterior of the jamb.
    b. The crank arm and linkage bar shall be a flat plate welded 316 stainless steel.
4. Bearings:
    a. Bearings to be Teflon sleeve type rated for minus 40 degrees C to plus 93.3 degrees C.
5. Shaft:
    a. Shaft to be 12 mm diameter 316 stainless steel, full length.
6. Seals:
    a. Blades to have extreme low temperature seal system of extruded silicone rubber edge seal with a 316 stainless steel seal at jambs.
    b. The temperature ratings for the seal to be minus 40 degrees C to plus 93.3 degrees C.

7. Manufacturer:
   a. American Warming and Ventilating (AWV); Model V421.
   b. Ruskin
   c. TAMCO.

2.24 MOTORIZED DAMPER ACTUATORS

A. General:
   1. Drawings, Control Diagrams and schedules indicate estimated quantities of actuators for each motorized damper.
   2. Select actual quantity of actuators required to operate each damper in accordance with size of damper provided.
   3. Coordinate exact quantity of actuators with electrical work to ensure that necessary wiring and conduit is provided for installation.

B. Electric Damper Actuators:
   1. Performance: As scheduled in Motorized Damper Schedule, Article Supplements.
   2. Mounting: External side plate. Provide weatherproof box for actuators mounted outside.
   3. Ample power to overcome friction of damper linkage and air pressure acting on damper blades.
   4. Furnished with external adjustable stops to limit stroke.
   5. Actuators on modulating dampers that are to be sequenced with other control devices shall have full relay type pilot positioner and interconnecting linkage to provide mechanical feedback that will accurately position and control damper.
   6. Intake, relief, and exhaust dampers shall close and return dampers shall open on control failure, unless indicated otherwise.
   7. Operating Torque:
      a. Provide multiple independent damper sections, each with separate actuator, as needed to provide minimum of 120 percent of operating torque required by damper(s).
      b. Required damper operating torque for actuator sizing calculations shall include friction of damper linkage and 250 Pa air pressure on damper blades:
         1) Opposed-Blade Dampers: Minimum 6 Nm per square meter of damper area, unless higher values are recommended by damper manufacturer.
         2) Parallel-Blade Dampers: Minimum 8.5 Nm per square meter of damper area, unless higher values are recommended by damper manufacturer.
   8. Electrical and Controls
      a. CSA or cUL approved
      b. Operating voltage: 120 VAC
      c. Provide two auxiliary end-switch contacts, one for fully open and for fully close, for each on/off damper
      d. Provide a 4-20 mA position feedback signal for each modulating damper
   9. Refer to P&ID drawings for details.
   10. Provide heated enclosure suitable for -40 degrees C for all outdoor applications.
   11. Actuators for Unclassified Areas
      a. Manufacturer and Model:
         1) Schischek by Rotork Controls (Canada) Ltd., InMax or RedMax
         2) Siemens Building Technologies.

3) Or approved equal in accordance with B8

12. Actuators for Hazardous Class I, Zone 2 Areas
    a. Housing must also allow for direct mounted to dampers via manufacturer approved coupling and be rated for hazardous area installation without the use of a separate, cast metal, bolted enclosure.
    b. Hermetically sealed so as not to require an external seal for the method of protection
    c. Manufacturer and Model:
        1) Schischek by Rotork Controls (Canada) Ltd., RedMax
        2) Or approved equal in accordance with B8

2.25 SOUND ATTENUATORS

A. Packed Type:
    1. Fabricate from not less than 22-gauge sheet metal of same material as ductwork.
    2. Furnish perforated interior partitions with moisture-resistant mineral fiber carrying an NFPA 255 Flame Spread Index of no greater than 20.
    3. Pressure rated airtight at 1500 Pa.
    4. Furnish vapor barrier lining on inside face of sound trap.
    5. Size and Performance: As indicated on Sound Attenuator Schedule.
    6. Manufacturers:
        a. Vibro-Acoustics
        b. Industrial Acoustics Co.
        c. Rink.

2.26 EXTERNAL DUCT INSULATION

A. Refer to Section 23 07 00, HVAC Insulation.

2.27 MISCELLANEOUS ACCESSORIES

A. Sheet Metal Plenums:
    1. Fabricate from minimum 18-gauge metal of same material as ductwork.
    2. Brace with frame of same material for rigidity.
    3. Line with sound attenuation material where indicated.

B. Louver and Grille Blank-Off Sections:
    1. Fabricate from 20-gauge sheets of same material as louver/grille.
    2. Line with sound attenuation/insulating material.
    3. Shop-prime and paint outside face of blank-off section with two coats of flat black exterior paint.

C. Auxiliary Drain Pans:
    1. Dimensions: Minimum 150 mm larger in both dimensions than equipment it is serving and 51 mm high, minimum.
    2. Construction: 16-gauge galvanized steel with brazed joints. Pans shall be watertight and have hemmed edges.
    3. Drain Connection:
        a. Minimum 25 mm or as shown on Drawings.
        b. Locate at lowest point of drain pan.

c. In lieu of drain connection, float switch may be installed. Float switch shall shut down air handling equipment upon sensing water.

D. Prefabricated Roof Curb:
1. Refer to Section 07 70 01, Roof Specialties and Accessories.
2. Lower section of roof curb that will be integrated with roofing system shall be constructed to accommodate roofing system provided.
3. Top surface of curb shall have rubber weather-seal pad. Provide wooden nailer sections as required for installation.
4. Sheet metal counterflashing shall be provided to accommodate rectangular or round ductwork.
5. Sheet metal screws and rivets shall be stainless steel or coated with corrosion-resistant material.
6. Height of roof curb shall be 305 mm, unless otherwise indicated herein or on Drawings.
7. Length and width of roof curb shall be sized by Contractor for particular application.
8. Manufacturer:
   a. Factory fabricated by equipment manufacturer.

E. Accessories Hardware:
1. Instrument Test Holes:
   a. Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.
   b. Size to allow insertion of pitot tube and other testing instruments.
   c. Provide in length to suit duct insulation thickness.
2. Flexible Duct Clamps:
   a. Stainless steel band with cadmium-plated hex screw to tighten band with worm-gear action.
   b. Provide in sizes from 75 mm to 450 mm to suit duct size.
3. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

2.28 REMOVABLE INSECT SCREENS

A. General

Frame	- extruded aluminum channel, 65 mm x 18 mm
	- extruded aluminum angle, 40 x 25 x 3 mm screen frame retainers
Screen Retention Frame	- extruded aluminum with rubber retainer gasket
Insect Screen	- 18 x 14 mesh, .011 gauge, grade 304 stainless steel
Max. Section Size	- 1.5 m x 1.5 m

B. Mounting

Ducting Mounting	- "slide out" screen
	- rubber gasket around screen slot in frame
	- cast aluminum handle rigidly attached to screen

	retention frame. 2 handles per screen section
Face Mounting	- "lift and remove" screen
	- nylon finger pulls, 25 x 30 x 1.5 mm mounted in screen retention frame

C. In locations where removable insect screen is associated with air control dampers, supply the two units as an integrated, factory assembled unit.

D. Manufacturer
   1. T.A. Morrison & Company Inc. Series 6000.

2.29 DUCTWORK IDENTIFICATION

A. Painted Identification Materials:
   1. Stencils: Standard metal stencils, prepared for required applications with letter sizes generally comply with recommendations of ASME A13.1 for piping and similar applications, but not less than 32 mm high letters for ductwork and not less than 20 mm high letters for access door signs and similar operational instructions.
   2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
   3. Identification Paint: Standard identification enamel of colors indicated or in accordance with ASME A13.1 for colors for systems not identified herein.

B. Plastic Duct Markers
   1. General: Provide manufacturer’s standard laminated plastic, color coded duct markers. Conform to the following color code:
      a. Black text on yellow background: Odorous Air.
      b. White text on blue background: Services other than hazardous exhaust and odorous air.
      c. For other hazardous exhausts, use colors and designs recommended by ASME A13.1.

C. Nomenclature: Include the following:
   1. Direction of air flow.
   2. Duct service (supply, return, exhaust).
   3. Duct origin (from).
   4. Duct destination (to).
   5. Design L/s.

D. Manufacturers:
   1. W.H. Brady, Co.
   2. Seton Identification Products.
   3. Craftmark.
   4. Brimar Industries, Inc.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

A. Miscellaneous:
   1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.
   2. Install ductwork using manufacturer's recommended adhesives, cement, sealant, and insulation accessories.
   3. Align ductwork accurately at connections, within 3.2 mm misalignment tolerance and with internal surfaces smooth.
   4. Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

B. Ductwork Location:
   1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.
   2. Avoid diagonal runs wherever possible.
   3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.
   4. In general, install as close to bottom of structure as possible.
   5. For ductwork run above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.
   6. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
   7. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

C. Penetrations:
   1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
   2. Clearances:
      a. For uninsulated ducts, allow 25 mm clearance between duct and sleeve, except at grilles, registers, and diffusers.
      b. For insulated ducts, allow 25 mm clearance between insulation and sleeve, except at grilles, registers, and diffusers.
   3. Closure Collars:
      a. Minimum 102 mm wide on each side of walls or floors where sleeves or prepared openings are installed.
      b. Fit collars snugly around ducts and insulation.
      c. Same gauge and material as duct.
      d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
      e. Use fasteners with maximum 152 mm centers on collars.
   4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

D. Concealment:
   1. Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.
   2. Do not encase horizontal runs in solid partitions, except as specifically shown.
   3. Limit clearance to 25 mm where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.

E. Coordination with Other Trades:
   1. Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
   2. Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.
   3. Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.
   4. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

F. Shower Room and Toilet Room Exhaust Ductwork:
   1. Joints and Seams: Seal watertight.
   2. Slope branch ducts downward to grille.

G. Fume Hood, Laboratory, and Chlorine Room Exhaust Ductwork:
   1. Seal joints and seams with chemical-resistant mastic.
   2. Rivet butt joints with minimum of eight pop rivets.

3.2 RECTANGULAR DUCTWORK

A. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.

B. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

3.3 RECTANGULAR DUCTWORK FITTINGS

A. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.

B. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.

C. Make offsets with maximum angle of 45 degrees.

D. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

3.4 RECTANGULAR DUCTWORK TRANSVERSE JOINTS

A. Install each run with a minimum of joints.

B. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

C. Mechanical Joint Option:
   1. Construct transverse joints with Ductmate 25/35 duct connector systems, W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system.
   2. When using W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.
   3. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.
   4. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.
   5. Conform to SMACNA Class A sealing requirements.

3.5 RIGID ROUND DUCTWORK

A. Except where interrupted by fittings, install round ducts in lengths not less than 3.6 meters.

3.6 RIGID ROUND DUCTWORK JOINTS

A. Rigid round ductwork joints shall be in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless otherwise specified.

B. Single and Double Wall Supply and Return System Joints:
   1. Less than 900 mm: Slip coupling.
   2. Larger than 900 mm: Flanged connector, Van Stone, or welded companion flange type.

C. Single and Double Wall Exhaust and Return System Joints:
   1. All Sizes, Spiral Seam Duct: Welded flanged connector.
   2. All Sizes, Longitudinal Seam Duct: Van Stone flange connector.

3.7 INSULATED FLEXIBLE DUCT

A. Installation:
   1. Where shown, between branch duct and ceiling diffusers and grilles.
   2. Without sags, kinks, sharp offsets, or elbows.
   3. As straight and taut as possible.

B. Connection: Connect flexible ductwork to round collars, air distribution devices, and terminal units in accordance with flexible duct manufacturer's recommendations.

C. Length:
   1. Maximum length of low-pressure flexible duct (construction pressure class up to 500 Pa) to be 2400 mm.
   2. Maximum length of medium pressure flexible duct (construction pressure class up to 1000 Pa) to be 2400 mm.

D. Flexible ductwork shall not pass through wall, floor, or fire resistant rated assembly.

3.8 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.

D. Support horizontal ducts within 610 mm of each elbow and within 1220 mm of each branch intersection.

E. Support vertical ducts at maximum interval of 4880 mm and at each floor.

F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

G. In new construction, install concrete insert prior to placing concrete.

3.9 FLEXIBLE CONNECTIONS

A. Flexible Collars and Connections:
   1. Use between fans and ducts.
   2. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.
   3. For rectangular ducts, lock flexible connections to metal collars.

3.10 DAMPERS

A. General:
   1. Inspection:
      a. Inspect areas to receive dampers.
      b. Notify Contract Administrator of conditions that would adversely affect installation or subsequent utilization of dampers.
      c. Do not proceed with installation until unsatisfactory conditions are corrected.
   2. Install dampers at locations indicated on Drawings and in accordance with manufacturer’s installation instructions.
   3. Install square and level.
   4. Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.
   5. Damper blades and hardware shall operate freely without obstruction.
   6. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
   7. When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.
   8. Head and sill shall have stops.
   9. Suitable for installation in mounting arrangement shown.
   10. Do not compress or stretch damper frame into duct or opening.

B. Manual Dampers:
   1. Provide balancing dampers for grilles and diffusers in branch duct as near main as possible.
   2. Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

C. Back Draft Dampers:
   1. Install dampers square and free from racking with blades running horizontally.
   2. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

D. Fire Dampers:
   1. At ceiling grille and diffuser fire dampers, provide thermal blankets where required by local authorities.
   2. Install 1-1/2-hour rated, unless otherwise indicated, at locations shown and in accordance with SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.

E. Motorized dampers:
   1. Install at locations indicated on Drawings and in accordance with manufacturer's instructions.
   2. Install square and free from racking with blades running horizontally.
   3. Operate opposed blade dampers from a power blade or drive axile.
   4. Bracing:
      a. Install for multiple section assemblies to support assembly weight and to hold against system pressure.
      b. Install at every horizontal and vertical mullion.

3.11 ACCESS DOORS

A. Ceilings:
   1. Install in nonaccessible ceilings below each electric duct heater, booster coil, motorized damper, terminal unit, smoke detector, and fire damper.

B. Ductwork: Install access doors in ductwork, in accordance with manufacturer's instructions, at each:
   1. Duct mounted fire damper.
   2. Duct mounted smoke or ionization detector.
   3. Electric duct heater.
   4. Booster coil.
   5. Humidifier.
   6. Motorized damper.
   7. Sail switch.
   8. Turning vane.
   9. Volume damper.
   10. Automatic damper.
   11. Temperature controller.
   12. Coil, on both upstream and downstream side.

3.12 SOUND ATTENUATORS

A. Install where shown and in accordance with applicable SMACNA Manual and manufacturer's recommendations.

B. Provide dielectric separation where attenuator material differs from connected duct system.

3.13 EXTERNAL DUCT INSULATION

A. Refer to Section 23 07 00, HVAC Insulation.

3.14 MISCELLANEOUS ACCESSORIES

A. Auxiliary Drain Pans:
   1. Under equipment for which pan is shown on Drawings and under all horizontal air handling units located above ceilings and piping located in ceiling space directly above computer facility areas; furnish and install auxiliary drain pans.
   2. Route drain lines to nearest floor or hub drain independent of any other drain.
   3. Slope drain pans toward drain connection to promote drainage.
   4. Louver and Grille Blank-off Sections: Attach airtight to louver or grille and install to allow for easy removal.

B. Prefabricated Roof Curb:
   1. Refer to Section 07 70 01, Roof Specialties And Accessories.
   2. Provide for ductwork roof penetrations and curb-mounted roof fans.
   3. Roof curb installation, including flashing and counterflashing, shall provide watertight weatherproof enclosure.
   4. Attach counterflashing to ductwork via rubber gasketed sheet metal screws.
   5. Fill space between counterflashing and ductwork with silicon-based sealant. Sealant shall also be applied at all sheet metal screw locations.

C. Inspection Plates and Test Holes:
   1. Where required in ductwork for balance measurements.
   2. Test holes shall be, airtight and noncorrosive with screw cap and gasket.
   3. Extend cap through insulation.

3.15 DUCT SEALING

A. Seal duct seams and joints as follows:
   1. As indicated on Ductwork Schedule

B. If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

C. Seal externally insulated ducts prior to insulation installation.

D. Provide additional duct sealing as required to comply with Article - Ductwork Leakage Testing.

E. Seal all audible leak.

3.16 FIRESTOPPING

A. Refer to Section 07 84 00, Firestopping.

3.17 PAINTING OF DUCTWORK

A. Refer to Section 09 90 00, Painting and Coating

3.18 DUCTWORK LEAKAGE TESTING

A. General:
   1. Tests shall be conducted on completed ductwork systems.
   2. Testing of partial installations or limited sections of ductwork will not be acceptable.
   3. All ductwork leakage test procedures and results shall be submitted to Contract Administrator for review.
   4. Contract Administrator shall retain the right to witness some or all ductwork leakage testing procedures.
   5. Contractor shall notify Contract Administrator in writing at least 5 working days prior to ductwork testing.

B. Leakage Criteria:
   1. Assemble and install ductwork with maximum leakage limited as follows:
   2. Constant Volume Systems:
      a. Supply Ductwork:
         1) Operating Pressure: 0- to 500 Pa
            a) Allowable Leakage: 2 percent of design airflow.
         2) Operating Pressure: 750 Pa and over.
            a) Allowable Leakage: 1 percent of design airflow.
      b. Return Ductwork:
         1) Operating Pressure: All.
         2) Allowable Leakage: 2 percent of design airflow.

C. Leakage Testing Method:
   1. Contractor shall be responsible for providing all necessary test fans and calibrated measuring devices to accomplish ductwork leakage test and to demonstrate that ductwork systems leakage rate is less than maximum rate specified.
   2. Pressure testing shall be accomplished using a pressure blower with a calibrated orifice and manometer.
   3. Blower shall maintain system design static pressure during test.
   4. Perform testing in accordance with procedures given in SMACNA HVAC Air Duct Leakage Test Manual.

3.19 BALANCING AND TESTING OF AIR SYSTEMS

A. Perform testing in accordance with the requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.20 PROTECTION OF INSTALLED WORK

A. Open ends of installed ductwork systems shall be covered to prevent dust, foreign objects and water from entering ductwork.

B. Ductwork systems shall not be used for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

3.21 CLEANING

A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

C. If duct systems are found to contain construction debris at time of construction completion Contractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

3.22 SUPPLEMENTS

A. The supplements listed below, following End of Section, are a part of this Specification:
   1. Section 23 31 13.01, Ductwork Schedule.
   2. Section 22 31 13 02 Sound Attenuator Schedule
   3. Section 23 31 13.03, Motorized damper Schedule.

END OF SECTION

DUCTWORK SCHEDULE 23 31 13.01

SYSTEMS	SERVICE	SECTION	SMACNA DUCT CONSTRUCTION CRITERIA			APPLICABLE REMARKS
			PRESSURE CLASS (Pa)	MATERIALS OF CONSTRUCTION	SEAL CLASS	
HIGH RATE CLARIFICATION FACILITY:						
AHU-K620. AHU-K630, AHU-K640	SUPPLY AIR	ALL	2500	ALUMINUM (AL61)	A	
	OUTDOOR AIR	ALL	-1500	ALUMINUM (AL61)	A	
AHU-K610	SUPPLY AIR	ALL	2500	STAINLESS STEEL (SS64)	A	
	OUTDOOR AIR	ALL	-1500	STAINLESS STEEL (SS64)	A	
EF-K621, EF-K622, EF-K631, EF-K652	EXHAUST AIR	ALL	-1500	ALUMINUM (AL61)	A	
EF-K611, EF-K612	EXHAUST AIR	UPSTREAM OF FANS	-1500	STAINLESS STEEL (SS66)	A	
	EXHAUST AIR	DOWNSTREAM OF FANS	3000	FRP (FP61)	A	A
SECONDARY CLARIFIIER FACILITY:						
AHU-S630. AHU-S640, AHU-S650	SUPPLY AIR	ALL	2500	ALUMINUM (AL61)	A	
	OUTDOOR AIR	ALL	-1500	ALUMINUM (AL61)	A	
EF-S651, EF-S652, EF-S653, EF-S654	EXHAUST AIR	ALL	-1500	ALUMINUM (AL61)	A	
BIOREACTOR FACILITY:						
AHU-R610	SUPPLY AIR	ALL	2500	ALUMINUM (AL61)	A	
	OUTDOOR AIR	ALL	-1500	ALUMINIUM (AL61)	A	
AHU-R620	SUPPLY AIR	ALL	2500	ALUMINIUM (AL61)	A	
	RETURN AIR	ALL	-1500	ALUMINIUM (AL61)	A	
AHU-R640	SUPPLY AIR	ALL	2500	ALUMINIUM (AL61)	A	

DUCTWORK SCHEDULE 23 31 13.01

SYSTEMS	SERVICE	SECTION	SMACNA DUCT CONSTRUCTION CRITERIA			APPLICABLE REMARKS
			PRESSURE CLASS (Pa)	MATERIALS OF CONSTRUCTION	SEAL CLASS	
AHU-R640	RETURN AIR	ALL	-1500	ALUMINIUM (AL61)	A	
EF-R601, EF-R602	EXHAUST AIR	ALL				B
EF-R611, EF-R612	EXHAUST AIR	UPSTREAM OF FANS	-1500	ALUMINIUM (AL61)	A	
	EXHAUST AIR	DOWNSTREAM OF FANS	2500	ALUMINIUM (AL61)	A	
EF-R652, EF-R653, EF-R651	EXHAUST AIR	ALL	-500	ALUMINIUM (AL61)	A	
EF-R621, EF-R622, EF-R623	EXHAUST AIR	ALL	-1500	ALUMINIUM (AL61)	A	
HEADWORKS FACILITY:						
AHU-G620	SUPPLY AIR	ALL	2500	STAINLESS STEEL (SS64)	A	
	OUTDOOR AIR	ALL	-1500	STAINLESS STEEL (SS64)	A	
EF-B685, EF-B686, EF-B687, EF-B688	EXHAUST AIR	UPSTREAM OF FANS	-2000	STAINLESS STEEL (SS66)	A	
	EXHAUST AIR	DOWNSTREAM OF FANS	3000	FRP (FP61)	A	A
AHU-G610	SUPPLY AIR	ALL	2500	STAINLESS STEEL (SS64)	A	
	OUTDOOR AIR	ALL	-1500	ALUMINIUM (AL61)	A	
AHU-G630	SUPPLY AIR	ALL	2500	STAINLESS STEEL (SS64)	A	
	OUTDOOR AIR	ALL	-1500	ALUMINUM (AL61)	A	
AHU-G640	SUPPLY AIR	ALL	1500	ALUMINUM (AL61)	A	
	RETURN AIR	ALL	-1500	ALUMINUM (AL61)	A	

DUCTWORK SCHEDULE 23 31 13.01

SYSTEMS	SERVICE	SECTION	SMACNA DUCT CONSTRUCTION CRITERIA			APPLICABLE REMARKS
			PRESSURE CLASS (Pa)	MATERIALS OF CONSTRUCTION	SEAL CLASS	
EF-G693	EXHAUST AIR	ALL	-1500	ALUMINUM (AL61)	A	
SF-G612, EF-G656, EF-G657	SUPPLY AIR	ALL	500	ALUMINUM (AL61)	C	
EF-G611	EXHAUST AIR	UPSTREAM OF FAN	-1500	STAINLESS STEEL (SS64)	A	
	EXHAUST AIR	DOWNSTREAM OF FAN	3000	FRP (FP61)	A	
CHEMICAL AND ELECTRICAL FACILITY:						
AHU-C611, AHU-C612	SUPPLY AIR	ALL	2500	STAINLESS STEEL (SS66)	A	
	OUTDOOR AIR	ALL	-1500	ALUMINIUM (AL61)	A	
AHU-C620	SUPPLY AIR	ALL	2500	ALUMINIUM (AL61)	A	
	OUTDOOR AIR	ALL	-1500	ALUMINIUM (AL61)	A	
AHU-C640	SUPPLY AIR	ALL	2500	ALUMINIUM (AL61)	A	
	RETURN AIR	ALL	-1500	ALUMINIUM (AL61)	A	
EF-C613, EF-C614, EF-C615, EF-C616	EXHAUST AIR	ALL	-1500	STAINLESS STEEL (SS66)	A	
EF-C653	EXHAUST AIR	ALL	500	STAINLESS STEEL (SS66)	C	
EF-C662	EXHAUST AIR	ALL	500	ALUMINIUM (AL61)	C	
EF-C651, EF-C652, EF-C661	EXHAUST AIR	UPSTREAM OF FANS	-1500	GALVANIZED STEEL (GS61)	A	
	EXHAUST AIR	DOWNSTREAM OF FANS	2500	GALVANIZED STEEL (GS61)	A	
EF-C621	EXHAUST AIR	UPSTREAM OF FAN	-1500	ALUMINIUM (AL61)	A	

DUCTWORK SCHEDULE 23 31 13.01

SYSTEMS	SERVICE	SECTION	SMACNA DUCT CONSTRUCTION CRITERIA			APPLICABLE REMARKS
			PRESSURE CLASS (Pa)	MATERIALS OF CONSTRUCTION	SEAL CLASS	
EF-C621	EXHAUST AIR	DOWNSTREAM OF FAN	2500	ALUMINIUM (AL61)	A	
UV FACILITY:						
SF-U660	SUPPLY AIR	ALL	2500	ALUMINUM (AL61)	A	
	OUTDOOR AIR	ALL	-1500	ALUMINUM (AL61)	A	
BIOFILTER FACILITY:						
AHU-T610	SUPPLY AIR	ALL	2500	ALUMINUM (AL61)	A	
EF-T611, EF-T612	EXHAUST AIR	ALL	-1500	ALUMINUM (AL61)	A	
ROTARY DRUM THICKENERS FACILITY:						
AHU-D610, AHU-D620	SUPPLY AIR	ALL	2500	ALUMINUM (AL61)	A	
AHU-D640, AHU-D650	SUPPLY AIR	ALL	2500	ALUMINUM (AL61)	A	
	RETURN	ALL	-1500	ALUMINUM (AL61)	A	
EF-D611, EF-D612	EXHAUST AIR	UPSTREAM OF FANS	-1500	ALUMINUM (AL61)	A	
	EXHAUST AIR	DOWNSTREAM OF FANS	2500	ALUMINUM (AL61)	A	
EF-D621	EXHAUST AIR	ALL	-1500	ALUMINUM (AL61)	A	
ADMINISTRATION FACILITY:						
AHU-M681	SUPPLY AIR	ALL	2500	GALVANIZED STEEL (GS61)	A	
EF-M687	EXHAUST AIR	UPSTREAM OF FAN	-1500	ALUMINUM (AL61)	A	
	EXHAUST AIR	DOWNSTREAM OF FANS	2500	ALUMINUM (AL61)	A	

DUCTWORK SCHEDULE 23 31 13.01

SYSTEMS	SERVICE	SECTION	SMACNA DUCT CONSTRUCTION CRITERIA			APPLICABLE REMARKS
			PRESSURE CLASS (Pa)	MATERIALS OF CONSTRUCTION	SEAL CLASS	
EF-M689	EXHAUST AIR	ALL	-500	ALUMINUM (AL61)	C	

REMARKS:

A: REFER SECTION 23 31 16.16, THERMOSET FIBERGLASS-REINFORCED PLASTIC DUCTS (FP61)

B: BIOREACTORS ODOUR CONTROL DUCTWORK, REFER TO SECTION 40 27 00, PROCESS PIPING GENERAL

SOUND ATTENUATOR SCHEDULE 23 31 13.02

SYMBOL			SIL-1	SIL-2	SIL-3	SIL-4	SIL-5
SERVING			GENERATOR ROOM (GENSET EX)	GENERATOR ROOM (GENSET EX)	GENERATOR ROOM (GENSET IN)	GENERATOR ROOM (GENSET IN)	GENERATOR ROOM (EF-C661)
AIRFLOW DATA	QUANTITY	L/s	41333	41333	44496	44496	142
	FACE VELOCITY	m/s	1.83	1.83	1.19	1.19	1.58
	FLOW DIRECTION	FWD/REV	FWD	FWD	REV	REV	FWD
	PRESSURE DROP	Pa	10	10	5	5	5
SIZE	WIDTH	mm	4600	4600	5000	5000	300
	HEIGHT	mm	4900	4900	7400	7400	300
	LENGTH	mm	1500	1500	900	900	1500
DYNAMIC INSERTION LOSS (dB)	MID OCTAVE BAND FREQUENCY (Hz)	63	7	7	7	7	4
		125	12	12	12	12	9
		250	21	21	18	18	20
		500	36	36	24	24	37
		1K	44	44	35	35	51
		2K	41	41	28	28	49
		4K	25	25	17	17	32
		8K	17	17	12	12	21
MANUFACTURER			VIBRO-ACOUSTICS	VIBRO-ACOUSTICS	VIBRO-ACOUSTICS	VIBRO-ACOUSTICS	VIBRO-ACOUSTICS
MODEL NO.			RD-LV-F6 -L17782	RD-LV-F6 -L17782	RD-ULV-F6 - L17782	RD-ULV-F6 - L17782	RD-MLV-F9 - L17782
APPLICABLE REMARKS							A

REMARKS

A: PROVIDE INLET AND OUTLET DUCT TRANSITIONS AS REQUIRED

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-R6011	XV-R6021		
SPECIFICATION TYPE			ODOUR DUCTWORK	ODOUR DUCTWORK		
LOCATION			BIOREACTORS	BIOREACTORS		
SERVICE			EF-R601 INLET	EF-R602 INLET		
DAMPER TYPES			PBD	PBD		
CONSTRUCTION MATERIALS			316 SST	316 SST		
PERFORMANCE	AIR FLOW	L/s	7196	7196		
NOMINAL DIMENSIONS	LENGTH	mm	950	950		
	HEIGHT	mm	950	950		
ACTUATOR DATA	FAILS		CLOSED	CLOSED		
	NUMBER		1	1		
	TYPE		TP, SP,LT, EXP	TP, SP, LT, EXP		
	MODEL No.		IQ3	IQ3		
	VOLTS		575	575		
MANUFACTURER	DAMPER		AWV	AWV		
	ACTUATOR		ROTORK	ROTORK		
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			FV-R6108	XV-R6111	XV-R6121	
SPECIFICATION TYPE			STANDARD DUTY	HIGH PERFORMANCE	HIGH PERFORMANCE	
LOCATION			MECHANICAL ROOM	GALLERY 8	BLOWER ROOM	
SERVICE			AHU-R640 OUTSIDE AIR	GALLERY 8/5B EXHAUST	GALLERY 8A EXHAUST	
DAMPER TYPES			OBD	PBD, INS	PBD, INS	
CONSTRUCTION MATERIALS			ALUM	ALUM	ALUM	
PERFORMANCE	AIR FLOW	L/s	378	3340	5100	
NOMINAL DIMENSIONS	LENGTH	mm	300	650	750	
	HEIGHT	mm	250	650	1250	
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	
	NUMBER		1	1	1	
	TYPE		MOD	TP, SP	TP, SP	
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF	
	VOLTS		120	120	120	
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-R6209-1,2	XV-R6207-1	XV-R6207-2	XV-R6211
SPECIFICATION TYPE			HIGH PERFORMANCE	HIGH PERFORMANCE	STANDARD DUTY	HIGH PERFORMANCE
LOCATION			MECHANICAL ROOM	MECHANICAL ROOM	MECHANICAL ROOM	MECHANICAL ROOM
SERVICE			BLOWER RM .OA INTAKE	BLOWER ROOM EXHAUST	BLOWER ROOM RECIRC.	BLOWER ROOM EXHAUST
DAMPER TYPES			PBD, INS	PBD, INS	PBD	PBD, INS
CONSTRUCTION MATERIALS			ALUM	ALUM	ALUM	ALUM
PERFORMANCE	AIR FLOW	L/s	11360	3775	3775	3800
NOMINAL DIMENSIONS	LENGTH	mm	2000	1450	700	914
	HEIGHT	mm	4730	600	700	914
ACTUATOR DATA	FAILS		CLOSED	CLOSED	OPEN	CLOSED
	NUMBER		1	1	1	1
	TYPE		TP,SP	TP, SP	TP, SP	TP, SP
	MODEL No.		InMax-50-YF	InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-R6221	XV-R6231	XV-R6511	XV-R6512
SPECIFICATION TYPE			HIGH PERFORMANCE	HIGH PERFORMANCE	HIGH PERFORMANCE	HIGH PERFORMANCE
LOCATION			MECHANICAL ROOM	MECHANICAL ROOM	MECHANICAL ROOM	MECHANICAL ROOM
SERVICE			BLOWER ROOM EXHAUST	BLOWER ROOM EXHAUST	MECH. RM. INTAKE	MECH. RM. EXHAUST
DAMPER TYPES			PBD,INS	PBD, INS	PBD, INS	PBD, INS
CONSTRUCTION MATERIALS			ALUM	ALUM	ALUM	ALUM
PERFORMANCE	AIR FLOW	L/s	3800	3800	378	378
NOMINAL DIMENSIONS	LENGTH	mm	914	914	500	500
	HEIGHT	mm	914	914	900	900
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	CLOSED
	NUMBER		1	1	1	1
	TYPE		TP, SP	TP, SP	TP, SP	TP, SP
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS						**23 31 13.03**
SYMBOL			XV-C6131	XV-C6141	XV-C6151	XV-C6161
SPECIFICATION TYPE			HEAVY DUTY	HEAVY DUTY	HEAVY DUTY	HEAVY DUTY
LOCATION			ROOF, EF-C613 INLET	ROOF, EF-C614 INLET	ROOF, EF-C615 INLET	ROOF, EF-C616 INLET
SERVICE			CHEM. LOAD. PLATFM. EXH.	CHEM. LOAD. PLATFM. EXH.	CHEM. CONTAIN. RM. EXH.	CHEM. CONTAIN. RM. EXH.
DAMPER TYPES			PBD, INS	PBD, INS	PBD, INS	PBD, INS
CONSTRUCTION MATERIALS			316 SST	316 SST	316 SST	316 SST
PERFORMANCE	AIR FLOW	L/s	4347	4347	4323	4232
NOMINAL DIMENSIONS	LENGTH	mm	1000	1000	1000	1000
	HEIGHT	mm	800	800	800	800
ACTUATOR DATA	FAILS		OPEN	OPEN	OPEN	OPEN
	NUMBER		1	1	1	1
	TYPE		TP, SP, LT	TP, SP, LT	TP, SP, LT	TP, SP, LT
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-C6208	XV-C6211		
SPECIFICATION TYPE			STANDARD DUTY	HIGH PERFORMANCE		
LOCATION			MECHANICAL ROOM 1	MECH. RM. 2, EF-C621		
SERVICE			AHU-C640 OUTSIDE AIR	GALLERY 6 EXHAUST		
DAMPER TYPES			OBD	PBD, INS		
CONSTRUCTION MATERIALS			ALUM	ALUM		
PERFORMANCE	AIR FLOW	L/s	566	1830		
NOMINAL DIMENSIONS	LENGTH	mm	300	1000		
	HEIGHT	mm	400	450		
ACTUATOR DATA	FAILS		CLOSED	CLOSED		
	NUMBER		1	1		
	TYPE		TP, SP	TP, SP		
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF		
	VOLTS		120	120		
MANUFACTURER	DAMPER		RUSKIN	RUSKIN		
	ACTUATOR		SCHISCHEK	SCHISCHEK		
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS						**23 31 13.03**
SYMBOL			XV-C6511	XV-C6512	XV-C6521	XV-C6522
SPECIFICATION TYPE			HIGH PERFORMANCE	HIGH PERFORMANCE	HIGH PERFORMANCE	HIGH PERFORMANCE
LOCATION			MECHANICAL ROOM 1	MECH. RM. 1, EF-C651	MECHANICAL ROOM 2	MECH. RM. 2, EF-C652
SERVICE			OUTSIDE AIR INTAKE	MECH. RM. 1 EXHAUST	OUTSIDE AIR INTAKE	MECH. ROOM 2 EXHAUST
DAMPER TYPES			PBD,INS	PBD, INS	PBD, INS	PBD, INS
CONSTRUCTION MATERIALS			STL	STL	STL	STL
PERFORMANCE	AIR FLOW	L/s	200	200	280	280
NOMINAL DIMENSIONS	LENGTH	mm	600	300	600	300
	HEIGHT	mm	450	300	600	300
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	CLOSED
	NUMBER		1	1	1	1
	TYPE		TP, SP	TP, SP	TP, SP	TP, SP
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-C6611	XV-C6612		
SPECIFICATION TYPE			HIGH PERFORMANCE	HIGH PERFORMANCE		
LOCATION			GENERATOR ROOM	GENERATOR ROOM		
SERVICE			NORMAL VENT. INTAKE	NORMAL VENT. EXHAUST		
DAMPER TYPES			PBD, INS	PBD, INS		
CONSTRUCTION MATERIALS			STL	STL		
PERFORMANCE	AIR FLOW	L/s	142	142		
NOMINAL DIMENSIONS	LENGTH	mm	300	300		
	HEIGHT	mm	300	300		
ACTUATOR DATA	FAILS		CLOSED	CLOSED		
	NUMBER		1	1		
	TYPE		TP, SP	TP, SP		
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF		
	VOLTS		120	120		
MANUFACTURER	DAMPER		RUSKIN	RUSKIN		
	ACTUATOR		SCHISCHEK	SCHISCHEK		
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-C6651-1..2	XV-C6652-1..8	TV-C6653-1..4	TV-C6654
SPECIFICATION TYPE			HIGH PERFORMANCE	HIGH PERFORMANCE	HEAVY DUTY	STANDARD DUTY
LOCATION			GENERATOR ROOM	GENERATOR ROOM	GENERATOR ROOM	GEN-C572 EXH. PLENUM
SERVICE			GEN-C572 COMB. AIR INTAKE	GEN-C572 H.R. VENT. INTAKE	GEN-C572 EXHAUST AIR	GEN-C572 RECIRC. AIR
DAMPER TYPES			PBD, INS	PBD, INS	OBD, INS	OBD, INS
CONSTRUCTION MATERIALS			STL	STL	STL	STL
PERFORMANCE	AIR FLOW	L/s	3092	41333	41333	6700
NOMINAL DIMENSIONS	LENGTH	mm	4600	4600	4600	1600
	HEIGHT	mm	450	4150	4900	1200
ACTUATOR DATA	FAILS		OPEN	OPEN	OPEN	CLOSED
	NUMBER		2	8	4	1
	TYPE		TP, SP	TP, SP	MOD, SP	MOD, SP
	MODEL No.		InMax-30-YF	InMax-30-YF	InMax-50-YF	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			TV-C6655	TV-C6656-1,2	TV-C6657-1..2	
SPECIFICATION TYPE			STANDARD DUTY	STANDARD DUTY	STANDARD DUTY	
LOCATION			GEN-C572 EXH. PLENUM	GEN-C572 EXH. PLENUM	GEN-C572 EXH. PLENUM	
SERVICE			GEN-C572 RECIRC. AIR	GEN-C572 RECIRC. AIR	GEN-C572 RECIRC. AIR	
DAMPER TYPES			OBD	OBD	OBD	
CONSTRUCTION MATERIALS			STL	STL	STL	
PERFORMANCE	AIR FLOW	L/s	6700	16760	11172	
NOMINAL DIMENSIONS	LENGTH	mm	1600	3000	2000	
	HEIGHT	mm	1200	1600	1600	
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	
	NUMBER		1	2	2	
	TYPE		MOD, SP	MOD, SP	MOD, SP	
	MODEL No.		InMax-30-YF	InMax-50-YF	InMax-50-YF	
	VOLTS		120	120	120	
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS — 23 31 13.03

SYMBOL			XV-C6661-1..2	XV-C6662-1..8	TV-C6663-1..4	TV-C6664
SPECIFICATION TYPE			HIGH PERFORMANCE	HIGH PERFORMANCE	HEAVY DUTY	STANDARD DUTY
LOCATION			GENERATOR ROOM	GENERATOR ROOM	GENERATOR ROOM	GEN-C582 EXH. PLENUM
SERVICE			GEN-C582 COMB. AIR INTAKE	GEN-C582 H.R. VENT. INTAKE	GEN-C582 EXHAUST AIR	GEN-C582 RECIRC. AIR
DAMPER TYPES			PBD, INS	PBD, INS	OBD	OBD
CONSTRUCTION MATERIALS			STL	STL	STL	STL
PERFORMANCE	AIR FLOW	L/s	3092	41333	41333	6700
NOMINAL DIMENSIONS	LENGTH	mm	4600	4600	4600	1600
	HEIGHT	mm	450	4150	4900	1200
ACTUATOR DATA	FAILS		OPEN	OPEN	OPEN	CLOSED
	NUMBER		2	8	4	1
	TYPE		TP, SP	TP, SP	MOD, SP	MOD, SP
	MODEL No.		InMax-30-YF	InMax-30-YF	InMax-50-YF	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			TV-C6665	TV-C6666-1..2	TV-C6667-1..2	
SPECIFICATION TYPE			STANDARD DUTY	STANDARD DUTY	STANDARD DUTY	
LOCATION			GEN-C582 EXH. PLENUM	GEN-C582 EXH. PLENUM	GEN-C582 EXH. PLENUM	
SERVICE			GEN-C582 RECIRC. AIR	GEN-C582 RECIRC. AIR	GEN-C582 RECIRC. AIR	
DAMPER TYPES			OBD	OBD	OBD	
CONSTRUCTION MATERIALS			STL	STL	STL	
PERFORMANCE	AIR FLOW	L/s	6700	16760	11172	
NOMINAL DIMENSIONS	LENGTH	mm	1600	3000	2000	
	HEIGHT	mm	1200	1600	1600	
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	
	NUMBER		1	2	2	
	TYPE		MOD, SP	MOD, SP	MOD, SP	
	MODEL No.		InMax-30-YF	InMax-50-YF	InMax-30-YF	
	VOLTS		120	120	120	
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			FV-G6108	FV-G6111	FV-G6122	FV-G6208
SPECIFICATION TYPE			STANDARD DUTY	HEAVY DUTY	HIGH PERFORMANCE	STANDARD DUTY
LOCATION			MECHANICAL ROOM	ROOF, EF-G611 DISCHARGE	MECH. ROOM, SF-G612 INLET	DRYWELL MR. AHU G620 OUTLET
SERVICE			AHU-G640 OUTSIDE AIR	GRIT & SCRNG. RM. EXHAUST	MECH. ROOM SUPPLY AIR	AHU-G649 OUTSIDE AIR
DAMPER TYPES			OBD	PBD	PBD, INS	OBD
CONSTRUCTION MATERIALS			ALUM	316 SST	ALUM	ALUM
PERFORMANCE	AIR FLOW	L/s	378	5304	185	423
NOMINAL DIMENSIONS	LENGTH	mm	200	550	400	350
	HEIGHT	mm	350	1500	400	250
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	CLOSED
	NUMBER		1	1	1	1
	TYPE		MOD, SP	TP, SP, LT	TP, SP	MOD, SP
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN		RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-B6851	XV-B6853		
SPECIFICATION TYPE			HEAVY DUTY	HEAVY DUTY		
LOCATION			GRIT TANK RM. AIR PLENUM 2	SERV. BLDG. MR., EF-B685 OULET		
SERVICE			SCREEN RM. EXHAUST	SCREEN RM. EXHAUST		
DAMPER TYPES			PBD, INS	PBD, INS		
CONSTRUCTION MATERIALS			316 SST	316 SST		
PERFORMANCE	AIR FLOW	L/s	5100	5100		
NOMINAL DIMENSIONS	LENGTH	mm	1300	1300		
	HEIGHT	mm	500	500		
ACTUATOR DATA	FAILS		CLOSED	CLOSED		
	NUMBER		1	1		
	TYPE		TP,SP, EXP	TP, SP, EXP		
	MODEL No.		RedMax-45.90-YF-A	RedMax-45.90-YF-A		
	VOLTS		120	120		
MANUFACTURER	DAMPER		RUSKIN	RUSKIN		
	ACTUATOR		SCHISCHEK	SCHISCHEK		
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-B6861	XV-B6863	XV-B6871	XV-B6873
SPECIFICATION TYPE			HEAVY DUTY	HEAVY DUTY	HEAVY DUTY	HEAVY DUTY
LOCATION			GRIT TANK RM. AIR PLENUM 1	SERV. BLDG. MR., EF-B686 OULET	GRIT TANK RM. AIR PLENUM 4	SERV. BLDG. MR., EF-B687 OULET
SERVICE			SCREEN RM. EXHAUST	SCREEN RM. EXHAUST	GRIT TK. RM. EXHAUST	GRIT TK. RM. EXHAUST
DAMPER TYPES			PBD	PBD, INS	PBD	PBD, INS
CONSTRUCTION MATERIALS			316 SST	316 SST	316 SST	316 SST
PERFORMANCE	AIR FLOW	L/s	5100	5100	5100	5100
NOMINAL DIMENSIONS	LENGTH	mm	1300	1300	650	650
	HEIGHT	mm	500	500	450	450
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	CLOSED
	NUMBER		1	1	1	1
	TYPE		TP, SP, EXP	TP, SP, EXP	TP,SP, EXP	TP, SP, EXP
	MODEL No.		RedMax-45.90-YF-A	RedMax-45.90-YF-A	RedMax-45.90-YF-A	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-B6881	XV-B6882	XV-G6931	XV-G6932
SPECIFICATION TYPE			HEAVY DUTY	HEAVY DUTY	HIGH PEFORMANCE	HIGH PERFORMANCE
LOCATION			GRIT TANK RM. AIR PLENUM 3	SERV. BLDG. MR., EF-B688 OULET	GRIT PUMP ROOM	ROOF, EF-G693 INLET
SERVICE			GRIT TK. RM. EXHAUST	GRIT TK. RM. EXHAUST	GRIT PMP RM. OA. INTAKE	GRIT PUMP ROOM EXHAUST
DAMPER TYPES			PBD	PBD, INS	PBD, INS	PBD, INS
CONSTRUCTION MATERIALS			316 SST	316 SST	ALUM	ALUM
PERFORMANCE	AIR FLOW	L/s	5100	5100	850	850
NOMINAL DIMENSIONS	LENGTH	mm	650	650	600	450
	HEIGHT	mm	450	450	400	450
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	CLOSED
	NUMBER		1	1	1	1
	TYPE		TP, SP, EXP	TP, SP, EXP	TP,SP	TP, SP, LT
	MODEL No.		RedMax-45.90-YF-A	RedMax-45.90-YF-A	RedMax-45.90-YF-A	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						A

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS — 23 31 13.03

SYMBOL			XV-K6111	XV-K6113	XV-K6121	XV-K6123
SPECIFICATION TYPE			HEAVY DUTY	HEAVY DUTY	HEAVY DUTY	HEAVY DUTY
LOCATION			ROOF, EF-K611 INLET	ROOF, EF-K611 DISCHARGE	ROOF, EF-K612 INLET	ROOF, EF-K612 DISCHARGE
SERVICE			CLARIFIER ROOM EXHAUST	CLARIFIER ROOM EXHAUST	CLARIFIER ROOM EXHAUST	CLARIFIER ROOM EXHAUST
DAMPER TYPES			PBD	PBD	PBD	PBD
CONSTRUCTION MATERIALS			316 SST	316 SST	316 SST	316 SST
PERFORMANCE	AIR FLOW	L/s	5000	5000	5000	5000
NOMINAL DIMENSIONS	LENGTH	mm	800	800	800	800
	HEIGHT	mm	900	600	900	600
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	CLOSED
	NUMBER		1	1	1	1
	TYPE		TP,SP,EXP,LT	TP,SP,EXP,LT	TP,SP,EXP,LT	TP,SP,EXP,LT
	MODEL No.		RedMax-45.90-YF-A	RedMax-45.90-YF-A	RedMax-45.90-YF-A	RedMax-45.90-YF-A
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		AWV	AWV	AWV	AWV
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-K6141	XV-K6142	XV-K6211	XV-K6221
SPECIFICATION TYPE			HEAVY DUTY	HEAVY DUTY	HIGH PERFORMANCE	HIGH PERFORMANCE
LOCATION			MECHANICAL ROOM	MECHANICAL ROOM	ROOF, EF-K621 INLET	ROOF, EF-K621 INLET
SERVICE			WASTE SLUDGE SUMP SUPPLY	WASTE SLUDGE SUMP EXHAUST	PUMP ROOM EXHAUST	PUMP ROOM EXHAUST
DAMPER TYPES			PBD	PBD	PBD, INS	PBD, INS
CONSTRUCTION MATERIALS			316 SST	304 SST	ALUM	ALUM
PERFORMANCE	AIR FLOW	L/s	685	737	1677	1677
NOMINAL DIMENSIONS	LENGTH	mm	400	400	600	600
	HEIGHT	mm	-	-	600	600
ACTUATOR DATA	FAILS		CLOSED	CLOSED	CLOSED	CLOSED
	NUMBER		1	1	1	1
	TYPE		TP, SP, EXP	TP, SP, EXP	TP,SP, LT	TP,SP, LT
	MODEL No.		RedMax-45.90-YF-A	RedMax-45.90-YF-A	RedMax-45.90-YF-A	RedMax-45.90-YF-A
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		AWV	AWV	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS						**23 31 13.03**
SYMBOL			XV-K6311			
SPECIFICATION TYPE			HIGH PERFORMANCE			
LOCATION			ROOF, EF-K631 INLET			
SERVICE			GALLERY 5 EXHAUST			
DAMPER TYPES			PBD, INS			
CONSTRUCTION MATERIALS			ALUM			
PERFORMANCE	AIR FLOW	L/s	3556			
NOMINAL DIMENSIONS	DIAMETER	mm	850			
			850			
ACTUATOR DATA	FAILS		CLOSED			
	NUMBER		1			
	TYPE		TP,SP,LT			
	MODEL No.		InMax-5.10-YF			
	VOLTS		120			
MANUFACTURER	DAMPER		RUSKIN			
	ACTUATOR		SCHISCHEK			
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS — 23 31 13.03

SYMBOL			XV-T6111	XV-T6121		
SPECIFICATION TYPE			HIGH PERFORMANCE	HIGH PERFORMANCE		
LOCATION			HUMIDIF. ROOM, EF T611 INLET	HUMIDIF. ROOM, EF T611 INLET		
SERVICE			HUMIDIF. RM. EXHAUST	HUMIDIF. RM. EXHAUST		
DAMPER TYPES			PBD, INS	PBD, INS		
CONSTRUCTION MATERIALS			ALUM	ALUM		
PERFORMANCE	AIR FLOW	L/s	519	519		
NOMINAL DIMENSIONS	LENGTH	mm	450	450		
	HEIGHT	mm	450	450		
ACTUATOR DATA	FAILS		OPEN	OPEN		
	NUMBER		1	1		
	TYPE		TP, SP	TP, SP		
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF		
	VOLTS		120	120		
MANUFACTURER	DAMPER		RUSKIN	RUSKIN		
	ACTUATOR		SCHISCHEK	SCHISCHEK		
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS — 23 31 13.03

SYMBOL			XV-D6111	XV-D6113	XV-D6121	XV-D6123
SPECIFICATION TYPE			HEAVY DUTY	HEAVY DUTY	HEAVY DUTY	HEAVY DUTY
LOCATION			ROOF, EF-D611 INLET	ROOF, EF-D611 DISCHARGE	ROOF, EF-D612 INLET	ROOF, EF-D612 DISCHARGE
SERVICE			RDT ROOM EXHAUST	RDT ROOM EXHAUST	RDT ROOM EXHAUST	RDT ROOM EXHAUST
DAMPER TYPES			PBD	PBD	PBD	PBD
CONSTRUCTION MATERIALS			ALUM	ALUM	ALUM	ALUM
PERFORMANCE	AIR FLOW	L/s	5663	5663	5663	5663
NOMINAL DIMENSIONS	LENGTH	mm	800	600	750	600
	HEIGHT	mm	800	850	1000	850
ACTUATOR DATA	FAILS		OPEN	OPEN	OPEN	OPEN
	NUMBER		1	1	1	1
	TYPE		TP, SP, LT	TP, SP, LT	TP, SP, LT	TP, SP, LT
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF
	VOLTS		120	120	120	120
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	RUSKIN
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	SCHISCHEK
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-D6207	XV-D6208	XV-D6211	
SPECIFICATION TYPE			STANDARD DUTY	STANDARD DUTY	HIGH PERFORMANCE	
LOCATION			MECH. PLATF. AHU-D640 INLET	ELECT. RM. B. AHU-D650 INLET	RDT PUMP ROOM	
SERVICE			AHU-D640 OUTSIDE AIR	AHU-D650 OUTSIDE AIR	RDT PUMP ROOM EXHAUST	
DAMPER TYPES			PBD	PBD	PBD,INS	
CONSTRUCTION MATERIALS			ALUM	ALUM	ALUM	
PERFORMANCE	AIR FLOW	L/s	189	189	566	
NOMINAL DIMENSIONS	LENGTH	mm	300	450	450	
	HEIGHT	mm	250	200	450	
ACTUATOR DATA	FAILS		OPEN	OPEN	OPEN	
	NUMBER		1	1	1	
	TYPE		TP,SP	TP,SP	TP,SP	
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF	
	VOLTS		120	120	120	
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS — 23 31 13.03

SYMBOL			XV-S6311	XV-S6321		
SPECIFICATION TYPE			HIGH PERFORMANCE	HIGH PERFORMANCE		
LOCATION			PUMP ROOM	PUMP ROOM		
SERVICE			PUMP ROOM EXHAUST	PUMP ROOM EXHAUST		
DAMPER TYPES			PBD,INS	PBD,INS		
CONSTRUCTION MATERIALS			ALUM	ALUM		
PERFORMANCE	AIR FLOW	L/s	1476	1476		
NOMINAL DIMENSIONS	LENGTH	mm	550	550		
	HEIGHT	mm	450	450		
ACTUATOR DATA	FAILS		OPEN	OPEN		
	NUMBER		1	1		
	TYPE		TP,SP	TP,SP		
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF		
	VOLTS		120	120		
MANUFACTURER	DAMPER		RUSKIN	RUSKIN		
	ACTUATOR		SCHISCHEK	SCHISCHEK		
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS — 23 31 13.03

SYMBOL			FV-S6508	XV-S6511	XV-S6541	
SPECIFICATION TYPE			STANDARD DUTY	HIGH PERFORMANCE	HIGH PERFORMANCE	
LOCATION			MECHANICAL ROOM	WALKWAY A	STORAGE ROOM	
SERVICE			AHU-S640 OUTSIDE AIR	WWAYS A,B & GAL. 3A EXH.	STORAGE ROOM EXHAUST	
DAMPER TYPES			OBD	PBD, INS	PBD,INS	
CONSTRUCTION MATERIALS			ALUM	ALUM	ALUM	
PERFORMANCE	AIR FLOW	L/s	566	2596	325	
NOMINAL DIMENSIONS	LENGTH	mm	350	850	250	
	HEIGHT	mm	350	850	250	
ACTUATOR DATA	FAILS		OPEN	OPEN	OPEN	
	NUMBER		1	1	1	
	TYPE		MOD, SP	TP,SP	TP,SP	
	MODEL No.		InMax-5.10-YF	InMax-5.10-YF	InMax-5.10-YF	
	VOLTS		120	120	120	
MANUFACTURER	DAMPER		RUSKIN	RUSKIN	RUSKIN	
	ACTUATOR		SCHISCHEK	SCHISCHEK	SCHISCHEK	
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-U6601	XV-U6602		
SPECIFICATION TYPE			HIGH PERFORMANCE	HIGH PERFORMANCE		
LOCATION			UV ROOM, SF-U660 INLET	UV ROOM		
SERVICE			UV ROOM SUPPLY AIR	UV ROOM RELIEF AIR		
DAMPER TYPES			PBD, INS	PBD, INS		
CONSTRUCTION MATERIALS			ALUM	ALUM		
PERFORMANCE	AIR FLOW	L/s	3585	1793		
NOMINAL DIMENSIONS	LENGTH	mm	1200	1200		
	HEIGHT	mm	1200	1200		
ACTUATOR DATA	FAILS		OPEN	OPEN		
	NUMBER		1	1		
	TYPE		TP,SP	TP,SP		
	MODEL No.		InMax-30-YF	InMax-30-YF		
	VOLTS		120	120		
MANUFACTURER	DAMPER		RUSKIN	RUSKIN		
	ACTUATOR		SCHISCHEK	SCHISCHEK		
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

CONTROL DAMPERS 23 31 13.03

SYMBOL			XV-P6401			
SPECIFICATION TYPE			STANDARD DUTY			
LOCATION			ELECTRICAL ROOM B			
SERVICE			AHU-P640 OUTSIDE AIR			
DAMPER TYPES			PBD			
CONSTRUCTION MATERIALS			ALUM			
PERFORMANCE	AIR FLOW	L/s	187			
NOMINAL DIMENSIONS	LENGTH	mm	300			
	HEIGHT	mm	200			
ACTUATOR DATA	FAILS		OPEN			
	NUMBER		1			
	TYPE		TP,SP			
	MODEL No.		InMax-5.10-YF			
	VOLTS		120			
MANUFACTURER	DAMPER		RUSKIN			
	ACTUATOR		SCHISCHEK			
REMARKS						

MATERIAL ABBREVIATIONS:

STL: GALVANIZED STEEL
ALUM: ALUMINUM
304 SST: STAINLESS STEEL, TYPE 304
316 SST: STAINLESS STEEL, TYPE 316
PVC: POLYVINYL CHLORIDE
EPDM: ETHYLENE PROPYLENE DIENE MONOMER

APPLICABLE REMARKS:

A: DAMPER IS MOUNTED IN EXTENDED ROOF CURB

DAMPER TYPES:

OBD: OPPOSED BLADE
PBD: PARALELL BLADE
INS: INSULATED

ACTUATOR TYPES:

MOD: MODULATION
TP: TWO POSITION
SP: SPRING RETURN
LT: -40 DEGREES C

SECTION 23 31 16.16

THERMOSET FIBERGLASS REINFORCED PLASTIC DUCTS AND ACCESSORIES (FP 61)

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Air Movement and Control Association (AMCA): 500-D, Laboratory Methods of Testing Dampers for Rating.
   2. American National Standards Institute (ANSI).
   3. American Society for Testing and Materials (ASTM):
      a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
      b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
      c. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment.
      d. D3982, Standard Specification for Contact Molded “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Duct and Hoods.
      e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   4. Sheet Metal and Air Conditioning Contractor’s National Association, Inc., (SMACNA): Thermoset FRP Duct Construction Manual.
   5. Factory Mutual (FM) 4922 approval for non-sprinklered smoke removal installation.
   6. Canadian Government Specification Board Standard (CGSB):
      a. CAN-CGSB-41.22-93 Fiberglass Reinforced Plastic Corrosion Resistant Equipment.

1.2 SUBMITTALS

A. Shop Drawings:
   1. Duct:
      a. Statement of resins and reinforcing proposed for use.
      b. Pressure, vacuum, and temperature rating of duct.
      c. Dimensions of subassemblies to be shipped.
      d. Manufacturer’s data and descriptive literature for duct accessories.
      e. Drawings showing layout, support, and joint details.
      f. Stamped and signed structural engineering design calculations.
      g. Information, details, and requirements for installation and support of duct and torque values for flange bolting.
      h. Name of manufacturer.
   2. Supports:
      a. Location plan.
      b. Type and details.
      c. Materials of construction.
      d. Stamped and signed structural engineering design calculations for special supports.

3. Expansion Joints/Flexible Connectors:
   a. Type and model.
   b. Materials of construction.
   c. Force required for expansion/contraction.
   d. Name of manufacturer.
4. Butterfly Dampers and Blast Gates:
   a. Statement of resins and reinforcing proposed for use.
   b. Pressure, vacuum, and temperature rating.
   c. Materials of construction.
   d. Total weight including operator.
   e. Drawings showing overall dimensions and connection size.
   f. Type and model.
   g. Name of manufacturer.
5. Acoustical Insulation and Jacketing:
   a. Type and Model.
   b. Material.
   c. Name of Manufacturer.
6. Vibration Isolation Devices:
   a. Type and Model.
   b. Material.
   c. Name of Manufacturer.

B. Information Submittals:
1. Qualifications:
   a. Fabricator: List of references substantiating experience.
   b. Installer: Manufacturer’s certification that installer is qualified for installation work.
2. Manufacturer’s installation instructions.
3. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the ductwork installation.
4. Certificates:
   a. Manufacturer’s Certificate of Compliance, in accordance with Section 01 43 33, Contractor Field Services.
   b. Manufacturer’s Certificate of Proper Installation.
5. Manufacturer’s factory inspection report.
6. Damper and Blast Gate: AMCA 500-D leakage test results by AMCA-approved laboratory.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Fabricator: Minimum 5 years’ experience.
2. Installer: Minimum 5 years’ experience.
3. Joint Installer: Manufacturer certified.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping:
1. Do not ship ducting by nesting small diameter components inside larger diameter components.
2. Protect flanged sections by bolting to wooden blinds 50 mm greater than outside diameter of flange.
3. For nonflanged components, use either rigid plugs inside ends to prevent deflection or protect with wooden boxes.
4. Crate materials whenever practical prior to shipment.
5. Firmly fasten and pad components shipped to prevent shifting or flexing of components while in transit.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Make field joints only when ambient temperature is above 12.7 degrees C and below 37.7 degrees C.

PART 2 PRODUCTS

2.1 MATERIALS

A. Resin:
1. Resin System: Premium corrosion-resistant, fire-retardant vinylester, or other qualified thermosetting resin. Resin to be selected by fabricator, subject to approval of Contract Administrator, and suitable for intended service with no fillers or thixotropic agents.
2. Liner Resin: Premium grade and corrosion resistant.
3. Structural wall resin may be of different chemical resistance, subject to conditions of service and approval of Contract Administrator.
4. Flame Spread Index: ASTM E84, less than 25; fire retardant additives used only in structural layer.
5. Smoke Generation: ASTM E84, rating less than 10 phenolic resins may be used only in structural layer.
6. Structural wall resin shall contain a minimum of 3 percent antimony trioxide to achieve required flame spread index.
7. Add ultraviolet absorbers to surfacing resin to improve weather resistance.
8. Color: Use no dyes, pigments, or colorants, except in exterior gel coat. Exterior gel coat shall be white.
9. For interior duct, final coat shall be factory applied intumescent coating to achieve designated results for low smoke development.

B. Reinforcement:
1. Veil: Chemical surfacing mat, polyester fabric, 0.305 mm to 0.406 mm thick, with finish and binder compatible with lay-up resin.
2. Corrosion Barrier: Resin-rich interior surface of nominal 100 to 120 mils thick, using chopped strand mat backing the veil. Use no additive in corrosion barrier.

3. Chopped Strand Mat: Type E glass, minimum 0.45 kg per square metre, with silane finish and styrene soluble binder.
4. Continuous Roving for Chopper Gun Spray-Up: Type E glass.
5. Woven Roving: Type E glass, nominal 0.8 kg per square metre, 4 by 5 weave, with silane type finish.
6. Continuous Roving for Filament Winding: Type E glass with silane type finish.

C. Fasteners:
1. Bolts: ASTM A193/A193M, Type 316 stainless steel, ASA coarse thread series, Grade B 8M hex head.
2. Nuts: ASTM A194/A194M, Type 316 stainless steel, Grade 8M.
3. Washers: ANSI B18.22.1, flat, Type 316 stainless steel.

2.2 DUCTWORK

A. Design Requirements:
1. Conform to ASTM D3982, ASTM C582, and CGSB.
2. Duct manufacturer's design for round section, including duct wall thickness and stiffeners.
3. Take into account expansion from seasonal temperature variations.
4. Provide UV protection for exposed outdoor duct.

B. Service Conditions:
1. System Maximum Pressure: 1.5 kPa.
2. System Maximum Vacuum: 3 kPa.
3. Atmosphere Ducted: Odour duct.
4. Location: Outside and inside.
5. Ambient Temperature: Minus 30 to 40 degrees C.
6. Ductwork and accessories shall be located in hydrogen sulfide (H_2S) rich environment. Ductwork and accessories will be exposed to (H_2S) gas at 200 ppm saturated with water vapor.

2.3 FABRICATION

A. Physical Properties: Meet or exceed requirements of ASTM D3982, ASTM C582, and CGSB.

B. Squareness of ends, fittings, elbows, and butt joints shall meet or exceed requirements of ASTM D3982 and CGSB.

C. Keep use of flanges to a minimum; butt joints are preferred method of joining sections of duct, unless otherwise indicated on drawings.

D. Butt joints shall only be permitted in duct sections that are accessible for inside overlay. Internal overlay to consist of two layers of 0.45 kg per square metre of fiberglass mat followed by one layer of surfacing veil, as a minimum.

E. Flanges for Duct to Duct Connections and Duct Wall Thicknesses: ASTM D3982 and CGSB, rated for specified pressure and vacuum.

F. Flange dimensions (except thickness) and drilling patterns for flanges that connect to equipment, valves, or dampers are to correspond to ANSI B16.5, Class 150 or ANSI B16.1, Class 125.

G. Furnish gussets on flanged nozzles from ducts.

H. Back Face of Flanges: Spot-faced, flat and parallel to flange face, and of sufficient diameter to accept ANSI metal washer under bolt head or nut.

I. Laminate:
   1. Reinforce inner surface of ducts with resin-rich surfacing veil 0.254 mm to 0.508 mm thick.
   2. Construct interior layer of resin reinforced with at least 2 plies of chopped strand mat; thickness at least 2.54 mm.
   3. Glass content of combined inner surface and interior layer shall be 27 percent plus or minus 5 percent.

J. Duct and Fittings:
   1. Type: Contact molded or filament wound, meeting requirements of ASTM D3982 and CGSB.
   2. Joints: Butt wrapped except flanged at connections to expansion joints, butterfly valves, blast gates, or mechanical equipment and unless otherwise indicated on drawings.
   3. Fittings: Plain end or flanged, manufacturer’s standard sizes. Comply with NBS PS-15 with a chemical resistance equal to or greater than the duct.
   4. Gaskets: EPDM, 5 mm thick, full-face, Type A Durometer of 50-60.

K. Manufacturers:
   1. Composites.
   2. Augusta Fiberglass.
   3. Industrial Plastics Fabricator.
   4. Precisioneering Ltd.

L. Supports:
   1. Supports for FRP ductwork as shown on structural drawings.
   2. Maximum Duct Deflection: 12 mm, including special sections at road crossings.
   3. Support Spacing:
      a. 600 mm Diameter and Larger: 6 m, maximum.
      b. 500 mm Diameter and Smaller: 4.6 m, maximum.

M. Marking:
   1. Identify each duct component with fabricator’s name, resin, minimum thickness, and date of manufacture.
   2. Use permanent marking. Seal decals and labels into laminate exterior with resin.
   3. For piece marking used for installation, use oil-based paint for easy removal.

N. Cure products to at least 90 percent of minimum Barcol hardness specified by resin manufacturer.

O. Expansion Joints/Flexible Connections:
   1. Provide where indicated on Drawings or as required for proper duct installation.
   2. Type: W-design configuration with integral flanges suitable for service with FRP duct.
   3. Material: EPDM.
   4. Backing Rings: 10 mm thick, 50 mm wide, Type 316 stainless steel. ANSI B16.1, Class 25 diameter and drilling.
   5. Length: 300 mm (size 600 mm dia. and larger), 150 mm (size 550 mm dia. and smaller), flange-to-flange.
   6. Extension: 25 mm.
   7. Compression: 100 mm.
   8. Lateral Offset: 75 mm.
   9. Thickness: 6.4 mm, minimum.
   10. Manufacturer and Product: RM-Holz; Style 945.
   11. Slip-on type expansion joints and flexible connections shall be sized to fit tightly on the outside diameter of the duct, secured in place by stainless steel worm screw type adjustable clamps to provide gas-tight connections.

P. Butterfly Dampers:
   1. Dampers:
      a. Single-blade type, complete with channel-type frame, close-fitting axle, and bearings.
      b. Same inside diameter as connecting ductwork.
      c. Axles not less than 20 mm in diameter and shall be continuous through damper.
      d. When used for isolation service, shall be furnished with blade seal and shaft seal.
      e. When used for balancing only, shall be furnished with full circumference molded in blade stop.
      f. Isolation dampers shall have maximum leakage rate of 7.5 litre per second per square metre of damper area, at a differential pressure of 1.245 kPa.
   2. Design Requirements:
      a. Each damper shall be designed for the following conditions:
         1) Air Temperature Range: Minus 40 to 93 degrees C.
         2) Differential Pressure: 1.245 kPa.
   3. Materials:
      a. FRP materials for dampers shall be same resin as used in ductwork.
      b. Requirements for flame spread and smoke development shall be same as required for ductwork.
   4. Construction:
      a. Frames: Fiberglass reinforced plastic with resin as described herein.
      b. Blades: Fiberglass reinforced plastic with resin as described herein. Blade thickness and stiffeners as required to meet design conditions. 0.9 m and under: 6.35 mm thick. Above 0.9 m: 12.7 mm thick.
      c. Axles: Continuous FRP rod with resin as described herein. Axle to extend 150 mm beyond frame.
      d. Bearings: Molded PTFE.
      e. Blade Stops: FRP with resin as described herein.
      f. Blade Seals: Neoprene.
      g. Shaft Seals: Neoprene.

h. Flanges: As specified to match ductwork flanges.

Q. Backdraft Dampers:
1. Backdraft dampers shall beof the multi-blade rectangular type complete with channel-type frame, blades, linkage, full-length axles, adjustable counterbalance assembly, and bearings.
2. Backdraft dampers shall have the same inside dimensions as the connecting ductwork.
3. Backdraft dampers shall have axles not less than 20 mm in diameter.
4. Backdraft dampers shall have a maximum leakage rate of 75 L/s per square meter of damper area, at a differential pressure of 1.245 kPa. AMCA leakage tests shall be furnished as part of the submittal.
5. Dampers shall be Swartwout Model 426AF, or approved equal in accordance with B8.

R. Blast Gates:
1. FRP body, FRP gate, neoprene seal, low leakage type designed for a maximum leakage rate of 100 L/s per square meter at an operating differential pressure of 2.5 kPa.
2. Provide with gasketed blind flange and removable blade with handle as detailed on Drawings.

S. Acoustical Insulation and Jacketing:
1. Insulation for FRP duct to be jacketed with special acoustic covering shall be provided in the density recommended by the manufacturer to support the acoustic jacketing with compression limited to 3 percent of the normal thickness. Duct 250 mm and larger may be insulated with “pipe wrap” type insulation meeting all requirements of this Specification, designed for application to round duct.
2. Jacketing: Acoustical jacketing shall be a laminated construction of lead or barium sulfate loaded vinyl bonded to aluminum. The composite shall be corrugated approximately 5 mm pitch and shall weigh not less than 4.4 kg per square metre. The aluminum jacket shall be 0.4 mm thick, minimum.
3. Manufacturers:
a. Childers Products Company, Muffl-Jac.
b. Or approved equal in accordance with B8.

2.4 SOURCE QUALITY CONTROL

A. Factory Inspection: Inspect fabrications for required construction, intended function and conformance with referenced standards.

B. Inspection of products is required prior to shipment, unless specifically waived in writing by Contract Administrator.

C. Notify Contract Administrator one week prior to estimated date of inspection.

D. Repairs authorized by Contract Administrator shall be reinspected before final acceptance, unless specifically waived.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify dimensions and conditions in field.

B. Layout routing in straight lines parallel to building lines.

C. Coordinate support locations with layout, joints, and structural drawing.

3.2 INSTALLATION

A. Ductwork:
1. Cut, fit, and install in accordance with duct manufacturer's recommendations. The SMACNA manual may be used for guidance, but duct manufacturer's recommendations shall take precedence.
2. Seal cut edges with compatible resin.
3. Ductwork shall be free of vibration when in operation. Vibration isolation devices shall be provided and installed by Contractor.
4. Install plumb and straight and in proper alignment.
5. Provide for expansion and contraction of ductwork and fittings.
6. Anti-seize thread compound shall be applied to all nuts and bolts.
7. Flange bolts shall be tightened to torque values specified by manufacturer. Install flat washer under each nut and bolt head.

B. Field Joints:
1. Provide material in kit form; one kit for one joint.
2. Make joints only when ambient temperature is above 12.7 degrees C and below 37.7 degrees C.
3. Made by manufacturer certified installer.

C. Dampers: Unless otherwise necessary for proper operation of damper, axles shall be installed in horizontal position.

3.3 FIELD TESTING

A. Field test ductwork after installation and before concealment or burying, with air test to 150 percent of maximum working pressure for a period of 4 hours. Leaks shall be corrected and duct retested until no further leaks appear.

3.4 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by the City, for minimum person-days listed below, travel time excluded:
1. Two person-days for installation assistance and inspection.
2. One person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

B. See Section 01 43 33, Contractor Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

C. Written certification shall be submitted by duct manufacturer, indicating individuals employed by the Contractor have satisfactorily completed all training and instruction.

3.5 ADJUSTING

A. After duct leakage testing, provide complete air balancing of entire system as described in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.6 CLEANING

A. Blow ductwork clean using system fans; purged continuously for not less than 48 hours at a flow rate not less than design flow rate. If required, system fan shall be throttled on inlet side to prevent motor overload. Temporary screen shall be installed on system fan inlet to protect fan from entering debris.

B. Dampers shall be smooth, clean, and free of dirt when installed.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Acoustical Society of America (ASA): S2.19, Mechanical Vibration – Balance Quality Requirement of Rigid Rotors – Part 1, Determination of Permissible Residual Unbalance.
   2. Air Movement and Control Association International (AMCA):
      a. 99, Standards Handbook.
      b. 201, Fans and Systems.
      c. 203, Field Performance Measurement of Fan Systems.
      d. 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
      e. 300, Reverberant Room Method for Sound Testing of Fans.
      f. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
   3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
   4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): HVAC Applications Manual.
      a. 52.2 Method of Testing General Ventilation Air – Cleaning Devices for Removal Efficiency by Particle Size.
      b. HVAC Applications Manual.
   5. ASTM International (ASTM):
      a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
      b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
      c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
      d. D3363, Standard Test Method for Film Hardness by Pencil Test.
      e. D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
      f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   6. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
   7. National Fire Protection Association (NFPA): 45, Fire Protection for Laboratories Using Chemicals.
   8. Occupational Safety and Health Act (OSHA).
   9. Society for Protective Coatings (SSPC):
      a. SP 3, Power Tool Cleaning.
      b. SP 5, Joint Surface Preparation Standard White Metal Blast Cleaning.
      c. SP 6, Joint Surface Preparation Standard Commercial Blast Cleaning.
      d. SP 10, Joint Surface Preparation Standard Near-White Blast Cleaning.
   10. Underwriters Laboratories Inc. (UL/ULC): 507, Electric Fans.

1.2 DEFINITIONS

A. The following is a list of abbreviations which may be used in this Section:
   1. AC: Alternating Current.
   2. CISD: Chemical Industry, Severe-Duty.
   3. dB: Decibel.
   4. DWDI: Double Width, Double Inlet.
   5. FRP: Fiberglass Reinforced Plastic.
   6. kW: Kilowatt.
   7. ODP: Open Drip Proof.
   8. SWSI: Single Width, Single Inlet.
   9. TEFC: Totally Enclosed, Fan Cooled.
   10. UV: Ultra Violet
   11. XP: Explosion Proof.

1.3 SUBMITTALS

A. Action Submittals:
   1. Provide for all products specified, as follows:
      a. Identification as referenced in Contract Documents.
      b. Manufacturer's name and model number.
      c. Descriptive specifications, literature and drawings.
      d. Dimensions and weights.
      e. Fan sound power level data (reference 10 to power minus 12 Watts) at design operating point.
      f. Fan Curves:
         1) Performance Curves Indicating:
            a) Relationship of flow rate to static pressure for various fan speeds.
            b) Brake horsepower curves.
            c) Acceptable selection range (surge curves, maximum revolutions per minute, etc).
            d) Static pressure, capacity, horsepower demand and overall efficiency required at the duty point, including drive losses.
         2) For variable air volume applications, indicate operating points at 100, 80, 60 and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure and brake horsepower.
      g. Capacities and ratings.
      h. Construction materials.
      i. Fan type, size, class, drive arrangement, discharge, rotation and bearings.
      j. Wheel type, diameter, revolutions per minute, and tip speed.
      k. Motor data.
      l. Power and control wiring diagrams, including terminals and numbers.
      m. Vibration isolation.
      n. Factory finish system.
      o. Color selection charts where applicable.
      p. Corrosion protection coating product data.
      q. Fiberglass Material: Statement of resins and reinforcing proposed for use.

B. Informational Submittals:
   1. Recommended procedures for protection and handling of products prior to installation.
   2. Manufacturer's installation instructions.
   3. Manufacturer's Certificate of Compliance in accordance with Section 01 43 33, Contractor Field Services, for the following:
      a. Motors specified to be premium efficient type.
      b. FRP fans.
   4. Component and attachment testing seismic certificate of compliance.
   5. Test reports.
   6. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.4 QUALITY ASSURANCE

A. Performance Ratings: Tested in accordance with AMCA 210.

B. Sound Ratings: Tested in accordance with AMCA 300.

C. Fabrication: In accordance with AMCA 99.

1.5 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

Item		Quantity
Vee Belts		One complete set per unit

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.1 EQUIPMENT SCHEDULES

A. Some specific equipment requirements are listed in Equipment Schedules. Refer to Article, Supplements.

2.2 SPARK RESISTANT CONSTRUCTION

A. Fans required to be spark resistant shall comply with requirements of AMCA 99-0401.

B. Alternative fans can also be FRP with graphite liner and grounding.

2.3 NAMEPLATES

A. All units shall include factory installed permanently attached nameplate displaying unit model and serial number.

2.4 OPERATING LIMITS

A. Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408-69.

2.5 ACOUSTICAL LEVELS

A. Equipment selections shall produce sound power levels in each octave band no greater than shown in Equipment Schedule.

2.6 FAN DRIVES

A. Furnish multiple drive belts where motor horsepower is 1.5 kW or larger.

B. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.

C. Sheaves shall be capable of providing 150 percent of motor horsepower.

D. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.

E. Furnish motors for V-belt drives with adjustable rails or bases.

F. Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.

G. Motors 15 kW or Smaller:
   1. Variable pitch V-belt sheaves allowing at least 20 percent speed variation.
   2. Final operating point shall be at approximate sheave midpoint.

H. Motors Larger than 15 kW: Fixed-pitch sheaves.

I. All motors driven by VFDs to have a shaft grounding ring installed:
   1. Current rating: 10 amps high frequency current up to 100 Mhz.
   2. Continuous fiber ring with frequency current up to 100 Mhz.
   3. Fiber wear: Less than 0.03 mm per 10,000 hours, designed for 200,000 plus hours of operation.
   4. Maintenance Requirements: None.
   5. Shaft grounding ring may be installed by the motor manufacturer or the fan manufacturer.
   6. Shaft grounding ring to be installed in accordance with manufacturer’s recommendations.
   7. Acceptable Products:
      a. AEGIS® Shaft Grounding Ring kit.
      b. Or integral to motor assembly.

J. Drive Adjustment:
   1. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
   2. Provide trial and final sheaves, as well as drive belts, as required.

K. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.

L. Belt and Shaft Guards:
   1. Easily removable and to enclose entire drive assembly, meeting federal, OSHA, and Province of Manitoba requirements.
   2. Guard faces of expanded metal having minimum 60 percent free area for ventilation.
   3. Bright yellow finish.

M. Provide speed test openings at shaft locations.

2.7 FINISHES

A. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.
   1. Parts cleaned and chemically pretreated with a phosphatizing process.
   2. Alkyd enamel primer.
   3. Air-dry enamel topcoat.

B. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.

C. Stainless Steel Parts: Finished smooth and left unpainted.

D. Fiberglass Parts: Finished in accordance with Paragraph, Fiberglass Material.

2.8 CABINET CEILING FAN

A. General:
   1. Factory-assembled, ceiling, wall or inline mounted, centrifugal cabinet fan; including housing, fan wheel, drive assembly, motor and accessories.
   2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:
   1. Material: Minimum 20-gauge galvanized steel.
   2. Construction:
      a. Minimum 14-gauge blower and motor support frame.
      b. Lined with minimum 12 mm acoustical insulation.
      c. Outlet duct collar with integral reinforced aluminum backdraft damper, with nylon bushings.
      d. Motor mounted on resilient vibration isolators.
      e. Motor and blower removable from unit without cabinet disassembly.
      f. Removable cabinet access panels.
      g. Air Inlet: Field convertible for bottom or end air inlet configuration.
      h. Predrilled universal mounting brackets, adjustable.

C. Wheel: Centrifugal forward curved type, galvanized steel or plastic construction.

D. Shaft, Bearings, Drive:
   1. Shafts: Turned, ground and polished carbon steel.
   2. Bearings: Grease lubricated, precision antifriction ball, sealed type.
   3. Drives:
      a. In accordance with Article, Drives.
      b. Factory set to the specified fan revolutions per minute.

c. Type: Direct.

E. Electrical:
1. Integral wiring box.
2. Factory-installed disconnect receptacle.

F. Accessories: Provide as scheduled in Equipment Schedule as follows:
1. Ceiling Grille: Factory fabricated, aluminum construction, white baked enamel finish.
2. Speed Controller:
a. Wall mount.
b. Solid state electronics.
c. Dial type combination ON/OFF switch and SPEED selector.
3. Wall Cap:
a. Aluminum construction, mild finish.
b. Built-in backdraft damper.
c. Bird screen.
d. Round duct connection.

G. Manufacturers and Products:
1. Loren Cook; Gemini Series.
2. Greenheck; SP Series.
3. ACME; Model VQ Series.
4. Twin City Fan; T Series.

2.9 INLINE FAN, CENTRIFUGAL, SQUARE

A. General:
1. Factory-assembled, centrifugal, inline fan, square housing configuration; including housing, fan wheel, drive assembly, motor and accessories.
2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:
1. Construction: All aluminum.
2. Integral duct collars.
3. Removable side panels, for ease of service.
4. Field convertible for side air discharge configuration.
5. Predrilled universal mounting brackets for vertical or horizontal installation.
6. Inlets: Aerodynamic aluminum venturi.
7. Corrosion-resistant fasteners.
8. Drive belt and bearings separated from air steam by enclosure.

C. Wheel:
1. Centrifugal backward inclined, 100 percent aluminum construction.
2. Precision machined cast aluminum hub.
3. Die-formed airfoil or backward inclined blades.
4. Matched to inlet venturi.
5. Attached to fan shaft with split taper lock bushing.

D. Shaft, Bearings, Drive:
   1. Shafts:
      a. Turned, ground and polished carbon steel.
      b. Keyed for sheave installation.
   2. Bearings:
      a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style, relubricable or sealed type.
      b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
   3. Drives:
      a. In accordance with Article, Drives.
      b. Factory set to the specified fan revolutions per minute.
      c. Type: As scheduled in Equipment Schedule.
      d. Arrangement: As scheduled in Equipment Schedule.

E. Accessories: Provide as scheduled in Equipment Schedule as follows:
   1. Belt Guard: Sheet metal construction, OSHA type.
   2. Motor and Drive Cover:
      a. Factory fabricated, OSHA type.
      b. Sheet metal construction, same material as fan housing.
      c. Vented, openings sufficient size for proper motor cooling.
      d. Fan speed controller.
   3. Gravity Backdraft Damper: Galvanized steel frame, aluminum blades, brass pivot pins, neoprene seals on damper blade edges, gravity operation, and adjustable counterweight.
   4. Motorized Damper: Galvanized steel frame, aluminum blades, neoprene seals on damper blade edges, 120V operator, minimum NEMA 4X.
   5. Insulated Housing: Fiberglass insulation, 25 mm-thick, neoprene coated, on interior of housing.
   6. Filter Box:
      a. Refer to Article Filter Housings.
      b. Attached to fan inlet.
      c. Box construction to match fan housing.
      d. Integral duct collars.
      e. Access Doors: Hinged and latched.
      f. Filter Media: 25 mm pleated disposable type.
   7. Inlet Screen: Removable 25 mm mesh screen, aluminum construction, overexposed inlets.
   8. Disconnect: NEMA 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
   9. Single Side Discharge: Package consisting of side duct connection collar and rear-discharge blank-off panel.
   10. Dual Side Discharge: Package consisting of side duct connection collars and rear-discharge blank-off panel.
   11. Bearing Lubrication Lines:
      a. Extended to outside of fan housing.
      b. Terminate with zerk fittings.
   12. Spark Resistant Construction Classification: AMCA 99-0401 Type as scheduled.

13. Corrosion Protection Coating:
    a. Provide factory-applied corrosion protection coating on these fan components:
        1) Wheel.
        2) Housing.
        3) Accessories.
        4) Interior surfaces in contact with airstream.
    b. Coating system shall be as scheduled in fan Equipment Schedule, and shall be in accordance with Article, Corrosion Protection Coating.

F. Manufacturers and Products:
    1. Twin City Fan; Model BSI (Belt); Model DSI (Direct).
    2. Loren Cook; Model SQNB (Belt); SQND (Direct).
    3. ACME; Centri-Master Model XB Series (Belt); XD (Direct).
    4. Greenheck; Model BSQ-HP (Belt); SQ (Direct).

2.10 INLINE FAN, TUBULAR CENTRIFUGAL

A. General:
    1. Factory-assembled tubular centrifugal fan, belt drive; including housing, fan wheel, drive assembly, motor and accessories.
    2. Fan Performance: AMCA 99-2408 Class as scheduled.
    3. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housings:
    1. Material: Aluminum.
    2. Construction:
        a. Heavy gauge rolled metal casing, with continuous seam welding.
        b. Air straightening vanes at fan outlet, integral with shaft, bearing support, and outer casing, fully welded.
        c. Bearing and drive components isolated from air stream within continuously welded tunnel, unless direct drive (motor).
        d. Lifting lugs welded to housing.
        e. Mounting brackets, welded to housing, as required for indicated fan arrangement.
    3. Bearing Lubrication Lines:
        a. Extended to outside of fan housing.
        b. Type 316 stainless steel construction.
        c. Terminate with zerk fittings.
    4. Inlets: Die-formed bell mouth, matched to fan wheel inlet shroud.
    5. Motor Base Plate: Minimum of 4.7 mm metal plate, welded to fan housing, to provide belt tensioning and adjustment.
    6. Duct Flanges: Angle ring flanges, same diameter as housing, at fan inlet and outlet, heavy construction, factory drilled.

C. Wheel:
    1. Material: Aluminum construction.
    2. Centrifugal, one-piece, nonoverloading, backwardly inclined blades.
    3. Blades continuously welded to inlet shroud and backplate.
    4. Attached to fan shaft with split taper lock bushing.

D. Shaft, Bearings, Drive:
   1. Shafts:
      a. Turned, ground and polished hot-rolled 316 stainless steel.
      b. Keyed for sheave installation.
   2. Bearings:
      a. Grease lubricated, precision antifriction ball, self-aligning type.
      b. Mounted in cast iron pillow block housing.
      c. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
      d. Suitable for fan operation in vertical configuration.
   3. Drives:
      a. In accordance with Article, Drives.
      b. Factory set to the specified fan revolutions per minute.
      c. Type: Belt.
      d. Arrangement: As scheduled in Equipment Schedule.

E. Roof Mount Accessories:
   1. Motor and Drive Cover:
      a. Factory fabricated, OSHA type.
      b. Sheet metal construction, same material as fan housing.
      c. Vented, openings sufficient size for proper motor cooling.
   2. Stack Cap:
      a. Factory fabricated.
      b. Same material as fan housing.
      c. Integral backdraft dampers.
   3. Curb Base:
      a. Factory fabricated.
      b. Sized to adapt fan inlet to roof curb.
      c. Same material as fan housing.

F. Accessories: Provide as scheduled in Equipment Schedule as follows:
   1. Roof Curb:
      a. Factory fabricated.
      b. With damper tray and extended curb.
      c. Sloped to match roof pitch and to provide level top.
      d. Height Above Finished Roof: As scheduled.
      e. Aluminum construction.
      f. Mitered continuous welded corner seams.
      g. Pressure-treated wood nailer.
      h. Insulation: Minimum 40 mm thick, 48 kg per cubic metre density, rigid mineral fiberboard insulation with metal liner.
   2. Housing Access Doors: Bolted and gasketed.
   3. Disconnect: NEMA 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
   4. Motor and Drive Cover:
      a. Factory fabricated, OSHA type.
      b. Sheet metal construction, same material as fan housing.
      c. Vented, openings sufficient size for proper motor cooling.

5. Belt Guard: Sheet metal construction, OSHA type.
6. Inlet Vanes: Variable position, for manual or automatic operation.
7. Housing Access Doors: Bolted and gasketed.
8. Shaft Seal: Ceramic felt.
9. Inlet Screen: Metal, spiral wire type, OSHA approved, removable, if required.
10. Outlet Screen: Metal, spiral wire type, OSHA approved, removable, if required.
11. Support Base: Welded metal, for standard platform or floor mounting.
12. Spark Resistant Construction: AMCA 99-0401 Type as scheduled.
13. Corrosion Protection Coating:
    a. Provide factory-applied corrosion protection coating on these fan components:
        1) Wheel.
        2) Housing.
        3) Accessories.
        4) Interior surfaces in contact with airstream.
    b. Coating system shall be as scheduled in Fan Equipment Schedule, and shall be in accordance with Article, Corrosion Protection Coating.

G. Manufacturers and Products:
1. Twin City; Model TSL.
2. Cook; Model TCNH-B.
3. Greenheck; Model TCF.

2.11 INLINE FAN, TUBULAR CENTRIFUGAL, FIBERGLASS

A. General:
1. Factory-assembled tubular centrifugal fan, fiberglass construction, belt drive; including housing, fan wheel, drive assembly, motor and accessories.
2. Fiberglass Construction: In accordance with ASTM D4167.
3. Fan Performance: AMCA 99-2408 Class as scheduled.
4. Air Stream Hardware: Type 316 stainless steel.

B. Fiberglass Material:
1. Construction: Resin reinforced fiber cloth and mat.
2. Resin:
    a. Vinyl ester thermosetting resin.
    b. Selected by fabricator, subject to approval by Contract Administrator.
    c. Suitable for intended service with no fillers or thixotropic agents.
    d. Premium grade and corrosion resistant.
    e. Structural wall resin may be of different chemical resistance, subject to conditions of service and approval by Contract Administrator.
    f. Flame Spread Index:
        1) ASTM E84, less than 25; fire retardant additives used only in structural layer.
        2) Structural wall resin shall contain a minimum of 3 percent antimony trioxide to achieve required flame spread index.
    g. For outdoor locations, add ultraviolet absorbers to surfacing resin to improve weather resistance.
    h. For interior locations, final coat shall be factory applied intumescent coating to achieve designated results for low smoke development.

i. Color:
   1) Use no dyes, pigments, or colorants, except in exterior gel coat.
   2) Exterior gel coat shall be white.

3. Reinforcement:
   a. Veil: Chemical surfacing mat, Nexus Surface Veil.
   b. Chopped Strand Mat: Type E glass, minimum 458 grams per square meter, with silane finish and styrene soluble binder.
   c. Continuous Roving for Chopper Gun Spray-Up: Type E glass.
   d. Woven Roving: Type E glass, nominal 814 grams per square meter, 4 by 5 weave, with silane type finish.
4. Laminate:
   a. Inner Surface (Veil):
      1) Resin rich, veil reinforced, 254 microns to 508 microns thick.
      2) Use no additives.
      3) Finish and binder compatible with lay-up resin.
      4) Reinforcement Content: Not more than 20 percent.
   b. Interior (Corrosion) Layer:
      1) Resin rich, at least two plies of chopped strand mat, nominal 2540 microns to 3048 microns thick.
      2) Use no additives.
      3) Construct interior layer of resin reinforced with at least two plies of chopped strand mat backing the veil.
      4) Reinforcement Content: 25 plus or minus 5 percent.
   c. Exterior (Structural) Layer:
      1) Resin with mat, cloth, woven roving or chopped strand glass reinforcement.
      2) Enough resin present to prevent surface fiber show.
      3) Exterior surface relatively smooth, with no exposed fibers or sharp projections.
   d. Wall Thickness: As required for equipment structural integrity, but not less than 4.8 mm.

C. Housing:
   1. Material: Fiberglass construction.
   2. Construction:
      a. Tubular housing shell.
      b. Integral predrilled duct connection flanges to ensure housing concentricity and housing strength.
      c. Air straightening vanes, fiberglass construction, at fan outlet, interconnected with inner and outer shell.
      d. Bearing Base and Drive Enclosure:
         1) Bearings and belts enclosed in air insulated fiberglass housing for protection from air stream gases, fumes, and vapors.
         2) Supported by tapered gussets interlocked into outer housing.
         3) Constructed of laminated glass and resin.
         4) Bearing housing furnished with a bolted, removable Teflon shaft closure plate to facilitate bearing access.
         5) Viton shaft seal.
      e. Lifting lugs, steel, bolted to fan housing flanges.

f. Mounting brackets, steel, bolted to fan housing flanges, as required for indicated fan arrangement.

3. Inlet:
   a. Bolted, removable.
   b. Streamlined, bell mouth type
   c. Fiberglass construction.
   d. Matched to fan wheel inlet shroud.
4. Bearing Lubrication Lines:
   a. Extended to outside of fan housing.
   b. Type 316 stainless steel construction.
   c. Terminated with zerk fittings.
5. Motor Base Plate:
   a. Minimum 4.8 mm steel plate.
   b. Bolted between gussets integral to fan housing flanges.
   c. Provision for belt tensioning and adjustment.

D. Wheel:
1. Material: Fiberglass construction.
2. Centrifugal, one-piece, nonoverloading, backwardly inclined airfoil blades.
3. Mechanically fastened to end of fan shaft by Type 316 stainless steel bolt.

E. Shaft, Bearings, Drive:
1. Shafts:
   a. Turned, ground and polished Type 316 stainless steel.
   b. Keyed for sheave installation.
2. Bearings:
   a. Grease lubricated, precision antifriction, ball self-aligning type.
   b. Mounted in cast iron pillow block housing.
   c. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
   d. Suitable for fan operation in vertical configuration.
3. Drives:
   a. In accordance with Article, Drives.
   b. Factory set to the specified fan revolutions per minute.
   c. Type: Belt.
   d. Arrangement: As scheduled in Equipment Schedule.

F. Accessories: Provide as scheduled in Equipment Schedule as follows:
1. Housing Access Doors: Fiberglass construction, bolted and gasketed.
2. Disconnect: NEMA 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
3. Motor and Drive Cover:
   a. Factory fabricated, OSHA type.
   b. Fiberglass construction, same material as fan housing.
   c. Vented, openings sufficient size for proper motor cooling.
4. Belt Guard: Sheet metal construction, OSHA type.
5. Inlet Vanes: Variable position, for manual or automatic operation.
6. Housing Access Doors: Bolted and gasketed.

7. Shaft Seal: Ceramic felt.
8. Inlet Screen: Metal, spiral wire type, OSHA approved, removable.
9. Outlet Screen: Metal, spiral wire type, OSHA approved, removable.
10. Nameplates: Type 316 stainless steel manufacturer's nameplates.
11. Support Base: Welded metal, for standard platform or floor mounting.
12. Spark Resistant Construction: AMCA 99-0401 Type as scheduled.
13. Corrosive Service Metal Components:
    a. Metal components including the fan shaft, motor pedestal, motor slide base, lube lines, accessories, hardware etc, shall be Type 316 stainless steel.
    b. Coated steel components will not be accepted.
14. Corrosion Protection Coating:
    a. Provide factory-applied corrosion protection coating on these fan components: Steel components.
    b. Coating system shall be as scheduled in fan Equipment Schedule, and shall be in accordance with Article, Corrosion Protection Coating.

G. Manufacturers and Products:
1. Twin City; Model ILCF.
2. Hartzell; Model 40.

2.12 ROOF FAN, CENTRIFUGAL UPBLAST

A. General:
1. Factory-assembled centrifugal upblast roof fan; including housing, fan wheel, drive assembly, motor and accessories.
2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:
1. Construction: Spun-formed aluminum, minimum 16-gauge marine alloy.
2. Windband: Finish with rolled bead.
3. Top Cap: Motor access via quick release latches.
4. Motor completely sealed from exhaust air stream.
5. Motor cooling via air breather tubes.
6. Integral conduit chase for wiring.
7. Drain trough at lowest point of housing.
8. Fan Inlet:
    a. Full inlet cone of aluminum construction.
    b. Match inlet shroud.

C. Wheel:
1. Aluminum construction, backward inclined centrifugal, nonoverloading type.
2. Machined, cast aluminum hub.
3. Matched to deep spun inlet venturi.

D. Shaft, Bearings, Drive:
   1. Shaft:
      a. Turned, ground and polished carbon steel.
      b. Keyed for sheave installation.
      c. Zinc-phosphate coated and oil emulsion-dipped.
   2. Bearings:
      a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style.
      b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
      c. Terminate with zerk fittings.
   3. Drives:
      a. In accordance with Article, Drives.
      b. Factory set to specified fan revolutions per minute.
      c. Type: As scheduled in Equipment Schedule.

E. Accessories: Provide as scheduled in Equipment Schedule as follows:
   1. Gravity Backdraft Damper: Gravity operation, adjustable counterweight, and aluminum construction.
   2. Motorized Damper: Aluminum frame, aluminum blades, aluminum hinge pins with nylon bushings, 120V operator.
   3. Bird Screens: Aluminum construction.
   4. Roof Curb:
      a. Factory fabricated, aluminum construction.
      b. With damper tray and extended curb.
      c. Sloped to match roof pitch, and to provide level top.
      d. Height Above Finished Roof: As scheduled.
      e. Mitered continuous welded corner seams.
      f. Pressure-treated wood nailer.
      g. Insulation: Minimum 38 mm thick, 48 kg per cubic meter density, rigid mineral fiberboard insulation with metal liner.
   5. Disconnect: NEMA 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
   6. Bearing Lubrication Lines:
      a. Extended to outside of fan housing.
      b. Type 316 stainless steel construction.
      c. Terminate with zerk fittings.
   7. Spark Resistant Construction Classification: AMCA 99-0401 Type as scheduled.
   8. Corrosion Protection Coating:
      a. Provide factory-applied corrosion protection coating on these fan components:
         1) Wheel.
         2) Housing.
         3) Accessories.
         4) Interior surfaces in contact with airstream.
      b. Coating system shall be as scheduled in fan Equipment Schedule, and shall be in accordance with Article, Corrosion Protection Coating.

F. Manufacturers and Products:
   1. Twin City Fan; Model DCRU (Direct Drive); BCRU (Belt Drive).

2. Aerovent: Model ATB.
3. Cook; Model ACRUD (Direct Drive); ACRUB (Belt Drive).
4. Greenheck; Model CUE (Direct Drive); CUBE (Belt Drive).
5. ACME, Model PDU (Direct Drive); PNU (Belt Drive).

2.13 ROOF FAN, FIBERGLASS CENTRIFUGAL UPBLAST

A. General:
1. Factory-assembled centrifugal upblast fiberglass roof fan; including housing, fan wheel, drive assembly, motor, and accessories.
2. Fiberglass Construction: In accordance ASTM D4167.
3. Suitable to convey air at temperatures up to 66 degrees C.
4. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Fiberglass Material:
1. Construction: Resin reinforced fiber cloth and mat.
2. Resin:
   a. Vinyl ester thermosetting resin.
   b. No fillers or thixotropic agents.
   c. Premium grade and corrosion resistant.
   d. Structural wall resin may be of different chemical resistance, subject to conditions of service and approval by Contract Administrator.
   e. Flame Spread Index:
      1) ASTM E84, less than 25; fire retardant additives used only in structural layer.
      2) Structural wall resin shall contain a minimum of 3 percent antimony trioxide to achieve required flame spread index.
   f. Add ultraviolet absorbers to surfacing resin to improve weather resistance.
   g. Color:
      1) Use no dyes, pigments, or colorants, except in exterior gel coat.
      2) Exterior gel coat shall be manufacturer’s standard.
3. Reinforcement:
   a. Veil: Chemical surfacing mat, Nexus surface veil.
   b. Chopped Strand Mat: Type E glass, minimum 458 grams per square meter, with silane finish and styrene soluble binder.
   c. Continuous Roving for Chopper Gun Spray-Up: Type E glass.
   d. Woven Roving: Type E glass, nominal 814 grams per square meter, 4 by 5 weave, with silane type finish.
4. Laminate:
   a. Inner Surface (Veil):
      1) Resin rich, veil reinforced, 254 microns to 508 microns thick.
      2) Use no additives.
      3) Finish and binder compatible with lay-up resin.
      4) Reinforcement Content: Not more than 20 percent.
   b. Interior (Corrosion) Layer:
      1) Resin rich, at least two plies of chopped strand mat, nominal 2540 microns to 3048 microns thick.
      2) Use no additives.

3) Construct interior layer of resin reinforced with at least two plies of chopped strand mat backing the veil.
4) Reinforcement Content: 25 plus or minus 5 percent.

c. Exterior (Structural) Layer:
1) Resin with mat, cloth, woven roving or chopped strand glass reinforcement.
2) Enough resin present to prevent surface fiber show.
3) Exterior surface relatively smooth, with no exposed fibers or sharp projections.

d. Outer Surface (Gel Coat):
1) Resin rich.
2) 254 microns to 508 microns thick.

e. Wall Thickness: As required for equipment structural integrity, but no less than 4.8 mm.

C. Housing:
1. Windband: FRP construction, finished with smooth edge.
2. Top Cap: FRP construction, with motor access via quick release latches.
3. Motor completely sealed from exhaust air stream.
4. Motor cooling via air breather tubes.
5. Integral conduit chase for wiring, vinyl coated flexible metal.
6. Drain trough at lowest point of housing.
7. Fan Inlet:
a. Aerodynamic inlet venturi, FRP construction.
b. Match wheel inlet shroud.
8. Hardware: Type 316 stainless steel.

D. Wheel:
1. Aluminum construction, fully welded, epoxy coated.
2. Backward inclined centrifugal, nonoverloading type.
3. Machined, cast aluminum hub.
4. Matched to housing inlet venturi.

E. Shaft, Bearings, Drive:
1. Shaft:
a. Turned, ground and polished Type 316 stainless steel.
b. Keyed for sheave installation.
2. Bearings:
a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style.
b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours' operation at maximum cataloged operating speed.
c. Terminate with zerk fittings.
3. Drives:
a. In accordance with Article, Fan Drives.
b. Factory set to specified fan revolutions per minute.
c. Type: Belt or Direct, as indicated in Equipment Schedule.

F. Accessories: Provide as scheduled on Equipment Schedule as follows:
1. Gravity Backdraft Damper: Gravity operation, adjustable counterweight, and aluminum construction.

2. Motorized Damper: Aluminum frame, aluminum blades, aluminum hinge pins with nylon bushings, 120V operator.
3. Bird Screen: Aluminum construction, PVC encapsulated.
4. Roof Curb:
   a. Factory fabricated, galvanized steel aluminum construction.
   b. With damper tray and extended curb.
   c. Sloped to match roof pitch, and to provide level top.
   d. Height Above Finished Roof: As scheduled.
   e. Mitered continuous welded corner seams.
   f. Pressure-treated wood nailer.
   g. Insulation: Minimum 38 mm thick, 48 kg/m^3 density, rigid mineral fiberboard insulation with metal liner.
5. Disconnect: NEMA Type 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
6. Bearing Lubrication Lines:
   a. Extended to outside of fan housing.
   b. Type 316 stainless steel construction.
   c. Terminate with zerk fittings.
7. Spark Resistant Construction:
   a. AMCA 99-0401 Type as scheduled.
   b. Graphite impregnated in housing.
   c. Static grounding.

G. Manufacturers and Products:
   1. Twin City; Whirlout Model WA/WAB.
   2. Composite Fan Technology; Corro-Vent Model CVC.

2.14 ROOF FAN, FIBERGLASS CENTRIFUGAL DOWNBLAST

A. General:
   1. Factory-assembled centrifugal upblast fiberglass roof fan; including housing, fan wheel, drive assembly, motor, and accessories.
   2. Fiberglass Construction: In accordance ASTM D4167.
   3. Suitable to convey air at temperatures up to 66 degrees C.
   4. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Fiberglass Material:
   1. Construction: Resin reinforced fiber cloth and mat.
   2. Resin:
      a. Polyester thermosetting resin.
      b. No fillers or thixotropic agents.
      c. Premium grade and corrosion resistant.
      d. Structural wall resin may be of different chemical resistance, subject to conditions of service and approval by Contract Administrator.
      e. Flame Spread Index:
         1) ASTM E84, less than 25; fire retardant additives used only in structural layer.
         2) Structural wall resin shall contain a minimum of 3 percent antimony trioxide to achieve required flame spread index.

f. Add ultraviolet absorbers to surfacing resin to improve weather resistance.
g. Color:
1) Use no dyes, pigments, or colorants, except in exterior gel coat.
2) Exterior gel coat shall be manufacturer's standard.

3. Reinforcement:
a. Veil: Chemical surfacing mat, Nexus surface veil.
b. Chopped Strand Mat: Type E glass, minimum 458 grams per square meter, with silane finish and styrene soluble binder.
c. Continuous Roving for Chopper Gun Spray-Up: Type E glass.
d. Woven Roving: Type E glass, nominal 814 grams per square meter, 4 by 5 weave, with silane type finish.

4. Laminate:
a. Inner Surface (Veil):
1) Resin rich, veil reinforced, 254 microns to 508 microns thick.
2) Use no additives.
3) Finish and binder compatible with lay-up resin.
4) Reinforcement Content: Not more than 20 percent.
b. Interior (Corrosion) Layer:
1) Resin rich, at least two plies of chopped strand mat, nominal 2540 microns to 3048 microns thick.
2) Use no additives.
3) Construct interior layer of resin reinforced with at least two plies of chopped strand mat backing the veil.
4) Reinforcement Content: 25 plus or minus 5 percent.
c. Exterior (Structural) Layer:
1) Resin with mat, cloth, woven roving or chopped strand glass reinforcement.
2) Enough resin present to prevent surface fiber show.
3) Exterior surface relatively smooth, with no exposed fibers or sharp projections.
d. Outer Surface (Gel Coat):
1) Resin rich.
2) 254 microns to 508 microns thick.
e. Wall Thickness: As required for equipment structural integrity, but no less than 4.8 mm.

C. Housing:
1. Windband: FRP construction, finished with smooth edge.
2. Top Cap: FRP construction, with motor access via quick release latches.
3. Motor completely sealed from exhaust air stream.
4. Motor cooling via air breather tubes.
5. Integral conduit chase for wiring, vinyl coated flexible metal.
6. Drain trough at lowest point of housing.
7. Fan Inlet:
a. Aerodynamic inlet venturi, FRP construction.
b. Match wheel inlet shroud.
8. Hardware: Type 316 stainless steel.

D. Wheel:
1. Polypropylene construction.

2. Backward inclined centrifugal, nonoverloading type.
3. Machined, cast aluminum hub.
4. Matched to housing inlet venturi.

E. Shaft, Bearings, Drive:
1. Shaft:
   a. Turned, ground and polished Type 316 stainless steel.
   b. Keyed for sheave installation.
2. Bearings:
   a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style.
   b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours' operation at maximum cataloged operating speed.
   c. Terminate with zerk fittings.
3. Drives:
   a. In accordance with Article, Fan Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: Belt or Direct, as indicated in Equipment Schedule.

F. Accessories: Provide as scheduled on Equipment Schedule as follows:
1. Gravity Backdraft Damper: Gravity operation, adjustable counterweight, and PVC construction.
2. Motorized Damper: Aluminum frame, aluminum blades, aluminum hinge pins with nylon bushings, 120V operator, minimum NEMA 4X.
3. Bird Screen: Stainless steel.
4. Roof Curb:
   a. Factory fabricated, galvanized steel aluminum construction.
   b. Sloped to match roof pitch, and to provide level top.
   c. Height Above Finished Roof: As scheduled.
   d. Mitered continuous welded corner seams.
   e. Pressure-treated wood nailer.
   f. Insulation: Minimum 38 mm thick, 48 kg/m^3 density, rigid mineral fiberboard insulation with metal liner.
5. Disconnect: NEMA Type 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
6. Bearing Lubrication Lines:
   a. Extended to outside of fan housing.
   b. Type 316 stainless steel construction.
   c. Terminate with zerk fittings.
7. Spark Resistant Construction:
   a. AMCA 99-0401 Type as scheduled.
   b. Graphite impregnated in housing.
   c. Static grounding.

G. Manufacturers and Products:
   1. Twin City; Model FA.
   2. Composite Fan Technology.

2.15 INLINE FAN, MIXED FLOW EXHAUST FAN

A. General:
   1. Factory-assembled tubular mixed flow fan, [belt] [direct] drive; including housing, fan wheel, drive assembly, motor, and accessories.
   2. Fan Performance: AMCA 99-2408 Class I.
   3. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housings:
   1. Material: Steel.
   2. Construction:
      a. Heavy-gauge rolled metal casing, with continuous seam welding.
      b. Air straightening vanes at fan outlet, integral with shaft, bearing support, and outer casing, fully welded.
      c. Bearing and drive components isolated from air stream within continuously welded tunnel.
      d. Lifting lugs welded to housing.
      e. Mounting brackets, welded to housing, as required for indicated fan arrangement.
   3. Bearing Lubrication Lines:
      a. Extended to outside of fan housing.
      b. Type 316 stainless steel construction.
      c. Terminate with Zerk fittings.
   4. Inlets: Die-formed bell mouth, matched to fan wheel inlet shroud.
   5. Motor Base Plate: Minimum of 0.19 mm metal plate, welded to fan housing, to provide belt tensioning and adjustment for belt drive.
   6. Duct Flanges: Angle ring flanges, same diameter as housing, at fan inlet and outlet, heavy construction, factory drilled.

C. Impeller:
   1. Mixed flow airfoil design.
   2. Continuously welded steel construction.
   3. Attached to fan shaft with split taper lock bushing.

D. Shaft, Bearings, Drive:
   1. Shafts:
      a. Turned, ground and polished hot-rolled stainless steel.
      b. Keyed for sheave installation.
   2. Bearings:
      a. Grease lubricated, precision antifriction ball, self-aligning type.
      b. Mounted in cast iron pillow block housing.
      c. Selected for average life (ABMA 9 L_{50}) of not less than 500,000 hours, or useful life (ABMA 9 L_{10}) of not less than 100,000 hours operation at maximum cataloged operating speed.
      d. Suitable for fan operation in vertical configuration.

3. Drives:
   a. In accordance with Article Fan Drives.
   b. Factory set to the specified fan revolutions per minute.
   c. Type: Belt or Direct as per equipment schedule.
   d. Arrangement: As per equipment schedule.

E. Accessories: Provide as follows:
1. Aluminum hood to prevent rain entry.
2. Belt Guard: Sheet metal construction, MSHA and OSHA type.
3. Housing Access Doors: Bolted and gasketed.
4. Gravity Backdraft Damper: Gravity operation, adjustable counterweight, and aluminum construction.
5. Motorized Damper: Aluminum frame, aluminum blades, aluminum hinge pins with nylon bushings, 120V operator minimum, NEMA 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
6. Bird Screen: Aluminum construction, PVC encapsulated.
7. Roof Curb:
   a. Factory fabricated, galvanized steel aluminum construction.
   b. With damper tray and extended curb.
   c. Sloped to match roof pitch, and to provide level top.
   d. Height Above Finished Roof: As scheduled.
   e. Mitered continuous welded corner seams.
   f. Pressure-treated wood nailer.
   g. Insulation: Minimum 38 mm thick, 48 kg/m^3 density, rigid mineral fiberboard insulation with metal liner.
8. Disconnect: NEMA Type 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
9. Bearing Lubrication Lines:
   a. Extended to outside of fan housing.
   b. Type 316 stainless steel construction.
   c. Terminate with zerk fittings.
10. Spark Resistant Construction:
    a. AMCA 99-0401 Type as scheduled.
    b. Graphite impregnated in housing.
    c. Static grounding.
11. Corrosion Protection Coating:
    a. Provide factory-applied corrosion protection coating on these fan components:
       1) Wheel.
       2) Housing.
       3) Accessories.
       4) Interior surfaces in contact with airstream.
    b. Coating system shall be baked polyester, and shall be in accordance with Article Corrosion Protection Coating.

F. Manufacturers and Products:
1. Twin City Fan Model QSL.
2. Greenheck; Model QEI, QEID
3. Cook; Model QMX.

4. Aerovent; Model AMX.
5. ACME QBMX.

2.16 ROOF FAN, CENTRIFUGAL DOWNBLAST

A. General:
1. Factory-assembled centrifugal downblast roof fan; including housing, fan wheel, drive assembly, motor and accessories.
2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:
1. Construction: Spun-formed aluminum, minimum 16-gauge marine alloy.
2. Windband: Finish with rolled bead.
3. Top Cap: Motor access via quick release latches.
4. Motor completely sealed from exhaust air stream.
5. Motor cooling via air breather tubes.
6. Integral conduit chase for wiring.
7. Drain trough at lowest point of housing.
8. Fan Inlet:
   a. Full inlet cone of aluminum construction.
   b. Match inlet shroud.

C. Wheel:
1. Aluminum construction, backward inclined centrifugal, nonoverloading type.
2. Machined, cast aluminum hub.
3. Matched to deep spun inlet venturi.

D. Shaft, Bearings, Drive:
1. Shaft:
   a. Turned, ground, and polished carbon steel.
   b. Keyed for sheave installation.
   c. Corrosion resistant coating.
2. Bearings:
   a. Grease lubricated, precision antifriction sealed ball, self-aligning, pillow block style, sealed type.
   b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
   c. Terminate with zerk fittings.
3. Drives:
   a. In accordance with Paragraph Fan Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: Belt or direct, as indicated in Equipment Schedule.

E. Accessories: Provide as follows:
1. Motorized Damper: Aluminum frame, aluminum blades, aluminum hinge pins with nylon bushings, 120V operator, unless specified otherwise.
2. Bird Screens: Aluminum construction.

3. Roof Curb:
   a. Factory fabricated, galvanized steel construction.
   b. With damper tray and extension curb, unless otherwise noted.
   c. Sloped to match roof pitch, and to provide level top.
   d. Height Above Finished Roof: As scheduled in Equipment Schedule.
   e. Mitered continuous welded corner seams.
   f. Pressure-treated wood nailer.
   g. Insulation: Minimum 40 mm thick, 48 kg per cubic meter density, rigid mineral fiberboard insulation with metal liner.
4. Disconnect: NEMA Type 4X, Supplied and installed on the field by electrical contractor as shown on the drawings, unless noted otherwise.
5. Corrosion Protection Coating:
   a. Provide factory-applied corrosion protection coating on these fan components:
      1) Wheel.
      2) Housing.
      3) Accessories.
      4) Interior surfaces in contact with airstream.
   b. Coating system shall be as scheduled in fan Equipment Schedule, and shall be in accordance with Article Corrosion Protection Coating.

F. Manufacturers and Products:
   1. Twin City Fan; Model DCRD (Direct Drive); BCRD (Belt Drive).
   2. Cook; Model ACWD (Direct Drive); ACWB (Belt Drive).
   3. Greenheck; Model G (Direct Drive); GB (Belt Drive).
   4. ACME, Model PRN (Direct Drive); PV (Belt Drive).

2.17 ROOF GRAVITY VENTILATOR, SPUN ALUMINUM

A. General: Factory-assembled low-sihouette, intake, exhaust or gravity relief vent; including housing and accessories, suitable for roof mounting.

B. Housing:
   1. Construction:
      a. Bolted and welded construction with corrosion resistant fasteners.
      b. Internal structure constructed of aluminum.
   2. Base:
      a. Reinforced and braced.
      b. Integral snow and storm baffle, spun aluminum with rolled bead stiffener.
      c. Minimum panel thickness, 12 gauge.
      d. Miter cut continuously welded curb cap corners, pre-punched mounting holes coordinated for attachment to roof curb assembly.
      e. Integral deep spun inlet venturi.
   3. Hood:
      a. Spun aluminum structural components, 16-gauge minimum thickness.
      b. Bird screen across opening, 12 mm aluminum mesh.

C. Accessories: Provide as scheduled in Equipment Schedule.
   1. Gravity Backdraft Damper: Gravity operation, adjustable counterweight, aluminum construction.
   2. Motorized Damper: Aluminum frame, aluminum blades, aluminum hinge pins with nylon bushings, 120–volt operator, NEMA 4X.
   3. Roof Curb:
      a. Factory fabricated.
      b. With damper tray and extended curb
      c. Sloped to match roof pitch, and to provide level top.
      d. Height Above Finished Roof: 300 mm.
      e. Aluminum construction.
      f. Mitered, continuous welded corner seams.
      g. Pressure-treated wood nailer.
      h. Insulation: Minimum 40 mm thick, 48 kg per cubic meter density, rigid mineral fiberboard insulation with metal liner.
   4. Corrosion Protection Coating:
      a. Provide factory-applied corrosion protection coating on these components:
         1) Housing.
         2) Interior surfaces in contact with airstream.
      b. Coating system shall as scheduled in fan Equipment Schedule, and shall be in accordance with Article Corrosion Protection Coating.

D. Manufacturers and Products:
   1. Twin City; Model GRV.
   2. Cook; Model PR.
   3. Greenheck; Model GRSI (intake); Model GRSR (relief).

2.18 UTILITY BLOWER, CENTRIFUGAL SWSI, FIBERGLASS

A. General:
   1. Factory-assembled utility blower; including housing, fan wheel, drive assembly, motor and accessories.
   2. Fiberglass Construction: In accordance ASTM D4167.
   3. Suitable to convey air at temperatures up to 121 degrees C.
   4. Fan Performance: AMCA 99-2408 Class as scheduled.
   5. Airstream Hardware: Type 316 stainless steel.

B. Fiberglass Material:
   1. Construction: Resin reinforced fiber cloth and mat.
   2. Resin:
      a. Polyester or other qualified thermosetting resin.
      b. Selected by fabricator, subject to approval by Contract Administrator and suitable for intended service with no fillers or thixotropic agents.
      c. Premium grade and corrosion resistant.
      d. Structural wall resin may be of different chemical resistance, subject to conditions of service and approval by Contract Administrator.
      e. Flame Spread Index:
         1) ASTM E84, less than 25; fire retardant additives used only in structural layer.

2) Structural wall resin shall contain a minimum of 3 percent antimony trioxide to achieve required flame spread index.

f. For outdoor locations, add ultraviolet absorbers to surfacing resin to improve weather resistance.

g. Color:

1) Use no dyes, pigments, or colorants, except in exterior gel coat.

2) Exterior gel coat shall be white.

h. For interior locations, final coat shall be factory-applied intumescent coating to achieve designated results for low smoke development.

3. Reinforcement:

a. Veil: Chemical surfacing mat, Nexus Surface Veil.

b. Chopped Strand Mat: Type E glass, minimum 458 grams per square meter, with silane finish and styrene soluble binder.

c. Continuous Roving for Chopper Gun Spray-Up: Type E glass.

d. Woven Roving: Type E glass, nominal 814 grams per square meter, 4 by 5 weave, with silane type finish.

4. Laminate:

a. Inner Surface (Veil):

1) Resin rich, veil reinforced, 254 microns to 508 microns thick.

2) Use no additives.

3) Finish and binder compatible with lay-up resin.

4) Reinforcement Content: Not more than 20 percent.

b. Interior (Corrosion) Layer:

1) Resin rich, at least two plies of chopped strand mat, nominal 2540 microns to 3048 microns thick.

2) Use no additives.

3) Construct interior layer of resin reinforced with at least two plies of chopped strand mat backing the veil.

4) Reinforcement Content: 25 plus or minus 5 percent.

c. Exterior (Structural) Layer:

1) Resin with mat, cloth, woven roving or chopped strand glass reinforcement.

2) Enough resin present to prevent surface fiber show.

3) Exterior surface relatively smooth, with no exposed fibers or sharp projections.

d. Wall Thickness: As required for equipment structural integrity, but no less than 4.8 mm.

C. Housing:

1. Material: Fiberglass.

2. Construction:

a. Curved scroll configuration.

b. Integral flanges to ensure housing concentricity and housing strength.

c. Flanged outlet to permit duct connection.

d. Drain connection located at lowest point of fan housing.

e. Inlet:

1) Die-formed bell mouth of fiberglass construction.

2) Fiberglass supports.

3) Bolted to housing to permit wheel removal.

f. Shaft Seal: Viton construction, located at shaft penetration of housing.

3. Base/Pedestal: All-welded heavy gauge Type 316 stainless steel.

D. Wheel:
1. Material: Fiberglass.
2. Centrifugal, one-piece, nonoverloading, blade type as scheduled.
3. Wheel hub permanently bonded to shaft and completely encapsulated in fiberglass.

E. Shaft, Bearings, Drive:
1. Shafts:
   a. Turned, ground and polished Type 316 stainless steel.
   b. Ends drilled and tapped for wheel installation.
   c. Keyed for sheave installation.
2. Bearings:
   a. Grease lubricated, precision antifriction ball, self-aligning type.
   b. Mounted in cast iron pillow block housing.
   c. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
3. Drives:
   a. In accordance with Article, Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: As scheduled in Equipment Schedule.
   d. Arrangement: 4 or As scheduled in Equipment Schedule.

F. Accessories: Provide as scheduled in Equipment Schedule as follows:
1. Housing Access Doors: Bolted and gasketed.
2. Curb Base: Molded one-piece fiberglass, seamless construction.
3. Disconnect: NEMA 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
4. Flanged Inlet: Heavy fiberglass construction, factory drilled and flanged.
5. Shaft Seal: Fiberglass and neoprene construction, located at shaft penetration of housing.
6. Belt Guard: OSHA type, carbon steel sheet metal, for complete coverage of belts and sheaves.
7. Shaft and Bearing Guard: Carbon steel sheet metal for complete coverage of shaft and bearings.
8. Motor and Drive Cover:
   a. Factory fabricated, OSHA type.
   b. Carbon steel sheet metal construction.
   c. Vented, openings sufficient size for proper motor cooling.
9. Inlet Screen: Removable 25 mm mesh screen of coated steel construction over exposed inlets.
10. Unitary Subbase:
    a. Structural metal subbase, same material as fan housing.
    b. Bolted to bottom of fan base/pedestal.
    c. Drilled for field installation of vibration isolators.
11. Spark Resistant Construction:
    a. Carbon fiber veil impregnated in housing and wheel fiberglass resin corrosion barrier.
    b. Static grounding.

c. Classification: AMCA 99-0401 Type as scheduled.

12. Corrosion Protection Coating:
    a. Provide factory-applied corrosion protection coating on these fan components:
        1) Steel components.
    b. Coating system shall be as scheduled in fan Equipment Schedule, and shall be in accordance with Article, Corrosion Protection Coating.

G. Nozzle and Windband: A nozzle and wind band combination shall be provided to efficiently induce ambient airflow from outside the fan housing and increase discharge velocities to be a recommended minimum of 15 m/s without significantly affecting BHP requirements. The wind band shall provide a minimum discharge height of between 2100 mm and 3000 mm from the roof surface. Design nozzle and wind band support on the fan housing.

H. Manufacturers and Products:
    1. Twin City; Model BCSF.
    2. Aerovent; Model RBF.
    3. New York Blower; Model FE.
    4. Hartzell; Series 41.

2.19 UTILITY BLOWER, CENTRIFUGAL SWSI, HEAVY DUTY

A. General:
    1. Factory-assembled utility blower; including housing, fan wheel, drive assembly, motor, and accessories.
    2. Suitable to convey air at temperatures up to 121 degrees C.

B. Housing:
    1. Material: Aluminum.
    2. Construction:
        a. Curved scroll configuration, with continuous seam welding and side angle reinforcement.
        b. Lifting lugs welded to housing.
        c. Flanged and drilled outlet to permit duct connection.
        d. Drain connection located at lowest point of fan housing.
        e. Inlet: Spun-formed aerodynamic bell mouth.
    3. Base/Pedestal: All-welded heavy gauge Type 316 stainless steel.

C. Wheel:
    1. Centrifugal, one-piece, nonoverloading, blade type as scheduled.
    2. Material: Aluminum.
    3. Attached to fan shaft with split taper lock bushing.

D. Shaft, Bearings, Drive:
    1. Shafts:
        a. Turned, ground and 316 stainless steel.
        b. Ends drilled and countersunk for tachometer readings.
        c. Keyed for sheave installation.

2. Bearings:
   a. Grease lubricated, precision antifriction ball, self-aligning type.
   b. Mounted in cast iron pillow block housing.
   c. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
3. Drives:
   a. In accordance with Article, Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: As scheduled in Equipment Schedule.
   d. Arrangement: As scheduled in Equipment Schedule.

E. Accessories: Provide as scheduled in Equipment Schedule as follows:
1. Housing Access Doors: Bolted and gasketed.
2. Disconnect: NEMA 4X or NEMA 7/9 for hazardous classified area. Supplied and installed on the field by electrical contractor as shown on the drawings.
3. Flanged Inlet: Heavy gauge construction, factory drilled and flanged.
4. Shaft Seal: Viton construction, located at shaft penetration of housing.
5. Belt Guard: OSHA type, sheet metal construction same material as fan housing, for complete coverage of belts and sheaves.
6. Shaft and Bearing Guard: Sheet metal construction same material as fan housing, for complete coverage of shaft and bearings.
7. Motor and Drive Cover:
   a. Factory fabricated, OSHA type.
   b. Sheet metal construction, same material as fan housing.
   c. Vented, openings sufficient size for proper motor cooling.
8. Inlet Guard: Spiral wire type, OSHA approved, removable, same material as fan housing.
9. Unitary Subbase:
   a. Structural metal subbase, same material as fan housing.
   b. Bolted to bottom of fan base/pedestal.
   c. Drilled for field installation of vibration isolators.
10. Spark Resistant Construction Classification: AMCA 99-0401 Type as scheduled.
11. Insulated Fan Housing:
    a. Provide a complete insulated housing around the fan scroll and assembly.
    b. Housing to be constructed with 100 mm thick insulation, refer to Section 23 07 00, HVAC Insulation for details.
    c. The housing construction is to be fulled framed with bolted construction.
    d. Panel seams to be caulked and sealed with silicone caulking.
    e. All fasteners to be constructed from 304 stainless steel.
    f. The exterior of insulated housing is to be constructed from 20 gauge Type 304 stainless steel.
12. Corrosion Protection Coating:
    a. Provide factory-applied corrosion protection coating on these fan components:
       1) Wheel (or propeller).
       2) Housing.
       3) Accessories.
       4) Interior surfaces in contact with airstream.
    b. Coating system shall be as scheduled in fan Equipment Schedule, and shall be in accordance with Article, Corrosion Protection Coating.

F. Manufacturers and Products:
   1. Twin City; Model BCS.
   2. Cook.
   3. New York Blower.

2.20 WALL FAN, CENTRIFUGAL FIBERGLASS

A. General:
   1. Factory-assembled centrifugal wall fan; including housing, fan wheel, drive assembly, motor and accessories.
   2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:
   1. Construction: Heavy gauge fiberglass reinforced plastic.
   2. Motor completely sealed from air stream.
   3. Integral conduit chase for wiring.
   4. Fan Inlet:
      a. Full inlet cone of fibreglass construction.
      b. Match inlet shroud.
   5. Wall Flange: With prepunched key slot holes.

C. Fan Wheels:
   1. Flat blade polypropylene, backward inclined centrifugal, nonoverloading type.
   2. Machined, cast aluminum hub.

D. Shaft, Bearings, Drive:
   1. Shaft:
      a. Turned, ground and polished carbon steel.
      b. Keyed for sheave installation.
      c. Zinc-phosphate coated and oil emulsion-dipped.
   2. Bearings:
      a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style.
      b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
      c. Terminate with zerk fittings.
   3. Drives:
      a. In accordance with Article, Drives.
      b. Factory set to the specified fan revolutions per minute.
      c. Type: As scheduled in Equipment Schedule.

E. Accessories: Provide as scheduled in Equipment Schedule as follows:
   1. Gravity Backdraft Damper: Gravity operation, adjustable counterweight, aluminum construction.
   2. Motorized Damper: Aluminum frame, aluminum blades, aluminum hinge pins with nylon bushings, 120V operator.
   3. Bird Screen: Aluminum construction.
   4. Disconnect: NEMA 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.

5. Bearing Lubrication Lines:
    a. Extended to outside of fan housing.
    b. Type 316 stainless steel construction.
    c. Terminate with zerk fittings.
6. Spark Resistant Construction: Classification: AMCA 99-0401 Type as scheduled.
7. Corrosion Protection Coating:
    a. Provide factory-applied corrosion protection coating on these fan components:
        1) Wheel.
        2) Housing.
        3) Accessories.
        4) Interior surfaces in contact with airstream.
    b. Coating system shall be as scheduled in fan Equipment Schedule, and shall be in accordance with Article, Corrosion Protection Coating.

F. Manufacturers and Products:
1. Twin City; Model SA.
2. Greenheck.

2.21 WALL FAN, PROPELLER, HEAVY DUTY

A. General: Factory-assembled wall propeller fan; including housing, propeller, drive assembly, motor and accessories.

B. Housing:
1. Material: Metal components constructed from aluminum.
2. Panel:
    a. Minimum 14-gauge mild steel construction.
    b. Integral formed venturi orifice.
    c. Continuously welded corners.
    d. Bolted to frame.
3. Frame:
    a. Minimum 14-gauge steel construction.
    b. Continuously welded joints.
    c. Reinforced motor base plate.

C. Propeller:
1. Cast aluminum construction.
2. Hub keyed and mechanically locked to shaft.

D. Shaft, Bearings, Drive:
1. Shaft:
    a. Turned, ground and polished carbon steel.
    b. Keyed for sheave installation.
2. Bearings:
    a. Grease lubricated, precision antifriction ball, self-aligning, sealed pillow block style.
    b. Mounted in cast iron pillow block housing.
    c. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.

3. Drives:
    a. In accordance with Article, Drives.
    b. Factory set to the specified fan revolutions per minute.
    c. Type: As scheduled in Equipment Schedule.

E. Accessories: Provide as scheduled in Equipment Schedule as follows:
1. Disconnect: NEMA 4X. Supplied and installed on the field by electrical contractor as shown on the drawings.
2. Propeller-Side Guard: Galvanized steel construction.
3. Motor-Side Guard: Galvanized steel construction.
4. Weather Hood:
    a. Heavy-gauge galvanized steel construction, to match fan and accessory size.
    b. Galvanized steel expanded metal bird screen.
5. Wall Housing:
    a. Allows fan mounting on interior or exterior wall.
    b. Heavy-gauge galvanized steel construction.
6. Shutters, Gravity Operated:
    a. Welded aluminum frame.
    b. Extruded aluminum blades.
    c. Felt edge seals.
    d. Oil impregnated bronze bushings.
    e. Reverse flange for building exterior mounting. Standard flange for indoor mounting.
7. Shutters, Motor Operated:
    a. Welded aluminum frame.
    b. Extruded aluminum blades.
    c. Stainless steel edge seals.
    d. Oil impregnated bronze bushings.
    e. 120-volt spring return damper actuator with end switch.
    f. Reverse flange for building exterior mounting. Standard flange for indoor mounting.
8. Spark Resistant Construction:
    a. Nonferrous blade assembly.
    b. Classification: AMCA 99-0401 Type as scheduled.
9. Panel Fan Boot:
    a. To adapt fan panel to wall louver.
    b. Size to suit louver dimension as shown on Drawings or indicated in Specifications.
    c. Sheet metal construction, same material as fan housing.
10. Corrosion Protection Coating:
    a. Provide factory-applied corrosion protection coating on these fan components:
        1) Housing.
        2) Accessories.
        3) Interior surfaces in contact with airstream.
    b. Coating system shall be as scheduled in fan Equipment Schedule, and shall be in accordance with Article, Corrosion Protection Coating.

F. Manufacturers and Products:
1. Twin City; Model TCWP (Direct), TCWPX (Direct, adjustable blades).
2. New York Blower; Model NYC.
3. Hartzell; Model Series 02.

2.22 CORROSION PROTECTION COATING

A. General:
   1. Factory-applied corrosion protection coating for application to fan components and accessories, where required by this Section.
   2. Quality Control:
      a. Verify dry film thickness before final baking.
      b. Finished coating system shall be free from voids, checks, cracks and blisters.
   3. Surface Cleaning: Clean parts to be coated as follows:
      a. Immerse parts in heated cleaning solution to remove lubricants, machining oils, and residual factory contamination.
      b. Follow with immersion in potable water bath to neutralize and remove cleaning solution.
      c. Chemical Pretreatment: Immerse parts in heated chemical solution, iron phosphate for steel, clear/yellow chromate for aluminum.

B. Baked Enamel:
   1. Material: Alkyd modified urea-melamine single component baking enamel.
   2. Surface Preparation: Clean surface to SSPC-SP 3.
   3. Application: Standard air-pressurized spray equipment.
   4. Curing: Oven baked at a metal temperature not to exceed 149 degrees C.
   5. Finished Thickness: 25 microns to 50 microns dry film thickness.
   6. Performance: Coating shall meet or exceed following criteria:
      a. Impact Resistance: 0.115 kg meter, ASTM D2794 test method.
      b. Pencil Hardness: 2H, ASTM D3363 test method.
      c. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
      d. Service Temperature: Maximum 110 degree C, continuous.

C. Baked Polyester:
   1. Material: Polyester.
   2. Surface Preparation: Sandblast surface to SSPC-SP 5.
   3. Application: Electrostatic spray.
   4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
   5. Finished Thickness: 38 microns to 62 microns dry film thickness.
   6. Performance: Coating shall meet or exceed following criteria:
      a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
      b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
      c. Impact Resistance: 1.15 kg meter, ASTM D2794 test method.
      d. Pencil Hardness: 2H, ASTM D3363 test method.
      e. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
      f. Service Temperature: Maximum 110 degrees C, continuous.

D. Air-Dry Epoxy:
   1. Material: Two-part catalyzed epoxy.
   2. Surface Preparation: Clean surface to SSPC-SP 3.
   3. Application: Standard air-pressurized spray equipment.

4. Curing: Air dry.
5. Finished Thickness: 100 microns to 150 microns dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   a. Salt Spray Test: Minimum 1,500-hour duration, ASTM B117 test method.
   b. Pencil Hardness: H-2H, ASTM D3363 test method.
   c. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
   d. Service Temperature: Maximum 65 degrees C, continuous.

E. Baked Epoxy:
1. Material: Epoxy.
2. Surface Preparation: Sandblast surface to SSPC-SP 10.
3. Application: Electrostatic spray.
4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
5. Finished Thickness: 62 microns to 88 microns dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
   b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
   c. Impact Resistance: 1.15 kg meter, ASTM D2794 test method.
   d. Pencil Hardness: 2H, ASTM D3363 test method.
   e. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
   f. Service Temperature: Maximum 110 degrees C, continuous.

F. Air Dry Phenolic:
1. Material:
   a. Phenolic resin, Heresite VR-500 Series or approved equal in accordance with B8.
   b. For outdoor applications, apply an UV resistant topcoat, Heresite UC-5500 or approved equal in accordance with B8.
2. Surface Preparation: Sandblast surface to SSPC-SP 6.
3. Application: Standard air-pressurized spray equipment.
4. Curing: Air dry.
5. Finished Thickness: 100 microns to 150 microns dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   a. Salt Spray Test: Minimum 500-hour duration, ASTM B117 test method.
   b. Humidity Resistance: Minimum 500-hour duration, ASTM D2247 test method.
   c. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
   d. Service Temperature: Maximum 82 degrees C, continuous.

G. Baked Phenolic:
1. Material: Phenolic resin, Heresite P-403 or approved equal in accordance with B8.
2. Surface Preparation: Sandblast surface to SSPC-SP 5.
3. Application: Standard air-pressurized spray equipment.
4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
5. Finished Thickness: 125 microns to 175 microns dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.

b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
c. Impact Resistance: 1.15 kg meter, ASTM D2794 test method.
d. Pencil Hardness: 2H, ASTM D3363 test method.
e. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
f. Service Temperature: Maximum 121 degrees C, continuous.

H. Baked Epoxy Phenolic:
1. Material:
a. Baking cross-linked epoxy-phenolic.
b. For outdoor applications, apply an UV resistant topcoat.
2. Surface Preparation: Sandblast surface to SSPC-SP 5.
3. Application: Electrostatic or conventional compressed air spray equipment.
4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
5. Finished Thickness: 150 microns to 200 microns dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
c. Impact Resistance: 1.84 kg meter, ASTM D2794 test method.
d. Pencil Hardness: 3H, ASTM D3363 test method.
e. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
7. Service Temperature: Maximum 177 degrees C, continuous.

2.23 MOTORS

A. General:
1. Fan motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction.
2. Provide integral self-resetting overload protection on single-phase motors.
3. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
4. Motors shall not operate into service factor in any case.

B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:
1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Winding Thermal Protection: None.
3. Space Heater: No.
4. Number of Speeds: Single.
5. Number of Windings: One.
6. Motor Efficiency: Premium efficient.
7. Shaft Type: Solid, carbon steel.
8. Mounting: As required for fan arrangement.
9. Service Factor: 1.15.

2.24 ACOUSTICAL ENCLOSURES FOR BIOFILTER FANS EF-T301 AND EF EF-T302

A. Walk around fan type.

B. Wind and seismic performance in accordance with building code. Provide structural drawings sealing by a Professional Engineer licensed in Manitoba.

C. Dimensions 3050 mm H x 3400 mm W x 5500 mm L

D. 100 mm thick Nois-eNvelope™ panels with solid galvanized exterior and galvanized inner perf, packed with acoustic media.

Frequency (Hz)	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Transmission Loss	21	21	30	41	52	59	64	67

E. Quantity one access door for access to fan motor for maintenance

F. Quantity two ventilation openings c/w silencer to maintain noise criteria at 70 dBA @ 1.5 m around enclosure and allowing 6000 cfm ventilation with maximum 20° F temperature rise at 2 air exchanges/min.

G. Flashing, anchoring and self-drilling fasteners

H. Manufacturer
1. Basis-of-Design Product: The design for the acoustical screens for this Project is based on dBNR Nois-eNvelope™ Architectural Environmental Noise Barrier System (AENBS) manufactured by dB Noise Reduction Inc.
2. dB Noise Reduction Inc. Cambridge, ON

2.25 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown on Drawings.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

2.26 SOURCE QUALITY CONTROL

A. General:
1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
3. Consider drive efficiency in motor selection according to manufacturer’s published recommendation or according to AMCA 203, Appendix L.

B. Testing Provisions:
   1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
   2. Center punch fan shaft to accommodate tachometer readings.

C. Acoustical Levels:
   1. Perform noise tests in accordance with AMCA 300 and AMCA 301.
   2. Fan sound power levels (dB, Reference 10^{-12} Watts) shall be no greater than scheduled values.

D. Balancing:
   1. Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.
   2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.

E. Vibration Test:
   1. Each fan furnished with a 3.7 kW or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
   2. Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
      a. Belt Drive (except Vane Axial): 0.38 cm per second peak velocity.
      b. Belt Drive Vane Axial: 0.2 cm per second peak velocity.
      c. Direct Drive: 0.2 cm per second peak velocity.
   3. Written records of run test and vibration test shall be made available upon request.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install fans level and plumb.

B. Secure roof-mounted fans to roof curbs with Type 316 stainless steel hardware.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Scroll Drains: Pipe drain connection through running trap to floor drain.

E. Labeling:
   1. Label fans in accordance with Article, Accessories.
   2. Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.

F. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

G. Equipment Support and Restraints:
   1. Refer to Section 23 05 48, Vibration for HVAC.

2. Install floor-mounted units on concrete bases designed to withstand, without damage to equipment.
3. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.

H. Connections
1. Refer to Section 23 31 13, Metal Ductwork and Accessories and Section 23 31 16.16, Thermoset Fiberglass-Reinforced Plastic Ducts and Accessories.
2. Isolate duct connections to fans.
3. Install ductwork adjacent to fans to allow proper service and maintenance.

3.2 FIELD QUALITY CONTROL

A. Functional Tests:
1. Verify blocking and bracing used during shipping are removed.
2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system; align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.
8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:
1. Starting Procedures:
   a. Energize motor and adjust fan to indicated revolutions per minute.
   b. Measure and record motor voltage and amperage.
2. Operational Test:
   a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
   c. Test and adjust control safeties.
   d. Replace damaged and malfunctioning controls and equipment.

3.3 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site in accordance with Section 01 43 33, Contractor Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of the City’s Manitoba personnel for specified component, subsystem, equipment, or system.

B. Manufacturer’s Representative: Present at Site or classroom designated by the City, of Manitoba, for minimum person-days listed below, travel time excluded:
1. One person-day for installation assistance and inspection.

2. One person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. One person-day for prestartup classroom or Site training.
4. One person-day for facility startup.
5. One person-day for post-startup training [of the City's personnel.]
6. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by the City and Contract Administrator.

C. Refer Section 01 43 33, Contractor Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Balancing:
1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
2. Replace fan and motor sheaves as required to achieve design airflow.

E. Vibration Testing:
1. Perform field testing on rotating equipment, where specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, to determine actual operating vibration.
2. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.6 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.
1. 23 34 00.01, Fans.

END OF SECTION

FANS — 23 34 00.01

SYMBOL				EF-K611	EF-K612	EF-K621	EF-K622
LOCATION				ROOF HRC	ROOF HRC	ROOF HRC	ROOF HRC
TYPE				UTILITY BLOWER CENTRIFUGAL FIBREGLASS	UTILITY BLOWER CENTRIFUGAL FIBREGLASS	ROOF CENTRIFUGAL DOWNBLAST	ROOF CENTRIFUGAL DOWNBLAST
FAN DATA	AIRFLOW	MAX	L/s	5000	5000	1677	1677
		@ SP	Pa	1000	1000	125	125
		MIN	L/s	2500	2500	839	839
	SPEED	RPM		1192	1192	1091	1091
	DRIVE TYPE			DIRECT	DIRECT	DIRECT	DIRECT
	WHEEL	TYPE		BI	BI	BI	BI
		MIN. DIA.	mm	-	-	450	450
	MAXIMUM	kW		6.77	6.77	0.63	0.63
SOUND DATA	SOUND POWER LEVEL dB (RE 10^{-12} W) @ MID OCTAVE BAND FREQUENCY (Hz)		63	89	89	89	89
			125	90	90	87	87
			250	89	89	84	84
			500	85	85	80	80
			1K	83	83	76	76
			2K	81	81	72	72
			4K	78	78	66	66
			8K	76	76	59	59
ELECTRICAL DATA	MOTOR		kW	11	11	0.75	0.75
			RPM	1200	1200	1200	1200
			ENCL.	XP	XP	TEFC	TEFC
	VOLT			575	575	575	575
	PH			3	3	3	3
MAXIMUM DIMENSIONS	LENGTH		mm	1174	1174	1016	1016
	WIDTH		mm	1422	1422	1016	1016
	HEIGHT		mm	1430	1430	820	820
	WEIGHT		kg	600	600	65	65
MANUFACTURER				TWIN CITY	TWIN CITY	TWIN CITY	TWIN CITY
MODEL NO.				BCSF 300M1	BCSF 300M1	DCRD 180B	DCRD 180B
APPLICABLE REMARKS:				A/B/C/F/G/H/I	A/B/C/F/G/H/I	B/C/D/E	B/C/D/E

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
G: DRAIN WITH PLUG
H: SUITABLE FOR CLASS I, ZONE 2
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING
P: BIRD SCREEN
Q: SUITABLE FOR CLASS I, ZONE 1

FANS **23 34 00.01**

SYMBOL				EF-K631	EF-K652	U-K614	
LOCATION				ROOF HRC	ROOF HRC	ROOF HRC	
TYPE				INLINE MIXED FLOW	ROOF CENTRIFUGAL UPBLAST	ROOF GRAVITY VENT SPUN ALUMINUM	
FAN DATA	AIRFLOW	MAX	L/s	3540	50	109	
		@ SP	Pa	187	62	8	
		MIN	L/s	-	50	-	
	SPEED	RPM		890	901	-	
	DRIVE TYPE			DIRECT	DIRECT	-	
	WHEEL	TYPE		AF	BI	-	
		DIA.	mm	-	735	-	
	MAXIMUM	kW		1.07	0.04	-	
SOUND DATA	SOUND POWER LEVEL dB (RE 10^{-12} W) @ MID OCTAVE BAND FREQUENCY (Hz)		63	82	64	-	
			125	80	66	-	
			250	77	55	-	
			500	74	51	-	
			1K	72	46	-	
			2K	67	39	-	
			4K	60	32	-	
			8K	53	28	-	
ELECTRICAL DATA	MOTOR		kW	1.5	0.093	-	
			RPM	900	1200	-	
			ENCL.	TEFC	ODP	-	
	VOLT			575	120	-	
	PH			3	1	-	
MAXIMUM DIMENSIONS	LENGTH		mm	1295	610	-	
	WIDTH		mm	1118	610	-	
	HEIGHT		mm	1118	575	-	
	WEIGHT		kg	171	29	-	
MANUFACTURER				TWIN CITY	TWIN CITY	TWIN CITY	
MODEL NO.				QSL 245	DCRU 082B	GRV-090B	
APPLICABLE REMARKS:				C/D/J	C/D/K	D/E	

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
G: DRAIN WITH PLUG
H: SUITABLE FOR CLASS I, ZONE 2
I: 25mm DEFLECTION INERTIA BASE
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING
P: BIRD SCREEN
Q: SUITABLE FOR CLASS I, ZONE 1
R: INSULATED WALKAROUND NOISE ENCLOSURE

FANS **23 34 00.01**

SYMBOL				EF-B685	EF-B686	EF-B687	EF-B688
LOCATION				VENTILATION ROOM	VENTILATION ROOM	VENTILATION ROOM	VENTILATION ROOM
TYPE				INLINE TUBULAR CENTRIFUGAL FIBERGLASS	INLINE TUBULAR CENTRIFUGAL FIBERGLASS	INLINE TUBULAR CENTRIFUGAL FIBERGLASS	INLINE TUBULAR CENTRIFUGAL FIBERGLASS
FAN DATA	AIRFLOW	MAX	L/s	5101	5101	2065	2065
		@ SP	Pa	1191	1191	1070	1070
	SPEED	RPM		1351	1351	2098	2098
	DRIVE TYPE			BELT	BELT	BELT	BELT
	WHEEL	TYPE		BI	BI	BI	BI
	MAXIMUM	kW		9.93	9.93	3.60	3.60
SOUND DATA	SOUND POWER LEVEL dB (RE 10^{-12} W) @ MID OCTAVE BAND FREQUENCY (Hz)		63	99	99	100	100
			125	99	99	97	97
			250	100	100	93	93
			500	98	98	91	91
			1K	95	95	89	89
			2K	90	90	83	83
			4K	84	84	77	77
			8K	77	77	72	72
ELECTRICAL DATA	MOTOR		kW	15.00	15.00	5.50	5.50
			RPM	1800	1800	1800	1800
			ENCL.	TEFC	TEFC	TEFC	TEFC
	VOLT			575	575	575	575
	PH			3	3	3	3
MAXIMUM DIMENSIONS	LENGTH		mm	1200	1200	794	794
	WIDTH		mm	1006	1006	711	711
	HEIGHT		mm	1006	1006	711	711
	WEIGHT		kg	315	315	181	181
MANUFACTURER				TWIN CITY	TWIN CITY	TWIN CITY	TWIN CITY
MODEL NO.				ILCF 32	ILCF 32	ILCF 20	ILCF 20
APPLICABLE REMARKS:				A/B/C/H	A/B/C/H	A/B/C/H	A/B/C/H

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
G: DRAIN WITH PLUG
H: SUITABLE FOR CLASS I, ZONE 2
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING
P: BIRD SCREEN
Q: SUITABLE FOR CLASS I, ZONE 1

FANS **23 34 00.01**

SYMBOL				EF-G611	SF-G612	EF-G656	EF-G657
LOCATION				GRIT AND SCREENING PLATFORM	MECHANICAL ROOM	WASHROOM	JANITOR'S ROOM
TYPE				UTILITY BLOWER CENTRIFUGAL FIBREGLASS	INLINE CENTRIFUGAL SQUARE	CABINET CEILING	CABINET CEILING
FAN DATA	AIRFLOW	MAX	L/s	5303	185	47	47
		@ SP	Pa	1313.0	63.0	62	62.0
	SPEED	RPM		1767	1014	770	770
	DRIVE TYPE			DIRECT	DIRECT	DIRECT	DIRECT
	WHEEL	TYPE		BI	BI	BI	BI
	MAXIMUM	kW		11.16	0.02	0.10	0.10
SOUND DATA	SOUND POWER LEVEL dB (RE 10^{-12} W) @ MID OCTAVE BAND FREQUENCY (Hz)		63	96	61	42	42
			125	97	60	43	43
			250	96	60	40	40
			500	92	63	40	40
			1K	89	64	37	37
			2K	83	55	34	34
			4K	76	47	24	24
			8K	69	41	11	11
ELECTRICAL DATA	MOTOR		kW	15.00	0.18	0.12	0.12
			RPM	1800	1750	950	950
			ENCL.	TEFC	TEFC	ODP	ODP
	VOLT			575	575	120	120
	PH			3	3	1	1
MAXIMUM DIMENSIONS	LENGTH		mm	1267	419	311	311
	WIDTH		mm	1481	389	311	311
	HEIGHT		mm	1620	389	298	298
	WEIGHT		kg	607	28	10	10
MANUFACTURER				TWIN CITY	TWIN CITY	TWIN CITY	TWIN CITY
MODEL NO.				BCSF 270M2	DSI 090AE	TL 150R	TL 150R
APPLICABLE REMARKS:				B/C/F/G	B/C	C /L	C /L

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
G: DRAIN WITH PLUG
H: SUITABLE FOR CLASS I, ZONE 2
I: 25mm DEFLECTION INERTIA BASE
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING
P: BIRD SCREEN
Q: SUITABLE FOR CLASS I, ZONE 1
R: INSULATED WALKAROUND NOISE ENCLOSURE

FANS								**23 34 00.01**
SYMBOL					EF-G693	U-G657-1		
LOCATION					ROOF GRIT TANKS	ROOF OF GRIT AND SCREENING		
TYPE					ROOF FIBERGLASS CENTRIFUGAL DOWNBLAST	ROOF GRAVITY VENT SPUN ALUMINUM		
FAN DATA	AIRFLOW	MAX	L/s		850	94		
		@ SP	Pa		210	8		
	SPEED	RPM			1160	-		
	DRIVE TYPE				DIRECT	-		
	WHEEL	TYPE			BI	-		
	MAXIMUM	kW			0.74	-		
SOUND DATA	SOUND POWER LEVEL		63		79	-		
	dB (RE 10^{-12} W)		125		85	-		
	@ MID OCTAVE BAND		250		88	-		
	FREQUENCY (Hz)		500		85	-		
			1K		76	-		
			2K		74	-		
			4K		65	-		
			8K		59	-		
ELECTRICAL DATA	MOTOR		kW		0.74	-		
			RPM		1160	-		
			ENCL.		TEFC	-		
	VOLT				575	-		
	PH				3	-		
MAXIMUM DIMENSIONS	LENGTH		mm		889	-		
	WIDTH		mm		889	-		
	HEIGHT		mm		553	-		
	WEIGHT		kg		53	-		
MANUFACTURER					TWIN CITY	TWIN CITY		
MODEL NO.					FA 18	GRV-090B		
APPLICABLE REMARKS:					B/C/D	E** *		

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING

FANS **23 34 00.01**

SYMBOL				EF-C613	EF-C614	EF-C615	EF-C616
LOCATION				ROOF CHEMICAL BUILDING	ROOF CHEMICAL BUILDING	ROOF CHEMICAL BUILDING	ROOF CHEMICAL BUILDING
TYPE				UTILITY BLOWER CENTRIFUGAL FIBREGLASS	UTILITY BLOWER CENTRIFUGAL FIBREGLASS	UTILITY BLOWER CENTRIFUGAL FIBREGLASS	UTILITY BLOWER CENTRIFUGAL FIBREGLASS
FAN DATA	AIRFLOW	MAX	L/s	4347	4347	4232	4232
		@ SP	Pa	623	623	573	573
		MIN	L/s	2277	2277	2216	2216
	SPEED	RPM		1150	1150	1150	1150
	DRIVE TYPE			DIRECT	DIRECT	DIRECT	DIRECT
	WHEEL	TYPE		BI	BI	BI	BI
	MAXIMUM	kW		4.5	4.5	4.2	4.2
SOUND DATA	SOUND POWER LEVEL		63	86	86	86	86
	dB (RE 10^{-12} W)		125	87	87	87	87
	@ MID OCTAVE BAND		250	88	88	88	88
	FREQUENCY (Hz)		500	84	84	83	83
			1K	83	83	84	84
			2K	80	80	81	81
			4K	76	76	76	76
			8K	73	73	73	73
ELECTRICAL DATA	MOTOR		kW	5.5	5.5	5.5	5.5
			RPM	1200	1200	1200	1200
			ENCL.	TEFC	TEFC	TEFC	TEFC
	VOLT			575	575	575	575
	PH			3	3	3	3
MAXIMUM DIMENSIONS	LENGTH		mm	2844	2844	2844	2844
	WIDTH		mm	1730	1730	1730	1730
	HEIGHT		mm	3245	3245	3245	3245
	WEIGHT		kg	509	509	509	509
MANUFACTURER				TWIN CITY	TWIN CITY	TWIN CITY	TWIN CITY
MODEL NO.				BCSF 300M2	BCSF 300M2	BCSF 300M2	BCSF 300M2
APPLICABLE REMARKS:				A/B/C/F/G	A/B/C/F/G	A/B/C/F/G	A/B/C/F/G

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING

FANS — 23 34 00.01

SYMBOL				EF-C621	EF-C651	EF-C652	EF-C653
LOCATION				MECHANICAL ROOM 2	MECHANICAL ROOM 1	MECHANICAL ROOM 2	WASHROOM
TYPE				INLINE TUBULAR CENTRIFUGAL	INLINE CENTRIFUGAL SQUARE	INLINE CENTRIFUGAL SQUARE	CABINET CEILING
FAN DATA	AIRFLOW	MAX	L/s	1830	200	280	47
		@ SP	Pa	250	100	100	100
		MIN	L/s	915	N/A	N/A	N/A
	SPEED	RPM		1156	1502	1399	606
	DRIVE TYPE			DIRECT	DIRECT	DIRECT	DIRECT
	WHEEL	TYPE		BI	BI	BI	BI
	MAXIMUM	kW		0.85	0.06	0.07	0.06
SOUND DATA	SOUND POWER LEVEL dB (RE 10^{-12} W) @ MID OCTAVE BAND FREQUENCY (Hz)		63	92	65	66	56
			125	85	65	66	56
			250	78	66	66	52
			500	78	66	68	48
			1K	75	66	70	44
			2K	69	60	64	37
			4K	61	52	56	32
			8K	54	46	50	26
ELECTRICAL DATA	MOTOR		kW	1.50	0.18	0.18	0.12
			RPM	1800	1750	1750	750
			ENCL.	TEFC	ECODP	ECODP	ODP
	VOLT			575	575	575	120
	PH			3	3	3	1
MAXIMUM DIMENSIONS	LENGTH		mm	876	500	500	311
	WIDTH		mm	770	390	390	311
	HEIGHT		mm	1066	390	390	298
	WEIGHT		kg	186	31	31	10
MANUFACTURER				TWIN CITY	TWIN CITY	TWIN CITY	TWIN CITY
MODEL NO.				TSL 200	DSI 080AE	DSI 090AE	T 150V
APPLICABLE REMARKS:				B/C	B/C	B/C	C

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING

FANS								**23 34 00.01**
SYMBOL					EF-C661	EF-C662		
LOCATION					GENERATOR ROOM	JANITOR'S ROOM		
TYPE					INLINE CENTRIFUGAL SQUARE	CABINET CEILING		
FAN DATA	AIRFLOW	MAX	L/s		142	47		
		@ SP	Pa		100	100		
		MIN	L/s		N/A	N/A		
	SPEED	RPM			1288	606		
	DRIVE TYPE				DIRECT	DIRECT		
	WHEEL	TYPE			BI	BI		
	MAXIMUM	kW			0.04	0.06		
SOUND DATA	SOUND POWER LEVEL dB (RE 10^{-12} W) @ MID OCTAVE BAND FREQUENCY (Hz)		63		63	56		
			125		62	56		
			250		64	52		
			500		64	48		
			1K		62	44		
			2K		57	37		
			4K		49	32		
			8K		45	26		
ELECTRICAL DATA	MOTOR		kW		0.18	0.12		
			RPM		1750	750		
			ENCL.		ECODP	ODP		
	VOLT				575	120		
	PH				3	1		
MAXIMUM DIMENSIONS	LENGTH		mm		500	311		
	WIDTH		mm		390	311		
	HEIGHT		mm		390	298		
	WEIGHT		kg		31	10		
MANUFACTURER					TWIN CITY	TWIN CITY		
MODEL NO.					DSI 080AE	T 150V		
APPLICABLE REMARKS:					B/C	C		

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING

FANS							**23 34 00.01**
SYMBOL				EF-D611	EF-D612	EF-D621	
LOCATION				RDT ROOM	RDT ROOM	RDT PUMP ROOM	
TYPE				UTILITY BLOWER CENTRIFUGAL HEAVY DUTY	UTILITY BLOWER CENTRIFUGAL HEAVY DUTY	ROOF CENTRIFUGAL UPBLAST	
FAN DATA	AIRFLOW	MAX	L/s	5663	5663	566	
		@ SP	Pa	374	374	200	
		MIN	L/s	1416	1416	N/A	
	SPEED	RPM		866	866	1351	
	DRIVE TYPE			DIRECT	DIRECT	DIRECT	
	WHEEL	TYPE		BI	BI	BI	
	MAXIMUM	kW		3.54	3.54	0.22	
SOUND DATA	SOUND POWER LEVEL		63	87	87	69	
	dB (RE 10^{-12} W)		125	86	86	71	
	@ MID OCTAVE BAND		250	85	85	75	
	FREQUENCY (Hz)		500	82	82	73	
			1K	80	80	70	
			2K	77	77	65	
			4K	69	69	61	
			8K	62	62	54	
ELECTRICAL DATA	MOTOR		kW	5.50	5.50	0.55	
			RPM	900	900	1800	
			ENCL.	TEFC	TEFC	TEFC	
	VOLT			575	575	120	
	PH			3	3	1	
MAXIMUM DIMENSIONS	LENGTH		mm	1388	1388	762	
	WIDTH		mm	1273	1273	691	
	HEIGHT		mm	1691	1691	691	
	WEIGHT		kg	594	594	68	
MANUFACTURER				TWIN CITY	TWIN CITY	TWIN CITY	
MODEL NO.				BCS 330	BCS 330	DCRU 120BE	
APPLICABLE REMARKS:				B/C/D/H	B/C/D/H	C/D	
ABBREVIATIONS:	FC: FORWARD CURVED	BI: BACKWARD INCLINED	AF: AIR FOIL				
REMARKS:							

FANS								**23 34 00.01**
SYMBOL					EF-M687	EF-M689		
LOCATION					LOCKER ROOM	JANITOR'S CLOSET		
TYPE					INLINE CENTRIFUGAL SQUARE	CABINET CEILING		
FAN DATA	AIRFLOW	MAX	L/s		613	35		
		@ SP	Pa		250	125		
		MIN	L/s		613	35		
	SPEED	RPM			1661	805		
	DRIVE TYPE				DIRECT	DIRECT		
	WHEEL	TYPE			BI	FC		
	MAXIMUM	kW			0.31	0.02		
SOUND DATA	SOUND POWER LEVEL		63		76	n/a		
	dB (RE 10^{-12} W)		125		75	n/a		
	@ MID OCTAVE BAND		250		67	n/a		
	FREQUENCY (Hz)		500		68	n/a		
			1K		63	n/a		
			2K		57	n/a		
			4K		53	n/a		
			8K		50	n/a		
ELECTRICAL DATA	MOTOR		kW		0.37	0.08		
			RPM		1800	900		
			ENCL.		TEFC	ODP		
	VOLT				575	120		
	PH				3	1		
MAXIMUM DIMENSIONS	LENGTH		mm		533	324		
	WIDTH		mm		483	352		
	HEIGHT		mm		483	254		
	WEIGHT		kg		33	9		
MANUFACTURER					GREENHECK	GREENHECK		
MODEL NO.					SQ-120-A	SP-B110		
APPLICABLE REMARKS:					B/C/F/K/M	C		
ABBREVIATIONS:	FC: FORWARD CURVED	BI: BACKWARD INCLINED	AF: AIR FOIL					
REMARKS:								

FANS							**23 34 00.01**
SYMBOL				EF-R601	EF-R602	EF-R611	EF-R612
LOCATION				OUTDOOR	OUTDOOR	GALLERY 8	BLOWER ROOM
TYPE				UTILITY BLOWER CENTRIFUGAL FIBREGLASS	UTILITY BLOWER CENTRIFUGAL FIBREGLASS	INLINE TUBULAR CENTRIFUGAL	INLINE TUBULAR CENTRIFUGAL
FAN DATA	AIRFLOW	MAX	L/s	7300	7300	3500	5097
		@ SP	Pa	1552	1552.0	250.0	250.0
		MIN	L/s	-	-	1755	2549
	SPEED	RPM		1488	1488	862	865
	DRIVE TYPE			DIRECT	DIRECT	DIRECT	DIRECT
	WHEEL	TYPE		BI	BI	AF	AF
	MAXIMUM	kW		16.55	16.55	1.45	2.40
SOUND DATA	SOUND POWER LEVEL		63	98	98	81	85
	dB (RE 10^{-12} W)		125	99	99	81	85
	@ MID OCTAVE BAND		250	97	97	81	86
	FREQUENCY (Hz)		500	93	93	81	82
			1K	90	90	77	76
			2K	85	85	72	67
			4K	77	77	63	59
			8K	69	69	55	87
ELECTRICAL DATA	MOTOR		kW	22.00	22.00	2.20	3.72
			RPM	1800	1800	900	900
			ENCL.	TEFC	TEFC	TEFC	TEFC
	VOLT			575	575	575	575
	PH			3	3	3	3
MAXIMUM DIMENSIONS	LENGTH		mm	2453	2453	1200	1333
	WIDTH		mm	1000	1000	1009	1139
	HEIGHT		mm	1700	1700	1009	1139
	WEIGHT		kg	2000	2000	265	423
MANUFACTURER				TWIN CITY	TWIN CITY	TWIN CITY	TWIN CITY
MODEL NO.				BCSF 300M1	BCSF 300M1	TSL 270	TSL 300
APPLICABLE REMARKS:				A/B/C/F/G/H/I	A/B/C/F/G/H/I	B/C/E/N	B/C/E/N
ABBREVIATIONS:	FC: FORWARD CURVED	BI: BACKWARD INCLINED	AF: AIR FOIL				
REMARKS:							

FANS								**23 34 00.01**
SYMBOL					EF-R621	EF-R622	EF-R623	EF-R651
LOCATION					BLOWER ROOM	BLOWER ROOM	BLOWER ROOM	MECHANICAL ROOM
TYPE					WALL PROPELLER HEAVY DUTY	WALL PROPELLER HEAVY DUTY	WALL PROPELLER HEAVY DUTY	WALL PROPELLER HEAVY DUTY
FAN DATA	AIRFLOW	MAX	L/s		3800	3800	3800	378
		@ SP	Pa		150	150	150	125
	SPEED	RPM			1149	1149	1149	1800
	DRIVE TYPE				DIRECT	DIRECT	DIRECT	DIRECT
	WHEEL	TYPE			AF	AF	AF	AF
	MAXIMUM	kW			1.12	1.12	1.12	0.18
SOUND DATA	SOUND POWER LEVEL		63		95	95	95	78
	dB (RE 10^{-12} W)		125		93	93	93	80
	@ MID OCTAVE BAND		250		89	89	89	78
	FREQUENCY (Hz)		500		85	85	85	76
			1K		82	82	82	75
			2K		80	80	80	71
			4K		76	76	76	66
			8K		71	71	71	63
ELECTRICAL DATA	MOTOR		kW		1.50	1.50	1.50	0.03
			RPM		1200	1200	1200	1800
			ENCL.		TEFC	TEFC	TEFC	TEFC
	VOLT				575	575	575	120
	PH				3	3	3	1
MAXIMUM DIMENSIONS	LENGTH		mm		914	914	914	530
	WIDTH		mm		768	768	768	508
	HEIGHT		mm		914	914	914	508
	WEIGHT		kg		183	183	183	66
MANUFACTURER					TWIN CITY	TWIN CITY	TWIN CITY	TWIN CITY
MODEL NO.					TCWPX 30DE4	TCWPX 30DE4	TCWPX 30DE4	TCWP 16DTC
APPLICABLE REMARKS:					E/O	E/O	E/O	E/O
ABBREVIATIONS:	FC: FORWARD CURVED	BI: BACKWARD INCLINED	AF: AIR FOIL					
REMARKS:								

FANS								**23 34 00.01**
SYMBOL					EF-R652	EF-R653		
LOCATION					WASHROOM	JANITOR'S ROOM		
TYPE					CABINET CEILING	CABINET CEILING		
FAN DATA	AIRFLOW	MAX	L/s		47	47		
		@ SP	Pa		63	63.0		
	SPEED	RPM			777	777		
	DRIVE TYPE				DIRECT	DIRECT		
	WHEEL	TYPE			BI	BI		
	MAXIMUM	kW			0.10	0.10		
SOUND DATA	SOUND POWER LEVEL		63		44	44		
	dB (RE 10^{-12} W)		125		47	47		
	@ MID OCTAVE BAND		250		44	44		
	FREQUENCY (Hz)		500		44	44		
			1K		42	42		
			2K		36	36		
			4K		26	26		
			8K		15	15		
ELECTRICAL DATA	MOTOR		kW		0.10	0.10		
			RPM		760	760		
			ENCL.		ODP	ODP		
	VOLT				120	120		
	PH				1	1		
MAXIMUM DIMENSIONS	LENGTH		mm		311	311		
	WIDTH		mm		311	311		
	HEIGHT		mm		298	298		
	WEIGHT		kg		10	10		
MANUFACTURER					TWIN CITY	TWIN CITY		
MODEL NO.					TL 100S	TL 100S		
APPLICABLE REMARKS:					C	C		

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING

FANS **23 34 00.01**

SYMBOL				EF-S631	EF-S632	EF-S646	EF-S651
LOCATION				PUMP ROOM	PUMP ROOM	LABORATORY	WALKWAY A
TYPE				ROOF CENTRIFUGAL DOWNBLAST	ROOF CENTRIFUGAL DOWNBLAST	WALL CENTRIFUGAL FIBERGLASS	INLINE CENTRIFUGAL SQUARE
FAN DATA	AIRFLOW	MAX	L/s	1476	1476	130	2596
		@ SP	Pa	125	125	125	125
		MIN	L/s	804	804	-	1212
	SPEED	RPM		1017	1017	1152	647
	DRIVE TYPE			DIRECT	DIRECT	DIRECT	BELT
	WHEEL	TYPE		BI	BI	BI	BI
		MIN. DIA.	mm	762	762	711	
	MAXIMUM	kW		0.51	0.51	0.04	0.83
SOUND DATA	SOUND POWER LEVEL dB (RE 10^{-12} W) @ MID OCTAVE BAND FREQUENCY (Hz)		63	89	89	78	93
			125	86	86	71	87
			250	82	82	65	79
			500	78	78	65	78
			1K	74	74	65	76
			2K	70	70	62	71
			4K	64	64	56	64
			8K	58	58	52	56
ELECTRICAL DATA	MOTOR		kW	0.75	0.75	0.19	1.12
			RPM	1200	1200	1800	1800
			ENCL.	ODP	ODP	TEFC	TEFC
	VOLT			575	575	120	575
	PH			3	3	1	3
MAXIMUM DIMENSIONS	LENGTH		mm	1007	1007	711	1003
	WIDTH		mm	1007	1007	711	1026
	HEIGHT		mm	768	768	381	1397
	WEIGHT		kg	66	66	29	135
MANUFACTURER				TWIN CITY	TWIN CITY	TWIN CITY	TWIN CITY
MODEL NO.				DCRD 180B	DCRD 180B	SA 12	BSI 245A
APPLICABLE REMARKS:				A/B/C/D/H	A/B/C/D/H	C/K/P	C

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

FANS								**23 34 00.01**
SYMBOL					EF-S652	EF-S653	EF-S654	
LOCATION					WALKWAY BRIDGE SC 4	WALKWAY BRIDGE SC 5	STORAGE ROOM	
TYPE					INLINE CENTRIFUGAL SQUARE	INLINE CENTRIFUGAL SQUARE	ROOF CENTRIFUGAL DOWNBLAST	
FAN DATA	AIRFLOW	MAX	L/s		109	109	325	
		@ SP	Pa		63	63	63	
		MIN	L/s		-	-	165	
	SPEED	RPM			879	879	982	
	DRIVE TYPE				DIRECT	DIRECT	DIRECT	
	WHEEL	TYPE			BI	BI	BI	
	MAXIMUM	kW			0.01	0.01	0.04	
SOUND DATA	SOUND POWER LEVEL		63		56	56	72	
	dB (RE 10^{-12} W)		125		55	55	70	
	@ MID OCTAVE BAND		250		55	55	63	
	FREQUENCY (Hz)		500		55	55	60	
			1K		55	55	56	
			2K		49	49	52	
			4K		41	41	47	
			8K		35	35	45	
ELECTRICAL DATA	MOTOR		kW		0.09	0.09	0.37	
			RPM		1800	1800	1800	
			ENCL.		OCODP	OCODP	TEFC	
	VOLT				120	120	575	
	PH				1	1	3	
MAXIMUM DIMENSIONS	LENGTH		mm		533	533	708	
	WIDTH		mm		495	495	708	
	HEIGHT		mm		389	389	568	
	WEIGHT		kg		28	28	39	
MANUFACTURER					TWIN CITY	TWIN CITY	TWIN CITY	
MODEL NO.					DSI 090AE	DSI 090AE	DCRD 120BE	
APPLICABLE REMARKS:					C	C	A/B/C/D/H	

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING

FANS								**23 34 00.01**
SYMBOL					EF-T611	EF-T612		
LOCATION					BIOFILTER HUMIDIFIER ROOM	BIOFILTER HUMIDIFIER ROOM		
TYPE					ROOF CENTRIFUGAL UPBLAST	ROOF CENTRIFUGAL UPBLAST		
FAN DATA	AIRFLOW	MAX	L/s		1038	1038		
		@ SP	Pa		187	187		
		MIN	L/s		260	260		
	SPEED	RPM			1200	1200		
	DRIVE TYPE				DIRECT	DIRECT		
	WHEEL	TYPE			BI	BI		
	MAXIMUM	kW			0.40	0.40		
SOUND DATA	SOUND POWER LEVEL		63		73	73		
	dB (RE 10^{-12} W)		125		77	77		
	@ MID OCTAVE BAND		250		82	82		
	FREQUENCY (Hz)		500		79	79		
			1K		73	73		
			2K		68	68		
			4K		63	63		
			8K		58	58		
ELECTRICAL DATA	MOTOR		kW		0.75	0.75		
			RPM		1200	1200		
			ENCL.		TEFC	TEFC		
	VOLT				575	575		
	PH				3	3		
MAXIMUM DIMENSIONS	LENGTH		mm		787	787		
	WIDTH		mm		787	787		
	HEIGHT		mm		757	757		
	WEIGHT		kg		82	82		
MANUFACTURER					TWIN CITY	TWIN CITY		
MODEL NO.					DCRU 160B	DCRU 160B		
APPLICABLE REMARKS:					A/B/C/D/H	A/B/C/D/H		

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING

FANS								**23 34 00.01**
SYMBOL					SF-U660			
LOCATION					EQUIPMENT ROOM			
TYPE					INLINE CENTRIFUGAL SQUARE			
FAN DATA	AIRFLOW	MAX	L/s		3585			
		@ SP	Pa		188			
	SPEED	RPM			538			
	DRIVE TYPE				BELT			
	WHEEL	TYPE			BI			
	MAXIMUM	kW			1.33			
SOUND DATA	SOUND POWER LEVEL dB (RE 10^{-12} W) @ MID OCTAVE BAND FREQUENCY (Hz)		63		83			
			125		87			
			250		80			
			500		73			
			1K		71			
			2K		65			
			4K		57			
			8K		50			
ELECTRICAL DATA	MOTOR		kW		1.49			
			RPM		1800			
			ENCL.		ODP			
	VOLT				575			
	PH				3			
MAXIMUM DIMENSIONS	LENGTH		mm		1130			
	WIDTH		mm		1121			
	HEIGHT		mm		1166			
	WEIGHT		kg		486			
MANUFACTURER					TWIN CITY			
MODEL NO.					BSI 300A			
APPLICABLE REMARKS:					C			

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: ROOF CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
J: ALUMINUM HOOD
K: BACK DRAFT DAMPER
L: MOTOR SPEED CONTROLLER
M: SIDE DISCHARGE
N: HOT DIP GALVANIZED
O: ALUMINUM CASING

FANS					**23 34 00.01**
SYMBOL				EF-T301	EF-T302
LOCATION				OUTDOOR	OUTDOOR
TYPE				UTILITY BLOWER CENTRIFUGAL FIBREGLASS	UTILITY BLOWER CENTRIFUGAL FIBREGLASS
FAN DATA	AIRFLOW	MAX	L/s	12,100	12,100
		@ SP	Pa	5350	5350
		MIN	L/s	6,110	6,110
	SPEED	RPM		2290	2290
	DRIVE TYPE			DIRECT	DIRECT
	WHEEL	TYPE		BI	BI
		MIN. DIA.	mm	900	900
	MAXIMUM	kW		91	91
SOUND DATA	SOUND POWER LEVEL dB (RE 10^{-12} W) @ MID OCTAVE BAND FREQUENCY (Hz)		63	105	105
			125	105	105
			250	105	105
			500	111	111
			1K	102	102
			2K	101	101
			4K	98	98
			8K	93	93
ELECTRICAL DATA	MOTOR		kW	112.00	112.00
			RPM	1800	1800
			ENCL.	TEFC	TEFC
	VOLT			575	575
	PH			3	3
MAXIMUM DIMENSIONS	LENGTH		mm	3000	3000
	WIDTH		mm	1700	1700
	HEIGHT		mm		
	WEIGHT		kg		
MANUFACTURER				TWIN CITY	TWIN CITY
MODEL NO.				365H2/BCSF	365H2/BCSF
APPLICABLE REMARKS:				A/B/C/I/Q/R	A/B/C/I/Q/R
ABBREVIATIONS:	FC: FORWARD CURVED	BI: BACKWARD INCLINED		AF: AIR FOIL	
REMARKS:					

SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Air-Conditioning and Refrigeration Institute (ARI): 880, Air Terminals.
   2. ASTM International (ASTM): C636, Standard Practice for Installation of Metal Ceiling Suspension System for Acoustical Tile and Lay-in Panels.
   3. Underwriters' Laboratories of Canada. (ULC): Product Directories.

1.2 DEFINITIONS

A. NC: Noise Criteria; background sound rating method for indoor sound.

B. VAV: Variable air volume.

1.3 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Manufacturer's data and descriptive literature for products specified.
      b. Furnish the following information for each type of diffuser, register, and grille furnished.
         1) NC sound data.
         2) Static pressure loss data.
         3) Throw data.

B. Informational Submittals:
   1. List of recommended spare parts for products specified.

PART 2 PRODUCTS

2.1 CEILING DIFFUSERS

A. Premium Louvered Face Diffusers (SCD1):
   1. Construction: As follows:
      a. Material: Welded aluminum.
      b. Finish: Baked white enamel face finish. Flat black interior.
      c. Neck: Round.
   2. Removable core section of louvers.
   3. Continuous sponge rubber gasket at face flange.

4. Performance: As follows:
    a. Distribution Pattern: 4-way.
    b. Maximum Pressure Drop: 25 Pa.
    c. Sound: Maximum NC 30.
5. Manufacturers and Products:
    a. Krueger; Model 5SHR (aluminum).
    b. Carnes; Type SE (aluminum).
    c. Titus; Model TDCA-AA (aluminum).
    d.

2.2 SUPPLY GRILLES AND REGISTERS

A. Supply Grilles and Registers (SG, SR):
1. Construction: As follows:
    a. Material: Aluminum.
    b. Finish: Aluminum face finish.
    c. SR Register Accessories:
        1) Gang-operated opposed-blade volume control damper.
        2) Material to match grille.
2. Adjustable front horizontal and rear vertical vanes on 20 mm centers.
3. Continuous sponge rubber gasket at face flange.
4. 25 mm minimum flat rectangular frame.
5. Performance: As follows:
    a. Maximum Pressure Drop: 25 Pa.
    b. Sound: Maximum NC 30.
6. Manufacturers and Products:
    a. Krueger; 880/5880 Series.
    b. Titus; 300 Series.

2.3 RETURN, EXHAUST AND TRANSFER GRILLES AND REGISTERS

A. Louvered Return, Exhaust and Transfer Grilles and Registers (RG, RR, EG, ER, TG):
1. Construction: As follows:
    a. Material: Aluminum.
    b. Finish: Aluminum face finish.
    c. RR and ER Register Accessories:
        1) Gang-operated opposed-blade volume control damper.
        2) Material to match grille.
2. Fixed horizontal louvers set at 35 degrees to 45 degrees.
3. 25 mm minimum flat, rectangular frame.
4. Manufacturers and Products:
    a. Krueger; S80/S580H Series.
    b. Carnes; Type RAAAH.
    c. Titus; 350 Series.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to architectural reflected ceiling plans for coordination of locations of ceiling-mounted air outlets and inlets with ceiling grids and lighting. Where locations of devices shown on mechanical drawings do not agree with locations that are shown on architectural reflected ceiling plans, reflected ceiling plans shall take precedence. If air outlets or inlets are shown on mechanical drawings, but are not shown on architectural reflected ceiling plans, devices shall be located as near as possible to locations shown on mechanical drawings when coordinating with ceiling.

B. Install diffusers, grilles, and registers tight on their respective mounting surfaces, level, plumb, and true with room dimensions.

C. Provide appropriate frame to adapt to mounting surface. Provide a 600 mm by 600 mm lay-in ceiling module for diffusers, registers, and grilles in lay-in ceilings.

D. Support air inlets and outlets where installed in metal suspension systems for acoustical tile and lay-in panel ceilings as specified in ASTM C636 and applicable building code.

END OF SECTION

SECTION 23 51 01

GENERATOR EXHAUST SYSTEM AND STACK

PART 1 GENERAL

1.1 RELATED SECTIONS

A. Section 26 32 10, Diesel Electric Generating Units (Liquid Cooled).

1.2 SUMMARY OF WORK

A. This Section covers the work necessary to design, furnish, install and commission the exhaust system and stacks for the two standby diesel electric generating units.

B. The system is composed of breeching, exhaust silencers, expansion joints, and exhaust stacks for the two standby diesel electric generating units.

C. Unit Responsibility: The Work requires that the exhaust system and stacks complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment, which (supplier) shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified or required features and functions without altering or modifying the Contactor's responsibilities under the Contract Documents. The Contractor is responsible to the City for providing the equipment systems as specified herein.

1.3 REFERENCES

A. ASME/ANSI STS-1

B. ANSI/ASME B31.1 : Power Piping

C. CSA Standard Work W47.1

D. CSA B139 Installation Code for Oil Burning Equipment

E. Manitoba Building Code (MBC)

F. Inspection and Technical Services Manitoba

1.4 DESIGN REQUIREMENTS

A. General:
   1. Design equipment, anchorage and support systems for vertical and lateral loading in accordance with MBC.
   2. Designed by a Professional Engineer licensed in the Province of Manitoba.
   3. Seismic restraints shall conform to requirements of latest edition of SMACNA Seismic Restraint Manual.

B. Detailed design of the exhaust stacks shall follow the procedures and methods, utilize the equations and formulas, and incorporate safety factors and allowable design stresses and strains set forth in ASME/ANSI STS-1.

C. Detailed design of exhaust stacks, supports and all related appurtenances suitable for continuous use with at design temperature of 400 degrees C for standby generator.

D. The Manufacturer/Supplier shall review the exhaust and stacks system layout shown on the Contract Drawings and note the design constraints for breeching and stacks design.

1.5 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, Submittal Procedures.

B. Shop Drawings, Information and Data:
   1. Shop drawings for the diesel generator exhaust system and stacks shall include material specifications, expansion joint details, supports, layout and details drawn to scale.
   2. Engineering Calculations: Exhaust system design calculations shall include thermal analysis and final expansion joint selection as well as pressure drop calculations.
   3. Shop drawings for the generator stacks shall include erection details, material specifications and gauges, anchor bolt assembly details, and all accessories. The stack shop drawings are to be stamped by the engineer who produced the stack structural calculations, and who is a Professional Engineer licensed in the Province of Manitoba.
   4. Engineering Calculations: Stack structural design calculations, stamped by a Professional Engineer licensed in the Province of Manitoba. Calculations are to show conformance to the 2010 Nation Building Code with 2011 Manitoba Amendment for wind exposure category – open terrain and 1 in 50 year hourly wind pressure of 0.45 kPa, wind sensitive deflection at top with a deflection limit of h/360, base moment, shear at base, vortex shedding, anchor bolt design, bolt circle diameter, and reinforcing around cleanout and breeching openings.
   5. Written certification from a Professional Engineer licensed in the Province of Manitoba stating that support systems, anchorage and equipment have been designed according to requirements of MBC for post-disaster structures at time of shop drawing submittals.

1.6 QUALITY ASSURANCE

A. All stack welding is to be full penetration conforming to CSA Standard W47.1, and performed by CWB certified welders.

B. The stacks erection shall be performed by the contractor, under the direction of the exhaust stacks Vendor.

PART 2 PRODUCTS

2.1 GENERAL

A. Standby generator exhaust system and stack shall be designed to handle gas stream with the following parameters:

Diesel Engine Gas Flowrate:	433 m^3/min
Normal Operating Static Pressure:	0.25 kPa
Back Pressure:	6.7 kPa
Maximum Gas Temperature:	400 degrees C
Ambient Temperature Range:	-40 to 40 degrees C

2.2 MANUFACTURER

A. System components and accessories specified in this Section shall be products of:
1. Van Packer
2. Lining Cheminee
3. Selkirk

2.3 EXHAUST BREECHING

A. Double wall factory built breeching system made in accordance with NFPA 211 and UL Listed in accordance with UL103 to withstand up to 1500 mm W.C. positive pressure and shall carry UL label only.

B. The breeching system shall be designed to compensate for all flue gas induced thermal expansions.

C. Insulation between inner and outer pipe shall be 50 mm thick minimum.

2.4 EXHAUST SYSTEM SILENCER

A. Provide critical grade silencer by SMS: silencer shall be sized with noise data provided by the manufacturer of standby generator in Section 26 32 10 Diesel Electric Generating Units (Liquid Cooled) to achieve a noise level of 45 dba at 200m from property line. Total losses through the silencer, exhaust stack and accessories shall be less than the allowable back pressure provided in 2.1 above.

B. Material Type 304L Stainless Steel.

2.5 EXPANSION JOINTS

A. Provide universal expansion joints with all stainless steel construction for lateral offset due to piping thermal expansion as follows:
   1. T321 stainless steel bellows.
   2. Internal stainless steel flow liner, Type 316 stainless steel.
   3. Tied with four (4) stainless steel control rods, provide centre stainless steel plate.
   4. ASA 150 lb plate steel flanged ends.
   5. Unit spring rate (i.e. lbs per inch of lateral movement) to be kept to a minimum.

2.6 BREECHING SUPPORTS

A. Provide and install the structural steel framework, supports, guides and directional stops as required.

2.7 EXHAUST STACK

A. Engineered one-piece, free-standing, self-supporting, double wall insulated stainless steel liners, designed and constructed so that the outer casing and inner liners can expand and contract vertically independent of each other, and bolted to a concrete base without the need for guy wires or roof bracing

B. The exhaust stack shall have a suitable location for connection to the grounding system (for lightning protection purposes). The stack shall be electrically continuous throughout. The Electrical Contractor will field connect 4/0 AWG copper ground cable to the stack using exothermic connection methods.

C. Generator stacks shall have a height of 16.5 meters above grade to be in compliance with the air emission stipulated by the Manitoba Ambient Air Quality Criteria. Concrete base finish grade for the generator stack is at elevation 233.65 meters.

D. The stack to be completed with the following, at a minimum.
   1. Shell Diameter 25” OD minimum
   2. Outer Casing: Type 304 stainless steel.
   3. Inner Liner: Type 316L stainless steel, welded, laterally braced to the outer casing at 120º intervals, vertically as required.
   4. Rain Shelf and Drain Connection: Sloped Type 316L stainless steel plate rain shelf continuously welded at the circumference to the interior of each inner liner, and equipped with a 38 mm diameter Type 316L stainless steel drain pipe extended from the bottom of the rain shelf to the exterior of the outer casing where it is to be terminated with a screw-on stainless steel cap.
   5. Insulation: Minimum 50 mm thick ceramic fibre insulation for standby generator stack, supported vertically as required, arranged with staggered joints, and banded to each inner liner on 300 mm centres with 12 mm wide stainless steel bands.
   6. Exit Cone: Minimum 3.0 mm thick type 316L stainless steel exit cone at each stack outlet. Provide with no-loss rain shield at stack outlet.
   7. Cleanout Door: 460 by 305 mm minimum Type 316L stainless steel, cleanout door welded to each inner liner, extended out through the outer casing, with reinforcing around

the outer casing opening, and equipped with a flanged bolt-on coverplate. Size cleanout door to suit actual stack diameter.

8. Wind Spoilers: Provide wind spoilers where required as per the design calculations on the top third of the stack.
9. Base Assembly: Minimum 20 mm thick baseplate with minimum 20 mm thick gusset ring welded to the outer casing, aligned bolt holes in both the baseplate and gusset ring, and 12.7 mm thick by 300 mm high gusset plates welded to the outer casing and between the baseplate and gusset ring.
10. Anchor Bolt Assembly: Factory assembled anchor bolt assembly ready for placement and securing to the concrete base formwork, consisting of stainless steel anchor bolts with stainless steel nuts and washers secured together in two circular steel retaining rings to suit the design calculations.
11. Sampling Ports: Port material shall be Schedule 40 Type 316 stainless steel and shall have an inside diameter of 75 mm or as recommended by the stack supplier. The ports shall be welded to the inner liner and extend outwards to the outer casing through expansion fittings or collars. Collars to be 150 mm diameter or as recommended by the stack supplier. The Fitting or collar shall have a flanged end and be supplied with a fitted bolt-in-place plate.
12. Lightning Protection: Type 304L stainless steel lightning rods secured (welded) to the top of the stack, and a minimum of two ground lugs welded to the top of the stack and/or to the base of the stack.
13. Drain: The stack inner liners shall be provided with a 38 mm drain connection.
14. Provide conical rain cap at the top of stack.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with the manufacturer’s instructions.

B. Coordinate this work with the installation of prepurchased diesel generator.

C. The Contractor is to provide and install grounding wires or rods and connections. Coordinate with grounding grid installation.

3.2 MANUFACTURER’S SERVICES

A. Manufacturer’s Authorized Representative: Present at Work Site or classroom designated by the City for the minimum person-days listed below, travel time excluded:
   1. 2 person-days for installation assistance, inspection, and certification of installation.
   2. 1-1/2 person-days for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
   3. 1/2 person-day for prestartup classroom or Jobsite training of the City’s personnel.
   4. 1 person-day for facility startup.
   5. 1 person-day for post-startup training of the City’s personnel.

B. Furnish assistance, inspection, testing, and certification services at such times as requested by the Contractor.

C. Furnish training of the City's personnel at such times as requested by the City.

D. See Section 01 43 33, Contractor Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 23 51 02

FREESTANDING STACK

PART 1 GENERAL

1.1 INTENT

A. This Section covers the Work (including design, fabrication, factory testing, supply, supervision of installation, on Site testing) for one exhaust stack that shall be made of stainless steel 316L in its entirety. This stack shall serve the secondary clarifier facilities exhaust air streams.

1.2 RELATED WORK

A. Refer to Section 01 33 00, Submittal Procedures.

1.3 SCOPE OF WORK

A. This section consists of all work to be done on specified stack shown on the secondary clarifier respective drawings.

1.4 QUALITY ASSURANCE

A. Welders Qualifications: All welders shall be certified in accordance with ASME BPVC Section IX – Welding and Brazing Qualifications.

B. All work shall comply with the following codes and standards:
   1. NFPA – Standard for chimneys, fireplaces, vents and solid fuel burning appliances,
   2. SMACNA – Low pressure duct standards for fabricated breeching and smoke pipe,
   3. ASME-STS1 – Steel Stacks
   4. ASHRAE – ASHRAE Equipment Handbook for chimney, gas vent and fireplace systems for material requirements and design criteria.
   5. MBC - Manitoba Building Code

1.5 SUBMITTALS

A. Product Data: Submit product data including materials, dimensions, weights, welding requirements and accessories

B. Shop Drawings: Submit detailed layout shop drawings showing plan and elevation views, thickness, overall height, diameter, required clearances, assembly, supports, anchors, bolts and installation instructions. Drawings shall be stamped by a registered Professional Engineer in the province of Manitoba.

C. Quality Control Submittals:
   1. Certificates: When required - Submit certificates of materials compliance with specified ASTM, UL, and ASHRAE requirements.

2. Calculations: Submit complete engineering calculation report certifying that stack and its anchorage is designed to resist wind, earthquake and vortex loads. Calculations shall be stamped by a registered Professional Engineer in the Province of Manitoba. Horizontal deflection of the stack shall in no case exceed a ratio of 1 to 200 of its height.
3. Written certification from a Professional Engineer licensed in the Province of Manitoba stating that support systems, anchorage and equipment have been designed according to requirements of MBC for post-disaster structures at time of shop drawing submittals.

1.6 WARRANTY

A. Refer to General Conditions.

PART 2 PRODUCTS

2.1 FREESTANDING STACK

A. Factory welded cylindrical single wall freestanding stack of 72 inches diameter by 33 of height. The sections of the stack shall be up to 50 feet in length.

B. Stack shall be made of AISI 316L Stainless Steel.

C. All components, bolts, and fasteners associated with the stack shall be made of 316 stainless steel.

D. Accessories:
1. Hinged access door at the base of the stack, 316 stainless steel butterfly nuts and handle,
2. False bottom plate at 10 degrees with a 2 inch diameter 316 stainless steel SCH40 NPT drain,
3. Structural reinforcement around openings for both, the access door and any flues,
4. All reinforcements needed to prevent ovaling of the stack,
5. ASTM-A307 anchor bolts installed according to the manufacturer's instructions.
6. Flanged transition piece of same type as chimney for conveying flue gases from breeching to the stack.
7. Lifting lugs, unloading lugs and temporary braces

2.2 APPROVED MANUFACTURERS AND PRODUCTS

A. Cheminée Lining.E inc, Model STS Stainless Steel 316

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. The stack along with all necessary accessories (anchor bolts, structural supports for the base and wall, roof flashing, opening for the drain, etc) shall be delivered and installed during the erection of the assembly, to ensure the proper and safe function of the stack.

B. All pre-installation work to permit erection of any temporary stack must be done.

C. The stack shall be mounted and secured on a concrete foundation. The vertical leveling shall not exceed 1" per 50 feet. Grouting of the stack base plate shall be by the stack erector.

D. All sections passing though building walls must be insulated. While also respecting clearance requirements of combustible materials, in accordance with NFPA-211.

E. Foresee the necessary vertical and horizontal supports for the stack and the flues.

F. All electric arc and resistance welds will conform to section IX of the ASME-BPVC.

G. All joints will be completely welded and fully penetrated. Certified welders shall do all field welding.

H. Foresee the installation of the lightning protection, see Division 26.

I. The stack erector shall use special care in unloading and handling all materials from truck. The erector shall handle all materials in such a way as to minimize damage and to avoid scarring or damaging the paint or the outer jacket.

J. All equipment, materials, labour, supervision and services necessary for the proper execution of the Work in accordance with this Specification shall be furnished by the Vendor at no additional cost.

K. The stack shall be installed by the Installation Contractor under the direction of the Vendor.

END OF SECTION

SECTION 23 57 00

HEAT EXCHANGERS FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
   1. Canadian Gas Association (CGA).
   2. American National Standards Institute (ANSI).
   3. American Society of Mechanical Engineers (ASME): Code for Unfired Pressure Vessels.
      a. BPVC Section VIII, Rules for Construction of Pressure Vessels.
      b. BPVC Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   5. National Electrical Manufacturers' Association (NEMA): MG 1, Motors and Generators.
   6. Underwriters Laboratories Inc. (UL).
   7. Canadian Standard Association (CSA), C.22.2. No. 119.
   8. Underwriters Laboratories of Canada (ULC).

1.2 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. Approach: Difference between hot side fluid discharge temperature and cold side fluid discharge temperature.

C. Fouling Factor: Factor to account for impediment to heat transfer caused by dirt or scale. Typical factors have been established by TEMA for different types of service.

1.3 SUBMITTALS

A. Action Submittals:
   1. Provide for products specified, as follows:
      a. Manufacturer's name and model number.
      b. Descriptive specifications, literature, and drawings.
      c. Dimensions, weight of products.
      d. Identification as referenced in Contract Documents.
   2. Complete performance data that indicates compliance with Specifications:
      a. Thermal approach.
      b. Heat transfer area.
      c. Pressure drop.
      d. Pressure rating.
      e. Materials of construction.
      f. Corrosion resistance.

g. Methods for cleaning.
3. Manufacturer's standard finish color selection for enclosure.
4. Submittals for packaged or skid-mounted equipment shall be submitted as one package, and shall include:
   a. Piping diagrams.
   b. Control Diagrams.
   c. Descriptive cut sheets and performance data for included hydronic and steam specialties.
5. Where submitted equipment results in change to equipment or piping configuration shown on drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

B. Informational Submittals:
1. Recommended procedures for protection and handling of equipment and materials prior to installation.
2. Manufacturer's installation instructions.
3. Manufacturer's Certificate of Compliance in accordance with Section 01 43 33, Contractor Field Services, for the following:
4. Test reports.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data; include as-built version of equipment schedules.
6. Special guarantees.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Provide ASME "U" stamp on pressure vessels in accordance with BPVC Section VIII, Division 1 where indicated or required.

B. Welding shall be in accordance with ASME BPVC Section IX.

C. Heat exchangers for potable water shall be UL/ULC-listed for potable water use and double walled where required by code or Authority Having Jurisdiction.

D. Tubular (including shell-and-tube) heat exchangers shall comply with TEMA Standards.

1.5 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, and materials:

Item		Quantity
Gaskets		Two complete sets per unit

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.6 SPECIAL GUARANTEE

A. Furnish manufacturer's extended guarantee or warranty, with the City named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the City, removal and replacement of Work specified in this Specification section found

defective during a period of 10 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

PART 2 PRODUCTS

2.1 GENERAL

A. Where Equipment Schedule calls out packaged or skid-mounted equipment, package components shall comply with requirements of applicable Specification.

2.2 HYDRONIC HEAT EXCHANGER, SHELL-AND-TUBE

A. General:
1. Cast iron head.
2. Tubing: Copper.
3. Shell-and-Tube Sheet: Steel.
4. Relief valve sized to pressure vessel.
5. Shell designed for 862 kPa working pressure.
6. Effluent Water Service (Source Side) Fouling Factor: 0.0003 m^2-K/W

B. Applications: Liquid to liquid, heating system.

C. Manufacturers and Products:
1. ITT/Bell & Gossett; Type QWU.
2. Taco Fabricated Products Division; Series L.

2.3 HYDRONIC HEAT EXCHANGER, GASKETED PLATE AND FRAME

A. General:
1. Single-wall, gasketed type for nonpotable applications. Individual and removable plates and gaskets contained in a carrier assembly.
2. Where indicated, unit shall be expandable by adding more plates.
3. Working Pressure Rating: 1586 kPa minimum at 82 degrees C.
4. Piping Connections: 150 ANSI Standard flanged nozzles.
5. Furnish unit with studded port connections integral with unit end plate with 150 ANSI Standard flanged pipe spool and gasket for each piping connection, sized to match connection and 300 mm long.
6. Base Anchor Bolts: 20 mm minimum diameter, Type 316 stainless steel.

B. Construction:
1. Frame: Painted carbon steel.
2. Plates: Type 304 stainless steel.
3. Gaskets: Nitrile.
4. Connections: Flanged.
5. Manufacturers and Products:
a. Alfa-Laval; Model M10.
b. API Heat Transfer; Schmidt-Bretten.

c. Tranter PHE, Inc.; Superchanger.

2.4 HYDRONIC HEAT EXCHANGER, DOUBLE-WALL PLATE AND FRAME

A. General:
1. Double-wall, gasketed type for potable water applications. Individual and removable plates and gaskets contained in a carrier assembly.
2. Where indicated, unit shall be expandable by adding more plates.
3. Working Pressure Rating: 2068 kPa at 160 degrees C saturated steam.
4. Piping Connections: 65 mm diameter, 150 ANSI Standard flanged nozzles.
5. Furnish unit with studded port connections integral with the unit end plate with a 150 ANSI Standard flanged pipe spool and gasket for each piping connection, sized to match connection and 300 mm long.
6. Specifically designed for heating potable water with steam.
7. Base Anchor Bolts: 20 mm minimum diameter, Type 316 stainless steel.

B. Construction:
1. Frame: Painted carbon steel.
2. Plates: Type 316 stainless steel.
3. Gaskets: Nitrile glued design.
4. Connections: Flanged.

C. Manufacturers and Products:
1. ITT/Bell & Gossett; Model GPX.
2. Alfa-Laval; Model M6-FS-ASME.
3. API Heat Transfer; Schmidt-Bretten.

2.5 STEAM HUMIDIFIERS

A. General:
1. Self-contained.
2. Electric steam generating.
3. UL or ULC listed.
4. Separate steam generator circuits for each distributor pipe.
5. Completely prepiped requiring only cold water connection.

B. Accessories:
1. Power ON/OFF switch.
2. Control power transformer.
3. Electronically controlled with internal circuit breaker.
4. Water filter with filter cartridge.
5. Pressure reducing valve.
6. Pressure gauge.
7. Adjustable water supply needle valve and solenoid supply and drain valves for each circuit.
8. Special length steam distributor pipes.
9. Adjustable steam orifice for each circuit.
10. Steam hose.

11. Condensate return line.
12. Air gap waste fitting.
13. Duct mounted humidity controls.

C. Manufacturers and Products:
1. Carnes; Model HB.
2. Armstrong; Model EHU, Series 600.

2.6 DESICCANT DEHUMIDIFIERS

A. Solid desiccant absorption type.

B. Single rotary desiccant bed capable of continuous operation.

C. Fully automatic.

D. Factory assembled.

E. Packaged complete with reactivation heaters.

F. Washable reactivation and process filters.

G. Motors.

H. Reactivation and supply fans.

I. Desiccant bed drive unit.

J. Access panels.

K. Dripproof automatic electrical controller.

L. Desiccant bed.

M. ON/OFF humidistat.

N. All component auxiliaries.

O. Casing shall have suitable access panels as required for inspection or servicing without disconnecting ducting or electrical wiring.

P. Observation window for visual inspection of the rotor or wheel while the unit is in operation.

Q. Manufacturers and Products:
1. Cargocaire; Model HC.
2. Bry-Air.

2.7 ACCESSORIES

A. Identification 16 gauge Type 304 stainless steel plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

2.8 SOURCE QUALITY CONTROL

A. Skid-mounted and packaged equipment shall be pressure tested and run-tested by manufacturer after assembly.

B. Factory Test: Perform full factory run test. Prior to shipping, verify the results in writing for the following test items:
   1. Monitor and record temperatures, flows, and pressures at specified conditions.
   2. Monitor and record ampere draw for each electric motor at specified conditions.
   3. Check controls for proper function and sequence.
   4. Verify heat exchanger capacity by checking hot water temperatures entering and leaving heat exchanger
   5. Leak test heat exchanger coils under water at 1.5 times design working pressure.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
   1. Mount level and according to manufacturer’s instructions.
   2. Provide access for maintenance.

B. Equipment Support and Restraints:
   1. Refer to Section 23 05 48, Vibration Isolation for HVAC.
   2. Install floor-mounted units on concrete base.
   3. Secure floor-mounted equipment to concrete base using anchor bolts cast in concrete base.
   4. Support from floor with angle iron frame and flush shells. Anchor securely in place.

3.2 FIELD QUALITY CONTROL

A. Functional Tests:
   1. Verify blocking and bracing used during shipping are removed.
   2. Verify heat exchanger is secure on mountings and supporting devices, and connections to pipes and electrical components are complete.
   3. Where provided, verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   4. Verify cleaning and adjusting are complete.

5. Check control valve, vacuum breaker, if provided, for proper operation.

B. Performance Tests:
1. After system has been activated, check that flow, pressure differential, and temperature differentials have been achieved.
2. Check modulating systems throughout range of modulation. Adjust any PID loops to ensure modulation is smooth and responsive.
3. Test and adjust control safeties.
4. Replace damaged and malfunctioning controls and equipment.

3.3 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by the City, for minimum person-days listed below, travel time excluded:
1. Half person-day for installation assistance and inspection.
2. Half person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. Half person-day for prestartup classroom or Site training.
4. Half person-day for facility startup.
5. Half person-day for post-startup training of the City's personnel.
6. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Contract Administrator.

B. Refer Section 01 43 33, Contractor Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.4 ADJUSTING

A. Adjust pressure regulators and balancing valves to assure proper operation.

B. Test and Balance: Perform hydronic system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. On completion of installation, internally clean heat exchangers according to manufacturers' written instructions. Remove foreign material and construction debris.

3.6 SUPPLEMENTS

A. The supplements listed below, following "End of Section", are part of this Specification:
1. 23 57 00.01, Heat Exchangers Data Sheet.

END OF SECTION

HEAT EXCHANGERS 23 57 00.01

SYMBOL				HE-G663	HE-G673	HE-K633	HE-S663
SERVICE				GYLCOL HEATING	GYLCOL HEATING	GYLCOL HEATING	GYLCOL HEATING
TYPE				HYDRONIC HEX, DOUBLE-WALL PLATE AND FRAME	HYDRONIC HEX, SHELL-AND-TUBE	HYDRONIC HEX, DOUBLE-WALL PLATE AND FRAME	HYDRONIC HEX, SHELL-AND-TUBE
CAPACITY			kW	1332.0	279.0	626.4	269.9
WATER SIDE DATA	FLOW RATE		L/s	29.4	9.23	13.8	8.9
	FLUID	TYPE		WATER	WATER	WATER	WATER
		CONC.	%	100	100	100	100
	EWT		DEG C	82.2	10.0	82.2	10.0
	LWT		DEG C	71.1	2.8	71.1	2.8
	DELTA P		kPa	34.5	19.1	27.6	55.4
PROPYLENE GLYCOL SIDE DATA	FLOW RATE		L/s	32.10	10.35	15.08	10.02
	FLUID	TYPE		PG	PG	PG	PG
		CONC.	%	50	50	50	50
	FOULING FACTOR			0.001	0.001	0.001	0.000033
	EWT		DEG C	65.6	-5.6	76.7	-5.6
	LWT		DEG C	76.7	1.7	65.6	1.7
	DELTA P		kPa	34.5	83.4	33.1	98.5
MAXIMUM DIMENSIONS	LENGTH		mm	1000	4366	1194	4223
	WIDTH		mm	521	686	600	584
	HEIGHT		mm	1842	584	521	356
	WEIGHT		kg	980	1484	469	977
MANUFACTURER				ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT	ITT/BELL & GOSSETT
MODEL NO.				GPX - P47	QWU 1415-4 5	GPX - P21	QWU 1412-6 3
APPLICABLE REMARKS				A	A	A	A

REMARKS:
A: ASME "U: STAMP FOR HOT SIDE PRESSURE RATING

ABBREVIATIONS:
EG: ETHYLENE GLYCOL
PG: PROPYLENE GLYCOL

SECTION 23 77 00

AIR HANDLING UNITS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Air-Conditioning and Refrigeration Institute (ARI):
      a. 410, Forced-Circulation Air-Cooling and Air-Heating Coils.
      b. 430, Central Station Air Handling Units.
   2. Air Movement and Control Association International, Inc. (AMCA):
      a. 201, Fans and Systems.
      b. 203, Field Performance Measurement of Fan Systems.
      c. 204, Balance Quality and Vibration Levels for Fans.
      d. 300, Reverberant Room Method for Sound Testing of Fans.
      e. 301, Methods for Calculating Fan Sound Ratings From Laboratory Test Data.
      f. 99-0401, Classifications for Spark Resistant Construction.
      g. 99-2408-69, Operating Limits for Centrifugal Fans.
   3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
   4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
      a. 15, Safety Standard for Refrigeration Systems.
      b. 52.1, Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
      c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
      d. 62.1, Ventilation for Acceptable Indoor Air Quality.
      e. HVAC Applications chapter in “Seismic Restraint Design.”
   5. ASTM International (ASTM):
      a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
      b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
      c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
      d. D3363, Standard Test Method for Film Hardness by Pencil Test.
      e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   6. CSA Canada (CSA):
      a. B149.1, Natural Gas and Propane Installation Code.
      b. Z83.4, Non-Recirculating Direct Gas-Fired Industrial Air Heaters.
      c. Z83.18, Recirculating Direct Gas-Fired Industrial Air Heaters.
      d. C22.1 Canadian Electrical Code

7. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 841, Standard for Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).
8. International Standards Organization (ISO): 9001, Quality Management Systems – Requirements.
9. National Electrical Manufacturers Association (NEMA).
10. National Fire Protection Association (NFPA):
    a. 54, National Fuel Gas Code.
    b. 70, National Electric Code (NEC).
    c. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
    d. 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
    e. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
11. Occupational Safety and Health Act (OSHA).
12. Society of Protective Coatings (SSPC):
    a. SP 3, Power Tool Cleaning.
    b. SP 5, White Metal Blast Cleaning.
    c. SP 6, Commercial Blast Cleaning.
    d. SP 10, Near-White Blast Cleaning.
13. Underwriters Laboratories Inc. (UL/ULC):
    a. Product Directories.
    b. 181, UL Standard for Safety Factory-Made Air Ducts and Connectors.
    c. 723, UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.
14. National Fire Code of Canada.

1.2 DEFINITIONS

A. The following is a list of abbreviations which may be used in this Section:
1. AC: alternating current.
2. AFD: Adjustable Frequency Drive.
3. AHU: Air Handling Unit.
4. CISD: Chemical Industry, Severe-Duty.
5. dB: Decibel.
6. DX: Direct Expansion.
7. DWDI: Double Width, Double Inlet.
8. ETL: ETL Testing Laboratories, Inc.
9. FM: Factory Mutual Insurance.
10. IAQ: Indoor Air Quality.
11. IEC: International Electro-technical Commission.
12. IRI: Industrial Risk Insurance.
13. kPa: Kilopascals.
14. kW: Kilowatt.
15. L/s: litre per second.
16. MAU: Make-Up Air Unit.
17. m/s: meter per second.
18. NRC: Noise Reduction Coefficient.

19. OD: Outside Diameter.
20. ODP: Open Drip Proof.
21. O&M: Operations and Maintenance.
22. P&ID: Process & Instrumentation Diagrams
23. PCN: HVAC Process Control Narrative
24. PVC: Polyvinyl Chloride.
25. rpm: revolutions per minute.
26. SCR: Silicon Control Rectifier.
27. SWSI: Single Width, Single Inlet.
28. TEFC: Totally Enclosed, Fan Cooled.
29. UV: Ultra Violet.
30. VFD: Variable Frequency Drive.
31. XP: Explosion Proof.

1.3 SUBMITTALS

A. Action Submittals:
   1. Provide Shop Drawings for products specified, including, as a minimum:
      a. Unit identification as referenced in Contract Documents.
      b. Manufacturer's name and model number.
      c. Descriptive specifications, literature, and drawings.
      d. Dimensions and weights for unit, including fully assembled and shipping sections.
      e. Acoustics:
         1) Fan sound power level data (ref. 10 to power minus 12 Watts) at design operating point, based on AMCA Bulletin 300 for unit discharge, inlet and casing.
         2) Additional requirements (including by others) to achieve specified sound performance levels.
      f. Fans:
         1) Type, size, quantity, class, drive arrangement, discharge, rotation and bearings.
         2) Wheel type, diameter, rpm, and tip speed.
         3) Performance curves indicating:
            a) Relationship of flow rate to static pressure for various fan speeds.
            b) Brake horsepower curves.
            c) Acceptable selection range (surge curves, maximum safe operating rpm, etc).
            d) Static pressure, capacity, horsepower demand and overall efficiency required at the duty point, including drive losses.
         4) For variable air volume applications, indicate operating points at 100, 80, 60, and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure and brake horsepower.
         5) VFD Control: Comply with Section 26 29 23, Variable Frequency Drives.

g. Coils:
   1) Type, quantity, dimensions, material of construction, coatings, if applicable, energy transfer capacity, air pressure drop, air inlet, and discharge temperature at design conditions.
   2) Hydronic Coils: Water pressure drop at design conditions, water discharge temperature at design conditions, piping connection data, coil fin spacing, coil row depth.
   3) DX Coils: Refrigerant saturated suction temperature at design conditions, refrigerant piping configuration (row split, face split, intertwined), coil fin spacing, coil row depth.
   4) Electric Resistance Coils: Voltage, phase, number of stages, safety features, controls.
   5) Drain pan details.
   6) Coil pull details and dimensions for service.
h. Motor(s) type, quantity, and performance data, comply with Section 26 20 00, Low Voltage AC Induction Motors.
i. Instrumentation product data with exact make and model number of all components.
j. Air filter(s) type, quantity, and performance data.
k. Unit capacities and ratings, including airflow and static pressure summary.
l. Construction materials.
m. Power and control wiring diagrams and schematics, including terminals and numbers.
n. Vibration Isolation:
   1) Vibration isolation methods with maximum deflection data.
   2) Additional requirements (including by others) to achieve specified vibration isolation levels.
o. Factory finish system, with color selection charts where applicable.
p. Corrosion protection coating product data.

2. “Or approved equal in accordance with B8” Equipment:
   a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.
   b. Where submitted equipment results in change to ductwork and equipment configuration shown on drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement or details shown to equipment furnished.

B. Informational Submittals:
   1. Manufacturer’s Certificate of Compliance in accordance with Section 01 43 33 Contractor Field Services.
   2. Sample copy of guarantee.
   3. Manufacturer’s Test Reports for the following:
      a. Water heating coil.
      b. Electric heating coil.
      c. Water cooling coil.
      d. DX cooling coil.
      e. Air handling unit leak tests.
      f. Acoustical tests.

g. Indirect gas fired burner test.
4. Recommended procedures for protection and handling of products prior to installation.
5. Manufacturer's installation instructions, including component spacing requirements.
6. Operation and Maintenance Data:
   a. In conformance with Section 01 78 23, Operation and Maintenance Data.
   b. Include as-built version of equipment schedules.
   c. Methods for accessing components for maintenance with required service clearances.

1.4 QUALITY ASSURANCE

A. Fans: Licensed to bear AMCA seal for air flow and sound performance.

B. Manufacturer's Qualifications:
   1. The air handling unit manufacturer shall have been successfully manufacturing air handling units for a period of no less than 10 years.
   2. Manufacturer's qualifications are subject to review by the City/Contract Administrator to determine acceptance.

C. Fan Performance:
   1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
   2. Fan and motor combination shall be capable of delivering 100 percent of scheduled air quantity and static pressure.
   3. Motor shall not operate into motor service factor in any listed case.
   4. Accommodate drive efficiency in motor selection according to manufacturer's published recommendation, or according to AMCA 203, Appendix L.

D. Thermal Insulation: Shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM E84 and UL 723).

E. Units with Fuel Gas Heating Sections:
   1. Conform to CSA Standards Z83.18 and Z83.4 and provide evidence that the air handler has been tested as a system and found in compliance with these standards by an independent national testing laboratory.
   2. Conform to NFPA 90A.
   3. Conform to the National Fuel Gas Code (NFPA 54/ANSI Z-223.1).
   4. Conform to required or specified insurance specifications (FM, IRI, etc.) for the gas manifold construction.
   5. For gas fired unit, provide an airflow switch on the supply. When airflow switch is open, the natural gas supply is to be shutdown.

F. Air Pressurization Unit:
   1. Manufacturer shall have a minimum of 10 years' experience in design, fabrication and testing of systems that are 99.95 percent efficient in the removal of these gases.
   2. Manufacturer shall be a single source provider of equipment, media, and testing services, and certified to ISO 9001 standards or adhere to quality standards equal to ISO 9001.

3. Welding procedure qualifications and welder performance qualifications shall conform to the requirements of Section IX of the ASME Code, latest edition. Welder's performance qualification records shall be made available to Contract Administrator upon request.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Air handling unit manufacturer shall coordinate with the Contractor as to the requirements for proper delivery, storage, and handling of the air handling unit and its components required in this Specification to ensure that the unit is properly cared for prior to final installation.

1.6 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, and special tools:

Item		Quantity
Filters (Prefilter, Post, Final)		Four complete sets per unit
Chemical Filters (1st Stage, 2nd Stage)		Four completer sets per unit

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.7 SPECIAL GUARANTEE

A. Manufacturer shall warrant all equipment and materials of its manufacture against defects in workmanship and material for a period of two years from date of Substantial Performance.

PART 2 PRODUCTS

2.1 EQUIPMENT SCHEDULES

A. Refer to Article Supplements.

2.2 OPERATING LIMITS

A. Fans designated to meet a specified Fan Class shall comply with requirements of AMCA 99-2408-69.

2.3 ACOUSTICAL LEVELS

A. Equipment selections shall produce sound power levels in each octave band no greater than shown in fan equipment schedule.

B. Perform noise tests in accordance with AMCA 300.

2.4 FAN DRIVES

A. Refer to Section 26 29 23, Variable Frequency Drives for details.

B. Inverter duty rated for use with variable frequency drive.

2.5 FINISHES

A. Carbon Steel Parts: Factory finished as follows, unless indicated otherwise.
   1. Parts cleaned and chemically pretreated with a phosphatizing process.
   2. Alkyd enamel primer.
   3. Air-dry enamel topcoat.

B. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.

C. Stainless Steel Parts: Finished smooth and left unpainted, unless stated otherwise.

2.6 AIR HANDLING UNITS—CUSTOM

A. General:
   1. Custom air handling unit, constructed by sections of factory-fabricated components such as fan units, motor and drive assembly, heat transfer devices, dampers, plenums, filters, condensate pans, heating units, control devices and accessories. Sections shipped separately will be assembled on Site.
   2. Required unit components as indicated on in this specification. Unit configuration and layout are shown on the Drawings, Contractor to review the Drawings to ensure correct unit configuration and layout is provided.
   3. Assembly shall be a complete and fully functioning system with all components and accessories as specified.
   4. Fan Air and Sound Performance: Tested and rated in accordance with AMCA and guaranteed by manufacturer.
   5. Where spark-proof construction requirements are noted in the Contract Documents, furnish fans in accordance with AMCA Standard 99-0401 for Type B spark-proof construction.
   6. Unit(s) to be supplied in sections as required to fit through building openings.
   7. All section to section connection brackets are to be heavy-gauge galvanized steel with heavy-duty non-corrosive hardware, designed for tight section-to-section connections with gasketing.

B. Unit Casing:
   1. General:
      a. Fully enclosed housing, with casing consisting of sheet metal side, floor and roof panels.
      b. Lifting lugs and unit support frames, factory installed, to facilitate installation.
      c. All casing insulated, formed and reinforced sheet metal panels; flat panel design not acceptable.
      d. For double wall units, distance between inner and outer panels as required to accommodate insulation thickness specified in Paragraph Insulation.
   2. Panel Arrangement: Panels mechanically fastened together forming a self-framing housing with no additional structural support required or mechanically fastened to a fully welded unitized frame assembly.
   3. Thermal Break Construction:
      a. “No-through-metal” design.

b. Casing structure shall incorporate insulating thermal breaks as required so that, when fully assembled, there exists no path of continuous unbroken metal to metal conduction from inner to outer surfaces.
c. Include the following construction features to minimize condensation on the unit exterior:
   1) Staggered wall construction for the interior wall (liner).
   2) Thermal breaks on all doors and door frames.
   3) Insulated cap between the interior wall and the floor.

4. Outdoor Units:
   a. Weathertight and rated for outdoor use.
   b. Cross broken and sloped roofcap system.
   c. Drip shield/overhand provided on all four side of unit.
   d. Caulked/sealed standing top seams to assure waterproofing.
5. Material: Panels, fasteners, and structural metal frame members constructed from G-90 galvanized steel. Type 304 stainless steel metal liner is provided to protect the insulation.
6. Outer Panels:
   a. Indoor Units:
      1) Walls: Minimum 16-gauge thickness sheet metal.
      2) Roof: Minimum 16-gauge thickness sheet metal.
   b. Outdoor Units:
      1) Walls: Minimum 14 gauge thickness sheet metal.
      2) Roof: Minimum 14 gauge thickness sheet metal.
7. Inner Panels:
   a. Walls and Roof: Minimum 20-gauge thickness sheet metal.
   b. Floor Plate: Minimum 14-gauge thickness sheet metal.
   c. Unit floor shall be factory covered with top coat industrial grade membrane to ensure air and water tightness as well as walk-on grip. Floor membrane shall be high performance, sprayed, plural-component pure polyurea elastomer, based on amine-terminated polyether resins, amine chain extenders and prepolymers. Floor membrane shall be flexible, tough, resilient monolithic membrane with good water and chemical resistance, and shall resist to temperatures up to 120 degrees C (250 degrees F).
8. Joints:
   a. All joints between exterior panels and structural frames shall have seals and gaskets with appropriate material type for air seal and acoustical break.
   b. All seams caulked and sealed for an airtight unit.
   c. Fully through-bolted section to section joints.
9. Insulation:
   a. Double Wall Casing Units: Insulation fully encased between outside and inside liner panels.
   b. Properties:
      1) 75 mm thickness, 48 kg per cubic metre density.
      2) Maximum effective thermal conductivity (C) of 0.035 W per square metre degrees C.
      3) Minimum NRC of 0.7 per 25 mm thickness.
   c. Manufacturer: Johns Manville.

10. Access Doors:
    a. Heavy-gauge, oversized access doors insulated, double wall construction, internal sheet metal skin.
    b. Sized and located to provide easy access to unit internal components.
    c. Hinged, latched, and gasketed to provide a weatherproof seal.
    d. Provide doors on one side of each unit; coordinate with layout drawings.
    e. Latches:
        1) Leverlock 6PA6 nylon lever handles.
        2) For access doors configured to open against unit operating pressure, provide safety latches that allow access doors to partially open after first handle movement and fully open after second handle movement.
11. Casing Performance:
    a. Air Leakage: Maximum of 2.5 L/s per square metre of cabinet area at 1.24 kPa static pressure.
    b. Panel Deflection: For modules under negative pressure located on the suction side of the fan, maximum permissible panel deflection shall not exceed 1/200th of panel length, when subject to 2 kPa differential pressure.

C. Drain Pans:
1. Location: Under each cooling coil, and where indicated in these Specifications.
2. IAQ style drain pans, complying with requirements of ASHRAE 62.
3. Formed sections of minimum 16-gauge Type 316 stainless steel.
4. Triple pitched for complete drainage, with no standing water in unit.
5. Double Wall Construction:
    a. Space between walls filled with foam insulation.
    b. Sealed moisture tight.
    c. Welded corners.
6. Drain Connections:
    a. Type 316 stainless steel, male pipe thread.
    b. Both ends of pan.
    c. Extended to exterior of unit cabinet.
    d. Connection centerline shall be a minimum of 75 mm above base rail. Drain connections that protrude from the base rail are not acceptable.

D. Unit Base:
1. Full perimeter insulated base frame.
2. Minimum 10-gauge structural steel construction, with 150mm tubular steel.
3. All joints fully welded.
4. Fitted with lifting lugs at corner of unit.
5. Attached to unit at factory unless noted otherwise for field assembly.

E. Supply Fan Section:
1. General:
    a. Supply air section with fan assembly, consisting of housing (where applicable), wheel, fan shaft, bearings, motor, disconnect switch, support structure, and accessories.
    b. Casing constructed in accordance with Article Unit Casing.
    c. Suitable to convey air at temperatures up to 121 degrees C.

d. Fan Performance: AMCA 99-2408 class rating corresponding to the static pressure at which the fan is designed to operate.
e. Fan Assemblies: Statically and dynamically balanced, designed for continuous operation at maximum rated fan speed and motor horsepower.

2. Fan Wheel:
   a. Plenum Fans:
      1) SWSI backward inclined fan wheel.
      2) Nonoverloading performance characteristics.
      3) Backward inclined blades, hollow die-formed airfoil design, heavy gage metal construction, continuously welded to backplate and smooth curved inlet flange.
   b. Material: Aluminum.
3. Multiple Fan Array:
   a. Fans:
      1) Each air handling unit shall have a minimum number of fans as indicated on the drawings and schedule.
      2) Must guarantee submitted AHU performance for flow, pressure and acoustics at the perimeter boundary of the unit.
      3) Any corrective acoustical treatment, added airway tunnel lengths, increased electrical service, and any structural modificaitons necessary to meet specified and scheduled performance shall be provided at no additional costs to the City to meet specified performance criteria.
      4) The multiple fan array systems shall include multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified, minimum class III.
      5) Fans shall be certified by AMCA for performance. All fans shall be specified operating Total Static Pressure and specified fan/motor speed.
      6) The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90 percent of the specified fan's peak static pressure producing capability at the specified fan/motor speed.
      7) Each fan/motor cube or cell shall include a 12 gauge, G90U galvanized steel intake wall, 14 gauge spun steel fan inlet funnel, and a 10 gauge G90 galvanized steel motor support plate rail and structure.
      8) All fan array components (excluding wheel and base) shall be coated with air dried industrial grade alkyd enamel that meets the requirements set forth in corrosion resistance standard ASTM B-117 providing 500 hour salt spray resistance.
   b. Motors:
      1) All motors shall be standard foot mounted type, TEFC or TEAO motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere.
      2) Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2.
      3) Motors shall be as manufactured by Siemens, or Toshiba for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD.
      4) Motor HP shall not exceed the HP indicated in the AHU Datasheets.
      5) Motor BHP shall not exceed the BHP indicated in the Datasheets.
      6) Steel cased motors and/or ODP motors are not acceptable.

7) All motors shall include permanently sealed bearings from electrical discharge machining due to stray shaft currents.

c. All motors driven by VFDs to have a shaft grounding ring installed:
1) Current rating: 10 amps high frequency current up to 100 Mhz.
2) Continuous fiber ring with frequency current up to 100 Mhz.
3) Fiber wear: Less than 0.03 mm per 10,000 hours, designed for 200,000 plus hours of operation.
4) Maintenance Requirements: None.
5) Shaft grounding ring may be installed by the motor manufacturer or the fan manufacturer.
6) Shaft grounding ring to be installed in accordance with manufacturer's recommendations.
7) Acceptable Products:
a) AEGIS® Shaft Grounding Ring kit.
b) Or integral to motor assembly.

d. Array Assembly:
1) Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, exceeding category BV-5, to meet or exceed an equivalent Grade G.55, producing a maximum rotational imbalance .55 mm per second peak, filter in.
2) Fan arrays that meet the balancing specification do not require spring isolation.
3) Copies of certified balancing reports shall be provided with the unit O&M manuals at the time of shipment. Submittals that do not include statement of compliance with this requirement will be returned to the Contractor without review.
4) The multiple fan array AHU shall provide the specified acoustical performance as indicated in Datasheets for the unit supply discharge opening(s), RA opening(s), and the outside air and exhaust air opening(s).
5) Any proposed remedy for deviations in submitted sound power levels shall be approved by a registered acoustical consultant as selected by the Contract Administrator. Costs for review of proposed changes shall be borne by the Contractor.

F. Gas Heat Section—Indirect Fired:
1. General:
a. Indirect-fired fuel gas heating section, fuel type as scheduled.
b. Casing constructed in accordance with Article, Unit Casing.
c. Entire assembly approved and labelled by cETL or other nationally recognized certification agency, for both sea level and high altitude areas.
d. Approved for operation down to minus 40 degrees C. ambient air.
e. Visual burner inspection port in unit casing.
f. Insulation in heat exchanger section covered by a heat-reflective Type 304 stainless steel liner.
2. Gas Pipe Train:
a. Housed within unit cabinet.
b. Gas Train Components:
1) Flow control valve.
2) Fail-safe shut off valve(s).

3) Main and pilot gas pressure regulators.
4) Manual shut off valves.
5) Electric pilot valve.

c. Operating Gas Pressure Range, at Unit(s) Manifold: 1.75 kPa through 3.5 kPa.

3. Heat Exchanger:
   a. Primary drum and multitube secondary assembly constructed of titanium Type 409 stainless steel with multiplane metal turbulators.
   b. Floating stress relieved design.
   c. Condensate drain connection.
4. Burner:
   a. Blow through positive pressure type.
   b. Intermittent pilot ignition system.
   c. Housed within unit cabinet.
   d. Turndown: Minimum 10 to 1.
   e. Atmospheric burners or burners requiring power assisted venting are not acceptable.
5. Venting:
   a. Installation and venting provisions in accordance with CSA B149.1, ANSI Z223.1, NFPA 54, and local authorities having jurisdiction.
   b. Venting arrangement approved by a nationally recognized certification agency.
   c. Double acting barometric damper.
6. Electrical/Controls:
   a. Flame Surveillance: solid state programmed flame relay complete with flame rod.
   b. Air proving switch.
   c. Control interlocks.
   d. Panelboard: Electrical/control components housed in Unit Main Control Panel; refer to Paragraph, Unit Electrical and Controls. mounted on the outside of unit.

G. Gas Heat Section—Direct Fired:
1. General:
   a. Direct-fired fuel gas heating section, fuel type as scheduled.
   b. Casing constructed in accordance with Article, Unit Casing.
   c. Certified to ANSI Z83.4, for nonrecirculating industrial air heaters.
   d. Entire unit approved and labelled by CETL or other nationally recognized certification agency, for both sea level and high altitude areas.
   e. Approved for operation down to minus 29 degrees C ambient air.
   f. Visual burner inspection port in unit casing.
   g. Insulation in burner section covered by a heat-reflective Type 304 stainless steel liner.
2. Pipe Chase:
   a. All piping and piping mounted controls located in pipe chase.
   b. Casing construction and insulation as for unit.
   c. External to unit casing.
   d. Adequately sized access door(s) for installation and maintenance of all piping.
3. Gas Pipe-Train:
   a. FM and IRI Code approved.
   b. Housed within unit cabinet.
   c. Gas Train Components:
      1) Flow control valve.

2) Fail-safe shut off valve(s).
3) Main and pilot gas pressure regulators.
4) Manual shut off valves.
5) Electric pilot valve.

d. Operating Gas Pressure Range, at Unit(s) Manifold: As scheduled.

4. Burner:
   a. Line type.
   b. Housed within unit cabinet.
   c. Constructed in a draw through arrangement; outside air is drawn across the burner section at a constant velocity, within allowable limits of burner design.
   d. Turndown: Minimum 20 to 1
   e. Combustion Air Openings:
      1) Burner combustion air openings shall be located in Type 430 stainless steel burner plates to maintain design combustion air requirements at inputs.
      2) Combustion air openings in burner castings are not acceptable because of potential blockage from corrosion.
   f. Gas orifices shall be adequately spaced for optimum combustion.
   g. Gas burner connection size shall be adequately sized in order to assure full turndown performance.
5. Electrical/Controls:
   a. Flame Surveillance: Solid state programmed flame relay complete with flame rod.
   b. Air proving switch.
   c. All necessary control interlocks.
   d. Panelboard: Electrical/control components housed in Unit Main Control Panel; Unit Electrical and Controls NEMA type 12, mounted on the outside of the unit.
6. Gas regulator venting piping shall be sized adequately and installed by the Contractor in accordance with CGA-B149.1 and vented to exterior.

H. Hydronic Coil Section:
1. General:
   a. Fin-tube hydronic coil, cooling and heating duty.
   b. Casing constructed in accordance with Article, Unit Casing.
   c. 1723 kPa working pressure.
   d. ARI 410 performance rated and certified.
2. Pipe Chase (applicable to outdoor units):
   a. Piping and piping mounted controls located in pipe chase.
   b. Chase construction and insulation as for unit.
   c. External to unit casing.
   d. Adequately sized access door(s) for installation and maintenance of all piping.
3. Coil Assembly:
   a. Mounted on stainless steel support rack to permit coils to slide out individually from unit.
   b. Water Supply and Return Connections:
      1) On same side of unit.
      2) Extended a minimum of 125 mm beyond the exterior of the unit casing by the manufacturer.
   c. Coils removable from the unit at header end, unless shown otherwise on drawings.
   d. Clearly label supply and return headers on outside of unit.

   e. Arranged for counterflow between water and air; water shall enter coil on leaving air side of coil.
   f. Completely drainable.
   g. Factory tested with air at 2068 kPa while immersed in an illuminated water tank.
4. Fins:
   a. Die-formed plate type, rippled for maximum heat transfer.
   b. Continuous metal across coil casing; split fins not acceptable.
   c. Shall have fully drawn collars and be mechanically bonded to tubes by mechanical expansion of tubes.
   d. Material: 0.2 mm aluminum.
   e. Fin density no greater than 14 fins per 25 mm.
5. Tubes:
   a. Material: 15.9 mm OD by 0.5 mm wall seamless copper tubing.
   b. Return Bends: Replaceable, brazed joints, 1.25 mm wall thickness.
   c. Circuited to provide adequate tube velocities to meet design requirements.
   d. Internal turbulators are not acceptable.
   e. Pressure-equalizing baffles as required.
   f. Intermediate tube supports shall be supplied on coils over 1100 mm fin length with an additional support every 1050 mm multiple thereafter.
6. Headers:
   a. Located inside unit.
   b. Constructed from seamless copper tubing with die formed tube holes.
   c. Water Supply and Return Connections:
      1) Schedule 40 Red Brass.
      2) Terminate with male pipe thread.
   d. Capped vent tapping at top of return header.
   e. Capped drain tapping at bottom of supply header.
   f. Completely drainable [and cleanable].
7. Casings:
   a. Construct from minimum 16-gauge Type 316 stainless steel.
   b. Formed end supports and top and bottom channels.
8. Drain Pan:
   a. Construction in accordance with Paragraph, Drain Pans.
   b. Furnish drain pan under each cooling coil.
   c. Intermediate Drain Pan:
      1) Provide intermediate drain pans on stacked cooling coils.
      2) Intermediate pan shall drain to main drain pan through copper downspout.
9. Accessories:
   a. Control Dampers:
      1) Located at inlet and discharge as shown on the drawings.
      2) Parallel configuration.
      3) Construction in accordance with Article, Control Dampers.
      4) Damper Actuator: Siemens OpenAir GCA Series electric actuator, factory installed.
      5) Explosion Proof Actuators: Redmax-c ¼ turn electric actuator, factory installed.

I. Filters:
   1. General:
      a. Air filtration section, complete with filter media and filter racks.
      b. Casing constructed in accordance with Article, Unit Casing.
      c. Double wall, hinged, removable access doors on one side of unit.
      d. Maximum 2.5 m/s face velocity across filters.
   2. Media Schedule:
      a. Prefilter:
         1) Vertical arrangement.
         2) Disposable pleated type.
   3. Media Construction:
      a. General:
         1) Contain in a rigid frame.
         2) Meet UL/ULC Class 2 standards.
         3) Rigid supporting mesh across the leaving face of media.
         4) Quality certified by ISO-9002.
      b. Preformed, Disposable Dry Extended Area Type: Rated at mean efficiency of 60 to 65 percent and average arrestance of 98 percent in accordance with ASHRAE 52, by ASHRAE Atmospheric Dust Test Method.
      c. Disposable Pleated Type:
         1) Pleated panel disposable filters.
         2) Nonwoven reinforced cotton/poly fabric media with a metal support grid and heavy duty beverage board-enclosing frame.
         3) 50 mm thickness.
         4) MERV 8 efficiency per ASHRAE 52.2.
         5) Minimum 30 percent Dust Spot Efficiency and 90 percent average arrestance in accordance with ASHRAE 52.
   4. Frame and Filter Assembly:
      a. Suitable for space indicated.
      b. Permanent re-usable, side-loading Type 304 stainless steel holding frame, retainer, and sealer frame.
      c. Filter blank-offs to prevent air bypass around filters, same material as frame.
   5. Accessories:
      a. Filter Pressure Gauge:
         1) Unless otherwise specified in the Contract Documents, Dwyer Series 605 Magnehelic gauges with indicating transmitters, one for each filter bank
         2) Use copper tubing for all control tubing.
   6. Manufacturers:
      a. Farr.
      b. Tri-Dim.
      c. American Air Filter.

J. Glycol Packaged Pumping System:
   1. General:
      a. All package components are mounted on a structural steel base with a maximum deflection of span/360 when lifted at the designated lifting points.

b. The structural design is capable of supporting the entire weight of the system when wet without detrimental deflection, when installed as per instructions provided in the Installation, Operations and Maintenance manual.
c. The package is also to include: interconnecting piping spools, elbow fittings, T-fittings, header pipe support clamps, braced pipe stands, necessary test points, air vents, drain connections, lifting lugs painted yellow, braided stainless steel pressure lines, and panel mounted pressure gauges.
d. All grooved piping black steel Schedule 40 for sizes up to 250 mm will be connected with threaded flanges and fittings in compliance with requirements of AES-09011.
e. The Package shall be UL listed, and manufactured at an ISO 9001 registered facility.
f. Acceptable manufacturers include Armstrong, or ITT.

2. Pumps and Motors: As per Section 23 21 14, Hydronic Specialties, and Section 26 20 00, Low Voltage AC Induction Motors.
3. Plate and Frame Heat Exchangers: As per Section 23 57 00, Heat Exchanger for HVAC.
4. Glycol Auto Fill Units: As per Section 23 21 14 Hydronic Specialties.
5. Valves and Gauges: As per Section 23 21 13, Hydronic Piping-General.

K. Control Dampers:
1. Internally mounted ultra low leak dampers at inlet and outlet as shown on the drawings.
2. Parallel blade action.
3. Construction:
a. Extruded aluminum blades.
b. Galvanized steel frame, U-shaped galvanized metal sections securely screwed or welded to unit chassis.
c. Vinyl blade seals, stainless steel jam seals.
d. Type 304 stainless steel linkage, shafts, and hardware.
e. Type 304 stainless steel sleeve bearings.
4. Performance: Leakage rate shall not exceed 25 L/s per square metre at 250 Pa and 45 L/s per square metre at 1000 Pa.
5. Controlled dampers locate at outside air intake and discharge with hard wired interlocks with fan start.
6. Damper: T. A. Morrison & Co. Inc., TAMCO 9000-SC.

L. Unit Electrical and Controls:
1. General:
a. All electrical and control components shall meet requirements of Section 26, Electrical.
b. Electrical and controls components and assemblies CSA or cUL listed and labeled.
c. Factory wired units shall bear an CSA or cUL label with necessary identification marks, electrical data, and cautions, as required by the CEC.
d. Provide as-built wiring diagrams and schematics for electrical and control systems, secured to inside of control panel door, or enclosed in plastic jackets placed inside control panel.
e. For additional requirements, refer to Specification paragraphs for individual sections and components, and Section 40 99 90, Package Control Systems.
2. Main Power Connection: Provide single point power connection to unit, serving both primary unit voltage and unit control voltage.

3. Main Control Panel:
    a. Provide main control panel complete with electrical, control components, and a single VFD housed in an enclosure factory wired and mounted integral to the AHU casing. For AHUs that are located outdoor, provide the main control panel separately to be installed remotely at the locations shown on the drawing.
    b. NEMA Type 12 enclosure.
    c. Adequate spare space for field installation wiring to the unit.
4. Factory Installed Variable Frequency Drives:
    a. Provide single Schnieder VFD and a separate Schneider single bypass starter to provide control of multiple fans and motors.
    b. Factory installed on outside of unit cabinet.
    c. Factory wired to motor terminal box housed in the Main Control Panel.
    d. NEMA Type 12 enclosure.
    e. Comply with requirements of Section 26 29 23, Variable Frequency Drives.
5. Factory Installed Disconnects:
    a. Provide main electric power disconnect for unit.
    b. Disconnect switch interruption rating shall be correctly sized to meet the maximum short circuit current available.
    c. NEMA Type 12 enclosure.
    d. Nonfused type.
    e. Disconnect switch shall be shipped loose and installed on Site.
6. Lighting:
    a. Vapor proof compact fluorescent fixture with guard and GFCI receptacle in each section.
    b. 120 V, factory installed and wired.
    c. Wired to a junction box, with one on/off switch for all lights, mounted on outside of unit, adjacent to unit access door.
    d. Provide single point power connection for 120/1/60 (lights and receptacles).
7. Electrical Convenience Outlets:
    a. Duplex type, 120V, factory installed and wired.
    b. Location:
        1) On exterior of unit, next to each fan section access door.

M. Instrumentation and Controls:
1. General:
    a. Review of the HVAC PCN (Process Control Narrative) and P&ID sections pertaining to the Air Handling system to gain a complete understanding of the intended instrumentation and controls integration requirements including monitoring/control signals, interlocking and alarms.
    b. Provide clearly labeled interfacing terminals for field wiring to the Plant HVAC PLC Control System, including but not limited to the following:
        1) Dry contact forPlant Control System 24 VDC discrete input signals (refer to the P&IDs for requirements):
            a) Local HOR (HAND/OFF/REMOTE) handswitch status
            b) Local BYPASS/NORMAL handswitch status
            c) Control damper(s) position status; closed/open
            d) AHU Running status
            e) VFD Fault status (fail-safe)

f) VFD(s) fault status
g) By-pass starter status
h) Temperature switch, i.e. Freezestat
i) Burner Run status (for gas fired equipment)
j) Burner Fault status (for gas fired equipment)

2) 24 VDC relay coil for Plant Control System discrete output signals:
a) Start command
b) Burner Enable command (for gas fired equipment)

3) Isolated 4-20 mA analog input signals from Plant HVAC PLC Control System:
a) VFD Speed control command
b) Burner temperature setpoint command (for gas fired equipment)

4) Provided Isolated 4-20 mA analog output signals to Plant HVAC PLC Control System:
a) Filter(s) differential pressure feedback (loop powered)
b) Supply and discharge air temperature sensor(s) feedback (loop powered)
c) Airflow sensor(s) feedback (loop powered)
d) VFD speed feedback

c. Provide “freezestat” downstream of heating coil where indicated on the P&IDs. Upon sensing heating coil discharge air temperature of 2 degrees C or less, the unit shall be de-energized through hardwired control.

d. Factory controls (for gas fired equipment only) shall be capable of receiving an analog input signal for discharge air temperature control.

e. Refer to Section 40 99 90, Packaged Control Systems for AHU control panel construction requirements

2. Integral Motor Control System:
a. Provide a complete system of motor control for unit motors, including but not limited to:
1) Motor contactors.
2) Motor overload protection.
3) Grounding lugs.
4) Control transformers.
5) Auxiliary contactors and terminals for connection of external control devices or relays.

b. Components located in unit Main Control Panel.

3. Instrumentation:
a. Provide instrumentation as required for a complete and operational system.
b. Instrumentation shall be industrial grade, CSA, or cUL approved products suitable for installation in a wastewater treatment facility.
c. the City has standardized on Siemens instrumentation. Provide Siemens products where possible.

4. Factory Installed Control System (for AHU Gas Fired Control only):
a. Automatic controls shall be housed in a control panel mounted in or on the air handler units, which will meet the standard of the specific installation.
b. Factory-supplied electronic temperature control system with the capability of providing multiple stages of heating control on the burner unit to maintain discharge temperature.

c. Factory-supplied control system with solid state controller incorporating proportional and integral control to maintain discharge air reset temperature setpoint provided by Plant Control System.

Fire alarm circuits (where required) shall be powered from a relay in the unit circuitry.

N. Accessories: Provide as follows:
1. Corrosion Protection Coating:
a. Provide factory applied corrosion protection coating on these unit components:
1) Fan wheel (or propeller).
2) Fan housing.
3) Fan accessories.
4) Interior surfaces in contact with air stream.
5) Exterior Cabinet.
b. Coating system shall be air dried phenolic, and shall be in accordance with Article, Corrosion Protection Coating.

O. Manufacturers and Products:
1. Venmar.
2. Haakon.

2.7 AIR PRESSURIZATION UNIT

A. General:
1. Air pressurization unit, designed for the removal of both organic and inorganic contaminants from recirculated air in gas or vapor atmospheres.
2. Indoor mounted, free standing, vertical configuration, draw-through, packaged unit consisting of fan, motor and drive assembly, variable frequency motor controller, particulate and chemical scrubbing filters.
3. Unit shall be arranged for horizontal or vertical airflow and shall deliver the designed combined airflow (pressurization air plus recirculation air).

B. Unit Cabinet:
1. Heavy gauge galvanized steel sheets, seam welded. Phosphatized and factory finished in manufacturer’s standard enamel paint.
2. Gasketed front access door(s) for servicing components. Latches shall have a positive locking action. Door seals shall be attached by mechanical means and designed for replacement. Seals shall be glued in conjunction with mechanical attachment.
3. Housing with base support.
4. Hinges and Draw Latches: Constructed of Type 316 stainless steel.
5. Type 316 stainless steel nameplate shall be provided permanently attached to the unit. Nameplate engraved with the scrubber type, order number and serial number.
6. Controlled damper located at the outside air intake with hardwired interlocks with fan start.
7. Return and discharge openings shall include grilles with four-way deflection louvers.

C. Blower Fan:
1. Located in the housing between the second and third stages of air cleaning.

2. Backward curved, centrifugal, Glass Reinforced Polyamine (GRP) wheel.
3. Drives Type: Direct.
4. Fan Motor:
   a. Totally enclosed and permanently lubricated with inherent protection.
   b. Schneider Altivar brand variable frequency drive integral to unit.
5. Maximum sound pressure level is 75 dBA at 1 meter from the unit.

D. Prefilter and After Filter:
1. Disposable 25 mm thick strainer type with pleated nonwoven fabric media.
2. Efficiency: 20 percent to 25 percent efficient.
3. Clean filter resistance shall not exceed 50 kPa based on a face velocity of 152 m per minute.

E. Chemical Scrubbing Filters:
1. Housing shall contain two chemical media sections, designed to accommodate 300 mm modular media containment devices.
2. Dimensions: 600 mm wide by 300 mm high by 300 mm deep, in direction of airflow.
3. Medium Bed Depth: Minimum of 75 mm.
4. Device shall be completely recyclable or disposable.
5. Device shall be constructed of 3 mm thick, black, high impact polystyrene.
6. Module shall be factory filled with selected chemical media.
7. Pressure drop through each chemical media section shall not exceed 325 Pa, at 1.27 m/s face velocity.
8. Maximum airflow through chemical media section shall be 76 m per minute.
9. Residence time through the chemical media section shall not be less than 0.24 seconds total; 0.12 seconds per media bed in direction of airflow.
10. Media:
    a. Media filter modules shall be UL/ULC rated Class 1. Manufacturer shall provide documentation.
       1) Media shall have a high removal capacity for sewerage gases, including hydrogen sulfide, aldehydes, and sulfur dioxide.
       2) Composition: Media shall consist of manufactured, generally spherical, porous pellets. Pellets shall be formed from a combination of activated alumina and other binders, suitably impregnated with potassium permanganate.
       3) Potassium Permanganate Content: 8 percent minimum. To be applied during pellet formation, such that impregnant is uniformly distributed throughout pellet volume.
       4) Landfill disposable.
       5) UL Classified Class 1.
       6) New and spent media is nontoxic.
       7) Will not support bacterial or fungal growth.
       8) Removal Capacity:
          a) Hydrogen Sulfide: 18 percent minimum by weight.
          b) Sulfur Dioxide: 7 percent minimum by weight.
       9) Operating Conditions:
          a) Temperature: Minus 15 degrees C to 52 degrees C.
          b) Humidity: 10 to 95 percent relative humidity.
       10) Products: Purafil ESD Odoroxidant

F. Final Filter:
   1. Disposable 5-inch thick cartridge type with pleated nonwoven fabric media.
   2. Efficiency: 85 percent to 90 percent efficient.
   3. Clean filter resistance shall not exceed 75 Pa based on a face velocity of 0.51 m per second.

G. Hot Water Coil Section:
   1. Refer to Hydronic Heating Coil item of this Section.

H. Unit Electrical and Controls:
   1. General:
      a. All electrical and control components shall meet requirements of Division 26, Electrical.
      b. Electrical and controls components and assemblies CSA or cULlisted and labeled.
      c. Factory wired units shall bear an CSA or cUL label with necessary identification marks, electrical data, and cautions, as required by the CEC.
      d. Provide as-built wiring diagrams and schematics for electrical and control systems, secured to inside of control panel door, or enclosed in plastic jackets placed inside control panel.
      e. For additional requirements, refer to Specification paragraphs for individual sections and components, and Section 40 99 90, Package Control Systems.
   2. Main Power Connection: Provide single point power connection to unit, serving both primary unit voltage and unit control voltage.
   3. Main Control Panel:
      a. Provide main control panel complete with electrical, control components, and a single VFD housed in an enclosure factory wired and mounted integral to AHU casing.
      b. NEMA Type 12 enclosure.
      c. Adequate spare space for field installation wiring to the unit.
   4. Factory Installed Variable Frequency Drives:
      a. Provide single Schnieder VFD
      b. Factory installed on outside of unit cabinet.
      c. Factory wired to motor terminal box housed in the Main Control Panel.
      d. NEMA Type 12 enclosure.
      e. Comply with requirements of Section 26 29 23, Variable Frequency Drives.
   5. Factory Installed Disconnects:
      a. Provide main electric power disconnect for unit.
      b. Disconnect switch interruption rating shall be correctly sized to meet the maximum short circuit current available.
      c. NEMA Type 12 enclosure.
      d. Nonfused type.
      e. Disconnect switch shall be shipped loose and installed on Site.
   6. Lighting:
      a. Vapor proof with guard and with GFCI receptacle in each section.
      b. 120 V, factory installed and wired.
      c. Wired to a junction box, with one on/off switch for all lights, mounted on outside of unit, adjacent to unit access door.

d. Provide single point power connection for 120/1/60 (lights and receptacles); refer to electrical lighting details for more information.

7. Electrical Convenience Outlets:
   a. Duplex type, 120V, factory installed and wired.
   b. Location:
      1) On exterior of unit, next to each fan section access door.

I. Instrumentation and Controls:
1. General:
   a. Review of the HVAC PCN (Process Control Narrative) and P&ID sections pertaining to the Air Handling system to gain a complete understanding of the intended instrumentation and controls integration requirements inincluding monitoring/control signals, interlocking and alarms.
   b. Provide clearly labeled interfacing terminals for field wiring to the Plant HVAC PLC Control System, including but not limited to the following:
      1) Dry contact for Plant Control System discrete intput signals (refer to the P&IDs for requirements):
         a) Local HOR (HAND/OFF/REMOTE) handswitch status
         b) Control damper(s) position status; closed/open
         c) Pressurization Unit Running status
         d) VFD Fault status (fail-safe)
      2) 24 VDC relay coil for Plant Control System discrete output signals (refer to the P&IDs for requirements):
         a) Start command
      3) Analog input signal from Plant Control System (refer to the P&IDs for requirements):
         a) VFD Speed control command
      4) Isolated Analog output signals to Plant Controls System (refer to the P&IDs for requirements):
         a) Filter(s) differential pressure feedback (loop powered)
         b) Airflow sensor(s) feedback (loop powered)
         c) VFD speed feedback
   c. Refer to Section 40 99 90, Packaged Control Systems, for AHU control panel construction requirements.
2. Instrumentation:
   a. Provide instrumentation as required for a complete and operational system.
   b. Instrumentation shall be industrial grade, CSA, or cUL approved products suitable for installation in a wastewater treatment facility.
   c. the City has standardized on Siemens instrumentation. Utilize Siemens products where possible.
3. Integral Motor Control System:
   a. Provide a complete system of motor control for unit motors, including but not limited to:
      1) Terminal blocks.
      2) Motor contactors.
      3) Motor overload protection.
      4) Grounding lugs.
      5) Control transformers.

6) Auxiliary contactors and terminals for connection of external control devices or relays.
b. Components located in unit Main Control Panel.
4. Interface with the Plant Control System controls. Refer to PCN and P&ID drawing for more details.

J. Manufacturer and Product:
1. Circul Aire, Air Purification System.
2. Purafil; Positive Pressurization Unit.

2.8 MOTORS

A. General:
1. Fan motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction Motors.
2. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
3. Fan motors shall not operate into service factor in any case.

B. Motor requirements shall be as follows unless designated otherwise on fan equipment schedule:
1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Winding Thermal Protection: None.
3. Space Heater: No.
4. Number of Speeds: Single.
5. Number of Windings: One.
6. Motor Efficiency: Premium efficient.
7. Shaft Type: Solid, carbon steel.
8. Mounting: As required for fan arrangement.

2.9 CORROSION PROTECTION

A. General:
1. Factory applied corrosion protection coating for application to unit components and accessories, where in required by this Section.
2. Quality Control:
a. Verify dry film thickness before final baking.
b. Finished coating system shall be free from voids, checks, cracks and blisters.
3. Surface Cleaning: For all coating systems, parts to be coated shall be cleaned as follows:
a. Immerse parts in heated cleaning solution to remove lubricants, machining oils, and residual factory contamination.
b. Follow with immersion in potable water bath to neutralize and remove cleaning solution.
c. Chemical Pretreatment: Immerse parts in heated chemical solution, iron phosphate for steel, clear/yellow chromate for aluminum.

B. Air-Dry Epoxy:
1. Material: Two-part catalyzed epoxy.

2. Surface Preparation: Clean surface to SSPC-SP 3.
3. Application: Standard air-pressurized spray equipment.
4. Curing: Air dry.
5. Finished Thickness: 4-mil to 6-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   a. Salt Spray Test: Minimum 500-hour duration, ASTM B117 test method.
   b. Pencil Hardness: H-2H, ASTM D3363 test method.
   c. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
   d. Service Temperature: Maximum 65 degrees C, continuous.

C. Air Dry Phenolic:
1. Material:
   a. Phenolic resin, Heresite VR-500 Series.
   b. For outdoor applications, apply an UV resistant topcoat, Heresite UC-5500.
2. Surface Preparation: Sandblast surface to SSPC-SP 6.
3. Application: Standard air-pressurized spray equipment.
4. Curing: Air dry.
5. Finished Thickness: 4-mil to 6-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   a. Salt Spray Test: Minimum 500-hour duration, ASTM B117 test method.
   b. Humidity Resistance: Minimum 500-hour duration, ASTM D2247 test method.
   c. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
   d. Service Temperature: Maximum 82 degrees C, continuous.

2.10 COIL PROTECTIVE COATING

A. General:
1. Factory dip-applied protective coating for application to plate fin and tube coils.
2. Coil factory assembled and tested before coating application.
3. Coating suitable for coils with maximum 30 fins per 25 mm fin density. Bridging of product across coil fins is unacceptable.
4. After application and proper curing, product shall endure bending of coil assembly in standard manufacturing process without cracking.
5. Apply coating to coil before final factory assembly of equipment. Coating process that requires disassembly of equipment for removal of coil to be coated is not acceptable.

B. Coating Material:
1. Use one of the following materials:
   a. Epoxy Modified Phenolic. Straight phenolic materials are not acceptable.
   b. Epoxy or epoxy-urethane.
   c. Polyelastomer: Complex chain linked polyelastomer material.
   d. Baked epoxy phenolic.

C. Coating Process:
   1. Coil Inspection and Sealing:
      a. Inspect coil for open tubes, headers, capillary tubes; repair as necessary.
      b. Fill with dry nitrogen, cap and seal, to prevent contamination of internal coil surfaces with cleaning or coating solutions.
   2. Coil Cleaning:
      a. Immerse coil in heated alkaline cleaning solution to remove lubricants, machining oils, and residual factory contamination.
      b. Followed with immersion in potable water bath to neutralize and remove cleaning solution.
   3. Coating Application:
      a. Immerse coil assembly in coating bath, including headers, casing, and heat exchange surfaces.
      b. Coil shall be completely removed from equipment during coating application.
      c. Spray-on coatings are not acceptable.
   4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
   5. Quality Control: Free from voids, checks, cracks and blisters.

D. Performance:
   1. Coil finish shall meet or exceed the following criteria:
      a. Salt Spray Test: In accordance with ASTM B117, minimum 3,000-hour duration, with no fin corrosion or degradation.
      b. Thermal Efficiency: Loss no greater than 1 percent after coating application.
      c. Exposure to UV Light: UV inhibited life of minimum 10 years when exposed to sun in the State of Florida.

E. Manufacturers and Products:
   1. Aero-Marine Engineering Inc.; Technicoat 10-1.
   2. AST ElectroFin Inc; ElectroFin.
   3. Bronzglow; Husky® Coil Coat (HLF 815C659).
   4. Meresite Coatings.

2.11 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component [and control panel] in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

2.12 SPARE PARTS

A. Provide spare parts as per Section 40 99 90, Packaged Control Systems

2.13 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test equipment actually furnished.

B. Testing Provisions:
   1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
   2. Center punch fan shaft to accommodate tachometer readings.

C. Manufacturer's Tests:
   1. Water Coil Test: No leaks when tested underwater with 1379 kPa air.
   2. Electric Heating Coil Test: 2,000-volt dielectric test.
   3. Electrical Circuits:
      a. Tested and checked as to proper function.
      b. Perform dielectric strength test.
   4. Air Handling Unit Cabinet Tests:
      a. Air Pressure Leak Testing: For modules under positive pressure located on discharge side of a fan, maximum permissible air leakage shall not exceed one percent of specified airflow, when subject to 2 kPa differential pressure.
      b. Panel Deflection Testing: For modules under negative pressure located on the suction side of the fan, maximum permissible panel deflection shall not exceed 0.13 mm of panel length, when subject to 0.13 mm differential pressure.
      c. Leakage Test Failure Guarantee: Upon completion of leakage test, if unit does not meet specified performance for deflection or leakage, the City may elect to have unit modified to meet specified performance or may request a credit according to performance failure.
   5. Gas fired heating tests.

D. Acoustical Test:
   1. Perform factory noise tests in accordance with AMCA 300 and AMCA 301.
   2. Fan sound power levels (dB, Reference 10^{-12} Watts) shall be no greater than scheduled values.

E. Balancing:
   1. Completed fan assemblies shall be dynamically balanced to minimum grade of G 6.3 per AMCA 204 at design operating speed.
   2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design RPM.

F. Vibration Test:
   1. Each fan furnished with a 3.75 kW or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
   2. Vibration reading as measured at fan scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
      a. Belt Drive (except Vane Axial): 3.75 mm/sec peak velocity.
      b. Belt Drive Vane Axial: 2 mm/sec peak velocity.
      c. Direct Drive: 2 mm/sec peak velocity.
      d. Written records of run test and vibration test shall be made available upon request.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install floor-mounted units on concrete bases.

C. Secure vibration controls to concrete bases using anchor bolts cast in concrete base. Refer to Section 23 05 48, Vibration Isolation for HVAC

D. Inspect internal casing insulation, seal all exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

E. All condensate drain connections piped and trapped separately for proper drainage.

F. Labeling: In accordance with Article, Accessories.

G. Service Access: Locate units to provide access spaces required for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.

H. Equipment Restraints:
1. Restrain equipment against seismic forces as required by Code.
2. Restrain equipment against wind loads as required by Code.
3. Refer Section 23 05 48, Vibration Isolation for HVAC.

I. Connections:
1. Isolate sheet metal duct connections from all noninternally spring-isolated fan units or other rotating equipment.
2. Install ductwork adjacent to fans so as to allow proper service and maintenance.
3. Pipe drain pan connection through trap running to floor drain.

J. Assembly of Split Sections:
1. Pre-wired devices are to be re-wired in the field back to installed control panels.

3.2 FIELD QUALITY CONTROL

A. Functional Tests:
1. Verify shipping blocking and bracing are removed.
2. Verify unit is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters and disconnect switches.
4. Verify cleaning and adjusting are complete.
5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system, align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.

8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:
1. Starting Procedures:
   a. Energize motor and adjust fan to indicated rpm.
   b. Measure and record motor voltage and amperage.
2. Operational Test:
   a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
   c. Test and adjust control safeties.
   d. Replace damaged and malfunctioning controls and equipment.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate non-sealed bearings prior to startup.

D. Air Balancing:
1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
2. Replace fan and motor sheaves as required to achieve design airflow.

E. Vibration Testing:
1. Perform field testing on rotating equipment, where specified in Section 23 05 93 Testing, Adjusting, and Balancing for HVAC to determine actual operating vibration.
2. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.

3.4 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

3.5 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Contractor Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of the City's personnel for specified component, subsystem, equipment, or system.

B. Manufacturer's Representative: Present at Site or classroom designated by the City, for minimum person-days listed below, travel time excluded:
   1. One person-day for installation assistance and inspection.
   2. Two person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   3. One person-day for prestartup classroom or Site training.
   4. One person-day for facility startup.
   5. One person-day for post-startup training of the City's personnel.
   6. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Contract Administrator.

C. Refer Section 01 43 33, Contractor Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.6 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.
   1. 23 77 00.01, Make-Up Air Handling Units.
   2. 23 77 00.02, Air Pressurization Units.

END OF SECTION

AIR HANDLING UNITS SCHEDULE **23 77 00.01**

SYMBOL				AHU-K610	AHU-K620	AHU-K630	AHU-B610
TYPE				CUSTOM	CUSTOM	CUSTOM	CUSTOM
LOCATION				HRC MECH. RM.	HRC MECH. RM.	HRC. MECH RM.	EXIST. MECH. RM.
FAN	AIRFLOW	SUPPLY:	L/s	9533	3210	3556	566
		OSA:	L/s	9533	3210	3556	189
	STATIC PRESSURE	TOTAL:	Pa	625	625	625	462.5
		EXT.:	Pa	125	125	125	250 Pa
	NUMBER OF FANS:			2 X 2 = 4	2 X 1 = 2	2 X 1 = 2	0.48 (1)
	FAN SPEED (RPM):			1747	1766	1824	3213
	WHEEL TYPE:			BI	BI	BI	AF
	DRIVE (BELT/DIRECT):			DIRECT	DIRECT	DIRECT	DIRECT
	MOTOR DATA (EACH)	SIZE:	kW	3.73	2.2	2.2	0.7
		SPEED:	RPM	1800	1800	1800	3450
		POWER:	VOLT	575	575	575	575
			PH	3	3	3	3
		ENCLOSURE:		TEFC	TEFC	TEFC	TEAO
HYDRONIC HEATING COIL	TOTAL CAPACITY:		kW	353	123	138	10.3
	AIRFLOW:		L/s	4767	1605	1778	566
	ENTER. AIR TEMPERATUE:		C	-35	-35	-35	5
	LEAVG. AIR TEMPERATURE:		C	15	17	18	20
	AIR PRESSURE DROP:		Pa	18	10	10	15
	LIQUID HEAT TRANSFER MEDIA:			50% PROP GLYCOL	50% PROP GLYCOL	50% PROP GLYCOL	WATER
	LQUID FLOW:		L/s	8.44	2.95	3.31	0.23
	ENTER. LIQUID TEMPERATURE:		C	77	77	77	82
	LEAVG. LIQUID TEMPERATURE:		C	66	66	66	71
	LIQUID PRESSURE DROP:		m (H_2O)	1.13	1.30	1.65	1.3
FILTER	EFFICIENCY:		%	MERV 8	MERV 8	MERV 8	MERV 8
	RESISTANCE (FINAL):		Pa	250	250	250	250
MAXIMUM DIMENSIONS	LENGTH:		mm	4267	3734	3734	1600
	WIDTH:		mm	2286	1930	2032	787
	HEIGHT:		mm	2489	1676	1727	1676
	WEIGHT:		kg	2698	825	2114	650
MANUFACTURER AND MODEL NO.:				VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK
APPLICABLE REMARKS:				A	A	A	

REMARKS:

A: UNIT TO BE SHIPPED IN SEPARATE SECTIONS WITH SPLIT LINES AS SHOWN ON DRAWINGS.
B: UNIT SHALL COME COMPLETE WITH GLYCOL PACKAGE PUMPING SYSTEM, REFER TO SPECIFICATIONS FOR DETAILS.
C: DIRECT FIRE GAS BURNER. REFER TO SPECIFICATION FOR DETAILS.
D: UNIT SHALL BE PROVIDED WITH REMOTE CONTROL PANEL

AIR HANDLING UNITS SCHEDULE **23 77 00.01**

SYMBOL				AHU-R610	AHU-R620	AHU-S630	AHU-S650
TYPE				CUSTOM	CUSTOM	CUSTOM	CUSTOM
LOCATION				BNR MECH. RM.	BNR. MECH . RM.	S.C. MECH. RM	S.C. MECH. RM
FAN	AIRFLOW	SUPPLY:	L/s	8816	3776	2965	3783
		OSA:	L/s	8816	3776	2965	3783
	STATIC PRESSURE	TOTAL:	Pa	709	709	875	875
		EXT.:	Pa	250 Pa	250 Pa	250 Pa	250 Pa
	NUMBER OF FANS:			2 X 2 = 4	2 X 1 = 2	2 X 2 = 4	2 X 2 = 4
	FAN SPEED (RPM):			1772	3719	3437	3239
	WHEEL TYPE:			AF	AF	AF	AF
	DRIVE (BELT/DIRECT):			DIRECT	DIRECT	DIRECT	DIRECT
	MOTOR DATA (EACH)	SIZE:	kW	2.2	3.7	1.1	1.5
		SPEED:	RPM	1800	3600	3450	3500
		POWER:	VOLT	575	575	575	575
			PH	3	3	3	3
		ENCLOSURE:		TEFC	TEFC	TEFC	TEFC
GAS FIRED HEATER	FUEL SOURCE:			NATURAL GAS	NA	NATURAL GAS	NATURAL GAS
	GAS INPUT:		kW	820	NA	239	257
	HEAT OUTPUT:		kW	655	NA	191	206
	AIRFLOW:		L/s	8816	NA	2965	3783
	ENTER. AIR TEMPERATUE:		C	-35	NA	-35	-35
	LEAVG. AIR TEMPERATURE:		C	10	NA	18	10
	GAS SUPPLY PRESS	MIN:	Pa	1750	NA	1750	1750
		MAX:	Pa		NA		
	BURNER	CONTROL TYPE:		MODULATION	NA	MODULATING	MODULATING
		IGNITION TYPE:			NA		
	AIR PRESSURE DROP:		Pa	102	NA	82.5	135
HYDRONIC HEATING COIL (HEAT RECOVERY)	TOTAL CAPACITY:		kW	126	125	99	110
	AIRFLOW:		L/s	8816	3776	2965	3783
	ENTER. AIR TEMPERATUE:		C	-35	30	-35	-35
	LEAVG. AIR TEMPERATURE:		C	-24	5	-7	-11
	AIR PRESSURE DROP:		Pa	70	171	53	60
	LIQUID HEAT TRANSFER MEDIA:			50% PROP GLYCOL	50% PROP GLYCOL	50% PROP GLYCOL	50% PROP GLYCOL
	LQUID FLOW:		L/s	4.73	4.73	5.62	4.40
	ENTER. LIQUID TEMPERATURE:		C	-11.8	-19.3	2	2
	LEAVG. LIQUID TEMPERATURE:		C	-19.3	-11.9	-3	-5
	LIQUID PRESSURE DROP:		m (H_2O)	5.87	6.77	3.58	5.65
FILTER	EFFICIENCY:		%	MERV 8	MERV 8	MERV 8	MERV 8
	RESISTANCE (FINAL):		Pa	25	25	250	250
MAXIMUM DIMENSIONS	LENGTH:		mm	5817	4877	5359	5359
	WIDTH:		mm	3302	1676	2845	2845
	HEIGHT:		mm	2794	1727	1880	1880
	WEIGHT:		kg	6370	2544	4280	4260
MANUFACTURER AND MODEL NO.:				VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK
APPLICABLE REMARKS:				A	A,B	A	A

REMARKS:

A: UNIT TO BE SHIPPED IN SEPARATE SECTIONS WITH SPLIT LINES AS SHOWN ON DRAWINGS.
B: UNIT SHALL COME COMPLETE WITH GLYCOL PACKAGE PUMPING SYSTEM, REFER TO SPECIFICATIONS FOR DETAILS.
C: DIRECT FIRE GAS BURNER. REFER TO SPECIFICATION FOR DETAILS.
D: UNIT SHALL BE PROVIDED WITH REMOTE CONTROL PANEL

AIR HANDLING UNITS SCHEDULE **23 77 00.01**

SYMBOL				AHU-G610	AHU-G620	AHU-G630	
TYPE				CUSTOM	CUSTOM	CUSTOM	
LOCATION				GRIT & SCRN. MECH. RM.	EXIST. DRYWELL MECH. RM.	GRIT & SCRN. MECH. RM.	
FAN	AIRFLOW	SUPPLY:	L/s	5496	9862	3823	
		OSA:	L/s	5496	9862	3823	
	STATIC PRESSURE	TOTAL:	Pa	625	625	625	
		EXT.:	Pa	125	125	125	
	NUMBER OF FANS:			2 X 1 = 2	2 X 2 = 4	2 X 1 = 2	
	FAN SPEED (RPM):			1786	1791	1937	
	WHEEL TYPE:			BI	BI	BI	
	DRIVE (BELT/DIRECT):			DIRECT	DIRECT	DIRECT	
	MOTOR DATA (EACH)	SIZE:	kW	3.73	3.73	2.24	
		SPEED:	RPM	1800	1800	1800	
		POWER:	VOLT	575	575	575	
			PH	3	3	3	
		ENCLOSURE:		TEFC	TEFC	TEFC	
HYDRONIC HEATING COIL (HEAT RECOVERY)	TOTAL CAPACITY:		kW	154	137	118	
	AIRFLOW:		L/s	5496	9862	3823	
	ENTER. AIR TEMPERATURE:		C	-35.0	-35.0	-35.0	
	LEAVING AIR TEMPERATURE:		C	-15.9	-25.6	-14.1	
	AIR PRESSURE DROP:		Pa	246	148	219	
	LIQUID HEAT TRANSFER MEDIA:			50% PROP GLYCOL	50% PROP GLYCOL	50% PROP GLYCOL	
	LQUID FLOW:		L/s	5.86	5.52	4.47	
	ENTER. LIQUID TEMPERATURE:		C	1.7	1.7	1.7	
	LEAVG. LIQUID TEMPERATURE:		C	-5.6	-5.2	-5.6	
	LIQUID PRESSURE DROP:		m (H_2O)	37435	23734	33651	
HYDRONIC HEATING COIL	TOTAL CAPACITY:		kW	364	665	298	
	AIRFLOW:		L/s	5493	9862	3823	
	ENTERING AIR TEMPERATURE:		C	-35.0	-35.0	-35.0	
	LEAVING AIR TEMPERATURE:		C	10.1	10.7	18.1	
	AIR PRESSURE DROP:		Pa	68	67	61	
	LIQUID HEAT TRANSFER MEDIA:			50% PROP GLYCOL	50% PROP GLYCOL	50% PROP GLYCOL	
	LQUID FLOW:		L/s	8.82	15.91	7.34	
	ENTER. LIQUID TEMPERATURE:		C	76.7	76.7	76.7	
	LEAVG. LIQUID TEMPERATURE:		C	65.6	65.6	65.6	
	LIQUID PRESSURE DROP:		m (H_2O)	14945	19236	16051	
FILTER	EFFICIENCY:		%	MERV 8	MERV 8	MERV 8	
	RESISTANCE (FINAL):		Pa	250	250	250	
MAXIMUM DIMENSIONS	LENGTH:		mm	5004	4508	4832	
	WIDTH:		mm	1422	2489	1422	
	HEIGHT:		mm	2388	2032	2032	
	WEIGHT:		kg	3043	3787	2712	
MANUFACTURER AND MODEL NO.:				VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	
APPLICABLE REMARKS:							

REMARKS:

A: UNIT TO BE SHIPPED IN SEPARATE SECTIONS WITH SPLIT LINES AS SHOWN ON DRAWINGS.
B: UNIT SHALL COME COMPLETE WITH GLYCOL PACKAGE PUMPING SYSTEM, REFER TO SPECIFICATIONS FOR DETAILS.
C: DIRECT FIRE GAS BURNER. REFER TO SPECIFICATION FOR DETAILS.
D: UNIT SHALL BE PROVIDED WITH REMOTE CONTROL PANEL

AIR HANDLING UNITS SCHEDULE **23 77 00.01**

SYMBOL				AHU-C611	AHU-C612	AHU-C620	
TYPE				CUSTOM	CUSTOM	CUSTOM	
LOCATION				CHEM. & ELECT. MECH. RM. 2	CHEM. & ELECT. MECH. RM. 2	CHEM. & ELECT. MECH. RM. 1	
FAN	AIRFLOW	SUPPLY:	L/s	8189	8189	2396	
		OSA:	L/s	8189	8189	2396	
	STATIC PRESSURE	TOTAL:	Pa	797	797	573	
		EXT.:	Pa				
	NUMBER OF FANS:			2 X 2 = 4	2 X 2 = 4	2 X 1 = 1	
	FAN SPEED (RPM):			1876	1876	1801	
	WHEEL TYPE:			AF	AF	AF	
	DRIVE (BELT/DIRECT):			DIRECT	DIRECT	DIRECT	
	MOTOR DATA (EACH)	SIZE:	kW	5.0	5.0	2.0	
		SPEED:	RPM	1750	1750	1750	
		POWER:	VOLT	575	575	575	
			PH	3	3	3	
		ENCLOSURE:		TEAO	TEAO	TEAO	
GAS FIRED HEATER	FUEL SOURCE:			NATURAL GAS	NATURAL GAS	NATURAL GAS	
	GAS INPUT:		kW	536.7	536.7	121.2	
	HEAT OUTPUT:		kW	494.2	494.2	96.4	
	AIRFLOW:		L/s	8189	8189	1481	
	ENTER. AIR TEMPERATUE:		C	-35	-35	-35	
	LEAVG. AIR TEMPERATURE:		C	14.4	14.4	18.3	
	GAS SUPPLY PRESS	MIN:	Pa	1744	1744	1744	
		MAX:	Pa	3488	3488	3488	
	BURNER	CONTROL TYPE:		MODULATING	MODULATING	MODULATING	
		IGNITION TYPE:					
	AIR PRESSURE DROP:		Pa	267	267	17	
FILTER	EFFICIENCY:		%	MERV 8	MERV 8	MERV 8	
	RESISTANCE (FINAL):		Pa	250	250	250	
MAXIMUM DIMENSIONS	LENGTH:		mm	4877	4877	5182	
	WIDTH:		mm	2718	2718	2413	
	HEIGHT:		mm	2083	2083	1880	
	WEIGHT:		kg	1340	1340	3450	
MANUFACTURER AND MODEL NO.:				VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	
APPLICABLE REMARKS:				A, C	A, C	A	

REMARKS:

A: UNIT TO BE SHIPPED IN SEPARATE SECTIONS WITH SPLIT LINES AS SHOWN ON DRAWINGS.
B: UNIT SHALL COME COMPLETE WITH GLYCOL PACKAGE PUMPING SYSTEM, REFER TO SPECIFICATIONS FOR DETAILS.
C: DIRECT FIRE GAS BURNER. REFER TO SPECIFICATION FOR DETAILS.
D: UNIT SHALL BE PROVIDED WITH REMOTE CONTROL PANEL

AIR HANDLING UNITS SCHEDULE **23 77 00.01**

SYMBOL				AHU-D610	AHU-D620	AHU-T610	
TYPE				CUSTOM	CUSTOM	CUSTOM	
LOCATION				RDT. BLDG. ROOF	FILTRATE SUMP ROOF	HUMIDIF. RM. ROOF	
FAN	AIRFLOW	SUPPLY:	L/s	5663	849	944	
		OSA:	L/s	5663	849	944	
	STATIC PRESSURE	TOTAL:	Pa	575	800	800	
		EXT.:	Pa	250 Pa	250 Pa	250 Pa	
	NUMBER OF FANS:			2 X 2 = 4	2 X 1 = 2	2 X 1 = 2	
	FAN SPEED (RPM):			1743	2658	2658	
	WHEEL TYPE:			AF	AF	AF	
	DRIVE (BELT/DIRECT):			DIRECT	DIRECT	DIRECT	
	MOTOR DATA (EACH)	SIZE:	kW	2.2	1.5	1.5	
		SPEED:	RPM	1755	3500	3600	
		POWER:	VOLT	575	575	575	
			PH	3	3	3	
		ENCLOSURE:		TEFC	TEFC	TEAO	
GAS FIRED HEATER	FUEL SOURCE:			NATURAL GAS	NATURAL GAS	NATURAL GAS	
	GAS INPUT:		kW	484	257	117	
	HEAT OUTPUT:		kW	387	206	94	
	AIRFLOW:		L/s	5663	849	944	
	ENTER. AIR TEMPERATUE:		C	-35	-35	-36	
	LEAVG. AIR TEMPERATURE:		C	21	10	21	
	GAS SUPPLY PRESS	MIN:	Pa	1750	1750	1750	
		MAX:	Pa				
	BURNER	CONTROL TYPE:		MODULATING	MODULATING	MODULATING	
		IGNITION TYPE:					
	AIR PRESSURE DROP:		Pa	55	32.5	32.5	
FILTER	EFFICIENCY:		%	MERV 8	MERV 8	MERV 8	
	RESISTANCE (FINAL):		Pa	250	250	250	
MAXIMUM DIMENSIONS	LENGTH:		mm	5563	2438	2438	
	WIDTH:		mm	2642	1930	2007	
	HEIGHT:		mm	2358	2007	1930	
	WEIGHT:		kg	5009	2016	2016	
MANUFACTURER AND MODEL NO.:				VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	VENMAR CES/ ENERGYPAK	
APPLICABLE REMARKS:				D	D	D	

REMARKS:

A: UNIT TO BE SHIPPED IN SEPARATE SECTIONS WITH SPLIT LINES AS SHOWN ON DRAWINGS.
B: UNIT SHALL COME COMPLETE WITH GLYCOL PACKAGE PUMPING SYSTEM, REFER TO SPECIFICATIONS FOR DETAILS.
C: DIRECT FIRE GAS BURNER. REFER TO SPECIFICATION FOR DETAILS.
D: UNIT SHALL BE PROVIDED WITH REMOTE CONTROL PANEL

AIR PRESSURIZATION UNITS							**23 77 00.02**
SYMBOL				AHU-K640	AHU-G640	AHU-S640	AHU-R640
TYPE				PRESSURIZATION UNIT	PRESSURIZATION UNIT	PRESSURIZATION UNIT	PRESSURIZATION UNIT
LOCATION				HRC MECH. ROOM	GRIT & SCREENING BLG. MECH. RM.	SECONDARY CLARIFIER MECH. RM.	BLOWER BLDG. MECHANICAL RM.
FAN	AIRFLOW	SUPPLY:	L/s	566	566	566	566
		OSA:	L/s	188	188	283	
	STATIC PRESSURE	TOTAL:	Pa	943	943	943	943
		EXT.:	Pa	125	125	200	200
	FAN SPEED (RPM):			3250	3250	3250	3600
	WHEEL TYPE:			BI	BI	BI	BI
	DRIVE (BELT/DIRECT):			DIRECT	DIRECT	DIRECT	DIRECT
	MOTOR DATA (EACH)	SIZE:	kW	2.45	2.45	2.45	2.45
		SPEED:	RPM	3600	3600	3600	3600
		POWER:	VOLT	575	575	575	575
			PH	3	3	3	3
		ENCLOSURE:		TEFC	TEFC	TEFC	TEFC
HYDRONIC HEATING COIL	TOTAL CAPACITY:		kW	14	NA	NA	NA
	AIRFLOW:		L/s	566	NA	NA	NA
	ENTER. AIR TEMPERATUE:		C	1	NA	NA	NA
	LEAVG. AIR TEMPERATURE:		C	19	NA	NA	NA
	AIR PRESSURE DROP:		Pa	53	NA	NA	NA
	LIQUID HEAT TRANSFER MEDIA:			50% PROP. GLYCOL	NA	NA	NA
	LQUID FLOW:		L/s	0.33	NA	NA	NA
	ENTER. LIQUID TEMPERATURE:		C	77	NA	NA	NA
	LEAVG. LIQUID TEMPERATURE:		C	66	NA	NA	NA
	LIQUID PRESSURE DROP:		m (H_2O)	1.93	NA	NA	NA
FILTER	MATERIALS	FILTER HOUSING		ALUMINUM	ALUMINUM	ALUMINUM	ALUMINUM
		PRE-FILTER		50mm - MERV 8	50mm - MERV 8	50mm - MERV 8	50mm - MERV 8
		GAS PHASE - FIRST STAGE		MM-12D Satin Coated Steel	MM-12D Satin Coated Steel	MM-12D Satin Coated Steel	MM-12D Satin Coated Steel
		GAS PHASE - SECOND STAGE		MM-12D Satin Coated Steel	MM-12D Satin Coated Steel	MM-12D Satin Coated Steel	MM-12D Satin Coated Steel
		AFTER -FILTER		50mm - MERV 8	50mm - MERV 8	50mm - MERV 8	50mm - MERV 8
		FINAL FILTER		150mm - MERV14	150mm - MERV14	150mm - MERV14	150mm - MERV14
	AIRFLOW	MAX	L/s	566	566	566	566
		MAX APD (CLEAN)	kPa	400	400	400	400
		MAX APD (DIRTY)	kPa	525	525	525	525
	NOMINAL FILTER DIMENSIONS (WxH)		mm x mm	600 x 600	600 x 600	600 x 600	600 x 600
	FACE AREA		m^2	0.37	0.37	0.37	0.37
	FACE VELOCITY		m/s	1.52	1.52	1.52	1.52
	EFFICIENCY	PRE-FILTER		20% TO 25%	20% TO 25%	20% TO 25%	20% TO 25%
		GAS FILTER		SEE SPECS	SEE SPECS	SEE SPECS	SEE SPECS
		AFTER -FILTER		MERV-8	MERV-8	MERV-8	MERV-8
		FINAL FILTER		MERV-14	MERV-14	MERV-14	MERV-14
MAXIMUM DIMENSIONS	LENGTH:		mm	3435	3435	2977	3435
	WIDTH:		mm	787	787	787	787
	HEIGHT:		mm	1019	1019	1162	1162
	WEIGHT:		kg				
MANUFACTURER AND MODEL NO.				Circul Aire - MODLR-302	Circul Aire - MODLR-302	Circul Aire - MODLR-302	Circul Aire - MODLR-302
APPLICABLE REMARKS							
REMARKS:							

AIR PRESSURIZATON UNITS							**23 77 00.02**
SYMBOL				AHU-C640	AHU-D640	AHU-D650	AHU-P640
TYPE				PRESSURIZATION UNIT	PRESSURIZATION UNIT	PRESSURIZATION UNIT	PRESSURIZATION UNIT
LOCATION				CHEMICAL & ELECT. BLDG. MECH. RM. 1	RDT ROOM MECH. PLATFORM	RDT ELECTRICAL M. B	PRIMARY ELECTRICAL ROOM B
FAN	AIRFLOW	SUPPLY:	L/s	708	283	283	283
		OSA:	L/s	566	189	189	189
	STATIC PRESSURE	TOTAL:	Pa	1265	640	640	640
		EXT.:	Pa	250	125	125	125
	FAN SPEED (RPM):			3320	3200	3200	3200
	WHEEL TYPE:			BI	BI	BI	BI
	DRIVE (BELT/DIRECT):			DIRECT	DIRECT	DIRECT	DIRECT
	MOTOR DATA (EACH)	SIZE:	kW	2.75	0.75	0.75	0.75
		SPEED:	RPM	3320	3450	3450	3450
		POWER:	VOLT	575	575	575	575
			PH	3	3	3	3
		ENCLOSURE:		TEFC	TEFC	TEFC	TEFC
HYDRONIC HEATING COIL	TOTAL CAPACITY:		kW	NA	NA	NA	NA
	AIRFLOW:		L/s	NA	NA	NA	NA
	ENTER. AIR TEMPERATUE:		C	NA	NA	NA	NA
	LEAVG. AIR TEMPERATURE:		C	NA	NA	NA	NA
	AIR PRESSURE DROP:		Pa	NA	NA	NA	NA
	LIQUID HEAT TRANSFER MEDIA:			NA	NA	NA	NA
	LQUID FLOW:		L/s	NA	NA	NA	NA
	ENTER. LIQUID TEMPERATURE:		C	NA	NA	NA	NA
	LEAVG. LIQUID TEMPERATURE:		C	NA	NA	NA	NA
	LIQUID PRESSURE DROP:		m (H_2O)	NA	NA	NA	NA
FILTER	MATERIALS	FILTER HOUSING		ALUMINUM	ALUMINUM	ALUMINUM	ALUMINUM
		PRE-FILTER		50mm - MERV 8	50mm - MERV 8	50mm - MERV 8	50mm - MERV 8
		GAS PHASE - FIRST STAGE		MM-12D Satin Coated Steel	0.023 m^3 - MM3000	0.023 m^3 - MM3000	0.023 m^3 - MM3000
		GAS PHASE - SECOND STAGE		MM-12D Satin Coated Steel	0.023 m^3 - MM1000	0.023 m^3 - MM1000	0.023 m^3 - MM1000
		AFTER -FILTER		50mm - MERV 8	50mm - MERV 8	50mm - MERV 8	50mm - MERV 8
		FINAL FILTER		150mm - MERV14	300mm - MERV14	300mm - MERV14	300mm - MERV14
	AIRFLOW	MAX	L/s	708	283	283	283
		MAX APD (CLEAN)	kPa	400	400	400	400
		MAX APD (DIRTY)	kPa	525	525	525	525
	NOMINAL FILTER DIMENSIONS (WxH)		mm x mm	610 x 915	600 x 600	600 x 600	600 x 600
	FACE AREA		m^2	0.56	0.37	0.37	0.37
	FACE VELOCITY		m/s	1.27	0.76	0.76	0.76
	EFFICIENCY	PRE-FILTER		20% TO 25%	MERV-8	MERV-8	MERV-8
		GAS FILTER		SEE SPECS	SEE SPECS	SEE SPECS	SEE SPECS
		AFTER -FILTER		MERV-8	MERV-8	MERV-8	MERV-8
		FINAL FILTER		MERV-14	MERV-14	MERV-14	MERV-14
MAXIMUM DIMENSIONS	LENGTH:		mm	2977	1918	1918	794
	WIDTH:		mm	787	826	826	381
	HEIGHT:		mm	1162	381	381	1981
	WEIGHT:		kg		207	207	207
MANUFACTURER AND MODEL NO.				Circul Aire - MODLR-302	Circul Aire - APS-500-H	Circul Aire - APS-500-H	Circul Aire - APS-500-V
APPLICABLE REMARKS							
REMARKS:							

SECTION 23 81 00

UNITARY AIR-CONDITIONING EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
   1. Air-Conditioning and Refrigeration Institute (ARI): 210/240, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
   2. Canadian Gas Association (CGA).
   3. Air Moving and Conditioning Association (AMCA): Bulletin 300, Setup No. 1.
   4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
      a. 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
      b. 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.
      c. HVAC Applications chapter in Seismic Restraint Design.
   5. ASTM International (ASTM):
      a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
      b. D2370, Standard Test Method for Tensile Properties of Organic Coatings.
      c. D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
      d. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      e. G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
   6. Canadian Standards Association (CSA).
   7. ETL Testing Laboratories (ETL).
   8. International Organization for Standardization (ISO): ISO 13256-1, Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps.
   9. National Electrical Manufacturers Association (NEMA).
   10. National Fire Protection Association (NFPA): 255, Method of Test of Surface Burning Characteristics of Building Materials
   11. Underwriters Laboratories Inc. (UL): UL 94-5V, Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
   12. Underwriters Laboratories of Canada (ULC).

1.2 DEFINITIONS

A. The following is a list of abbreviations which may be used in this Section:
   1. AC: Air Conditioning.
   2. COP: Coefficient of Performance.
   3. EER: Energy Efficiency Ratio.

4. DX: Direct Expansion.
5. HP: Heat Pump.
6. IR: Infra Red.
7. LED: Light Emitting Diode.
8. PSC: Permanent Split Capacitor.
9. PTAC: Packaged Terminal Air Conditioner.
10. SPST: Single Pole, Single Throw.
11. TXV: Thermostatic Expansion Valve.
12. UV: Ultra Violet.

1.3 SUBMITTALS

A. Action Submittals:
1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for all products specified.
2. Manufacturer's standard finish color selection for enclosure finishes.
3. Complete performance data that will indicate full compliance with the specifications:
   a. Include fan sound power level data (ref. 10 to 12 watts) at design operating point, based on AMCA Bulletin 300, Setup No. 1.
   b. Include heating and cooling performance data at design operating conditions.
4. Air Pressurization Unit: Documentation that media filter modules are UL rated Class 1.
5. Factory dip-applied protective coating product data.

B. Informational Submittals:
1. Manufacturer's Certificate of Compliance, Certificate of Proper Installation in accordance with Section 01 43 33, Contractor Field Services, for heat pumps, air conditioning units, and motors.
2. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement or details shown to equipment furnished.
3. Sample copy of guarantee.
4. Test reports.
5. Operation and Maintenance Data in conformance with Section 01 78 23, Operation and Maintenance Data.
   a. Include wiring and control diagrams for equipment.
   b. Include as-built version of equipment schedules.

1.4 QUALITY ASSURANCE

A. Heating and Cooling Equipment: Minimum operating efficiencies, defined as COP and EER, as specified in ASHRAE 90.1.

B. Unit shall be rated (when matched with appropriate outdoor unit) per ARI 210/240.

C. Units shall be certified by UL/ULC and CSA, and shall be UL/ULC or ETL listed and labeled.

D. Cooling performance rated in accordance with ARI testing procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

B. Protection of Equipment:
   1. Box, crate, or otherwise protect from damage and moisture during shipment, handling, and storage.
   2. Protect from exposure to corrosive fumes and keep thoroughly dry at all times.
   3. Store motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings in weathertight and heated storage facilities prior to installation.
   4. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

1.6 SPECIAL GUARANTEE

A. Refrigerant Compressors: Furnish manufacturer's extended guarantee or warranty, with the City named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the City, removal and replacement of compressors specified in this Specification section found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

1.7 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following materials:

Item		Quantity
Fan Belts		One complete set for each belt-driven fan.
Filters		two complete set per unit.

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.1 GENERAL

A. Specified components of this Section, including insulation, facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Multiple Compressor Units:
   1. Provide completely independent refrigeration circuits and controls.
   2. Indoor unit air coils shall have intermingled circuits, unless specified otherwise.

2.2 EQUIPMENT SCHEDULES

A. Refer to Article, Supplements.

2.3 SPLIT SYSTEM IN-CEILING CASSETTE AC UNIT, DUCTLESS

A. General:
1. Split system, indoor, DX, ductless, fan coil AC unit, complete with DX coil, fan, fan motor, piping connectors, electrical controls, condensate pump, and hanging brackets.
2. Suitable for use with air conditioner or heat pump outdoor unit.
3. Indoor unit shall be of the same manufacturer as the associated outdoor unit.
4. Entire system to be fed from one common power supply.
5. Integral overload protection for all motors.

B. Unit Cabinet:
1. Constructed of zinc-coated steel.
2. Fully insulated.
3. Discharge and inlet grilles, high-impact polystyrene.
4. Adjacent room cooling to be provided by a simple knockout in cabinet side panel.

C. Evaporator Fan:
1. Centrifugal, direct-drive blower type with air intake in center of unit and discharge on perimeter.
2. Air louvers shall be adjustable for 2-, 3-, or 4-way discharge.
3. Motors:
   a. Totally enclosed and permanently lubricated with inherent protection.
   b. Three-speed.

D. DX Evaporator Coil:
1. Copper tube with aluminum fins and galvanized steel tube sheets.
2. Fins bonded to tubes by mechanical expansion.
3. Condensate Drip Pan: Locate under coil with drain connection for hose attachment to remove condensate.

E. Internal Condensate Pump:
1. To remove condensate from drain pan when gravity drainage cannot be used.
2. Lift capability of condensate pump shall be 5 kPa.

F. Electric Heater: Units shall be equipped with factory-mounted electric heaters. Minimum protection shall include overcurrent and high temperature protection.

G. Controls:
1. Refrigerant Metering:
   a. Factory installed refrigerant metering device.
   b. Heat Pump Applications: Reverse flow bypass refrigerant metering device with internal check valves.
2. Automatic restart after power failure at same operating conditions as at failure.
3. Timer function to provide a minimum 15-hour timer cycle for system AUTO/START/STOP.

4. Temperature-sensing controls shall sense return air temperature. Provide indoor air high discharge temperature shutdown.
5. Indoor coil freeze protection.
6. Wireless infrared remote control to enter set points and operating conditions.
7. Filter status indication after 250 hours of indoor fan operation.
8. Test mode button to run self-diagnostics and aid in troubleshooting.
9. AUTO/STOP features shall have integral setback control.
10. Automatic air sweep control provides ON or OFF activation of air sweep louvers.
11. Dehumidification mode provides increased latent removal capability by modulating fan speed and set point temperature.
12. Fan only operation provides room air circulation when no cooling is required.
13. Diagnostics to provide continuous checks of unit operation and warn of possible malfunctions. Error message shall be displayed at the unit and at the remote controller.
14. Fan Speed Control: User-selectable for high, medium, low or microprocessor automatic operation during all operating modes.
15. Time delay shall prevent compressor restart in less than 3 minutes.
16. Provide outdoor unit high temperature protection to detect excessive outdoor unit discharge temperatures.
17. Automatic heating-to-cooling changeover to provide automatic heating and cooling operation. Control shall include deadband to prevent rapid mode cycling.
18. Manual defrost button to initiate defrost cycle from handset.
19. Demand defrost shall be provided and shall minimize defrost cycles by internally adjusting defrost timing based on frost accumulation.
20. Provide indoor coil high temperature protection to detect excessive indoor discharge temperature when unit is in heat pump mode.

H. Air Filters: Filter tracks and cleanable filters, accessible from below with a 1/4-turn fastener.

I. Accessories: Provide as follows:
1. Electronic Programmable Thermostat:
a. Commercial grade, 7-day, four-event scheduling.
b. Integral subbase, three-speed fan control, heating/cooling switchover capability, air sweep auto changeover.
c. Shall not require battery to retain memory.

J. Manufacturers and Products:
1. Mitsubishi; Mr. Slim; Model PLA.
2. Carrier; Model 40QK Series.

2.4 SPLIT SYSTEM HIGH WALL AC UNIT, DUCTLESS

A. General:
1. Split system, indoor, DX, ductless, fan coil AC unit, complete with DX coil, fan, fan motor, piping connectors, electrical controls, and microprocessor control system.
2. Suitable for use with air conditioner or heat pump outdoor unit.
3. Indoor unit shall be of the same manufacturer as the associated outdoor unit.
4. Entire system to be fed from one common power supply.
5. Integral overload protection for all motors.

B. Unit Cabinet:
   1. High-impact plastic or painted galvanized steel.
   2. Fully insulated.
   3. Discharge and inlet grilles, high-impact polystyrene.

C. Evaporator Fan:
   1. Tangential direct-drive blower type with air intake at upper front face of unit and discharge at bottom front.
   2. Air Sweep:
      a. Provide automatic, motor-driven horizontal air sweep as standard.
      b. Air sweep operation shall be user selectable.
      c. Vertical direction may be manually adjusted and horizontal air sweep may be manually set.
   3. Motor:
      a. Open drip-proof, permanently lubricated ball bearing with inherent overload protection.
      b. Three speed.

D. DX Evaporator Coil:
   1. Copper tube with aluminum fins and galvanized steel tube sheets.
   2. Fins bonded to tubes by mechanical expansion
   3. Condensate Drip Pan:
      a. Locate under coil with drain connection for hose attachment to remove condensate.
      b. Provide internal trap and auxiliary drip pan under coil header.

E. Electric Heater: Units shall be equipped with factory-mounted electric heaters. Minimum protection shall include overload, overcurrent and high temperature protection.

F. Controls:
   1. Refrigerant Metering:
      a. Factory installed refrigerant metering device.
      b. Heat Pump Applications: Reverse flow bypass refrigerant metering device with internal check valves.
   2. Automatic restart after power failure at same operating conditions as at failure.
   3. Timer function to provide a minimum 15-hour timer cycle for system AUTO/START/STOP.
   4. Temperature-sensing controls shall sense return air temperature. Provide indoor air high discharge temperature shutdown.
   5. Indoor coil freeze protection.
   6. Wireless infrared remote control to enter set points and operating conditions.
   7. Filter status indication after 250 hours of indoor fan operation.
   8. Test mode button to run self-diagnostics and aid in troubleshooting.
   9. AUTO/STOP features shall have integral setback control.
   10. Automatic air sweep control provides ON or OFF activation of air sweep louvers.
   11. Dehumidification mode provides increased latent removal capability by modulating fan speed and set point temperature.
   12. Fan only operation provides room air circulation when no cooling is required.
   13. Diagnostics to provide continuous checks of unit operation and warn of possible malfunctions. Error message shall be displayed at the unit and at the remote controller.

14. Fan Speed Control: User-selectable for high, medium, low or microprocessor automatic operation during all operating modes.
15. Time delay shall prevent compressor restart in less than 3 minutes.
16. Provide outdoor unit high temperature protection to detect excessive outdoor unit discharge temperatures.
17. Automatic heating-to-cooling changeover to provide automatic heating and cooling operation. Control shall include deadband to prevent rapid mode cycling.
18. Manual defrost button to initiate defrost cycle from handset.
19. Demand defrost shall be provided and shall minimize defrost cycles by internally adjusting defrost timing based on frost accumulation.
20. Provide indoor coil high temperature protection to detect excessive indoor discharge temperature when unit is in heat pump mode.

G. Air Filters: Filter track with factory-supplied cleanable filters.

H. Accessories: Provide as follows:
1. Internal Condensate Pump:
   a. To remove condensate from drain pan when gravity drainage cannot be used.
   b. Lift Capability: 75 kPa.
   c. Float control in condensate drain pan to shut unit down in case of pump malfunction.
2. Wall Mount Thermostat Mounting Kit: Locking cover kit available for IR controller.

I. Manufacturers and Products:
1. Mitsubishi; Mr. Slim; Model PKA.
2. Carrier; Model 40QN Series.

2.5 SPLIT SYSTEM AC INDOOR UNIT, DUCTED (UP TO 17.5 MINIMAL KW)

A. General:
1. Indoor mounted, draw-through, packaged air-handling unit consisting of forward-curved centrifugal fan(s), motor and drive assembly, prewired fan motor contactor, factory-installed refrigerant metering devices, cooling coil, disposable air filters, and condensate drain pan.
2. Suitable for use with air conditioner or heat pump outdoor unit.
3. Indoor unit shall be of the same manufacturer as the associated outdoor unit.
4. Modular design vertical upflow, field convertible for vertical downflow, or horizontal flow.
5. Entire system to be fed from one common power supply.
6. Integral overload protection for all motors.

B. Unit Cabinet:
1. Heavy gauge galvanized steel sheets.
2. Phosphatized and factory finished in manufacturer’s standard enamel paint.
3. Sufficient removable panels for access to all internal components.
4. Interior of casing insulated with 25 mm, 16 kg/m^3 density coated glass fiber insulation attached with adhesive material.
5. Duct flanges for connection of supply and return ductwork, and filter racks.
6. Knockouts for unit electrical power and condensate piping connections.

C. Evaporator Fan:
   1. Double-inlet, double-width, forward-curved fans mounted on rubber isolators.
   2. Direct-drive or belt-drive as standard with the unit furnished.
   3. Fan Motor:
      a. Totally enclosed and permanently lubricated with inherent protection.
      b. Three-speed.

D. DX Evaporator Coil:
   1. Copper tube with aluminum fins and galvanized steel tube sheets.
   2. Fins bonded to tubes by mechanical expansion.
   3. Condensate Drain Pan: High-impact thermoplastic, insulated, with primary and secondary brass drain fittings.
   4. Refrigerant piping sweat connections.

E. Electric Heating Coil:
   1. UL/ULC listed.
   2. Heavy-duty nickel-chromium elements.
   3. Contactors with 24-volt coils, power wiring, 24-volt control wiring terminal blocks, and a hinged access panel.
   4. Individual line-break HIGH limit control for each stage.
   5. HIGH limit control operating through heating element contactors, equipped with automatic reset.
   6. Internally factory-wired to provide single-point power connection with unit.

F. Controls:
   1. Refrigerant Metering:
      a. Factory installed refrigerant metering device.
      b. Heat Pump Applications: Reverse flow bypass refrigerant metering device with internal check valves.
   2. Magnetic contactor for fan.
   3. Overload protection in each leg.
   4. Control voltage transformer.
   5. Terminal strip for connection of remote controls.
   6. Control board fusing.

G. Air Filters: Disposable 25 mm thick strainer type with pleated nonwoven fabric media.

H. Accessories: Provide as follows:
   1. Premium Electronic Thermostat: Factory provided programmable thermostat with 7-day clock, auto-changeover, multi-stage capability, holiday scheduling, large LCD display, remote sensor capability.

I. Manufacturers:
   1. Mitsubishi, Mr. Slim; Model PEA/PEAD.
   2. Carrier.

2.6 SPLIT SYSTEM AC OUTDOOR UNITS

A. General:
   1. Factory assembled, single piece, air-cooled air conditioner outdoor unit.
   2. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, and holding charge of R-410A refrigerant.
   3. Outdoor unit shall be of the same manufacturer as the associated indoor unit.
   4. Entire system to be fed from one common power supply.
   5. Integral overload protection for all motors.

B. Unit Cabinet:
   1. Constructed of galvanized steel, phosphatized and coated with a baked enamel finish NEMA 4X.
   2. Removable access panels for access to all internal components.
   3. Outdoor Compartment: Isolated, with acoustic lining to assure quiet operation.
   4. Knockouts for unit electrical power.

C. Condenser Fans:
   1. Direct-drive propeller type shall discharge air horizontally and shall blow air through outdoor coil.
   2. Motors:
      a. Totally enclosed, with Class B insulation and permanently lubricated bearings.
      b. Thermal overload protection.
   3. Shaft shall have inherent corrosion resistance.
   4. Fan blades shall be corrosion-resistant and shall be statically and dynamically balanced.
   5. Equip openings with PVC coated protection grille over fan and coil.

D. Compressor:
   1. Fully hermetic reciprocating or scroll type.
   2. Equipped with oil system, operating oil charge, and motor.
   3. Internal overloads shall protect compressor from overtemperature and overcurrent.
   4. Motor: NEMA rated, Class F, suitable for operation in a refrigerant atmosphere.
   5. Scroll compressors shall have high discharge gas temperature protection.
   6. Reciprocating compressors shall be equipped with crankcase heaters to minimize liquid refrigerant accumulation in compressor during shutdown and to prevent refrigerant dilution of oil.
   7. Installed on rubber vibration isolators and shall have internal spring isolation.

E. Condenser Coil:
   1. Constructed of aluminum fins mechanically bonded to internally enhanced seamless copper tubes that are cleaned, dehydrated, and sealed.
   2. Coat entire coil with anti-corrosion protective coating, in accordance with Article, Factory Dip-Applied Protective Coating.

F. Refrigeration Components:
   1. Brass external liquid line service valve with service gauge port connections.
   2. Suction line service valve with service gauge connection port.
   3. Service gauge port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps.

4. Suction Line: Accumulator.
5. Pressure relief.

G. Controls:
1. Factory selected, assembled, and tested.
2. Refrigerant Metering:
   a. Reversing valve for heat pump units.
   b. Heating mode metering device for heat pump units.
3. Automatic restart on power failure.
4. Three-pole contactors.
5. Time delay control sequence shall be provided standard through control board on indoor units.
6. High pressure and liquid line low pressure switches.
7. Automatic outdoor fan motor protection.
8. Start capacitor and relay (single-phase units without scroll compressors).
9. Defrost board to provide defrost control.
10. Safeties:
    a. Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
    b. Safety lockout if any outdoor unit safety is open.
    c. High condensing temperature protection.
    d. System diagnostics.
    e. Compressor motor current and temperature overload protection.
    f. High pressure relief.
    g. Outdoor fan failure protection.

H. Accessories: Provide as scheduled in Equipment Schedule.
1. Low-Ambient Cooling Kit for Outdoor Units:
   a. Solid state condenser fan motor fully modulating speed controller; responds to saturated condensing pressure/temperature of unit.
   b. Maintains a saturated condensing temperature of 37.5 degrees C plus or minus 5 degrees C with outdoor temperatures down to minus 40 degrees C.
   c. Includes winter start control package, to bypass low-pressure switch temporarily to allow compressor start during low load conditions.
   d. Includes ball bearing condenser fan motor.
2. Compressor Cycle Delay: Compressor prevented from restarting for a minimum of 5 minutes after shutdown.
3. Hot Gas Bypass: Cooling capacity modulation with hot-gas solenoid valve and bypass piping on lead compressor on both compressors.
4. Hot-Gas Reheat: Solenoid valve and controls shall allow redirection of refrigerant hot gas to reheat coil located in associated indoor unit.
5. Wall-Mount Kit: Steel frame, baked enamel finish.
6. Compressor Start Assist: Capacitor/relay type.
7. Evaporator Freeze Thermostat: SPST temperature activated switch, shuts down unit upon evaporator freeze-up.
8. Liquid Solenoid Valve: Electric operated shutoff valve, bi-flow for heat pumps, interlocked with compressor operation.

I. Manufacturers:
   1. Mitsubishi; Model PUZ/PUY.
   2. Carrier.

2.7 UNITARY EQUIPMENT CONTROLS

A. Electronic Multistage AC Unit Controller:
   1. Heating and Cooling Stages:
      a. Four-stage cooling and four-stage heating electronic control.
      b. Staging delay between each cycle.
      c. Visual indication of activation of each stage.
   2. Integrated thermostat.
   3. Temperature Scale: Manually adjustable, 13 degrees C to 32 degrees C scale.
   4. Duty Cycle:
      a. Automatic duty cycling of equipment.
      b. Manual adjustment for 1-day to 24-day cycle time.
      c. Manual cycle advance.
      d. Visual indication of lead unit.
   5. Enclosure:
      a. Single wall-mounted enclosure with operator interface on outside of panel door.
      b. NEMA Type 1 enclosure.
   6. Operator interface to consist of temperature adjustment, LCD room temperature display, and visual indication of lead unit and each cooling and heating stage activation.
   7. Adjustments external to controller.
   8. Adjustable “dead band” between heating and cooling to be between 2 degrees C and 11 degrees C.
   9. Power loss memory for restoration of sequence of operation in the event of loss of power.
   10. Manufacturer and Model: MIT, PAR-31 MAA .

B. Thermo output which is active when the unit is not at set point.

C. Active operation mode selective heating or cooling.

D. IO Adapter for each unit to interface with PLC:
   1. Inputs (For Future Use):
      a. ON/OFF.
   2. Outputs:
      a. Status ON/OFF.
      b. Error.
   3. Manufacturer and Model: MIT, PAC-SA88-HA-EP.

2.8 FACTORY DIP-APPLIED PROTECTIVE COATING

A. General:
   1. Factory dip-applied protective coating for application to plate fin and tube coils.
   2. Coil factory assembled and tested before coating application.
   3. Coating suitable for coils with maximum 30 fins per inch fin density. Bridging of product across coil fins is unacceptable.

4. After application and proper curing, product shall endure bending of coil assembly in standard manufacturing process without cracking.
5. Apply coating to coil before final factory assembly of equipment. Coating process that requires disassembly of equipment for removal of coil to be coated is not acceptable.

B. Coating Material: Use one of the following materials:
1. Epoxy Modified Phenolic. Straight phenolic materials are not acceptable.
2. Epoxy or Epoxy-Urethane.
3. Polyelastomer: Complex chain linked polyelastomer material.

C. Coating Process:
1. Coil Inspection and Sealing:
   a. Inspect coil for open tubes, headers, capillary tubes; repair as necessary.
   b. Fill with dry nitrogen, cap and seal, to prevent contamination of internal coil surfaces with cleaning or coating solutions.
2. Coil Cleaning:
   a. Immerse coil in heated alkaline cleaning solution to remove lubricants, machining oils, and residual factory contamination.
   b. Followed with immersion in potable water bath to neutralize and remove cleaning solution.
3. Coating Application:
   a. Immerse coil assembly in coating bath, including headers, casing, and heat exchange surfaces.
   b. Coil shall be completely removed from equipment during coating application.
   c. Spray-on coatings are not acceptable.
4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
5. Quality Control: Free from voids, checks, cracks and blisters.

D. Performance: Coil finish shall meet or exceed the following criteria:
1. Salt Spray Test: In accordance with ASTM B117, minimum 3,000-hour duration, with no fin corrosion or degradation.
2. Thermal Efficiency: Loss no greater than 1 percent after coating application.
3. Exposure to UV Light: UV inhibited life of minimum 10 years.

E. Manufacturers and Products:
1. Aero-Marine Engineering Inc.; Technicoat 10-1.
2. AST ElectroFin Inc; ElectroFin.

2.9 ELECTRICAL

A. General:
1. Units shall include high and low voltage terminal block connections.
2. Control voltage to indoor unit fan shall be 24 volts.
3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.
4. Disconnects: Field supplied and installed by electrical contractor in accordance with local Codes.

B. Motors:
   1. Refer to Section 26 20 00, Low Voltage AC Induction Motors, for general requirements.
   2. Unless otherwise stated, electric motors shall comply with the following:
      a. Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.
      b. Enclosure: Open Drip Proof (ODP), unless specified otherwise.
      c. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
      d. Winding Thermal Protection: Manufacturer's standard.
      e. Space Heater: Manufacturer's standard.
      f. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer's standard.
      g. Efficiency: Minimum efficiency per Section 26 20 00, Low Voltage AC Induction Motors.

2.10 ACCESSORIES

A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 45 kg.

B. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 12 mm minimum diameter, and as specified in Section 05 50 00, Metal Fabrications (Basic). Quantity as recommended by manufacturer.

2.11 SOURCE QUALITY CONTROL

A. Factory Tests:
   1. Direct expansion coils leak tested underwater with 1378 kPa air. Pressure tested to 3102 kPa.
   2. Electric heating coils tested with 2,000-volt dielectric test.

PART 3 EXECUTION

3.1 INSTALLATION

A. Set and install equipment so that equipment is level and properly supported.

B. Make certain that piping connections to equipment do not cause any strain on equipment.

C. Make certain that vibration isolation has been installed per manufacturer's instructions and isolation devices are performing satisfactorily.

D. Install equipment in accordance with manufacturer's recommendations, and these Specifications.

E. Install all safety devices as recommended by manufacturer and/or required by code in these Specifications.

F. Initial equipment startup shall be made by an authorized representative of the unit manufacturer.

G. Air-cooled outdoor unit shall not be started without complete prestart checkout of entire refrigerant piping system and charging of system with refrigerant as recommended by equipment manufacturer.

H. Startup: Manufacturer shall provide a factory-trained representative employed by the equipment manufacturer to perform the following services. Supervision only, of Contractor personnel, will not be acceptable.
   1. Leak test.
   2. Refrigerant pressure test.
   3. Evacuate (if required).
   4. Dehydrate (if required).
   5. Charge condensing unit with refrigerant and oil (if required).

I. Factory Checkout:
   1. Contractor shall secure the services of a factory trained and qualified service engineer employed by the equipment manufacturer who shall inspect the installation including external interlock, power connections; supervise initial operation, calibration of operating and safety controls and supervise electrical testing including insulation resistance of motors and voltage balance between phases during starting and running.
   2. This service engineer shall forward a report in three copies to Contract Administrator when the unit is in safe and proper operating condition. This report shall contain all pressure and control settings, meg readings, voltage readings per phase during START and RUN, suction temperature and pressure, liquid temperature and pressure, and shall list minor discrepancies to be corrected which do not affect safe and reliable operation.
   3. One additional copy of report shall be left in unit control panel. One copy of bound installation operation and maintenance service, and parts brochures, including applicable serial numbers, full unit description, parts ordering sources, shall be placed in the unit control panel at the time of starting.

J. Locate units to provide access for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.

K. Seal outside air intake watertight to roof curb.

L. Isolate sheet metal duct connections from all portions of the unit not internally spring-isolated from fans, or other vibrating or rotating equipment.

M. Inspect internal casing insulation, seal all exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

3.2 ADJUSTING AND CLEANING

A. Air System Balancing: As specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

B. Lubricate unsealed bearings prior to startup.

C. Do not operate units until filters are installed. If operated without filters, completely clean ductwork, coils, and interior of units.

3.3 FILTERS

A. Install a complete set of filters in each unit before operating, and leave in place during startup and testing to keep the equipment and ductwork clean.

B. Install a complete set of filters at the time of final cleaning as defined in Section 01 77 00, Closeout Procedures.

3.4 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Contractor Field Services, for installation assistance, inspection, and certification of proper installation, equipment testing, startup assistance, and training of the City's personnel for specified equipment.

3.5 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.
   1. 23 81 00.01, Ductless Split System DX Indoor Units Schedule.
   2. 23 81 00.02, Split System DX Outdoor Units Schedule.

END OF SECTION

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-C641	ACU-C642	ACU-C643	ACU-C644
LOCATION				ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM
FAN DATA	SUPPLY AIR		L/s	700	700	700	700
	EXTERNAL STATIC PRESS.		kPa	150	150	150	150
DX COOLING DATA	TOTAL		kW	12.3	12.3	12.3	12.3
	SENS.		kW	-	-	-	-
	ENTERING AIR TEMP.	DEG. C	DB	27	27	27	27
		DEG. C	WB	19	19	19	19
	COND. TEMP.		DEG. C	35	35	35	35
FAN MOTOR DATA	FLA			2.8	2.8	2.8	2.8
	VOLT			208	208	208	208
	PH			1	1	1	1
ELECTRICAL DATA	# CONN.			1	1	1	1
	MCA			3.5	3.5	3.5	3.5
	FUSE			15	15	15	15
	VOLT			208	208	208	208
	PH			1	1	1	1
	FACTORY INSTALLED DISCONNECT?			NO	NO	NO	NO
DIMENSIONS	WIDTH		mm	1400	1400	1400	1400
	DEPTH		mm	732	732	732	732
	HEIGHT		mm	250	250	250	250
	MAXIMUM WEIGHT		kg	43	43	43	43
MANUFACTURER				MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL NO.				PEAD-A42AA5	PEAD-A42AA5	PEAD-A42AA5	PEAD-A42AA5
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-C645	ACU-C646		
LOCATION				ELECTRICAL ROOM	AUTOMATION ROOM		
FAN DATA	SUPPLY AIR		L/s	700	566		
	EXTERNAL STATIC PRESS.		kPa	150	-		
DX COOLING DATA	TOTAL		kW	12.3	5.3		
	SENS.		kW	-	-		
	ENTERING AIR TEMP.	DEG. C	DB	27	27		
		DEG. C	WB	19	19		
	COND. TEMP.		DEG. C	35	35		
DX HEATING DATA	TOTAL		kW	N/A	5.9		
	ENTERING AIR TEMP.	DEG. C	DB	N/A	21		
	COND. TEMP.		DEG. C	N/A	8		
FAN MOTOR DATA	FLA			2.8	0.5		
	VOLT			208	208		
	PH			1	1		
ELECTRICAL DATA	# CONN.			1	1		
	MCA			3.5	1.0		
	FUSE			15	15		
	VOLT			208	208		
	PH			1	1		
	FACTORY INSTALLED DISCONNECT?			NO	NO		
DIMENSIONS	WIDTH		mm	1400	840		
	DEPTH		mm	732	840		
	HEIGHT		mm	250	258		
	MAXIMUM WEIGHT		kg	43	22		
MANUFACTURER				MITSUBISHI	MITSUBISHI		
MODEL NO.				PEAD-A42AA5	PLA-A18BA6		
APPLICABLE REMARKS:				A	A		

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-D641	ACU-D642	ACU-D643	ACU-D651
LOCATION				ELECTRICAL ROOM A	ELECTRICAL ROOM A	ELECTRICAL ROOM A	ELECTRICAL ROOM B
FAN DATA	SUPPLY AIR		L/s	515	515	515	515
	EXTERNAL STATIC PRESS.		kPa	-	-	-	-
DX COOLING DATA	TOTAL		kW	12.3	12.3	12.3	12.3
	SENS.		kW	-	-	-	-
	ENTERING AIR TEMP.	DEG. C	DB	27	27	27	27
		DEG. C	WB	19	19	19	19
	COND. TEMP.		DEG. C	35	35	35	35
FAN MOTOR DATA	FLA			1.0	1.0	1.0	1.0
	VOLT			208	208	208	208
	PH			1	1	1	1
ELECTRICAL DATA	# CONN.			1	1	1	1
	MCA			2.0	2.0	2.0	2.0
	FUSE			15	15	15	15
	VOLT			208	208	208	208
	PH			1	1	1	1
	FACTORY INSTALLED DISCONNECT?			NO	NO	NO	NO
DIMENSIONS	WIDTH		mm	950	950	950	950
	DEPTH		mm	950	950	950	950
	HEIGHT		mm	293	293	293	293
	MAXIMUM WEIGHT		kg	25	25	25	25
MANUFACTURER				MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL NO.				PLA-A42BA6	PLA-A42BA6	PLA-A42BA6	PLA-A42BA6
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-D652			
LOCATION				ELECTRICAL ROOM B			
FAN DATA	SUPPLY AIR		L/s	515			
	EXTERNAL STATIC PRESS.		kPa	-			
DX COOLING DATA	TOTAL		kW	12.3			
	SENS.		kW	-			
	ENTERING AIR TEMP.	DEG. C	DB	27			
		DEG. C	WB	19			
	COND. TEMP.		DEG. C	35			
FAN MOTOR DATA	FLA			1.0			
	VOLT			208			
	PH			1			
ELECTRICAL DATA	# CONN.			1			
	MCA			2.0			
	FUSE			15			
	VOLT			208			
	PH			1			
	FACTORY INSTALLED DISCONNECT?			NO			
DIMENSIONS	WIDTH		mm	950			
	DEPTH		mm	950			
	HEIGHT		mm	293			
	MAXIMUM WEIGHT		kg	25			
MANUFACTURER				MITSUBISHI			
MODEL NO.				PLA-A42BA6			
APPLICABLE REMARKS:				A			

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-G641	ACU-G642	ACU-G643	
LOCATION				ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM	
FAN DATA	SUPPLY AIR		L/s	1400	1400	1200	
	EXTERNAL STATIC PRESS.		kPa	250	250	250	
DX COOLING DATA	TOTAL		kW	28.1	28.1	21.1	
	SENS.		kW	-	-	-	
	ENTERING AIR TEMP.	DEG. C	DB	27	27	27	
		DEG. C	WB	19	19	19	
	COND. TEMP.		DEG. C	30	30	30	
FAN MOTOR DATA	FLA						
	VOLT			208	208	208	
	PH			1	1	1	
ELECTRICAL DATA	# CONN.			1	1	1	
	MCA			8.2	8.2	7.7	
	FUSE			15	15	15	
	VOLT			208	208	208	
	PH			1	1	1	
	FACTORY INSTALLED DISCONNECT?			NO	NO	NO	
DIMENSIONS	WIDTH		mm	1250	1250	1250	
	DEPTH		mm	1120	1120	1120	
	HEIGHT		mm	470	470	470	
	MAXIMUM WEIGHT		kg	100	100	97	
MANUFACTURER				MITSUBISHI	MITSUBISHI	MITSUBISHI	
MODEL NO.				PEFY-P96NMHSU	PEFY-P96NMHSU	PEFY-P72NMHSU	
APPLICABLE REMARKS:				A	A	A	

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER (ONE THERMOSTAT FOR ALL INDOOR UNITS)

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-K641	ACU-K642		
LOCATION				ELECTRICAL ROOM	ELECTRICAL ROOM		
FAN DATA	SUPPLY AIR		L/s	434	434		
	EXTERNAL STATIC PRESS.		kPa	-	-		
DX COOLING DATA	TOTAL		kW	10.1	10.1		
	SENS.		kW	-	-		
	ENTERING AIR TEMP.	DEG. C	DB	27	27		
		DEG. C	WB	19	19		
	COND. TEMP.		DEG. C	30	30		
DX HEATING DATA	TOTAL		kW	11.2	11.2		
	ENTERING AIR TEMP.	DEG. C	DB	27	27		
	COND. TEMP.		DEG. C	20	20		
FAN MOTOR DATA	FLA			0.6	0.6		
	VOLT			208	208		
	PH			1	1		
ELECTRICAL DATA	# CONN.			1	1		
	MCA			1.0	1.0		
	FUSE			15	15		
	VOLT			208	208		
	PH			1	1		
	FACTORY INSTALLED DISCONNECT?			NO	NO		
DIMENSIONS	WIDTH		mm	1170	1170		
	DEPTH		mm	300	300		
	HEIGHT		mm	365	365		
	MAXIMUM WEIGHT		kg	21	21		
MANUFACTURER				MITSUBISHI	MITSUBISHI		
MODEL NO.				PKA-A36KA	PKA-A36KA		
APPLICABLE REMARKS:				A	A		

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-M641	ACU-M642		
LOCATION				CONTROL ROOM	AUTOMATION ROOM		
FAN DATA	SUPPLY AIR		L/s	500	500		
	EXTERNAL STATIC PRESS.		kPa	-	-		
DX COOLING DATA	TOTAL		kW	10.6	10.6		
	SENS.		kW	-	-		
	ENTERING AIR TEMP.	DEG. C	DB	27	27		
		DEG. C	WB	19	19		
	COND. TEMP.		DEG. C	35	35		
DX HEATING DATA	TOTAL		kW	11.7	11.7		
	ENTERING AIR TEMP.	DEG. C	DB	21	21		
	COND. TEMP.		DEG. C	8	8		
FAN MOTOR DATA	FLA						
	VOLT			208	208		
	PH			1	1		
ELECTRICAL DATA	# CONN.			1	1		
	MCA			1.3	1.3		
	FUSE			15	15		
	VOLT			208	208		
	PH			1	1		
	FACTORY INSTALLED DISCONNECT?			NO	NO		
DIMENSIONS	WIDTH		mm	840	840		
	DEPTH		mm	840	840		
	HEIGHT		mm	298	298		
	MAXIMUM WEIGHT		kg	27	27		
MANUFACTURER				MITSUBISHI	MITSUBISHI		
MODEL NO.				PLFY-P36NBMU	PLFY-P36NBMU		
APPLICABLE REMARKS:				A	A		

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-P641			
LOCATION				ELECTRICAL ROOM B			
FAN DATA	SUPPLY AIR		L/s	515			
	EXTERNAL STATIC PRESS.		kPa	-			
DX COOLING DATA	TOTAL		kW	12.3			
	SENS.		kW	-			
	ENTERING AIR TEMP.	DEG. C	DB	27			
		DEG. C	WB	19			
	COND. TEMP.		DEG. C	35			
FAN MOTOR DATA	FLA			1.0			
	VOLT			208			
	PH			1			
ELECTRICAL DATA	# CONN.			1			
	MCA			2.0			
	FUSE			15			
	VOLT			208			
	PH			1			
	FACTORY INSTALLED DISCONNECT?			NO			
DIMENSIONS	WIDTH		mm	950			
	DEPTH		mm	950			
	HEIGHT		mm	293			
	MAXIMUM WEIGHT		kg	25			
MANUFACTURER				MITSUBISHI			
MODEL NO.				PLA-A42BA6			
APPLICABLE REMARKS:				A			

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-R641-1	ACU-R641-2	ACU-R642-1	ACU-R642-2
LOCATION				ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM
FAN DATA	SUPPLY AIR		L/s	700	700	700	700
	EXTERNAL STATIC PRESS.		kPa	-	-	-	-
DX COOLING DATA	TOTAL		kW	15.8	15.8	15.8	15.8
	SENS.		kW	-	-	-	-
	ENTERING AIR TEMP.	DEG. C	DB	27	27	27	27
		DEG. C	WB	19	19	19	19
	COND. TEMP.		DEG. C	35	35	35	35
DX HEATING DATA	TOTAL		kW	17.6	17.6	17.6	17.6
	ENTERING AIR TEMP.	DEG. C	DB	21	21	21	21
	COND. TEMP.		DEG. C	8	8	8	8
FAN MOTOR DATA	FLA			2.2	2.2	2.24	2.24
	VOLT			208	208	208	208
	PH			1	1	1	1
ELECTRICAL DATA	# CONN.			1	1	1	1
	MCA			3.3	3.3	3.31	3.31
	FUSE			15	15	15	15
	VOLT			208	208	208	208
	PH			1	1	1	1
	FACTORY INSTALLED DISCONNECT?			NO	NO	NO	NO
DIMENSIONS	WIDTH		mm	1600	1600	1600	1600
	DEPTH		mm	732	732	732	732
	HEIGHT		mm	250	250	250	250
	MAXIMUM WEIGHT		kg	42	42	42	42
MANUFACTURER				MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL NO.				PEFY-P54NMAU	PEFY-P54NMAU	PEFY-P54NMAU	PEFY-P54NMAU
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-R643	ACU-R644		
LOCATION				AUTOMATION ROOM	CONTROL ROOM		
FAN DATA	SUPPLY AIR		L/s	378	378		
	EXTERNAL STATIC PRESS.		kPa	-	-		
DX COOLING DATA	TOTAL		kW	8.8	15.8		
	SENS.		kW	-	-		
	ENTERING AIR TEMP.	DEG. C	DB	27	27		
		DEG. C	WB	19	19		
	COND. TEMP.		DEG. C	35	35		
DX HEATING DATA	TOTAL		kW	9.4	17.6		
	ENTERING AIR TEMP.	DEG. C	DB	21	21		
	COND. TEMP.		DEG. C	8	8		
FAN MOTOR DATA	FLA			2.2	2.2		
	VOLT			208	208		
	PH			1	1		
ELECTRICAL DATA	# CONN.			1	1		
	MCA			2.7	3.3		
	FUSE			30	15		
	VOLT			208	208		
	PH			1	1		
	FACTORY INSTALLED DISCONNECT?			NO	NO		
DIMENSIONS	WIDTH		mm	1100	1600		
	DEPTH		mm	732	732		
	HEIGHT		mm	210	250		
	MAXIMUM WEIGHT		kg	33	42		
MANUFACTURER				MITSUBISHI	MITSUBISHI		
MODEL NO.				PEAD-A30AA4	PLA-A18BA6		
APPLICABLE REMARKS:				A	A		

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-S641	ACU-S642	ACU-S643	ACU-S644
LOCATION				ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM
FAN DATA	SUPPLY AIR		L/s	700	700	700	700
	EXTERNAL STATIC PRESS.		kPa	-	-	150	150
DX COOLING DATA	TOTAL		kW	12.3	12.3	12.3	12.3
	SENS.		kW	-	-	-	-
	ENTERING AIR TEMP.	DEG. C	DB	27	27	27	27
		DEG. C	WB	19	19	19	19
	COND. TEMP.		DEG. C	35	35	35	35
FAN MOTOR DATA	FLA			2.8	2.8	2.8	2.8
	VOLT			208	208	208	208
	PH			1	1	1	1
ELECTRICAL DATA	# CONN.			1	1	1	1
	MCA			26	26	26	26
	FUSE			40	40	40	40
	VOLT			208	208	208	208
	PH			1	1	1	1
	FACTORY INSTALLED DISCONNECT?			NO	NO	NO	NO
DIMENSIONS	WIDTH		mm	1400	1400	1400	1400
	DEPTH		mm	732	732	732	732
	HEIGHT		mm	250	250	250	250
	MAXIMUM WEIGHT		kg	41	41	41	41
MANUFACTURER				MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL NO.				PEAD-A42AA5	PEAD-A42AA5	PEAD-A42AA6	PEAD-A42AA5
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS							23 81 00.01
SYMBOL				ACU-S646			
LOCATION				LABORATORY			
FAN DATA	SUPPLY AIR		L/s	283			
	EXTERNAL STATIC PRESS.		kPa	-			
DX COOLING DATA	TOTAL		kW	5.3			
	SENS.		kW	-			
	ENTERING AIR TEMP.	DEG. C	DB	27			
		DEG. C	WB	19			
	COND. TEMP.		DEG. C	35			
DX HEATING DATA	TOTAL		kW	5.9			
	ENTERING AIR TEMP.	DEG. C	DB	21			
	COND. TEMP.		DEG. C	8			
FAN MOTOR DATA	FLA			0.51			
	VOLT			208			
	PH			1			
ELECTRICAL DATA	# CONN.			1			
	MCA			13			
	FUSE			15			
	VOLT			208			
	PH			1			
	FACTORY INSTALLED DISCONNECT?			NO			
DIMENSIONS	WIDTH		mm	950			
	DEPTH		mm	950			
	HEIGHT		mm	293			
	MAXIMUM WEIGHT		kg	22			
MANUFACTURER				MITSUBISHI			
MODEL NO.				PLA-A18BA6			
APPLICABLE REMARKS:				A			

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						**23 81 00.02**
SYMBOL			CU-C641	CU-C642	CU-C643	CU-C644
SERVING			ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM
DX COOLING DATA	CAPACITY	kW	12.3	12.3	12.3	12.3
	AMBIENT TEMP.	DEG. C	35	35	35	35
	SEER	@ ARI	13.8	13.8	13.8	13.8
OUTDOOR FAN DATA	NO.		2	2	2	2
	kW (EA.)		0.086	0.086	0.086	0.086
	VOLT		208	208	208	208
	PH		1	1	1	1
	L/s (TOTAL)		1666	1666	1666	1666
COMPRESSOR DATA	NO.		1	1	1	1
	RLA (EA.)		20	20	20	20
	LRA (EA.)		27.5	27.5	27.5	27.5
	VOLT		208	208	208	208
	PH		1	1	1	1
ELECTRICAL DATA	# CONN.		1	1	1	1
	MCA		26	26	26	26
	MOCP (FUSE)		40	40	40	40
	VOLT		208	208	208	208
	PH		1	1	1	1
DIMENSIONS	LENGTH	mm	950	950	950	950
	WIDTH	mm	330	330	330	330
	HEIGHT	mm	1350	1350	1350	1350
	MAXIMUM WEIGHT	kg	112	112	112	112
MANUFACTURER			MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL NO.			PUY-A42NHA6	PUY-A42NHA6	PUY-A42NHA6	PUY-A42NHA6
APPLICABLE REMARKS:			A/B/C	A/B/C	A/B/C	A/B/C

REMARKS:
A: 5-YEAR WARRANTY FOR EACH COMPRESSOR
B: ULTRA-LOW AMBIENT COOLING KIT
C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						23 81 00.02
SYMBOL			CU-C645	CU-C646		
SERVING			ELECTRICAL ROOM	AUTOMATION ROOM		
DX COOLING DATA	CAPACITY	kW	12.3	5.3		
	AMBIENT TEMP.	DEG. C	35	35		
	SEER	@ ARI	13.8	14.2		
DX HEATING DATA	CAPACITY	kW	N/A	5.9		
	COND. TEMP.	DEG. C	8	8		
	COP	@ ARI	N/A	2.93		
OUTDOOR FAN DATA	NO.		2	1		
	kW (EA.)		0.086	0.04		
	VOLT		208	208		
	PH		1	1		
	L/s (TOTAL)		1666	566		
COMPRESSOR DATA	NO.		1	1		
	RLA (EA.)		20	12		
	LRA (EA.)		27.5	14		
	VOLT		208	208		
	PH		1	1		
ELECTRICAL DATA	# CONN.		1	1		
	MCA		26	13		
	MOCP (FUSE)		40	20		
	VOLT		208	208		
	PH		1	1		
DIMENSIONS	LENGTH	mm	950	800		
	WIDTH	mm	330	300		
	HEIGHT	mm	1350	600		
	MAXIMUM WEIGHT	kg	112	41		
MANUFACTURER			MITSUBISHI	MITSUBISHI		
MODEL NO.			PUY-A42NHA6	PUZ-A18NHA6		
APPLICABLE REMARKS:			A/B/C	A/B/C		

REMARKS:
A: 5-YEAR WARRANTY FOR EACH COMPRESSOR
B: ULTRA-LOW AMBIENT COOLING KIT
C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						23 81 00.02
SYMBOL			CU-D641	CU-D642	CU-D643	CU-D651
SERVING			ELECTRICAL ROOM A	ELECTRICAL ROOM A	ELECTRICAL ROOM A	ELECTRICAL ROOM B
DX COOLING DATA	CAPACITY	kW	12.3	12.3	12.3	12.3
	AMBIENT TEMP.	DEG. C	35	35	35	35
	SEER	@ ARI	14.4	14.4	14.4	14.4
OUTDOOR FAN DATA	NO.		2	2	2	2
	kW (EA.)		0.04	0.04	0.04	0.04
	VOLT		208	208	208	208
	PH		1	1	1	1
	L/s (TOTAL)		1665	1665	1665	1665
COMPRESSOR DATA	NO.		1	1	1	1
	RLA (EA.)		20	20	20	20
	LRA (EA.)		27.5	27.5	27.5	27.5
	VOLT		208	208	208	208
	PH		1	1	1	1
ELECTRICAL DATA	# CONN.		1	1	1	1
	MCA		26	26	26	26
	MOCP (FUSE)		40	40	40	40
	VOLT		208	208	208	208
	PH		1	1	1	1
DIMENSIONS	LENGTH	mm	0.95	0.95	0.95	0.95
	WIDTH	mm	0.36	0.36	0.36	0.36
	HEIGHT	mm	1.35	1.35	1.35	1.35
	MAXIMUM WEIGHT	kg	112	112	112	112
MANUFACTURER			MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL NO.			PUY-A42NHA6	PUY-A42NHA6	PUY-A42NHA6	PUY-A42NHA6
APPLICABLE REMARKS:			A/B/C	A/B/C	A/B/C	A/B/C

REMARKS:

A: 5-YEAR WARRANTY FOR EACH COMPRESSOR

B: ULTRA-LOW AMBIENT COOLING KIT

C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						**23 81 00.02**
SYMBOL			CU-D652			
SERVING			ELECTRICAL ROOM B			
DX COOLING DATA	CAPACITY	kW	12.3			
	AMBIENT TEMP.	DEG. C	35			
	SEER	@ ARI	14.4			
OUTDOOR FAN DATA	NO.		2			
	kW (EA.)		0.04			
	VOLT		208			
	PH		1			
	L/s (TOTAL)		1665			
COMPRESSOR DATA	NO.		1			
	RLA (EA.)		20			
	LRA (EA.)		27.5			
	VOLT		208			
	PH		1			
ELECTRICAL DATA	# CONN.		1			
	MCA		26			
	MOCP (FUSE)		40			
	VOLT		208			
	PH		1			
DIMENSIONS	LENGTH	mm	950			
	WIDTH	mm	360			
	HEIGHT	mm	1350			
	MAXIMUM WEIGHT	kg	112			
MANUFACTURER			MITSUBISHI			
MODEL NO.			PUY-A42NHA6			
APPLICABLE REMARKS:			A/B/C			

REMARKS:
A: 5-YEAR WARRANTY FOR EACH COMPRESSOR
B: ULTRA-LOW AMBIENT COOLING KIT
C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						23 81 00.02
SYMBOL			CU-G641	CU-G642	CU-G643	
SERVING			ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM	
DX COOLING DATA	CAPACITY	kW	28.1	21.1	28.1	
	AMBIENT TEMP.	DEG. C	35	35	35	
	SEER	@ ARI	14.3	14.3	14.3	
CIRCULATING WATER	FLOW RATE (L/s)		1.6	1.6	1.6	
	PRESSURE DROP (Pa)		17914	17914	17914	
	CONNECTION SIZE (mm)		38	38	38	
COMPRESSOR DATA	NO.		1	1	1	
	VOLT		575	575	575	
	PH		3	3	3	
ELECTRICAL DATA	# CONN.		1	1	1	
	MCA		12	12	12	
	MOCP (FUSE)		15	15	15	
	VOLT		575	575	575	
	PH		3	3	3	
DIMENSIONS	LENGTH	mm	880	880	880	
	WIDTH	mm	550	550	550	
	HEIGHT	mm	1100	1100	1100	
	MAXIMUM WEIGHT	kg	185	185	185	
MANUFACTURER			MITSUBISHI	MITSUBISHI	MITSUBISHI	
MODEL NO.			PQHY-P96ZKMU	PQHY-P72ZKMU	PQHY-P96ZKMU	
APPLICABLE REMARKS:			A/C/D	A/C	A/C/D	

REMARKS:

A: 5-YEAR WARRANTY FOR EACH COMPRESSOR
B: ULTRA-LOW AMBIENT COOLING KIT
C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER
D: TWINNING KIT

SPLIT SYSTEM DX OUTDOOR UNITS						23 81 00.02
SYMBOL			CU-K641	CU-K642		
SERVING			ELECTRICAL ROOM	ELECTRICAL ROOM		
DX COOLING DATA	CAPACITY	kW	10.1	10.1		
	AMBIENT TEMP.	DEG. C	35	35		
	SEER	@ ARI	14	14		
DX HEATING DATA	CAPACITY	kW	11.2	11.2		
	COND. TEMP.	DEG. C	8	8		
	COP	@ ARI	3	3		
OUTDOOR FAN DATA	NO.		1	1		
	kW (EA.)		0.075	0.075		
	VOLT		208	208		
	PH		1	1		
	L/s (TOTAL)		916	916		
COMPRESSOR DATA	NO.		1	1		
	RLA (EA.)		12	12		
	LRA (EA.)		17.5	17.5		
	VOLT		208	208		
	PH		1	1		
ELECTRICAL DATA	# CONN.		1	1		
	MCA		25	25		
	MOCP (FUSE)		30	30		
	VOLT		208	208		
	PH		1	1		
DIMENSIONS	LENGTH	mm	950	950		
	WIDTH	mm	360	360		
	HEIGHT	mm	943	943		
	MAXIMUM WEIGHT	kg	75	75		
MANUFACTURER			MITSUBISHI	MITSUBISHI		
MODEL NO.			PUZ-A36NHA3	PUZ-A36NHA3		
APPLICABLE REMARKS:			A/C	A/C		

REMARKS:
A: 5-YEAR WARRANTY FOR EACH COMPRESSOR
B: ULTRA-LOW AMBIENT COOLING KIT
C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						23 81 00.02
SYMBOL			CU-M641	CU-M642		
SERVING			CONTROL ROOM	AUTOMATION ROOM		
DX COOLING DATA	CAPACITY	kW	10.6	10.6		
	AMBIENT TEMP.	DEG. C	35	35		
	SEER	@ ARI	14.3	14.3		
DX HEATING DATA	CAPACITY	kW	11.7	11.7		
	COND. TEMP.	DEG. C	8	8		
	COP	@ ARI	3.14	3.14		
OUTDOOR FAN DATA	NO.		2	2		
	kW (EA.)		0.086	0.086		
	VOLT		208	208		
	PH		1	1		
	L/s (TOTAL)		1665	1665		
COMPRESSOR DATA	NO.		1	1		
	RLA (EA.)		20	20		
	LRA (EA.)		27.5	27.5		
	VOLT		208	208		
	PH		1	1		
ELECTRICAL DATA	# CONN.		1	1		
	MCA		26	26		
	MOCP (FUSE)		40	40		
	VOLT		208	208		
	PH		1	1		
DIMENSIONS	LENGTH	mm	950	950		
	WIDTH	mm	360	360		
	HEIGHT	mm	1350	1350		
	MAXIMUM WEIGHT	kg	130	130		
MANUFACTURER			MITSUBISHI	MITSUBISHI		
MODEL NO.			PUMY-P36NHMU	PUMY-P36NHMU		
APPLICABLE REMARKS:			A/B/C	A/B/C		

REMARKS:
A: 5-YEAR WARRANTY FOR EACH COMPRESSOR
B: ULTRA-LOW AMBIENT COOLING KIT
C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						**23 81 00.02**
SYMBOL			CU-P641			
SERVING			ELECTRICAL ROOM B			
DX COOLING DATA	CAPACITY	kW	12.3			
	AMBIENT TEMP.	DEG. C	35			
	SEER	@ ARI	14.4			
OUTDOOR FAN DATA	NO.		2			
	kW (EA.)		0.04			
	VOLT		208			
	PH		1			
	L/s (TOTAL)		1665			
COMPRESSOR DATA	NO.		1			
	RLA (EA.)		20			
	LRA (EA.)		27.5			
	VOLT		208			
	PH		1			
ELECTRICAL DATA	# CONN.		1			
	MCA		26			
	MOCP (FUSE)		40			
	VOLT		208			
	PH		1			
DIMENSIONS	LENGTH	mm	950			
	WIDTH	mm	360			
	HEIGHT	mm	1350			
	MAXIMUM WEIGHT	kg	112			
MANUFACTURER			MITSUBISHI			
MODEL NO.			PUY-A42NHA6			
APPLICABLE REMARKS:			A/B/C			

REMARKS:
A: 5-YEAR WARRANTY FOR EACH COMPRESSOR
B: ULTRA-LOW AMBIENT COOLING KIT
C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						23 81 00.02
SYMBOL			CU-R641	CU-R642	CU-R643	CU-R644
SERVING			GALLERY 8A	GALLERY 8A	GALLERY 8	GALLERY 8
DX COOLING DATA	CAPACITY	kW	35.1	28.1	8.8	5.3
	AMBIENT TEMP.	DEG. C	35	35	35	35
	IEER	@ ARI	24.6	28	16.5	14.2
DX HEATING DATA	CAPACITY	kW	33.4	27.0	9.4	5.9
	COND. TEMP.	DEG. C	8	8	8	8
	COP	@ ARI	4.01	4.14	1.9	2.94
OUTDOOR FAN DATA	NO.		2	1	1	1
	kW (EA.)		10	8	3.75	2.57
	VOLT		575	575	208	208
	PH		3	3	1	1
	L/s (TOTAL)		5333	3162	915	566
COMPRESSOR DATA	NO.		2	1	1	1
	RLA (EA.)		N/A	N/A	12	12
	LRA (EA.)		N/A	N/A	17.5	14
	VOLT		575	575	208	208
	PH		3	3	1	1
ELECTRICAL DATA	# CONN.		2	1	1	1
	MCA		19	15	25	13
	MOCP (FUSE)		30	20	40	20
	VOLT		575	575	208	208
	PH		3	3	1	1
DIMENSIONS	LENGTH	mm	1650	1650	950	800
	WIDTH	mm	1750	1220	330	365
	HEIGHT	mm	740	740	1350	600
	MAXIMUM WEIGHT	kg	316	252	75	41
MANUFACTURER			MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL NO.			PUHY-P120ZKMU	PUHY-P96ZKMU	PUZ-A30NHA4	PUZ-A18NHA6
APPLICABLE REMARKS:			A/B/C	A/B/C	A/B/C	A/B/C

REMARKS:
A: 5-YEAR WARRANTY FOR EACH COMPRESSOR
B: ULTRA-LOW AMBIENT COOLING KIT
C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						**23 81 00.02**
SYMBOL			CU-S641	CU-S642	CU-S643	CU-S644
SERVING			ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM
DX COOLING DATA	CAPACITY	kW	12.3	12.3	12.3	12.3
	AMBIENT TEMP.	DEG. C	35	35	35	35
	SEER	@ ARI	14.0	14.0	14.0	14.0
OUTDOOR FAN DATA	NO.		2	2	2	2
	kW (EA.)		0.04	0.04	0.04	0.04
	VOLT		208	208	208	208
	PH		1	1	1	1
	L/s (TOTAL)		1665	1665	1665	1665
COMPRESSOR DATA	NO.		1	1	1	1
	RLA (EA.)		20	20	20	20
	LRA (EA.)		27.5	27.5	27.5	27.5
	VOLT		208	208	208	208
	PH		1	1	1	1
ELECTRICAL DATA	# CONN.		1	1	1	1
	MCA		26	26	26	26
	MOCP (FUSE)		40	40	40	40
	VOLT		208	208	208	208
	PH		1	1	1	1
DIMENSIONS	LENGTH	mm	950	950	950	950
	WIDTH	mm	360	360	360	360
	HEIGHT	mm	1350	1350	1350	1350
	MAXIMUM WEIGHT	kg	112	112	112	112
MANUFACTURER			MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL NO.			PUY-A42NHA6	PUY-A42NHA6	PUY-A42NHA6	PUY-A42NHA6
APPLICABLE REMARKS:			A/B/C	A/B/C	A/B/C	A/B/C

REMARKS:

A: 5-YEAR WARRANTY FOR EACH COMPRESSOR

B: ULTRA-LOW AMBIENT COOLING KIT

C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SPLIT SYSTEM DX OUTDOOR UNITS						**23 81 00.02**
SYMBOL			CU-S646			
SERVING			LABORATORY			
DX COOLING DATA	CAPACITY	kW	5.3			
	AMBIENT TEMP.	DEG. C	35			
	SEER	@ ARI	14.2			
DX HEATING DATA	CAPACITY	kW	5.9			
	COND. TEMP.	DEG. C	8			
	COP	@ ARI	2.94			
OUTDOOR FAN DATA	NO.		1			
	kW (EA.)		0.04			
	VOLT		208			
	PH		1			
	L/s (TOTAL)		566			
COMPRESSOR DATA	NO.		1			
	RLA (EA.)		12			
	LRA (EA.)		14			
	VOLT		208			
	PH		1			
ELECTRICAL DATA	# CONN.		1			
	MCA		13			
	MOCP (FUSE)		20			
	VOLT		208			
	PH		1			
DIMENSIONS	LENGTH	mm	800			
	WIDTH	mm	330			
	HEIGHT	mm	660			
	MAXIMUM WEIGHT	kg	41			
MANUFACTURER			MITSUBISHI			
MODEL NO.			PUZ-A18NHA6			
APPLICABLE REMARKS:			A/B/C			

REMARKS:
A: 5-YEAR WARRANTY FOR EACH COMPRESSOR
B: ULTRA-LOW AMBIENT COOLING KIT
C: ELECTRONIC PROGRAMMABLE THERMOSTAT AND IO ADAPTER

SECTION 23 82 00

TERMINAL HEATING AND COOLING UNITS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Canadian Gas Association (CGA).
   2. Air Moving and Conditioning Association (AMCA): Standard 300, Reverberant Room Method for Sound Testing of Fans
   3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90.1 IP/SI, Energy Standard for Buildings, Except Low-Rise Residential Buildings.
   4. ASTM International (ASTM): A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   5. Canadian Gas Association (CGA).
   6. Electrical Test Laboratories (ETL).
   7. National Electrical Manufacturer's Association (NEMA).
   8. National Fire Protection Association (NFPA):
      a. 54, National Fuel Gas Code.
      b. 70, National Electric Code (NEC).
      c. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   9. Sheet Metal and Air Conditioning Contractors' National Assoc., Inc. (SMACNA): Ducted Electric Heat Guide for Air Handling Systems.
   10. Underwriters Laboratories Inc. (UL): Product Directories.
   11. Underwriters Laboratories of Canada (ULC): Product Directories.
   12. Canadian Standard Association (CSA).
   13. Natural Gas Code and Propane Installation Code CAN/CSA-B149.1.

1.2 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:
   1. AC: Alternating Current.
   2. CISD: Chemical Industry, Severe-Duty.
   3. dB: Decibel.
   4. DWDI: Double Width, Double Inlet.
   5. FRP: Fiberglass Reinforced Plastic.
   6. hp: Horsepower.
   7. ODP: Open Drip Proof.
   8. PSC: Permanent Split Capacitor.
   9. SWSI: Single Width, Single Inlet.
   10. TEFC: Totally Enclosed, Fan Cooled.
   11. UV: Ultraviolet
   12. XP: Explosion Proof.

1.3 SUBMITTALS

A. Action Submittals:
1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.
2. Manufacturer's standard finish color selection for cabinet finishes.
3. Performance Data, including sound power level data (ref. 10 to minus 12 watts) at design operating point, shall be based on AMCA Bulletin 300, Setup No. 1.

B. Informational Submittals:
1. Manufacturer's test reports for the following:
   a. Hot water unit heater(s) pressure.
   b. Cabinet unit heater electric heating coil.
   c. Booster heating coil.
   d. Electric duct heater.
2. Recommended procedures for protection and handling of equipment and materials prior to installation.
3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Heating Equipment: Minimum operating efficiencies, specified in Chapter 6 of ASHRAE 90A the Provincial Energy Code.

PART 2 PRODUCTS

2.1 EQUIPMENT SCHEDULES

A. Refer to Article, Supplements.

2.2 UNIT HEATER, GAS, PROPELLER FAN

A. Characteristics:
1. Factory assembled, wired and test fired.
2. Dynamically balanced, direct drive, propeller type fan.
3. UL listed.
4. CGA certified.
5. Minimum 80 percent efficient.
6. Steel cabinet with baked enamel or powder coated finish.
7. Designed for ceiling suspension.
8. Sealed flue product collection chamber.
9. Totally enclosed motors with thermal overload protection and vibration isolation.
10. Motor contactor.
11. Horizontal discharge with adjustable face louvers.
12. Horizontal and vertical vent outlets.
13. External gas connection.

14. Solid state ignition; a match lit pilot is not acceptable.
15. Described by manufacturer in published literature as commercial or industrial grade.

B. Controls:
1. Fan and limit safety controls.
2. Combustion air pressure switch.
3. 24-volt control transformer.
4. Relays and contactor to interface with PLC controls.

C. Accessories and Features: Provide as follows:
1. Suitable for natural gas.
2. Venting and Combustion:
   a. Concentric adapter box and brackets
   b. Combustion air inlet for combustion air ducting from outside. CC6 horizontal vent terminal.
3. Finger-proof fan guard.
4. Spark ignited intermittent safety pilot with electronic flame supervision or direct spark ignition.
5. Two-stage heating control.
6. Aluminized steel heat exchanger.
7. Electrical disconnect to be field supplied and installed by electrical contractor in accordance with local Codes.

D. Manufacturers:
1. Reznor; Model UDAS.
2. Modine.
3. Trane.

2.3 UNIT HEATER, HOT WATER, HORIZONTAL

A. Characteristics:
1. Arranged for horizontal air distribution.
2. 18-gauge cabinet finished with baked enamel paint.
3. Coil of single tube, single serpentine flow.
4. Copper tubes without turbulators.
5. Aluminum fins mechanically bonded to tubes.
6. Direct-drive motor of shaded pole design with oil-lubricated sleeve bearings and built-in thermal overload protection.
7. Nonferrous multiblade propeller type fan.
8. Adjustable horizontal louvers and vertical diffuser vanes on air discharge side.
9. Relays and contactor to interface with PLC controls.

B. Manufacturers and Products:
1. Trane; Model-S.
2. Dunham-Bush; Model H.

2.4 BASEBOARD, ELECTRIC HEATERS

A. Characteristics:
1. Horizontal air delivery, suspended electric baseboard heater.
2. UL/ULC listed and CSA certified.
3. Cabinet Casing:
   a. 16 gauge steel front with epoxy polyester powder paint.
   b. Top: Slope top design.
   c. Pencil proof opening.
4. Elements:
   a. Stainless steel tubular heating with aluminum fins.
   b. Kilowatt rating as specified.
5. Electrical:
   a. Linear high limit temperature with automatic reset.
   b. Electronic relays and contactor for low voltage controls.
6. Controls: Operated by wall mounted low voltage thermostat.

B. Manufacturers:
1. Ouellet; Model OPR.
2. Modine.
3. Caloritech.

2.5 BASEBOARD, ELECTRIC HEATERS, HEAVY DUTY

A. Characteristics:
1. Floor mounted, heavy duty electric convection heater.
2. UL/ULC listed and CSA certified.
3. Cabinet Casing:
   a. 316 stainless steel front with watertight control enclosure.
   b. Top: Slope top design.
4. Elements:
   a. 304 Stainless steel tubular with fins.
   b. Kilowatt rating as specified.
5. Electrical:
   a. Linear high limit temperature with automatic reset.
   b. Electronic relays and contactor for low voltage controls.
6. Controls: Built-in controls with adjustable thermostat.

B. Manufacturers:
1. Indeeco; Model CE.
2. Modine.

2.6 UNIT HEATER, ELECTRIC, CABINET

A. Characteristics:
1. Fiberglass fan scroll and wheels.
2. Direct-drive motor.
3. Electric heating coil.

4. Disposable filters.
5. Integral speed control switch.
6. Cabinet mounted.

B. Cabinet:
1. 16-gauge steel arranged for freestanding floor mounting.
2. Baked enamel finish of color selected by the City from manufacturer's standard color chart.
3. Insulated front panel.
4. Hinged access door for access to speed switch.
5. Stamped grille for top discharge.
6. Toe-space return air opening.

C. Electric Heating Coil:
1. Low surface temperature type with sheath element inserted in finned-tube coil.
2. Factory wiring shall include operating and safety controls required by UL/ULC and NEC, and carry UL/ULC listing mark.

D. Motor: Three-speed PSC motor, operated through an integral fan speed switch from a unit mounted transformer.

E. Manufacturers and Products:
1. Modine.
2. Caloritech.
3. Ouellet.

2.7 UNIT HEATER, ELECTRIC, SUSPENDED

A. Characteristics:
1. Factory assembled including casing, heater elements, fan wheel, drive assembly, motor, controls and accessories.
2. UL/ULC listed.
3. Meet requirements of National Electrical Code.
4. Three phase heaters shall have balanced phases.
5. Casing:
   a. Heavy gage steel casing.
   b. Baked enamel finish.
   c. Individual adjustable discharge louvers.
   d. Protective air inlet louvers or fan guards.
6. Heating elements shall be one of the following types:
   a. Aluminum finned, copper clad, steel sheath.
   b. High mass, all steel tubular finned type, copper brazed, in fixed element banks.
   c. Nickel-chromium wire elements enclosed in powder filled aluminum coated steel tubes with permanently fused fins.
   d. Steel tubes with nickel chromium resistance wire embedded in a dielectric with steel fins crimped and brazed to the tube.
   e. Corrosion resistant steel fins brazed to tubular heating elements.

7. Fan and Motor:
    a. Totally enclosed motor.
    b. Direct drive fan.
    c. Sealed bearings. Permanently lubricated.
8. Controls:
    a. Thermal overload protection with automatic reset.
    b. Controls, transformers, and contactors shall be factory assembled.
    c. Relays and contactor to interface with PLC control or room thermostat.

B. Accessories and Features: Provide as follows:
1. Airflow discharge shall be horizontal.
2. Electrical Disconnect: NEMA 4 to be field supplied and installed by electrical contractor in accordance with local Codes.
3. Voltage: As shown on equipment schedule.
4. Wall mounting bracket.
5. Fan delay feature that starts fan after element warmup and stops fan after element cool down.
6. Control transformer.
7. Louver cone diffuser.
8. Two-stage heating operation.
9. Adjustable wall mounted room low voltage thermostat with a minimum temperature range of 4 degrees C to 25 degrees C as shown on the drawing.

C. Manufacturers and Products:
1. Modine: Type HER (horizontal discharge), VE (vertical discharge).
2. Caloritech.
3. Ouellet.

2.8 CONVECTION HEATER, HOT WATER, FINNED-TUBE

A. Characteristics:
1. Wall-hung cabinet, finned tube hot water convection heater.
2. 16-gauge steel sheet metal enclosure.
3. Wall brackets with concealed fasteners.
4. Element supports.
5. Stamped louvered discharge grille.
6. Heating Element: 32 mm steel tube with 65 mm by 125 mm, steel finned element.
7. Cabinet Finish: Baked enamel of color selected from manufacturer’s standard color chart.
8. Accessories:
    a. Sponge rubber wall gasket.
    b. Outlet dampler.
    c. End panels wherever enclosure does not abut a finished wall.
    d. Thermostatic radiator control valve (TRV) with dial and sensor from Armstrong or Damfoss. This TRV will automatically open or close to control room temperature.
9. Access Panel: 150 mm wide panel at each end of every enclosure section for access to valves and balance fittings.

B. Manufacturers and Products:
   1. Rosemex; Model WF.
   2. Trane.
   3. Dunham-Bush.

2.9 RADIANT HEATER, ELECTRIC

A. Characteristics:
   1. Electric radiant heating system; complete with reflectors, controls, and accessories.
   2. CSA certified.
   3. Anodized aluminum finish with built in adjustable directional system.
   4. Heating Element: Stainless steel tubular heating elements with 60 degrees standard radiation angle.
   5. Hangers and Supports:
      a. Suspension Chain and Hanger Rods: As recommended by manufacturer for designated spacing.
   6. Controls: Proportional control timer, Series: CT2000, manufacturer: Intermatic.

B. Manufacturer and Product:
   1. Ouellet; Model OKB.
   2. Caloritech.

2.10 GAS VENT STACKS

A. Characteristics:
   1. Suitable for gas-fired unit heaters and water heaters.
   2. UL listed Category III vent pipe.
   3. Single galvanized pipe for combustion inlet.
   4. Manufacturer’s standard fittings as required.

B. Manufacturers and Products:
   1. Selkirk; Metalbestos.
   2. Van Packer.

2.11 ELECTRICAL

A. General:
   1. Units shall include high and low voltage terminal block connections.
   2. Control voltage to indoor unit fan shall be 24 volts.
   3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.
   4. Disconnects: To be field supplied and installed by electrical contractor in accordance with local Codes.

B. Motors:
   1. Refer to Section 26 20 00, Low Voltage AC Induction Motors, for general requirements.
   2. Unless otherwise stated, electric motors shall comply with the following:
      a. Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.
      b. Enclosure: ODP, unless specified otherwise.
      c. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
      d. Winding Thermal Protection: Manufacturer's standard.
      e. Space Heater: Manufacturer's standard.
      f. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer's standard.
      g. Efficiency: Minimum efficiency per Section 26 20 00, Low Voltage AC Induction Motors.

2.12 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

2.13 SOURCE QUALITY CONTROL

A. Functional Test:
   1. Perform manufacturer's standard factory test and, motor and, coil test on equipment.
   2. Test equipment actually identical to that furnished.
   3. Motor Test: See Section 26 20 00, Low Voltage AC Induction Motors.
   4. Equipment with Hot Water Heating Coils: No leaks when tested underwater with 2068 kPa air.
   5. Equipment with Electric Resistance Heating Coils: Test with 2,000-volt dielectric test.

PART 3 EXECUTION

3.1 INSTALLATION

A. Gas-Fired, Hot Water, Unit Heaters:
   1. Install in accordance with manufacturer's recommendations.
   2. Mount bottom of unit at 2.5 metre above floor, except where noted otherwise on Drawings.

B. Electric Unit Heaters, All Types:
   1. Install in strict compliance with manufacturer's instructions. Maintain clearances around unit as listed in manufacturer's recommendations.
   2. Bottom of unit shall be a minimum of 2.5 metre above finish floor, unless indicated otherwise.

3. Heater shall be permanently mounted in position indicated with a fixed power supply.
4. Install so obstructions do not block heater air inlet or outlet.

C. Convectors, Finned-Tube: Install in accordance with manufacturer's instructions.

D. Gas Vent Stacks:
1. Install in accordance with manufacturer's recommendations.
2. Install in accordance with requirements of NFPA 54.

3.2 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Contractor Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of the City's personnel for specified equipment.

3.3 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.
1. 23 82 00.01 Electric Unit Heaters Schedule
2. 23 82 00.02 Gas Unit Heaters Schedule.
3. 23 82 00.03 Hot Water Unit Heaters Schedule
4. 23 82 00.04, Hot Water Convection Heaters Schedule.
5. 23 82 00.05 Electric Baseboard Heaters Schedule
6. 23 82 00.06 Electric Radiant Heaters Schedule.

END OF SECTION

ELECTRIC UNIT HEATERS							**23 82 00.01**
SYMBOL				UH-C625-1	UH-C625-2	UH-C648-1	UH-C648-2
LOCATION				CABLE SERVICE	CABLE SERVICE	ELECTRICAL ROOM	ELECTRICAL ROOM
TYPE				ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		240	240	240	240
	MOTOR	RPM		1550	1550	1550	1550
		POWER	kW	0.025	0.025	0.025	0.025
		VOLT		575	575	575	575
		PH		3	3	3	3
	DELTA T	DEG C		7	7	14	14
ELECTRIC HEAT DATA	CAPACITY	kW		2.0	2.0	4.0	4.0
	NUMBER OF STEPS			1	1	1	1
	VOLT			575	575	575	575
	PH			3	3	3	3
UNIT ELECTRICAL DATA	MOCP			15	15	15	15
	VOLT			575	575	575	575
	PH			3	3	3	3
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	432	432	432	432
	WIDTH		mm	419	419	419	419
	HEIGHT		mm	305	305	305	305
	WEIGHT		kg	20	20	20	20
MANUFACTURER				OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.				OAS02036	OAS02036	OAS04036	OAS04036
APPLICABLE REMARKS:				A	A		

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

ELECTRIC UNIT HEATERS							**23 82 00.01**
SYMBOL				UH-C648-3	UH-C654	UH-D644	UH-D653
LOCATION				ELECTRICAL ROOM	MECHANICAL ROOM 1	ELECTRICAL ROOM A	ELECTRICAL ROOM B
TYPE				ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		240	240	240	240
	MOTOR	RPM		1550	1550	1550	1550
		POWER	kW	0.025	0.025	0.025	0.025
		VOLT		575	575	575	575
		PH		3	3	3	3
	DELTA T	DEG C		14	7	14	14
ELECTRIC HEAT DATA	CAPACITY	kW		4.0	2.0	4.0	4.0
	NUMBER OF STEPS			1	1	1	1
	VOLT			575	575	575	575
	PH			3	3	3	3
UNIT ELECTRICAL DATA	MOCP			15	15	15	15
	VOLT			575	575	575	575
	PH			3	3	3	3
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	432	432	432	432
	WIDTH		mm	419	419	419	419
	HEIGHT		mm	305	305	305	305
	WEIGHT		kg	20	20	20	20
MANUFACTURER				OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.				OAS04036	OAS02036	OAS04036	OAS04036
APPLICABLE REMARKS:					A		

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

ELECTRIC UNIT HEATERS							**23 82 00.01**
SYMBOL				UH-S635-1	UH-S635-2	UH-S645	UH-S657-1
LOCATION				MECHANICAL ROOM	MECHANICAL ROOM	ELECTRICAL ROOM	STORAGE ROOM
TYPE				ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		240	240	240	330
	MOTOR	RPM		1550	1550	1550	1550
		POWER	kW	0.025	0.025	0.025	0.025
		VOLT		575	575	575	575
		PH		3	3	3	3
	DELTA T	DEG C		10	10	10	13
ELECTRIC HEAT DATA	CAPACITY	kW		3.0	3.0	3.0	5.0
	NUMBER OF STEPS			1	1	1	1
	VOLT			575	575	575	575
	PH			3	3	3	3
UNIT ELECTRICAL DATA	MOCP			15	15	15	15
	VOLT			575	575	575	575
	PH			3	3	3	3
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	432	432	432	432
	WIDTH		mm	419	419	419	419
	HEIGHT		mm	305	305	305	305
	WEIGHT		kg	20	20	20	20
MANUFACTURER				OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.				OAS03036	OAS03036	OAS03036	OAS05036
APPLICABLE REMARKS:				A	A		A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

ELECTRIC UNIT HEATERS							**23 82 00.01**
SYMBOL				UH-S657-2	UH-R645	UH-G644	UH-P643
LOCATION				STORAGE ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM	ELECTRICAL ROOM B
TYPE				ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED	ELECTRIC, SUSPENDED
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		330	330	240	240
	MOTOR	RPM		1550	1550	1550	1550
		POWER	kW	0.025	0.025	0.025	0.025
		VOLT		575	575	575	575
		PH		3	3	3	3
	DELTA T	DEG C		10	13	10	13
ELECTRIC HEAT DATA	CAPACITY	kW		5.0	5.0	3.0	5.0
	NUMBER OF STEPS			1	1	1	1
	VOLT			575	575	575	575
	PH			3	3	3	3
UNIT ELECTRICAL DATA	MOCP			15	15	15	15
	VOLT			575	575	575	575
	PH			3	3	3	3
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	432	432	432	432
	WIDTH		mm	419	419	419	419
	HEIGHT		mm	305	305	305	305
	WEIGHT		kg	20	20	20	20
MANUFACTURER				OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.				OAS05036	OAS05036	OAS03036	OAS05036
APPLICABLE REMARKS:				A			

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

GAS UNIT HEATERS — 23 82 00.02

SYMBOL				UH-C617	UH-C663-1	UH-C663-2	
LOCATION				MECHANICAL ROOM 2	GENERATOR ROOM	GENERATOR ROOM	
TYPE				GAS, PROPELLER FAN	GAS, PROPELLER FAN	GAS, PROPELLER FAN	
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		215	363	363	
	MOTOR	RPM		1550	1550	1550	
		POWER	kW	0.045	0.045	0.045	
		VOLT		120	120	120	
		PH		1	1	1	
	DELTA T	DEG C		13	13	13	
GAS TRAIN DATA	FUEL TYPE			NG	NG	NG	
	GAS INPUT		kW	8.8	17.6	17.6	
	GAS OUTPUT		kW	7.2	14.6	14.6	
	SUPPLY PRESSURE	MIN	Pa	1246	1246	1246	
		MAX	Pa	3487	3487	3487	
UNIT ELECTRICAL DATA	MCA			1.9	2.4	2.4	
	MOCP			15	15	15	
	VOLT			120	120	120	
	PH			1	1	1	
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	
MAXIMUM DIMENSIONS	LENGTH		mm	660	686	686	
	WIDTH		mm	676	676	676	
	HEIGHT		mm	308	384	384	
	WEIGHT		kg	25	31	31	
MANUFACTURER				REZNOR	REZNOR	REZNOR	
MODEL NO.				UDAS 30	UDAS 60	UDAS 60	
APPLICABLE REMARKS:				A	A	A	

ABBREVIATIONS:
NG: NATURAL GAS
PG: PROPANE GAS
NG/PG: DUAL FUEL, NATURAL AND PROPANE GAS

REMARKS:
A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

GAS UNIT HEATERS — 23 82 00.02

SYMBOL				UH-R654	UH-R624	UH-R625	
LOCATION				MECHANICAL ROOM	BLOWER ROOM	BLOWER ROOM	
TYPE				GAS, PROPELLER FAN	GAS, PROPELLER FAN	GAS, PROPELLER FAN	
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		215	297	297	
	MOTOR	RPM		1550	1550	1550	
		POWER	kW	0.045	0.045	0.045	
		VOLT		120	120	120	
		PH		1	1	1	
	DELTA T	DEG C		13	13	13	
GAS TRAIN DATA	FUEL TYPE			NG	NG	NG	
	GAS INPUT		kW	8.8	13.2	13.2	
	GAS OUTPUT		kW	7.2	10.9	10.9	
	SUPPLY PRESSURE	MIN	Pa	1246	1246	1246	
		MAX	Pa	3487	3487	3487	
UNIT ELECTRICAL DATA	MCA			1.9	2.4	2.4	
	MOCP			15	15	15	
	VOLT			120	120	120	
	PH			1	1	1	
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	
MAXIMUM DIMENSIONS	LENGTH		mm	660	660	660	
	WIDTH		mm	676	676	676	
	HEIGHT		mm	308	308	308	
	WEIGHT		kg	25	25	25	
MANUFACTURER				REZNOR	REZNOR	REZNOR	
MODEL NO.				UDAS 30	UDAS 45	UDAS 45	
APPLICABLE REMARKS:				A	A	A	

ABBREVIATIONS:

NG: NATURAL GAS

PG: PROPANE GAS

NG/PG: DUAL FUEL, NATURAL AND PROPANE GAS

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

GAS UNIT HEATERS — 23 82 00.02

SYMBOL				UH-S655	UH-S656	UH-S659	
LOCATION				WALKWAY A	WALKWAY A	LOADING AREA	
TYPE				GAS, PROPELLER FAN	GAS, PROPELLER FAN	GAS, PROPELLER FAN	
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		363	363	215	
	MOTOR	RPM		1550	1550	1550	
		POWER	kW	0.045	0.045	0.045	
		VOLT		120	120	120	
		PH		1	1	1	
	DELTA T	DEG C		13	13	13	
GAS TRAIN DATA	FUEL TYPE			NG	NG	NG	
	GAS INPUT		kW	17.6	17.6	8.8	
	GAS OUTPUT		kW	14.6	14.6	7.2	
	SUPPLY PRESSURE	MIN	Pa	1246	1246	1246	
		MAX	Pa	3487	3487	3487	
UNIT ELECTRICAL DATA	MCA			2.4	2.4	1.9	
	MOCP			15	15	15	
	VOLT			120	120	120	
	PH			1	1	1	
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	
MAXIMUM DIMENSIONS	LENGTH		mm	686	686	660	
	WIDTH		mm	676	676	676	
	HEIGHT		mm	384	384	308	
	WEIGHT		kg	31	31	25	
MANUFACTURER				REZNOR	REZNOR	REZNOR	
MODEL NO.				UDAS 60	UDAS 60	UDAS 30	
APPLICABLE REMARKS:				A	A	A	

ABBREVIATIONS:
NG: NATURAL GAS
PG: PROPANE GAS
NG/PG: DUAL FUEL, NATURAL AND PROPANE GAS

REMARKS:
A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

GAS UNIT HEATERS							**23 82 00.02**
SYMBOL				UH-U654			
LOCATION				WALKWAY B			
TYPE				GAS, PROPELLER FAN			
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		215			
	MOTOR	RPM		1550			
		POWER	kW	0.045			
		VOLT		120			
		PH		1			
	DELTA T	DEG C		13			
GAS TRAIN DATA	FUEL TYPE			NG			
	GAS INPUT		kW	8.8			
	GAS OUTPUT		kW	7.2			
UNIT ELECTRICAL DATA	MCA			1.9			
	MOCP			15			
	VOLT			120			
	PH			1			
MOUNTING HEIGHT	MAXIMUM	mm		2400			
MAXIMUM DIMENSIONS	LENGTH		mm	660			
	WIDTH		mm	676			
	HEIGHT		mm	308			
	WEIGHT		kg	25			
MANUFACTURER				REZNOR			
MODEL NO.				UDAS 30			
APPLICABLE REMARKS:				A			

ABBREVIATIONS:
NG: NATURAL GAS
PG: PROPANE GAS
NG/PG: DUAL FUEL, NATURAL AND PROPANE GAS

REMARKS:
A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-G614-1	UH-G614-2	UH-G614-3	UH-G614-4
LOCATION				GRIT & SCREENING PLATFORM	GRIT & SCREENING PLATFORM	GRIT & SCREENING PLATFORM	GRIT & SCREENING PLATFORM
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		661	661	661	661
	MOTOR	RPM		1000	1000	1000	1000
		POWER	kW	0.062	0.062	0.062	0.062
		VOLT		120	120	120	120
		PH		1	1	1	1
	DELTA T	DEG C		22	22	22	22
HOT WATER HEATING COIL DATA	CAPACITY	kW		17.9	17.9	17.9	17.9
	FLOW	L/s		0.39	0.39	0.39	0.39
	EWT	DEG C		82	82	82	82
	LWT	DEG C		71	71	71	71
	DELTA P	Pa		717	717	717	717
UNIT ELECTRICAL DATA	MCA			2.8	2.8	2.8	2.8
	MOCP			5.0	5.0	5.0	5.0
	VOLT			120	120	120	120
	PH			1	1	1	1
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	300	300	300	300
	WIDTH		mm	530	530	530	530
	HEIGHT		mm	616	616	616	616
	WEIGHT		kg	21	21	21	21
MANUFACTURER				TRANE	TRANE	TRANE	TRANE
MODEL NO.				MODEL S084	MODEL S084	MODEL S084	MODEL S084
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-G615-1	UH-G615-2	UH-G615-3	UH-G615-4
LOCATION				TRUCK LOADING BAY	TRUCK LOADING BAY	TRUCK LOADING BAY	TRUCK LOADING BAY
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		260	212	260	212
	MOTOR	RPM		1550	1550	1550	1550
		POWER	kW	0.025	0.016	0.025	0.016
		VOLT		120	120	120	120
		PH		1	1	1	1
	DELTA T	DEG C		24	20	24	20
HOT WATER HEATING COIL DATA	CAPACITY	kW		7.6	5.1	7.6	5.1
	FLOW	L/s		0.17	0.11	0.17	0.11
	EWT	DEG C		82	82	82	82
	LWT	DEG C		71	71	71	71
	DELTA P	Pa		269	42	269	42
UNIT ELECTRICAL DATA	MCA			1.5	1	1.5	1
	MOCP			2.7	1.8	2.7	1.8
	VOLT			120	120	120	120
	PH			1	1	1	1
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	238	238	238	238
	WIDTH		mm	371	371	371	371
	HEIGHT		mm	457	457	457	457
	WEIGHT		kg	14	14	14	14
MANUFACTURER				TRANE	TRANE	TRANE	TRANE
MODEL NO.				MODEL S036	MODEL S024	MODEL S036	MODEL S024
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-G616-1	UH-G617-1	UH-G624-1	UH-G624-2
LOCATION				MECHANICAL ROOM	CABLE SERVICE ROOM	SCREEN ROOM	SCREEN ROOM
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		354	116	1369	1369
	MOTOR	RPM		1000	1550	1140	1140
		POWER	kW	0.037	0.016	0.19	0.19
		VOLT		120	120	120	120
		PH		1	1	1	1
	DELTA T	DEG C		24	17	26	26
HOT WATER HEATING COIL DATA	CAPACITY	kW		10.2	2.4	43.4	43.4
	FLOW	L/s		0.22	0.05	0.94	0.94
	EWT	DEG C		82	82	82	82
	LWT	DEG C		71	71	71	71
	DELTA P	Pa		359	2388	2358	2358
UNIT ELECTRICAL DATA	MCA			1.8	1	6.8	6.8
	MOCP			3.2	1.8	12.2	12.2
	VOLT			120	120	120	120
	PH			1	1	1	1
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	278	241	349	349
	WIDTH		mm	435	457	625	625
	HEIGHT		mm	521	406	737	737
	WEIGHT		kg	19	10	41	41
MANUFACTURER				TRANE	TRANE	TRANE	TRANE
MODEL NO.				MODEL S048	MODEL A08	MODEL S204	MODEL S204
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS — 23 82 00.03

SYMBOL				UH-G624-3	UH-G624-4	UH-G624-5	UH-G694
LOCATION				SCREEN ROOM	SCREEN ROOM	SCREEN ROOM CORRIDOR	GRIT PUMP ROOM
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		1369	1369	519	1652
	MOTOR	RPM		1140	1140	1140	1000
		POWER	kW	0.187	0.187	0.124	0.249
		VOLT		120	120	120	120
		PH		1	1	1	1
	DELTA T	DEG C		26	26	24	26
HOT WATER HEATING COIL DATA	CAPACITY	kW		43.4	43.4	15.3	51
	FLOW	L/s		0.94	0.94	0.33	1.098
	EWT	DEG C		82	82	82	82
	LWT	DEG C		71	71	71	71
	DELTA P	Pa		2358	2358	688	3168
UNIT ELECTRICAL DATA	MCA			6.8	6.8	4.6	5.6
	MOCP			12.2	12.2	8.3	10.1
	VOLT			120	120	120	120
	PH			1	1	1	1
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	349	349	281	356
	WIDTH		mm	625	625	467	708
	HEIGHT		mm	737	737	552	768
	WEIGHT		kg	41	41	20	57
MANUFACTURER				TRANE	TRANE	TRANE	TRANE
MODEL NO.				MODEL S204	MODEL S204	MODEL S072	MODEL S240
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-G695-1	UH-G695-2		
LOCATION				GRIT PUMP ROOM	GRIT PUMP ROOM		
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL		
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		425	425		
	MOTOR	RPM		1000	1000		
		POWER	kW	0.037	0.037		
		VOLT		120	120		
		PH		1	1		
	DELTA T	DEG C		25	25		
HOT WATER HEATING COIL DATA	CAPACITY	kW		12.8	12.8		
	FLOW	L/s		0.28	0.28		
	EWT	DEG C		82	82		
	LWT	DEG C		71	71		
	DELTA P	Pa		508	508		
UNIT ELECTRICAL DATA	MCA			1.8	1.8		
	MOCP			3.2	3.2		
	VOLT			120	120		
	PH			1	1		
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400		
MAXIMUM DIMENSIONS	LENGTH		mm	278	278		
	WIDTH		mm	435	435		
	HEIGHT		mm	521	521		
	WEIGHT		kg	19	19		
MANUFACTURER				TRANE	TRANE		
MODEL NO.				MODEL S060	MODEL S060		
APPLICABLE REMARKS:				A	A		

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-K613-1	UH-K613-2	UH-K613-3	UH-K613-4
LOCATION				CLARIFIER ROOM	CLARIFIER ROOM	CLARIFIER ROOM	CLARIFIER ROOM
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		661	661	661	661
	MOTOR	RPM		1140	1140	1140	1140
		POWER	kW	0.124	0.124	0.124	0.124
		VOLT		120	120	120	120
		PH		1	1	1	1
	DELTA T	DEG C		22	22	22	22
HOT WATER HEATING COIL DATA	CAPACITY	kW		17.9	17.9	17.9	17.9
	FLOW	L/s		0.39	0.39	0.39	0.39
	EWT	DEG C		82	82	82	82
	LWT	DEG C		71	71	71	71
	DELTA P	Pa		717	717	717	717
UNIT ELECTRICAL DATA	MCA			4.6	4.6	4.6	4.6
	MOCP			8.3	8.3	8.3	8.3
	VOLT			120	120	120	120
	PH			1	1	1	1
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	300	300	300	300
	WIDTH		mm	530	530	530	530
	HEIGHT		mm	616	616	616	616
	WEIGHT		kg	21	21	21	21
MANUFACTURER				TRANE	TRANE	TRANE	TRANE
MODEL NO.				MODEL S084	MODEL S084	MODEL S084	MODEL S084
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-K623-1	UH-K623-2	UH-K623-3	UH-K623-4
LOCATION				PUMP ROOM	PUMP ROOM	PUMP ROOM	PUMP ROOM
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		186	186	186	186
	MOTOR	RPM		1550	1550	1550	1550
		POWER	kW	0.016	0.016	0.016	0.016
		VOLT		120	120	120	120
		PH		1	1	1	1
	DELTA T	DEG C		19	19	19	19
HOT WATER HEATING COIL DATA	CAPACITY	kW		3.8	3.8	3.8	3.8
	FLOW	L/s		0.08	0.08	0.08	0.08
	EWT	DEG C		82	82	82	82
	LWT	DEG C		71	71	71	71
	DELTA P	Pa		15	15	15	15
UNIT ELECTRICAL DATA	MCA			1	1	1	1
	MOCP			1.8	1.8	1.8	1.8
	VOLT			120	120	120	120
	PH			1	1	1	1
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	238	238	238	238
	WIDTH		mm	371	371	371	371
	HEIGHT		mm	381	381	381	381
	WEIGHT		kg	12	12	12	12
MANUFACTURER				TRANE	TRANE	TRANE	TRANE
MODEL NO.				MODEL S018	MODEL S018	MODEL S018	MODEL S018
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-K633-1	UH-K633-2	UH-K634-1	UH-K634-2
LOCATION				WALKWAY/ LOADING AREA	WALKWAY/ LOADING AREA	SERVICE GALLERY	SERVICE GALLERY
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		186	186	186	186
	MOTOR	RPM		1550	1550	1550	1550
		POWER	kW	0.016	0.016	0.016	0.016
		VOLT		120	120	120	120
		PH		1	1	1	1
	DELTA T	DEG C		19	19	19	19
HOT WATER HEATING COIL DATA	CAPACITY	kW		3.8	3.8	3.8	3.8
	FLOW	L/s		0.08	0.08	0.08	0.08
	EWT	DEG C		82	82	82	82
	LWT	DEG C		71	71	71	71
	DELTA P	Pa		15	15	15	15
UNIT ELECTRICAL DATA	MCA			1	1	1	1
	MOCP			1.8	1.8	1.8	1.8
	VOLT			120	120	120	120
	PH			1	1	1	1
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	238	238	238	238
	WIDTH		mm	371	371	371	371
	HEIGHT		mm	381	381	381	381
	WEIGHT		kg	12	12	12	12
MANUFACTURER				TRANE	TRANE	TRANE	TRANE
MODEL NO.				MODEL S018	MODEL S018	MODEL S018	MODEL S018
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-K634-3	UH-K634-4	UH-K635-1	UH-K635-2
LOCATION				SERVICE GALLERY	SERVICE GALLERY	MECHANICAL ROOM	MECHANICAL ROOM
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		186	186	212	212
	MOTOR	RPM		1550	1550	1550	1550
		POWER	kW	0.016	0.016	0.016	0.016
		VOLT		120	120	120	120
		PH		1	1	1	1
	DELTA T	DEG C		19	19	20	20
HOT WATER HEATING COIL DATA	CAPACITY	kW		3.8	3.8	5.1	5.1
	FLOW	L/s		0.08	0.08	0.11	0.11
	EWT	DEG C		82	82	82	82
	LWT	DEG C		71	71	71	71
	DELTA P	Pa		15	15	42	42
UNIT ELECTRICAL DATA	MCA			1	1	1	1
	MOCP			1.8	1.8	1.8	1.8
	VOLT			120	120	120	120
	PH			1	1	1	1
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	2400
MAXIMUM DIMENSIONS	LENGTH		mm	238	238	238	238
	WIDTH		mm	371	371	371	371
	HEIGHT		mm	381	381	457	457
	WEIGHT		kg	12	12	14	14
MANUFACTURER				TRANE	TRANE	TRANE	TRANE
MODEL NO.				MODEL S018	MODEL S018	MODEL S024	MODEL S024
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-K636-1	UH-K636-2	UH-K637	
LOCATION				WALKWAY/ LOADING AREA	WALKWAY/ LOADING AREA	BALLAST ROOM	
TYPE				HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	HOT WATER, HORIZONTAL	
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		186	186	186	
	MOTOR	RPM		1550	1550	1550	
		POWER	kW	0.016	0.016	0.016	
		VOLT		120	120	120	
		PH		1	1	1	
	DELTA T	DEG C		19	19	19	
HOT WATER HEATING COIL DATA	CAPACITY	kW		3.8	3.8	3.8	
	FLOW	L/s		0.08	0.08	0.08	
	EWT	DEG C		82	82	82	
	LWT	DEG C		71	71	71	
	DELTA P	Pa		15	15	15	
UNIT ELECTRICAL DATA	MCA			1	1	1	
	MOCP			1.8	1.8	1.8	
	VOLT			120	120	120	
	PH			1	1	1	
MOUNTING HEIGHT	MAXIMUM	mm		2400	2400	2400	
MAXIMUM DIMENSIONS	LENGTH		mm	238	238	238	
	WIDTH		mm	371	371	371	
	HEIGHT		mm	381	381	381	
	WEIGHT		kg	12	12	12	
MANUFACTURER				TRANE	TRANE	TRANE	
MODEL NO.				MODEL S018	MODEL S018	MODEL S018	
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER UNIT HEATERS							**23 82 00.03**
SYMBOL				UH-P614			
LOCATION				STORAGE ROOM			
TYPE				HOT WATER, HORIZONTAL			
AIR SIDE DATA	SUPPLY AIRFLOW	L/s		212			
	MOTOR	RPM		1550			
		POWER	kW	0.016			
		VOLT		120			
		PH		1			
	DELTA T	DEG C		20			
HOT WATER HEATING COIL DATA	CAPACITY	kW		5.1			
	FLOW	L/s		0.11			
	EWT	DEG C		82			
	LWT	DEG C		71			
	DELTA P	Pa		42			
UNIT ELECTRICAL DATA	MCA			1			
	MOCP			1.8			
UNIT ELECTRICAL DATA	VOLT			120			
	PH			1			
MOUNTING HEIGHT	MAXIMUM	mm		2400			
MAXIMUM DIMENSIONS	LENGTH		mm	238			
	WIDTH		mm	371			
	HEIGHT		mm	457			
	WEIGHT		kg	14			
MANUFACTURER				TRANE			
MODEL NO.				MODEL S024			
APPLICABLE REMARKS:				A			

REMARKS:

A: CONTROLLED BY HVAC PLC, PROVIDE REQUIRED RELAY AND TRANSFORMER

HOT WATER CONVECTION HEATERS — 23 82 00.04

SYMBOL				HTR-G656	HTR-G657	HTR-G659	HTR-G658
LOCATION				WASHROOM	JANITOR'S ROOM	STAIR	STAIR
TYPE				HOT WATER, FINNED-TUBE	HOT WATER, FINNED-TUBE	HOT WATER, FINNED-TUBE	HOT WATER, FINNED-TUBE
ELEMENT DATA	MATERIAL			STEEL	STEEL	STEEL	STEEL
	LENGTH		mm	419	419	826	826
	TUBE DIAMETER		mm	32	32	32	32
HOT WATER HEATING COIL DATA	CAPACITY		kW	0.5	0.5	1.0	1.0
	AIR SIDE	EAT	DEG C	18	18	18	18
	WATER SIDE	FLOW	L/s	0.01	0.01	0.02	0.02
		EWT	DEG C	82	82	82	82
		LWT	DEG C	71	71	71	71
MAXIMUM DIMENSIONS	LENGTH		mm	508	508	915	915
	WIDTH		mm	106	106	106	106
	HEIGHT		mm	457	457	457	457
MANUFACTURER				ROSEMEX	ROSEMEX	ROSEMEX	ROSEMEX
MODEL NO.				WF 18x4Rx20	WF 18x4Rx20	WF 18x4Rx36	WF 18x4Rx36
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: THERMOSTATIC CONTROL VALVE COMPLETE WITH THERMOSTAT AND CONTROL KNOB

HOT WATER CONVECTION HEATERS							**23 82 00.04**
SYMBOL				HTR-K653-1	HTR-K653-2		
LOCATION				VESTIBULE	VESTIBULE		
TYPE				HOT WATER, FINNED-TUBE	HOT WATER, FINNED-TUBE		
ELEMENT DATA	MATERIAL			STEEL	STEEL		
	LENGTH		mm	419	724		
	TUBE DIAMETER		mm	32	32		
HOT WATER HEATING COIL DATA	CAPACITY		kW	0.5	1.5		
	AIR SIDE	EAT	DEG C	10	10		
	WATER SIDE	FLOW	L/s	0.01	0.03		
		EWT	DEG C	82	82		
		LWT	DEG C	71	71		
MAXIMUM DIMENSIONS	LENGTH		mm	508	813		
	WIDTH		mm	106	152		
	HEIGHT		mm	457	457		
MANUFACTURER				ROSEMEX	ROSEMEX		
MODEL NO.				WF 18x4Rx20	WF 18x6Rx32		
APPLICABLE REMARKS:				A	A		

REMARKS:

A: THERMOSTATIC CONTROL VALVE COMPLETE WITH THERMOSTAT AND CONTROL KNOB

ELECTRIC BASEBOARD HEATERS							**23 82 00.05**
SYMBOL				HTR-C653	HTR-C657	HTR-C658	HTR-C659
LOCATION				WASHROOM	VESTIBULE 3	STAIR 1	STAIR 1
TYPE				BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER
UNIT ELECTRICAL DATA	CAPACITY		kW	0.3	0.3	2.0	1.0
	VOLTAGE		V	208	208	208	208
	PHASE		-	1	1	1	1
MAXIMUM DIMENSIONS	LENGTH		mm	522	522	2084	1162
	WIDTH		mm	79	79	79	79
	HEIGHT		mm	258	258	258	258
	WEIGHT		kg	4.7	4.7	21.6	11.8
MANUFACTURER				OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.				OPR0308	OPR0308	OPR2008	OPR1008
APPLICABLE REMARKS:				A	A	A	A

REMARKS:

A: ROOM THERMOSTAT CONTROL
B: BUILT-IN CONTROL INCLUDE ADJUSTABLE THERMOSTAT

ELECTRIC BASEBOARD HEATERS — 23 82 00.05

SYMBOL				HTR-C662	HTR-C667	HTR-C668	HTR-C669
LOCATION				JANITOR'S ROOM	STAIR 2	VESTIBULE 1	CHEMICAL FILL STATION 1
TYPE				BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER, HEAVY DUTY
UNIT ELECTRICAL DATA	CAPACITY		kW	0.3	1.0	0.3	0.5
	VOLTAGE		V	208	208	208	208
	PHASE		-	1	1	1	1
MAXIMUM DIMENSIONS	LENGTH		mm	522	1162	522	381
	WIDTH		mm	79	79	79	178
	HEIGHT		mm	258	258	258	533
	WEIGHT		kg	4.7	11.8	4.7	17
MANUFACTURER				OUELLET	OUELLET	OUELLET	INDEECO
MODEL NO.				OPR0308	OPR1008	OPR0308	CE 1-1/2
APPLICABLE REMARKS:				A	A	A	B

REMARKS:

A: ROOM THERMOSTAT CONTROL
B: BUILT-IN CONTROL INCLUDE ADJUSTABLE THERMOSTAT

ELECTRIC BASEBOARD HEATERS							**23 82 00.05**
SYMBOL				HTR-C670			
LOCATION				CHEMICAL FILL STATION 2			
TYPE				BASEBOARD ELECTRIC HEATER, HEAVY DUTY			
UNIT ELECTRICAL DATA	CAPACITY		kW	0.5			
	VOLTAGE		V	208			
	PHASE		-	1			
MAXIMUM DIMENSIONS	LENGTH		mm	381			
	WIDTH		mm	178			
	HEIGHT		mm	533			
	WEIGHT		kg	17			
MANUFACTURER				INDEECO			
MODEL NO.				CE 1-1/2			
APPLICABLE REMARKS:				C			

REMARKS:

A: ROOM THERMOSTAT CONTROL
B: BUILT-IN CONTROL INCLUDE ADJUSTABLE THERMOSTAT

ELECTRIC BASEBOARD HEATERS — 23 82 00.05

SYMBOL			HTR-R646-1	HTR-R646-2	HTR-R652	HTR-R653
LOCATION			CONTROL ROOM	CONTROL ROOM	WASHROOM	JANITOR'S ROOM
TYPE			BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER
UNIT ELECTRICAL DATA	CAPACITY	kW	1.0	1.0	0.5	0.5
	VOLTAGE	V	120	120	120	120
	PHASE	-	1	1	1	1
MAXIMUM DIMENSIONS	LENGTH	mm	1162	1162	647	647
	WIDTH	mm	79	79	79	79
	HEIGHT	mm	258	258	258	258
	WEIGHT	kg	11.8	11.8	6.4	6.4
MANUFACTURER			OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.			OPR1002	OPR1002	OPR0502	OPR0502
APPLICABLE REMARKS:			A	A	A	A

REMARKS:

A: ROOM THERMOSTAT CONTROL
B: BUILT-IN CONTROL INCLUDE ADJUSTABLE THERMOSTAT

ELECTRIC BASEBOARD HEATERS						**23 82 00.05**
SYMBOL			HTR-R655	HTR-R656	HTR-R657	HTR-R658
LOCATION			STAIR NO.1	STAIR NO.1	VESTIBULE	CORRIDOR
TYPE			BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER
UNIT ELECTRICAL DATA	CAPACITY	kW	1.0	1.0	2.0	0.5
	VOLTAGE	V	120	120	208	120
	PHASE	-	1	1	1	1
MAXIMUM DIMENSIONS	LENGTH	mm	1162	1162	410	647
	WIDTH	mm	79	79	33	79
	HEIGHT	mm	258	258	561	258
	WEIGHT	kg	11.8	11.8	10.9	6.4
MANUFACTURER			OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.			OPR1002	OPR1002	OAC2008	OPR0502
APPLICABLE REMARKS:			A	A	A	A

REMARKS:

A: ROOM THERMOSTAT CONTROL
B: BUILT-IN CONTROL INCLUDE ADJUSTABLE THERMOSTAT

ELECTRIC BASEBOARD HEATERS						**23 82 00.05**
SYMBOL			HTR-R680	HTR-R681		
LOCATION			STAIR NO.2	STAIR NO.2		
TYPE			BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER		
UNIT ELECTRICAL DATA	CAPACITY	kW	1.0	1.0		
	VOLTAGE	V	120	120		
	PHASE	-	1	1		
MAXIMUM DIMENSIONS	LENGTH	mm	1162	1162		
	WIDTH	mm	79	79		
	HEIGHT	mm	258	258		
	WEIGHT	kg	11.8	11.8		
MANUFACTURER			OUELLET	OUELLET		
MODEL NO.			OPR1002	OPR1002		
APPLICABLE REMARKS:			A	A		

REMARKS:

A: ROOM THERMOSTAT CONTROL
B: BUILT-IN CONTROL INCLUDE ADJUSTABLE THERMOSTAT

ELECTRIC BASEBOARD HEATERS — 23 82 00.05

SYMBOL			HTR-S626	HTR-S627	HTR-S637	HTR-S638
LOCATION			STAIR 1	STAIR 1	STAIR 2	STAIR 2
TYPE			BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER
UNIT ELECTRICAL DATA	CAPACITY	kW	1.0	1.0	1.0	1.0
	VOLTAGE	V	120	120	120	120
	PHASE	-	1	1	1	1
MAXIMUM DIMENSIONS	LENGTH	mm	1162	1162	1162	1162
	WIDTH	mm	79	79	79	79
	HEIGHT	mm	258	258	258	258
	WEIGHT	kg	11.8	11.8	11.8	11.8
MANUFACTURER			OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.			OPR1002	OPR1002	OPR1002	OPR1002
APPLICABLE REMARKS:			A	A	A	A

REMARKS:

A: ROOM THERMOSTAT CONTROL
B: BUILT-IN CONTROL INCLUDE ADJUSTABLE THERMOSTAT

ELECTRIC BASEBOARD HEATERS						**23 82 00.05**
SYMBOL			HTR-S646			
LOCATION			LABORATORY			
TYPE			BASEBOARD ELECTRIC HEATER			
UNIT ELECTRICAL DATA	CAPACITY	kW	0.8			
	VOLTAGE	V	120			
	PHASE	-	1			
MAXIMUM DIMENSIONS	LENGTH	mm	901			
	WIDTH	mm	79			
	HEIGHT	mm	258			
	WEIGHT	kg	9.1			
MANUFACTURER			OUELLET			
MODEL NO.			OPR752			
APPLICABLE REMARKS:			A			

REMARKS:

A: ROOM THERMOSTAT CONTROL
B: BUILT-IN CONTROL INCLUDE ADJUSTABLE THERMOSTAT

ELECTRIC BASEBOARD HEATERS — 23 82 00.05

SYMBOL			HTR-U653-1	HTR-U653-2		
LOCATION			STORAGE ROOM	STORAGE ROOM		
TYPE			BASEBOARD ELECTRIC HEATER	BASEBOARD ELECTRIC HEATER		
UNIT ELECTRICAL DATA	CAPACITY	kW	1.0	1.0		
	VOLTAGE	V	120	120		
	PHASE	-	1	1		
MAXIMUM DIMENSIONS	LENGTH	mm	1162	1162		
	WIDTH	mm	79	79		
	HEIGHT	mm	258	258		
	WEIGHT	kg	11.8	11.8		
MANUFACTURER			OUELLET	OUELLET		
MODEL NO.			OPR1002	OPR1002		
APPLICABLE REMARKS:			A	A		

REMARKS:

A: ROOM THERMOSTAT CONTROL
B: BUILT-IN CONTROL INCLUDE ADJUSTABLE THERMOSTAT

ELECTRIC RADIANT HEATERS						**23 82 00.06**
SYMBOL			HTR-C623	HTR-C624		
LOCATION			GALLERY 6	GALLERY 7		
TYPE			RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC		
UNIT ELECTRICAL DATA	CAPACITY	kW	2.0	2.0		
	VOLTAGE	V	208	208		
	PHASE	-	1	1		
MAXIMUM DIMENSIONS	LENGTH	mm	1105	1105		
	WIDTH	mm	105	105		
	HEIGHT	mm	168	168		
	WEIGHT	kg	3.3	3.3		
MANUFACTURER			OUELLET	OUELLET		
MODEL NO.			OKB412C621	OKB412C621		
APPLICABLE REMARKS:			A	A		

REMARKS:

A: PROVIDE CYCLE PERCENTAGE TIMER CT2000 SERIES BY INTERMATIC

ELECTRIC RADIANT HEATERS						**23 82 00.06**
SYMBOL			UH-G617-1			
LOCATION			ELECTRICAL ROOM			
TYPE			RADIANT HEATER, ELECTRIC			
UNIT ELECTRICAL DATA	CAPACITY	kW	2.0			
	VOLTAGE	V	208			
	PHASE	-	1			
MAXIMUM DIMENSIONS	LENGTH	mm	1105			
	WIDTH	mm	105			
	HEIGHT	mm	168			
	WEIGHT	kg	3.3			
MANUFACTURER			OUELLET			
MODEL NO.			OKB412C621			
APPLICABLE REMARKS:			A			

REMARKS:

A: PROVIDE CYCLE PERCENTAGE TIMER CT2000 SERIES BY INTERMATIC

ELECTRIC RADIANT HEATERS						**23 82 00.06**
SYMBOL			HTR-R660	HTR-R661	HTR-R662	HTR-R663
LOCATION			GALLERY 8	GALLERY 8	GALLERY 8	GALLERY 8
TYPE			RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC
UNIT ELECTRICAL DATA	CAPACITY	kW	2.0	2.0	2.0	2.0
	VOLTAGE	V	208	208	208	208
	PHASE	-	1	1	1	1
MAXIMUM DIMENSIONS	LENGTH	mm	1105	1105	1105	1105
	WIDTH	mm	105	105	105	105
	HEIGHT	mm	168	168	168	168
	WEIGHT	kg	3.3	3.3	3.3	3.3
MANUFACTURER			OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.			OKB412C621	OKB412C621	OKB412C621	OKB412C621
APPLICABLE REMARKS:			A	A	A	A

REMARKS:

A: PROVIDE CYCLE PERCENTAGE TIMER CT2000 SERIES BY INTERMATIC

ELECTRIC RADIANT HEATERS						**23 82 00.06**
SYMBOL			HTR-R664	HTR-R670	HTR-R671	HTR-R672
LOCATION			GALLERY 8	GALLERY 8A	GALLERY 8A	GALLERY 8A
TYPE			RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC
UNIT ELECTRICAL DATA	CAPACITY	kW	2.0	2.0	2.0	2.0
	VOLTAGE	V	208	208	208	208
	PHASE	-	1	1	1	1
MAXIMUM DIMENSIONS	LENGTH	mm	1105	1105	1105	1105
	WIDTH	mm	105	105	105	105
	HEIGHT	mm	168	168	168	168
	WEIGHT	kg	3.3	3.3	3.3	3.3
MANUFACTURER			OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.			OKB412C621	OKB412C621	OKB412C621	OKB412C621
APPLICABLE REMARKS:			A	A	A	A

REMARKS:

A: PROVIDE CYCLE PERCENTAGE TIMER CT2000 SERIES BY INTERMATIC

ELECTRIC RADIANT HEATERS						**23 82 00.06**
SYMBOL			HTR-R673	HTR-R674	HTR-R675	
LOCATION			GALLERY 8A	GALLERY 8A	GALLERY 8A	
TYPE			RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC	
UNIT ELECTRICAL DATA	CAPACITY	kW	2.0	2.0	2.0	
	VOLTAGE	V	208	208	208	
	PHASE	-	1	1	1	
MAXIMUM DIMENSIONS	LENGTH	mm	1105	1105	1105	
	WIDTH	mm	105	105	105	
	HEIGHT	mm	168	168	168	
	WEIGHT	kg	3.3	3.3	3.3	
MANUFACTURER			OUELLET	OUELLET	OUELLET	
MODEL NO.			OKB412C621	OKB412C621	OKB412C621	
APPLICABLE REMARKS:			A	A	A	

REMARKS:

A: PROVIDE CYCLE PERCENTAGE TIMER CT2000 SERIES BY INTERMATIC

ELECTRIC RADIANT HEATERS						**23 82 00.06**
SYMBOL			HTR-S624	HTR-S625	HTR-S652	HTR-S653
LOCATION			GALLERY 3A	GALLERY 3A	WALKWAY BRIDGE SC 4	WALKWAY BRIDGE SC 5
TYPE			RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC	RADIANT HEATER, ELECTRIC
UNIT ELECTRICAL DATA	CAPACITY	kW	2.0	2.0	2.0	2.0
	VOLTAGE	V	208	208	208	208
	PHASE	-	1	1	1	1
MAXIMUM DIMENSIONS	LENGTH	mm	1105	1105	1105	1105
	WIDTH	mm	105	105	105	105
	HEIGHT	mm	168	168	168	168
	WEIGHT	kg	3.3	3.3	3.3	3.3
MANUFACTURER			OUELLET	OUELLET	OUELLET	OUELLET
MODEL NO.			OKB412C621	OKB412C621	OKB412C621	OKB412C621
APPLICABLE REMARKS:			A	A	A	A

REMARKS:

A: PROVIDE CYCLE PERCENTAGE TIMER CT2000 SERIES BY INTERMATIC