PROJECT MANUAL

FOR

GOVERNMENT OF CANADA
DRIVER TRAINING BUILDING

DATE: April 26, 2016

PREPARED BY:

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Project No 2016008

Part 1 General

1.1 SECTION INCLUDES

.1 Alteration project procedures.

.2 Removal of designated building equipment and fixtures.

.3 Removal of designated construction.

.4 Disposal of materials.

.5 Identification of utilities.

.6 Refer to items as indicated.

1.2 ALTERATION PROJECT PROCEDURES

.1 Materials: As specified in Product sections; match existing Products and work for patching and extending work.

.2 Employ skilled and experienced installer to perform alteration work.

.3 Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.

.4 Remove, cut, and patch Work in a manner to minimize damage and to provide means of restoring Products and finishes to specified condition.

.5 Refinish existing visible surfaces to remain in renovated rooms and spaces, to specified condition for each material, with a neat transition to adjacent finishes.

.6 Where new Work abuts or aligns with existing, provide a smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.

.7 When finished surfaces are cut so that a smooth transition with new Work is not possible, terminate existing surface along a straight line at a natural line of division and submit recommendation to Consultant for review.

.8 Where a change of plane of 6 mm or more occurs, request instructions from Consultant.

.9 Patch or replace portions of existing surfaces which are damaged, lifted, discoloured, or showing other imperfections.

.10 Finish surfaces as specified in individual Product sections.

1.3 REGULATORY REQUIREMENTS

.1 Conform to applicable code for demolition work, dust control, products requiring electrical disconnection and re-connection.

.2 Obtain required permits from authorities.

.3 Do not close or obstruct egress width to any building or site exit.

.4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.

.5 Conform to procedures applicable when hazardous or contaminated materials are discovered.

1.4 PROJECT CONDITIONS

.1 Conduct demolition to minimize interference with adjacent and occupied building areas.

.2 Cease operations immediately if structure appears to be in danger and notify Consultant. Do not resume operations until directed.

Part 2 Products

Not Used

Part 3 Execution

3.1 DEMOLITION REQUIREMENTS

.1 Demolition drawings are provided to assist the contractor in determining the extent of demolition work, but may not include all demolition required for the installation of all new construction.

.2 Coordinate the required demolition with all drawings, specifications and trades.

.3 Conduct demolition to minimize interference with adjacent structures and occupancies.

.4 Cease operations immediately if adjacent structures appear to be in danger. Notify Consultant. Do not resume operations until directed.

.5 Conduct operations with minimum interference to public or private accesses. Maintain protected egress and access at all times.

.6 Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon or limit access to their property.

3.2 PREPARATION

.1 Provide, erect, and maintain temporary barriers at locations indicated.

.2 Erect and maintain weatherproof closures for exterior openings.

.3 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued Owner occupancy.

.4 Protect existing materials which are not to be demolished.

.5 Prevent movement of structure; provide bracing.

.6 Notify affected utility companies before starting work and comply with their requirements.

.7 Mark location and termination of utilities.

.8 Provide appropriate temporary signage including signage for exit or building egress.

3.3 DEMOLITION

.1 Provide select demolition, create openings, and/or remove existing construction as required to accommodate new construction and services.

.2 Remove existing finishes as required to allow for the installation of new finishes.

.3 Disconnect remove, cap, and identify designated utilities within demolition areas.

.4 Demolish in an orderly and careful manner. Protect existing supporting structural members.

.5 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

.6 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

.7 Remove temporary Work.

END OF SECTION

Part 1 General

1.1 GENERAL CONDITIONS

.1 The General Conditions of the Contract, Supplementary General Conditions and General Requirements are hereby made part of this Section.

1.2 WORK INCLUDED

.1 Structural steel framing members, structural steel support members, complete with washers, nuts, shims, anchor plates and bolts.

.2 Erection.

1.3 QUALITY ASSURANCE

.1 Structural steel fabricator to be certified as minimum Division 2 Company under CSA W47.1-09 (R2014) - “Certification of Companies for Fusion Welding of Steel Structures” or CSA Standard W55.3-08 (R2013) “Resistance Welding Qualification Code for Fabricators of Structural Members” or both, as applicable.

.2 Design to strictly adhere to all codes and standards as enumerated under Section 1.5 Reference Standards.

.3 In the event of conflict between pertinent codes, standards and/or regulations, most stringent shall govern.

1.4 REFERENCE STANDARDS

.1 CSA Standard CAN/CSA-S16-14 - “Limit States Design of Structural Steel Buildings”.

.2 CSA G40.21-13 - “Structural Quality Steel”.

.3 ASTM Standard A325M - “High Strength Bolts for Structural Steel Joints including Suitable Nuts and Plane Hardened Washers”.

.4 CSA Standard W59-13 - ‘Welded Steel Construction”.

.5 CSA Standard W47.1-09 (R2014) - “Certification of Companies for Fusion Welding of Steel Structures”.

1.5 SHOP DRAWINGS

.1 Submit shop drawings in accordance with General Conditions.

.2 Clearly indicate sizes, spacing and locations of structural members, connections, attachments, anchorages, framed openings and size and type of fasteners and welds.

.3 Indicate all shop and erection details including cuts, copes, connections, holes, threaded fasteners and welds.

.4 Show all welds, both shop and field, by the currently recommended symbols of the Canadian Welding Bureau.

.5 Review of shop drawings for size and arrangement of principal and auxiliary members only. Such review will not relieve the Contractor of responsibility for general and detail dimension and fit, or any errors or omissions.

1.6 INSPECTION AND TESTING

.1 Materials and workmanship subject to inspection on behalf of Owner.

.2 Report failure of material to fit together properly to Consultant. No corrective measures permitted unless approved by Consultant in writing.

Part 2 Products

2.1 MATERIALS/COMPONENTS

.1 *Standard Rolled Sections:* new material conforming to CSA G40.21-13, Grade 350W.

.2 *Beam End Plates, Ledger Angles and Miscellaneous Steel:* new material conforming to CSA G40.21-13, Grade 300W.

.3 *Bolts, Nuts and Washers:* high strength type recommended for structural steel joints, conforming to requirements of ASTM A325M-83c.

.4 *Paint for Primer:* shall be grey (unless approved otherwise) and meet requirements of one of the following:
  - .1 CGSB 1-GP-40d, Primer, Structural Steel, oil alkyd type.
  - .2 CISC/CPMA Standard 1-73a, quick drying one-coat paint for use on structural steel.

2.2 FABRICATION

.1 Fabricate structural steel members in accordance with building design drawings and all requirements of CAN/CSA S16-14. Welding to conform to CSA W59-13 “Welded Steel Construction”. Verify all dimensions prior to fabrication.

.2 No cutting of openings in structural members except as shown on structural drawings. Reinforce openings to maintain required design strength.

.3 Accurately cut and mill column ends to assure full contact of bearing surfaces.

.4 Camber horizontal members as specified on drawings. Mill camber up where not specifically detailed.

.5 All bolted connections to be “bearing” type connections.

.6 All beams to be connected for the greater of the following conditions.

  - .1 Loads shown on drawings.
  - .2 50% of the total uniformly distributed load resistance of the member.

.3 Half depth of the connected member using M20 bolts (minimum two bolts) in double shear.

2.3 PAINTING

.1 All structural steel shall be prepared in accordance with SSPC Standard SP2 “Hand Tool Cleaning” and have one coat of specified shop applied primer.

Part 3 Execution

3.1 ERECTION

.1 Erect structural steel in accordance with building design drawings and all requirements on CAN/CSA S16-14.

.2 Make adequate provision for all erection loads and for sufficient temporary bracing to maintain structure safe, plumb and in true alignment until completion of erection. Leave such bracing in place as long as required for safety and integrity of the structure.

.3 As erection progresses, securely bolt work to take care of full design loads and to provide structural integrity as required.

.4 Tolerances

.1 Tolerance of all structural steel shall be maintained strictly in accordance with CAN/CSA S16-14.

.5 After erection, prime all welds, abrasions, bolted connections and all other surfaces not shop primed, except surfaces to be in contact with concrete.

.6 Obtain written permission of Consultant prior to altering or field welding of structural members.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Blocking in wall openings.

.2 Wood furring and grounds.

.3 Concealed wood blocking for support of wall cabinets wood trim and all items and equipment deriving support from the walls.

1.2 RELATED SECTIONS

.1 Section 06 20 00 - Finish Carpentry

.2 Section 09 21 16 - Gypsum Board Assemblies

1.3 REFERENCES

.1 CAN/CSA-O80 Series-08 (R2012) - Wood Preservation.CAN/CSA-O80 Series-08 (R2012) - Wood Preservation.

.2 NLGA (National Lumber Grades Authority) - Standard Grading Rules for Canadian Lumber, 2010 edition.

.3 CSA B111-1974 (R2003) -Wire Nails, Spikes and Staples

.4 CAN/CSA G164-M92 (R2003) - Hot Dip Galvanizing of Irregularly Shaped Articles

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Divert unused wood materials from landfill to recycling reuse composting facility.

.4 Do not dispose of preservative treated wood through incineration.

.5 Do not dispose of preservative treated wood with materials destined for recycling or reuse.

.6 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill.

.7 Dispose of unused wood preservative material at official hazardous material collections site.

.8 Do not dispose of unused preservative material into sewer system, into streams, lakes, onto ground or in other locations where they will pose health or environmental hazard.

1.5 QUALITY ASSURANCE

.1 Perform Work in accordance with the following agencies:

  .1 Lumber Grading Agency: Certified by NLGA.

  .2 Preservative Wood Treatment: CSA O80M.

Part 2 Products

2.1 MATERIALS

.1 Lumber Grading Rules: NLGA.

.2 Miscellaneous Framing: Non-structural light grading 19 percent maximum moisture

.3 Panel Materials: (Interior use only):

.1 Venneer core plywood: AWS Skyply Veneer core plywood core, 0 formaldehyde; type of glue recommended for application, voc and formaldehyde free.

2.2 ACCESSORIES

.1 Nails, spikes and staples: to CSA B111.

.2 Fasteners and Anchors:

.1 Fasteners: Hot dipped galvanized steel meeting CAN/CSA-G164, minimum coating of 300 g/m2 for high humidity and treated wood locations, unfinished steel elsewhere.

.2 Anchors: Toggle bolt type for anchorage to hollow masonry. Expansion shield and lag bolt type for anchorage to solid masonry or concrete. Bolt or ballistic fastener for anchorages to steel.

Part 3 Execution

3.1 FRAMING

.1 Set members level and plumb, in correct position.

.2 Place horizontal members, crown side up.

.3 Space framing and furring 400 mm oc.

.4 Place miscellaneous blocking, furring, strapping, nailing strips, framing and sheathing where indicated on drawings and as required for secure support of anchorage of other specified materials. Place members true to lines and levels. Secure rigidly in place.

.5 Coordinate the installation of bucks, anchors, blocking, electrical and mechanical work which is to be placed in or behind partitions. Allow such items to be installed after partition framing is complete. Ensure that allowance is made for thickness of wall finish to be applied.

3.2 SHEATHING

.1 Place sheathing with end joints staggered. Secure sheets over firm bearing. Maintain minimum 1.5 mm and maximum 3 mm spacing between joints on walls. Place perpendicular to framing members.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

.1 Custom wood millwork.

1.2 RELATED SECTIONS

.1 Section 06 10 53 - Rough Carpentry.

.2 Section 09 90 00 - Painting: finishing of finish carpentry items.

1.3 REFERENCES

.1 CSA O115-M82(R2001), Hardwood and Decorative Plywood.

.2 AWI / AWMAC QSI - Quality Standards Illustrated.

1.4 SUBMITTALS

.1 Samples: Submit two samples of finish plywood, 300x300 mm in size illustrating wood grain and specified finish from Section 09 90 00.

.2 Shop Drawings: Indicate materials, component profiles and elevations, assembly methods, surface graining elevations of sheet paneling, joint details, fastening methods, accessory listings, and schedule of finishes.

1.5 QUALITY ASSURANCE

.1 Perform work in accordance with AWI /AWMAC Custom Quality.

1.6 QUALIFICATIONS

.1 Fabricator: Company specializing in fabricating the products specified in this section with minimum five years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Protect work from moisture damage.

.2 Store materials in ventilated interior locations with constant minimum temperatures of 16 degrees C and maximum relative humidity of 55 percent.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate wood waste and place in designated areas in categories as follows for recycling: Solid wood/softwood/hardwood, composite wood, and treated, painted, or contaminated wood.

.2 Set aside damaged wood for acceptable alternative uses (e.g. bracing, blocking, cripples, bridging, finger-joining, or ties). Store separated reusable wood waste convenient to cutting station and area of work.

.3 Separate corrugated cardboard in accordance with Waste Management Plan and place in designated areas for recycling.

.4 Do not burn scrap at project site.

.5 Fold up metal banding, flatten, and place in designated area for recycling.

1.9 COORDINATION

.1 Coordinate the work with plumbing and electrical rough-in, installation of associated and adjacent components.

1.10 FIELD MEASUREMENTS

.1 Verify that field measurements are as on shop drawings instructed by the manufacturer.

Part 2 PRODUCTS

2.1 SHEET MATERIALS

.1 Plywood (WD-1): Rift Cut oak veneer panel, Thickness; varies from 12 mm to 19 mm.

.2 Hardwood Plywood: Conforming to requirements of CSA 0115; Graded in accordance with AWI /AWMAC QSI AA face veneer select white birch, Veneer core, type of glue recommended for application, plain cut matched.

2.2 FASTENERS

.1 Fasteners: Of size and type to suit application; finish in concealed locations and finish in exposed locations.

2.3 ADHESIVE

.1 Adhesive: Type recommended by laminate manufacturer to suit application.

2.4 ACCESSORIES

.1 Wood Filler: tinted to match surface finish colour.

2.5 FABRICATION CASEWORK

.1 Fabricate to AWI /AWMAC QSI Custom standards.

.2 Shop assemble work for delivery to site, permitting passage through building openings.

.3 When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

2.6 SHOP FINISHING

.1 Sand work smooth and set exposed nails and screws.

.2 Apply wood filler in exposed nail and screw indentations.

Part 3 EXECUTION

3.1 EXAMINATION

.1 Verify adequacy of backing and support framing.

.2 Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.2 INSTALLATION

.1 Install work in accordance with AWI /AWMAC QSI custom Quality Standard.

.2 Set and secure materials and components in place, plumb and level.

.3 Carefully scribe work abutting other components. Do not use additional overlay trim to conceal larger gaps.

.4 Install prefinished paneling with full bed contact adhesive applied to substrate. Wall adhesive by the bead method.

3.3 ERECTION TOLERANCES

.1 Maximum Variation from True Position: 1.5 mm.

.2 Maximum Offset from True Alignment with Abutting Materials: 0.7 mm.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

.1 Batt insulation.

.2 Spray Foam Insulation

1.2 RELATED SECTIONS

.1 Section 06 10 53 - Rough Carpentry.

.2 Section 09 21 16 – Gypsum Board Assemblies

1.3 REFERENCES

.1 CAN/ULC-S701-11, Thermal Insulation, Polystrene, Boards and Pipe Coverings.

.2 CAN/ULC-S702-97, Thermal Insulation, Mineral Fibre, for Buildings.

.3 ASTM C665 – Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

.4 UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.4 ENVIRONMENTAL REQUIREMENTS

.1 Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

Part 2 PRODUCTS

2.1 INSULATION MATERIALS

.1 Batt Insulation: ASTM C665; preformed glass fiber batt, roll, blanket; friction fit.

  .1 Acceptable manufacturers: Fibreglass Pink as manufactured by Owens Corning.; Certainteed; Johns Manville.

2.2 SPRAY-ON INSULATION

.1 Foamed-in-place insulation: Portable, self-contained two component polyurethane foam insulation;

  .1 Acceptable manufactures: Versi-Foam, manufactured by Abisko Manufacturing Inc.

.2 Primer: Type recommended by insulation manufacturer.

Part 3 EXECUTION

3.1 EXAMINATION

.1 Verify that substrate, adjacent materials, and batts are dry and ready to receive insulation.

.2 Verify substrate surface is flat, free of honeycomb, fins, irregularities, materials or substances that may impede installation.

.3 Verify surfaces within walls being insulated have been inspected and approved.

3.2 BATT INSULATION

.1 Install batt insulation locations as noted on drawings without gaps or voids.

.2 Fit insulation tight in spaces and behind exterior side of mechanical and electrical services leaving no gaps or voids.

3.3 FOAMED-IN-PLACE INSULATION

.1 Apply foamed-in-place insulation to insulation manufacturers written instructions.

.2 Apply insulation to junction of roof deck and wall and as noted on the drawings.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Preparing substrate surfaces.

.2 Sealant and joint backing.

1.2 RELATED SECTIONS

.1 Section 07 21 15 - Insulation.

.2 Section 09 21 16 - Gypsum Board Assemblies: Sealants required in conjunction with acoustic treatment.

1.3 REFERENCES

.1 ASTM C919-11 - Standard Practice for Use of Sealants in Acoustical Applications.

.2 ASTM C920-13 - Standard Specification for Elastomeric Joint Sealants.

.3 ASTM C1311-10 - Standard Specification for Solvent Release Sealants.

.4 ASTM C1330-02(2007) - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.

1.4 QUALITY ASSURANCE

.1 Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

1.5 QUALIFICATIONS

.1 Applicator: Company specializing in performing the work of this section with minimum Three years documented experience and approved by manufacturer.

1.6 ENVIRONMENTAL REQUIREMENTS

.1 Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material for recycling.

.2 Dispose of unused sealant materials at official hazardous material collections site.

.3 Do not dispose of unused sealant materials into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.

1.8 WARRANTY

.1 Provide five year warranty.

.2 Warranty: Include coverage for installed sealants and accessories which fail to achieve air tight seal, water tight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.1 SEALANTS

.1 Acrylic Sealant (Type A): ASTM C920, paintable; single component, solvent curing, non-staining, non-bleeding, non-sagging; Tremflex 834. Colour to be selected by consultant.

.2 Acoustic Sealant (Type B): ASTM C1311, Acoustic grade, single component, solvent release, non-skinning, non-sagging, synthetic rubber, Tremco Acoustic Sealant Grey colour.

.3 Polyurethane Sealant (Type C): ASTM C920, single component, chemical curing, non-staining, non-bleeding, Elongation Capability25 percent, non-sagging; Tremco Dymonic; PRC RC-1; Sonneborn NP-1; Vulkem 931. Colour as selected by Consultant

.4 Silicone Sealant (Type D): ASTM C920, single component, fungus resistant, acidic curing, non-sagging, non-staining, non-bleeding; General Electric 'Sanitary 1700; Dow Corning 786. Colours as selected by Consultant.

2.2 ACCESSORIES

.1 Primer: Non-staining type, recommended by sealant manufacturer to suit application.

.2 Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

.3 Joint Backing: ASTM C1330; round, closed cell polyethylene foam rod; oversized 30 to 50 percent larger than joint width.

.4 Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Verify that substrate surfaces and joint openings are ready to receive work.

.2 Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

.1 Remove loose materials and foreign matter which might impair adhesion of sealant.

.2 Clean and prime joints in accordance with manufacturer's instructions.

.3 Perform preparation in accordance with manufacturer's instructions.

.4 Protect elements surrounding the work of this section from damage or disfiguration.

3.3 INSTALLATION

.1 Install sealant in accordance with manufacturer's instructions.

.2 Measure joint dimensions and size materials to achieve required 2:1 width/depth ratios.

.3 Install bond breaker where joint backing is not used.

.4 Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

.5 Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

.6 Tool joints concave.

3.4 CLEANING

.1 Clean adjacent soiled surfaces.

3.5 PROTECTION OF FINISHED WORK

.1 Protect finished installation.

.2 Protect sealants until cured.

3.6 SCHEDULE

.1 Apply sealant type 'A' to junctures of millwork items and adjacent building components and perimeter of door frames as directed by Consultant.

.2 Apply sealant type 'B' in two continuous beads around perimeter of plates, at top, bottom and sides of all partitions.

.3 Apply double bead sealant type 'B' around designated fire separations i.e. before setting top and bottom plates, where studs set around other materials, etc

.4 Apply sealant Type `C' to exterior condition joints between door frames, window frames, siding components, etc. and where indicated on drawings.

.5 Apply sealant Type 'D' to perimeter joints of all sanitary components, vanities, counters, sinks, water closets, shower heads, etc. unless noted otherwise on drawings.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Repair of interior flat gypsum plaster walls and ceilings.

1.2 RELATED SECTIONS

.1 Section 09 21 16 – Gypsum Board Assemblies.

1.3 REFERENCES

.1 ASTM C28/C28M-10 - Standard Specification for Gypsum Plasters.

.2 ASTM C1396/C1396M-13 - Standard Specification for Gypsum Board.

1.4 QUALITY ASSURANCE

.1 Restorer Qualifications:

- .1 Company specializing in performing the work of this section with minimum three (3) years documented experience.

.2 Analysis of Existing Plaster:

- .1 Remove four (4) samples of existing plaster from different locations.
- .2 Retain one sample for later comparison.
- .3 Break up remaining samples individually with mallet until constituent parts remain. Examine under microscope to determine:
  - .1 Approximate proportions of aggregate and gypsum.
  - .2 Type, size, and colour of aggregate.
  - .3 Types of additives.

1.5 DELIVERY, STORAGE, AND PROTECTION

.1 Protect materials from moisture absorption and damage; reject damaged containers.

.2 Store sand to prevent inclusion of foreign matter.

1.6 SITE CONDITIONS

.1 Ambient Conditions:

- .1 Do not apply plaster when ambient or substrate temperature is less than 50 degrees F nor more than 85 degrees F.
- .2 Maintain minimum ambient temperature of 50 degrees F during and after application of plaster.

Part 2 Products

2.1 MATERIALS

.1 Gypsum Plaster: ASTM C28/C28M.

.2 Aggregate: sand, size, colour, and texture to match existing.

.3 Additives: As determined by existing plaster analysis, to match existing original plaster.

.4 Gypsum Lath: ASTM C1396/C1396M; 10mm thick.

.5 Water: Clean and potable.

2.2 ACCESSORIES

.1 Patching Compound: Premixed, containing gypsum and aggregate.

.2 Tape: Woven glass fibre type, 200 mm wide.

.3 Gypsum Lath Fasteners: Drywall screws; minimum 16 mm penetration into framing.

.4 Tie Wire: Galvanized annealed steel, minimum 18 gauge.

.5 Bonding Agent: Type recommended for bonding plaster directly to masonry surfaces.

2.3 MIXES

.1 Scratch, Brown, and Finish Coats: Mix gypsum additives and aggregate in proportions to match existing plaster. Add water to achieve workable consistency.

.2 Patching Compound: Mix with water to manufacturer's written instructions.

Part 3 Execution

3.1 REPAIR OF SMALL CRACKS AND MINOR DAMAGE

.1 Remove existing damaged plaster back to a point at which sound material is reached.

.2 Remove loose and foreign matter that could impair adhesion.

.3 Fill voids with patching compound; apply with sufficient pressure to eliminate voids and ensure adhesion.

.4 Finish to match adjacent surfaces.

3.2 REPAIR OF LARGE CRACKS

.1 Remove existing damaged plaster back to a point at which sound material is reached.

.2 Remove loose and foreign matter that could impair adhesion.

.3 Fill voids with patching compound; apply with sufficient pressure to eliminate voids and ensure adhesion.

.4 Embed tape in wet compound. Apply additional compound to cover tape.

.5 Finish to match adjacent surfaces.

3.3 REPAIR OF DELAMINATED PLASTER LAYERS

.1 Remove existing damaged plaster layers down to a point at which sound material is reached.

.2 Remove loose and foreign matter that could impair adhesion.

.3 Apply bonding agent to manufacturer's written instructions.

.4 Fill voids with patching compound; apply with sufficient pressure to eliminate voids and ensure adhesion.

.5 Finish to match adjacent surfaces.

3.4 REPAIR OF DAMAGED PLASTER OVER WOOD LATH

.1 Remove existing damaged plaster down to lath.

.2 Reattach loose lath with nails or wire ties.

.3 Install metal lath over existing wood lath. Cut lath approximately 13 mm smaller on all sides than area to be patched. Attach to wood lath with nails or wire ties.

.4 Apply scratch, brown, and finish coats to thickness to match existing original plaster.

.5 Finish to match adjacent surfaces.

3.5 REPAIR OF DAMAGED PLASTER OVER METAL LATH

.1 Remove existing damaged plaster down to lath.

.2 Reattach loose lath with nails or wire ties.

.3 Apply scratch, brown, and finish coats to thickness to match original existing plaster.

.4 Finish to match adjacent surfaces.

3.6 REPAIR OF DAMAGED PLASTER OVER GYPSUM LATH

.1 Remove existing damaged plaster and gypsum lath.

.2 Apply gypsum lath with ends and edges occurring over supports.

  .1 Cut panels with maximum 3 mm gaps at perimeter and around openings and penetrations.

  .2 Mechanically fasten panels to framing. Place fasteners minimum 3/8 inch from edges of panels. Drive heads slightly below surface.

.3 Apply scratch, brown, and finish coats to thickness to match existing original plaster.

.4 Finish to match adjacent surfaces.

3.7 REPAIR OF DAMAGED PLASTER OVER MASONRY

.1 Remove existing damaged plaster down to masonry.

.2 Rout out mortar joint to 16 mm depth.

.3 Apply bonding agent to manufacturer's written instructions.

.4 Apply scratch, brown, and finish coats to thickness to match existing original plaster.

.5 Finish to match adjacent surfaces.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Gypsum board and joint treatment.

.2 Gypsum sheathing.

.3 Cementitious backer board.

.4 Light gauge metal stud wall framing.

.5 Metal channel ceiling framing.

1.2 RELATED SECTIONS

.1 Section 06 10 53 - Rough Carpentry.

.2 Section 07 21 15 - Insulation: Thermal insulation.

.3 Section 07 92 00 - Joint Sealers

.4 Section 09 90 00 - Painting and Coating.

1.3 REFERENCES

.1 ASTM C840-13 - Standard Specification for Application and Finishing of Gypsum Board.

.2 ASTM C1002-07(2013) - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

.3 ASTM C1177M-13) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing

.4 ASTM C1396/C1396M-13 - Standard Specification for Gypsum Board.

.5 Gypsum Association GA-214-10 - Recommended Levels of Gypsum Board Finish.

.6 Gypsum Association GA-216-10 - Application and Finishing of Gypsum Panel Products.

.7 Gypsum Association GA-600-12 - Fire Resistance Design Manual.

1.4 SUBMITTALS

.1 Shop Drawings:

  .1 Indicate design loads, member sizes, member spacing, materials, design thickness exclusive of coatings, coating specifications, connection and bracing details, screw sizes and spacing, and anchors.

  .2 Indicate locations, dimensions, openings and requirements of related work.

  .3 Indicate welds by welding symbols as defined in CSA W59.

.2 Prior to beginning Work, upon request, submit: two certified copies of mill reports covering material properties.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Collect and separate for disposal, paper, plastic, metal, corrugated cardboard, and other packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.2 Divert unused materials, cut offs etc, from landfill appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Dispose of unused sealant materials, paint, primers, at official hazardous material collections site.

.4 Do not dispose of unused sealant materials, paint, primers, into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.

1.6 QUALITY ASSURANCE

.1 Perform Work in accordance with ASTM C840.

.2 Applicator Qualifications: Company specializing in performing the work of this section with minimum five years documented experience.

.3 Design structural elements under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

1.7 REGULATORY REQUIREMENTS

.1 Conform to applicable code for fire rated assemblies.

Part 2 Products

2.1 MANUFACTURERS - GYPSUM BOARD SYSTEM

.1 Domtar Construction Materials.

.2 Certainteed.

.3 Canadian Gypsum Company

.4 Georgia Pacific Co.

2.2 FRAMING MATERIALS

.1 Studs and Tracks: GA-216 and GA-600; galvanized sheet steel, 0.53mm thick, C shape, with knurled faces. Use minimum 1.22 mm steel studs for exterior wall framing.

.2 Slip joint head track: 0.61 mm thick, galvanized sheet steel, 50 mm deep.

.3 Fire rated slip joint head track: Firetrak manufactured by Firetrak corp.

.4 Furring, Framing, and Accessories: GA-216 and GA-600.

.5 Fasteners: ASTM C1002.

.6 Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

.7 Carrying Channels: 1.52 mm galvanized sheet steel, 12 x 19 mm.

.8 Hangers: galvanized steel wire, size to suit application, maximum deflection 1/360.

.9 Accessories for load bearing framing:

.1 Bridging: fabricated from same material and finish as studs, 38 x 12 x 1.09 mm minimum thickness.

.2 Angle clips: fabricated from same material and finish as studs, 38 x 38 mm x depth of steel stud, 1.52 mm minimum thickness.

.3 Tension straps and accessories: as recommended by manufacturer.

2.3 GYPSUM BOARD MATERIALS

.1 Standard Gypsum Board: ASTM C1396; 16 mm thick, maximum available length in place; ends square cut, tapered edges.

.2 Fire Rated Gypsum Board: ASTM C1396; fire resistive type, UL or WH rated; 16 mm thick, maximum available length in place; ends square cut, tapered edges.

.3 All gypsum board on ceilings to be 16 mm thick unless noted

2.4 ACCESSORIES

.1 Acoustic Insulation: Section 07 21 15.

.2 Acoustical Sealant: non-hardening, non-skinning, for use in conjunction with gypsum board, specified in Section 079200.

.3 Corner Beads: 0.45 mm. thick, galvanized sheet steel, paper faced; tapable

.4 Edge Trim: GA-201 and GA-216; Galvanized steel with 'J' type bead, tapable.

.5 Joint Materials: GA-201 and GA-216; reinforcing tape, joint compound, adhesive, and water.

.6 Fasteners: ASTM C1002, Type S12.

.7 Control joints: V profile with 6mm open slot protected with plastic tape to be removed after joint finishing.

Part 3 Execution

3.1 METAL STUD INSTALLATION

.1 Install studs in accordance with GA-201, GA-216 and GA-600.

.2 Metal Stud Spacing: minimum 400 mm on center.

.3 Refer to shop drawings for load bearing stud size and spacing

.4 Reduce spacing of metal studs on curved walls to prevent flat sections between studs.

.5 Install 0.91 mm steels studs at locations where stud wall heights are greater than 3.5 m.

.6 Extend stud framing to ceiling only. Attach ceiling runner securely to ceiling framing in accordance with manufacturer's instructions.

.7 Refer to Drawings for indication of partitions extending stud framing through the ceiling to the structure above. Maintain clearance under structural building members to avoid deflection transfer to studs.

.8 Install slip joint head track where stud walls meet structure. Allow for 40 mm deflection.

.9 Door Opening Framing: Install double studs at door frame jambs.

.10 Coordinate installation of bucks, anchors, blocking, electrical and mechanical work placed in or behind partition framing.

.11 Install slip joint head track in non-load bearing fire rated walls in accordance with the requirements of the Manitoba Building code.

.12 Frame openings in fire rated walls for fire dampers and hollow metal frames in accordance with NFPA 80.

3.2 GYPSUM BOARD INSTALLATION

.1 Install gypsum board in accordance with GA-201, GA-216 and GA-600.

.2 Erect single layer standard gypsum board in most economical direction, with ends and edges occurring over firm bearing.

.3 Erect single layer fire rated gypsum board vertically, with edges and ends occurring over firm bearing.

.4 Erect exterior gypsum sheathing horizontally, with edges butted tight and ends occurring over firm bearing.

.5 Use screws when fastening gypsum board to metal furring or framing.

.6 Double Layer Applications: Secure second layer to first with. adhesive and sufficient support to hold in place. Apply adhesive in accordance with manufacturer's instructions.

.7 Place second layer perpendicular to first layer. Offset joints of second layer from joints of first layer.

.8 Place control joints consistent with lines of building spaces as directed, but not more than 10 m o.c.

.9 Place corner beads at external corners as indicated. Use longest practical length. Place edge trim where gypsum board abuts dissimilar materials.

.10 Install gypsum board in top of door frames and in perimeter of fire damper openings in accordance with NFPA 80.

3.3 JOINT TREATMENT

.1 Finish in accordance with GA-214 Level 4.

.2 Finish fire rated walls above ceilings in accordance with GA-214 level 1.

.3 Feather coats on to adjoining surfaces so that camber is maximum 0.8 mm.

.4 Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile.

.5 Feather coats on to adjoining surfaces so that camber is maximum 0.8 mm.

.6 Fill and finish joints and corners of cementitious backing board.

3.4 TOLERANCES

.1 Maximum Variation of Finished Gypsum Board Surface from True Flatness: 3 mm in 3 m in any direction.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Suspended metal grid ceiling system and perimeter trim.

.2 Acoustic tile.

1.2 RELATED SECTIONS

.1 Section 09 21 16 – Gypsum Board Assemblies.

.2 Mechanical devices in ceiling system.

.3 Electrical fixtures in ceiling system.

1.3 REFERENCES

.1 ASTM C635/C635M-12 **-** Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan

1.5 REGULATORY REQUIREMENTS

.1 Conform to applicable code for fire rated assembly and combustibility requirements for materials.

1.6 ENVIRONMENTAL REQUIREMENTS

.1 Maintain uniform temperature of minimum 16 degrees C, and maximum humidity of 40 percent prior to, during, and after acoustic unit installation.

.2 Store material in work area 48 hours prior to installation.

1.7 PROJECT CONDITIONS

.1 Sequence work to ensure acoustic ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

.2 Install acoustic units after interior wet work is dry.

Part 2 Products

2.1 SUSPENSION SYSTEM MATERIALS (lay in tile)

.1 Non-fire Rated Grid: ASTM C635, intermediate duty; exposed T; components die cut and interlocking. Armstrong Prelude.

.2 Grid Materials: Commercial quality cold rolled steel with galvanized coating.

.3 Exposed Grid Surface Width: 9/16 inch.

.4 Grid Finish: White.

.5 Accessories: Stabilizer bars, clips, splices, perimeter moldings, required for suspended grid system.

.6 Support Channels and Hangers: Galvanized steel; size and type to suit application, and ceiling system flatness requirement specified.

2.2 ACOUSTIC UNIT MATERIALS

.1 Manufacturers:

 .1 Armstrong

 .2 Canadian Gypsum Co.

 .3 Celotex

.2 Acoustic Panels: ASTM E1264, 24 x 48 x ¾" ; square edge; white colour; Armstrong Cirrus Fine Texture.

2.3 ACCESSORIES

.1 Touch-up Paint: Type and colour to match acoustic and grid units.

Part 3 Execution

3.1 EXAMINATION

.1 Verify that layout of hangers will not interfere with other work.

3.2 INSTALLATION - LAY-IN GRID SUSPENSION SYSTEM

.1 Install suspension system in accordance with manufacturer's instructions and as supplemented in this section.

.2 Install system capable of supporting imposed loads to a deflection of 1/360 maximum.

.3 Locate system on room axis according to reflected plan.

.4 Install after major above ceiling work is complete. Coordinate the location of hangers with other work.

.5 Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

.6 Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

.7 Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability. Support fixture loads by supplementary hangers located within 150 mm of each corner; or support components independently.

.8 Do not eccentrically load system, or produce rotation of runners.

.9 Perimeter Molding:

.1 Install edge molding at intersection of ceiling and vertical surfaces.

.2 Use longest practical lengths.

.3 Miter corners.

.4 Provide at junctions with other interruptions.

.10 Form expansion joints to accommodate plus or minus 25 mm movement. Maintain visual closure.

3.3 INSTALLATION - ACOUSTIC UNITS

.1 Install acoustic units in accordance with manufacturer's instructions.

.2 Fit acoustic units in place, free from damaged edges or other defects detrimental to appearance and function.

.3 Lay directional patterned units one way with pattern parallel to longest shortest room axis. Fit border trim neatly against abutting surfaces.

.4 Install units after above ceiling work is complete.

.5 Install acoustic units level, in uniform plane, and free from twist, warp, and dents.

.6 Cutting Acoustic Units:

.1 Cut to fit irregular grid and perimeter edge trim.

.2 Double cut and field paint exposed edges of tegular units.

.7 Where bullnose concrete block corners round obstructions occur, provide preformed closures to match perimeter molding.

3.4 ERECTION TOLERANCES

.1 Maximum Variation from Flat and Level Surface: 3 mm in 3 m.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

.1 Surface preparation and field application of paints and coatings.

1.2 RELATED SECTIONS

.1 Section 09 21 16 – Gypsum Board Assemblies

1.3 REFERENCES

.1 NPCA (National Paint and Coatings Association) - Guide to U.S. Government Paint Specifications.

.2 MPI (The Master Painters Institute) - Architectural Painting Specification Manual

.3 SPCC - Society for Protective Coatings (formerly Steel Structures Painting Council):

  .1 Steel Structures Painting Manual.

1.4 SUBMITTALS

.1 Samples: Submit two samples, 200x200 mm in size illustrating selected colours and textures for each colour selected.

.2 Provide sample of stains finish for approval.

1.5 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

.2 Applicator: Company specializing in performing the work of this section with minimum five years documented experience.

.3 Acceptable manufacturers, materials, workmanship and all items affecting the work of this section is to be in accordance with The Master Painters Institute (MPI) "Architectural Painting Specification Manual".

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, protect and handle products to site.

.2 Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

.3 Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, colour designation, and instructions for mixing and reducing.

.4 Store paint materials at minimum ambient temperature of 7 degrees C and a maximum of 32 degrees C, in ventilated area, and as required by manufacturer's instructions.

1.7 ENVIRONMENTAL REQUIREMENTS

.1 Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

.2 Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

.3 Minimum Application Temperatures for Latex Paints: 7 degrees C for interiors; 10 degrees C for exterior; unless required otherwise by manufacturer's instructions.

.4 Provide lighting level of 860 lx measured mid-height at substrate surface.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Paint, stain and wood preservative finishes and related materials (thinners, solvents, etc.,) are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.

.2 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.

.3 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.

.4 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground the following procedures shall be strictly adhered to:

- .1 Retain cleaning water for water-based materials to allow sediments to be filtered out.
- .2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
- .3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
- .4 Dispose of contaminants in an approved legal manner in accordance with hazardous waste regulations.
- .5 Empty paint cans are to be dry prior to disposal or recycling (where available).

.5 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

.6 Set aside and protect surplus and uncontaminated finish materials: Deliver to or arrange collection for verifiable re-use or re-manufacturing.

.7 Close and seal tightly partly used sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.

Part 2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturers: all paint and varathane used shall be listed in the Master Painters Institute approved product List – most recent edition.

.2 Paint materials for paint systems shall be products of a single manufacturer.

2.2 MATERIALS

.1 Coatings: Ready mixed, except field catalyzed coatings, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.

.2 Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.

.3 Patching Materials: Latex filler.

.4 Fastener Head Cover Materials: Latex filler.

2.3 FINISHES

.1 Refer to schedule at end of section for surface finish and colour schedule.

Part 3 EXECUTION

3.1 EXAMINATION

.1 Verify that surfaces are ready to receive work as instructed by the product manufacturer.

.2 Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

.3 Test shop applied primer for compatibility with subsequent cover materials.

.4 Do not apply finishes unless moisture content of surfaces are below the paint manufacturer’s recommended maximums.

3.2 PREPARATION

.1 Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

.2 Correct defects and clean surfaces which affect work of this section. Remove existing coatings that exhibit loose surface defects.

.3 Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.

.4 Interior Wood Items Scheduled to Receive Paint Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats.

3.3 APPLICATION

.1 Apply products in accordance with manufacturer's instructions.

.2 Do not apply finishes to surfaces that are not dry.

.3 Apply each coat to uniform finish.

.4 Sand wood lightly between coats to achieve required finish.

.5 Apply each coat of paint slightly darker than preceding coat unless otherwise approved.

.6 Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.

.7 Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.

.8 Prime concealed surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.

.9 Allow applied coat to dry before next coat is applied.

3.4 CLEANING

.1 Collect waste material which may constitute a fire hazard, place in closed metal containers and remove daily from site.

3.5 SCHEDULE - INTERIOR SURFACES

.1 MPI Gloss Levels

	Description	**Gloss at 60º**	**Sheen at 85º**
Gloss Level 1	Traditional matte	5 units	10 units max.
Gloss Level 2	Velvet - like finish	Max 10 units	10 - 35 units
Gloss Level 3	Traditional eggshell	10 - 25 units	10 - 35
Gloss Level 4	Satin - like finish	20 – 35 units	35 units min.
Gloss Level 5	traditional semi-gloss	35 – 70 units	
Gloss Level 6	Traditional gloss	70 – 85 units	
Gloss Level 7	High gloss	More than 85	

.2 Plaster, Gypsum Board:

.1 One coat of alkyd primer sealer.

.2 Two coats of alkyd enamel.

.3 Wood - Painted:

.1 One coat of alkyd prime sealer.

.2 Two coats of alkyd enamel.

END OF SECTION

PART 1.0 GENERAL PROVISIONS

1.1 GENERAL

.1 Refer to Section 23 00 00 for general conditions for the plumbing systems.

.2 Refer to Divisions 21, 22, 23, and 25 for specific requirements of the plumbing systems.

- END OF SECTION -

PART 1.0 GENERAL

1.1 Work Included

.1 Clean-outs.

.2 Floor and area drains.

.3 Pressure regulator and relief valves.

.4 Vacuum breakers.

1.2 General Requirements

.1 Provide materials, equipment and labor to install plumbing as required by Provincial and Local Codes and as specified herein.

.2 Provide an approved water meter and bypass installation conforming to Local Codes and Standards.

.3 Provide piping connections to equipment furnished in other sections of this specification and by the Owner.

.4 Provide and include charges for connections to Municipal and Utility company services.

1.3 Submittals

.1 Submit shop drawing of plumbing equipment and accessories in accordance with Section 23 00 00.

PART 2.0 PRODUCTS

2.1 Cleanouts

.1 Provide caulked or threaded type extended to finish floor or wall surface. Provide bolted cover plate clean-outs on vertical rainwater leaders only. Ensure ample clearance at clean-out for rodding of drainage system.

.2 Floor clean-out access covers in unfinished areas shall be round with nickel bronze scoriated frames and plates. Provide [round] [square] access covers in finished areas with depressed centre section to accommodate floor finish. Wall clean-outs to have chrome plated caps.

.3 Not all clean-out locations are shown on the drawings. Provide clean-outs as required by the Plumbing Code and the Authority having Jurisdiction.

2.2 Floor Drains

.1 Floor drains shall have lacquered cast iron body with double drainage flange, and or seepage flange, weep holes combined two piece body reversible clamping device and adjustable nickel/bronze strainer. Shower and washroom floor drains shall have a removable perforated sediment bucket.

.2 Floor drains in equipment rooms shall have polished bronze funnel type strainer.

2.3 Equipment Drains

.1 Provide a sloped connection from packaged equipment drain pans to nearest sanitary sewer trapped connection. Slope at minimum of 0.5% grade. Drains size to be 20mm complete with minimum 100mm (water depth) deep trap at unit. Provide a minimum of 50mm air gap between equipment drain outlet and nearest sanitary trapped connection.

2.4 Vacuum Breaker Assemblies

.1 Provide pressure type vacuum breaker assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall consist of one (1) positive sealing check valve and one (1) atmospheric vent disk with stainless steel or bronze seats complete with shut-off valves before and after check valves and test cocks. Assembly shall meet AWWA requirements and CSA B64 standards. Watts No. 800.

.2 Provide atmospheric type vacuum breaker assembly complete with shut-off valve before assembly. Assembly shall consist of one (1) free floating poppet to seal the atmospheric vent under flow conditions. Watts No. 288A. For bottom inlet and outlet, Watts No. 388ASC.

.3 Provide hose connection type vacuum breaker assembly, consisting of a check valve disc assembly to be vandal proof and drainable. Watts No. 8A. For freezing conditions, Watts No. NF8.

2.5 Pressure Reducing Valves

.1 25mm and smaller: Bronze body, SS integral strainer, renewable SS seat, high temperature rated diaphragm suitable for hot or cold water. Rated at maximum inlet pressure of 2060 kPa psi, maximum reduced pressure 170 kPa, maximum temperature 90°C.

.2 30mm and larger: Pilot operated, cast iron body, modified globe design, threaded ends to 50mm, flanged ends 65mm and larger. Maximum inlet pressure 2060 kPa. Maximum temperature 90°C. Bronze trim. Pilot control system: bronze with SS trim, hydraulically operated, diaphragm actuated.

.3 Size to suit flow capacities and service.

.4 Provide with gate valve and union on inlet and outlet, globe valve bypass, pressure gauge on inlet and outlet and pressure relief valve on reduced pressure side.

PART 3.0 EXECUTION

3.1 Installation

.1 Lubricate clean-out plugs with mixture of graphite and linseed oil. Prior to building turnover remove clean-out plugs, re-lubricate and reinstall using only enough force to ensure permanent leak-proof joint.

.2 Install vacuum breakers on plumbing lines where contamination of domestic water may occur. Generally necessary on makeup lines, hose bibs and flush valves.

.3 Where floor drains are located over occupied areas, provide waterproof installation.

.4 Drainage lines shall grade 2% unless otherwise indicated on drawings.

.5 Install pressure reducing valves to limit maximum static pressure at plumbing fixtures to 550 kPa.

.6 Install all equipment and fitments to manufacturer’s installation instructions.

.7 Locate plumbing vents minimum 4.5m from air intakes.

- END OF SECTION -

PART 1.0 GENERAL MECHANICAL CONDITIONS

1.1 GENERAL

.1 This section applies to all Division 21, 22, 23, and 25 work, unless specifically noted otherwise.

.2 Provide complete, fully tested and operational mechanical systems to meet requirements described in these specifications and on the drawings, and in complete accord with all applicable codes and ordinances.

.3 Contract documents of Division 21, 22, 23, and 25 work are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.4 Install equipment generally in locations and routes shown, close to building structure with minimum interference with other services or free space.

.5 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start-up and test.

1.2 WRITTEN GUARANTEE

.1 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of one (1) year from the date of Total Performance. The Contractor shall, at his own expense, repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not, in any way, supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.

1.3 EXTENT OF CONTRACT

.1 Unless otherwise shown on the plans, the work of this Division includes all work to 1.5 meters outside of the exterior of the building. Coordinate the tie-in of building utility services and include equipment, materials and services for connection to utilities installed under other Divisions. The Contractor shall be responsible for any additional costs incurred due to lack of coordination in the installation and commissioning of building services.

1.4 AVAILABILITY OF EQUIPMENT AND MATERIALS

.1 Make known in writing to the Engineer seven (7) working days prior to the tender closing date any materials specified that are required to complete the work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the tender price.

1.5 CODES, ORDINANCES AND FEES

.1 Give all required notices, obtain all necessary permits and pay all fees in order that work herein specified may be carried out. Furnish any certificates necessary as evidence that the work installed conforms with the laws and regulations of all Authorities Having Jurisdiction. This must be done before final certificates will be issued.

.2 Changes and alterations required by any authorized inspector or any Authority Having Jurisdiction, shall be carried out at no additional cost.

.3 The codes referenced in this section are these current at the time of permit issuance for that portion of the work.

1.6 HAZARDOUS MATERIALS

.1 The Contractor shall identify any suspected hazardous materials such as mould or asbestos not already identified on the drawings or in the specifications. If it is determined that testing is required, the Owner shall undertake and pay for testing necessary to determine hazard of material, and, if necessary, its encapsulation or removal.

1.7 MATERIALS AND EQUIPMENT

.1 Materials and equipment installed shall be new and of quality specified. Use same brand or manufacturer for each specific application.

.2 Use products of one manufacturer for material and equipment of same type or classification unless otherwise specified.

.3 Statically and dynamically balance rotating equipment for minimum vibration and low operating noise level.

.4 Each major component of equipment shall bear manufacturer's name, address, catalogue and serial number in a conspicuous place.

.5 All materials brought onto the construction site shall, where applicable, have the supplier's WHMIS label attached, material safety data sheets available, and ensure all persons in contact with hazardous material are informed of such and have information readily available.

1.8 METRIC CONVERSION

.1 All units in this Division are expressed in SI units.

.1 Where imperial units are shown, these are for information purposes only. Where there is a conflict between the metric units and imperial units given, the metric units shall apply.

.2 Submit all shop drawings and maintenance manuals in SI units.

.3 On all submittals (shop drawings, etc.) use the same SI units as stated in the specification.

1.9 CUTTING AND PATCHING

.1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Structural Engineer before coring, cutting, or burning structural members.

.4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm in diameter and larger. Field cut holes smaller than 100 mm.

.5 Patch the building where damaged from equipment installation, improperly located holes, etc. Use matching materials as specified in the respective Section.

1.10 FIRE STOPPING

.1 Fire-stop all pipe and duct penetrations through floors and walls designated as fire and/or smoke separations.

.2 Fire-stopping materials to meet ULC CAN 2S115.

.1 Acceptable Materials: by “Tremco” or “National Firestopping”.

.3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per Manufacturer's Instructions.

1.11 DRAWINGS AND SPECIFICATIONS

.1 Drawings and specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both.

.2 Should any discrepancy appear between drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain a ruling from the Engineer, before submitting a tender. If this is not done, it will be assumed that the most expensive alternate has been included.

.3 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

1.12 QUALITY CONTROL

.1 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.2 Remove and replace improperly installed equipment to the satisfaction of the Engineer at no additional cost.

.3 Replace material or workmanship below specified quality and relocate work wrongly placed, to the satisfaction of the Engineer, at no additional cost.

.4 Provide labour and materials required to install test and place mechanical systems into operation. Provide additional labour and material for modifications required to correct any incorrect installations.

1.13 EXAMINATION OF SITE

.1 Examine the site and the local conditions affecting work of this Contract. Examine carefully all contract drawings and be satisfied that the Work under Division 21, 22, 23, and 25 can be satisfactorily carried out as shown on these plans without changes to the building. Before commencing the Work, examine the Work of the other trades and report at once any defect or interference affecting the Work of Division 21, 22, 23, and 25, or the Guarantee of this Work. No extras will be subsequently allowed to cover any such error, omission or oversight on the thorough inspection of the grounds, building, existing conditions, etc.

1.14 COORDINATION OF WORK

.1 Co-operate and co-ordinate with other trades on the project.

.2 Make reference to electrical, mechanical, structural, architectural, and all other contract drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained.

.3 Where dimensional details are required, work with the applicable architectural and structural drawings.

.4 Full size and detailed drawings shall take precedence over scale measurements from drawings.

.5 Assume full responsibility for laying out work and for any damage caused to the Owner, or other trades by improper location or carrying out work.

.6 Be responsible for prompt installation of work in advance of concrete pouring or similar work. Provide and set sleeves where required.

.7 Arrange the Work in cooperation with other trades in the building in such a manner as not to interfere with other work being carried on in the building and places where other pipes and equipment must be installed along with the pipes and ducts pertaining to this Contract. Cooperate with the other trades to install all pipes, ducts, conduit and equipment, to the best advantage. When open web structural joists are used, obtain structural shop drawings to ensure space available for installation of pipes and ductwork.

.8 Where any pipes, ducts and equipment supplied by this trade must be built into the Work of other Sections such as masonry, structural, or plastering, be responsible for supplying the equipment to be built-in, or measurements to allow the necessary openings to be accommodated. All pipes and ducts which are to be concealed shall be installed neatly and closely to the building structure so that the necessary furring can be kept as small as possible. Any pipes, ducts, or other work which are not, in the opinion of the Engineer, installed as they should be, shall be taken out and replaced without cost to the Owner.

.9 Protect other trades from damage due to the carrying out of the Work, giving special attention to the protection of building vapour barriers, waterproof membranes and finishes. Cover floors and other parts of the building with tarpaulins, etc. and repair all damage to the satisfaction of the Engineer.

.10 Co-operate with the owner in carrying out all work. The building is to remain functional in as much as possible throughout the construction period. Provide the owner with a minimum of 4 working days notice for any areas that must be vacated by occupants or where the mechanical ventilating or plumbing systems must be shut down.

.11 There are areas of the building where construction work can be conducted only outside of the normal 8:00 am to 5:00pm work day. Refer to Instructions to Bidders.

1.15 SUBSTANTIAL AND TOTAL PERFORMANCE INSPECTIONS

.1 Prior to Substantial Performance Inspection, provide complete list of items which are deficient at the time of the Substantial Performance Inspection.

.2 Perform the following items prior to Substantial Performance Inspection:

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

.2 Make final change-over of permanent locks and transmit keys to the Owner. Advise the Owner’s personnel of change-over in security provisions.

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

.4 Make all systems capable of operation, with alarm controls functional and automatic controls generally operational, but not necessarily finally calibrated.

.5 Make necessary tests on equipment including those required by inspecting authorities. Obtain certificates of approval.

.6 Rough balance air, gas, and liquid systems.

.7 Complete all valve tagging and identify equipment. Paint equipment and piping. Install escutcheons.

.8 Lubricate equipment as per manufacturer's data.

.9 Mail warranty forms to manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.10 Chemically clean systems. Flush and initiate water treatment. Provide report from manufacturer's representative to confirm status of treatment.

.11 Submit sample of Operating/Maintenance Manuals. Arrange Operating and Maintenance Instructional Seminar and submit schedule for approval.

.12 Review all installations and ensure access doors are suitably located and equipment easily accessible, including all plumbing clean-outs.

.13 Have noise and vibration control devices and flexible connections inspected by manufacturer's representative [and submit written report].

.14 Complete and have operational graphics on DDC system.

.15 Align equipment and ensure smooth operation.

.1 Qualified Millwright to submit certified report.

.16 Check operations of plumbing systems and fixtures and ensure fixtures are solidly supported.

.17 Clean fan plenums, remove temporary filters and install permanent filters.

.3 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted prior to, during, and after Substantial Performance Inspection have been corrected, and the following items have been completed prior to the Total Performance Inspection:

.4 Perform the following items prior to the Total Performance Inspection:

.1 Clean equipment both inside and out and lubricate. Clean plumbing fixtures and brass.

.2 Complete final balancing. Submit final balance reports.

.3 Complete final calibration of all controls.

.4 Maintenance and Operating manuals to be submitted and approved.

.5 Submit record drawings.

.6 Record all motor nameplates ratings and actual operating amps and voltages.

.7 All systems shall be certified by the Contractor as complete and fully operational.

.8 Instructions to the Owner's operating personnel shall have been provided in accordance with the specifications.

.9 A complete list of items which the Contractor has not finished and items that are deficient shall be provided. If, in the opinion of the Engineer, this list indicates the project is excessively incomplete, a Final Acceptance Inspection will NOT be performed.

.10 The controls acceptance testing must be complete see Division 25.

.5 Contractor shall be fully responsible to accumulate all necessary data from his sub-trades and suppliers and present it in the specified format for approval by the Engineer.

.6 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until substantial performance is declared.

1.16 SHOP DRAWINGS AND SUBMITTALS

.1 Before fabrication of any materials or equipment, submit through the General Contractor one (1) complete set of shop drawings and data sheets covering all items of equipment furnished by him and intended for installation under this Contract, for review by the Engineer. Maximum sheet size 8.5"x14". Do not order equipment or material until the Engineer has approved and returned shop drawing. These may be submitted in PDF format (with Contractor Review stamps included), or hard copy. One electronic copy (in PDF format) will be returned to the General Contractor.

.2 Identify materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Engineer's office. Maintenance and operating manuals are not suitable submittal material.

.3 Clearly mark submittal material using arrows, underlining or circling to show differences from specified: i.e. ratings, capacities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps seals materials or painting.

.4 Each submission shall also be clearly identified according to the Project name and equipment number.

.5 Include dimensional and technical data sufficient to check if equipment meets requirements. Include wiring, piping, service connection data and motor sizes.

.6 For specific shop drawings as identified below, each shop drawing shall have attached xerographic copies of specification, drawing, addendum, addendum and/or change order(s) relating to the product submitted, with an indication on each sentence, clause, paragraph or item indicating compliance or non-compliance with each and every requirement.

  .1 Beside each clause, sentence, or paragraph indicate either "comply" or "do not comply". Statements such as "comply with intent" or any other statement are not acceptable.

  .2 Where "comply" is noted, this indicates that the Vendor is stating his 100% compliance with the specifics of the clause, sentence or paragraph.

  .3 Where "do not comply" is used, provide an explanation of the specifics of non-compliance, and the alternate proposed to comply with the specification.

  .4 This shall apply to shop drawings for the following equipment:

    .1 Pumps

    .2 Heat Exchangers

    .3 Variable Frequency Drives

    .4 Air Handling Units

    .5 Energy Recovery Ventilator (ERV)

    .6 Controls

.7 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Engineer.

.8 Do not order equipment or material until the Engineer has reviewed and returned shop drawing.

.9 Prior to submission to the Engineer, the Contractor shall review all shop drawings. By this review, the Contractor certifies that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data, and certifies that he has checked and coordinated each shop drawing with the requirements of the work of the contract documents. The Contractor's review of each shop drawing shall be indicated by stamp, date and signature of a responsible person.

1.17 PERFORMANCE VERIFICATION OF INSTALLED EQUIPMENT

.1 Installed mechanical equipment whose performance is questioned by the Owner or his representative may be subject to performance verification.

.2 When performance verification is requested, equipment shall be tested to determine compliance with specified performance requirements.

.3 The Owner will determine by whom testing shall be carried out. When requested, the Contractor shall arrange for services of an independent testing agency.

.4 Testing procedures shall be approved by the Engineer.

.5 Maintain building comfort conditions when equipment is removed from service for testing purposes.

.6 Promptly provide the Engineer with all test reports.

.7 Should test results reveal that originally installed equipment meets specified performance requirements, the Owner will pay all costs resulting from performance verification procedure.

.8 Should test results reveal that equipment does not meet specified performance requirements, equipment will be rejected and the following shall apply:

   .1 Remove rejected equipment. Replace with equipment which meets requirements of Contract Documents including specified performance requirements.

.2 Replacement equipment will be subject to performance verification as well, using same testing procedures on originally installed equipment.

.3 Contractor shall pay all costs resulting from performance verification procedure.

1.18 EQUIPMENT PROTECTION AND CLEAN-UP

.1 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.19 OPERATING AND MAINTENANCE MANUALS

.1 Provide services of qualified and experienced personnel to prepare proper documentation and to instruct the Owner's personnel in the operation of the systems. Submit Operation and Maintenance Manuals which include manufacturers' recommended maintenance and operating instructions of all pieces of equipment, including controls.

.2 Provide three (3) 215 x 280 mm (8½” x 11”) high capacity heavy duty expandable binder similar to Davies 058025 (black), hot stamped in gold lettering on front and spine.

.1 In addition to the three hard copies, provide one electronic copy in PDF format, indexed as to section as described below.

.3 Each binder shall be indexed according to the following indexing system.

.1 Tab - 1.0 Mechanical Systems: Title page with clear plastic protection cover.

.1 Tab 1.1 List of Mechanical Drawings: List drawing titles and drawing numbers.

.2 Tab 1.2 Description of Systems: Provide complete description of each system. Include detailed system description and components comprising that system, explanation of how each component interfaces with others to complete the system, location of each thermostat, controller or operating set points.

.3 Tab 1.3 Operation Division: Provide complete and detailed operation of each major component. Include starting procedure, exact location of switches and controls, how the component interfaces with other components, operational sequence, changes for summer or winter operation, and how to accomplish the changeover, complete trouble shooting sequences if set points cannot be maintained, and safeguards to check if equipment goes off line.

.4 Tab 1.4 Maintenance and Lubrication Division: Provide detailed preventative maintenance and lubrication schedule for each of the major components including daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to proceed with each task required for each piece of typical equipment such as bearings, drives, motors and filters. Compile this information for each typical piece of equipment separate from the shop drawings section.

.5 Tab 1.5 List of Equipment Suppliers and Contractors: Provide complete list of spare parts with the most direct equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

.2 Tab-2.0 Certification: Title page as above.

.1 Tab (2.1, 2.2, etc.): Include copy of test data, degreasing and flushing analysis of system water taken at time of system operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for gas and liquid systems, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, air heating and ventilation systems and operational tests on gas fired equipment.

.3 Tab 3.0 Shop Drawings and Maintenance Bulletins: Title page as above.

.1 Tab (3.1, 3.2, etc.): Provide materials as received in compliance with clause "Shop Drawings", plus manufacturers' maintenance literature.

.4 Tab 4.0 Safety and Maintenance: Title page as above.

.1 Tab (4.1, 4.2, etc.): Include specific and general safety requirements applicable to maintenance procedures on the installed Mechanical systems.

.4 The divider tabs shall be laminated Mylar plastic, and coloured according to section.

.1 The colouring is as follows:

Sections	Description	Tab Colour
1.0 to 1.x	Mechanical Systems	Orange
2.0 to 2.x	Certification	Green
3.0 to 3.x	Shop Drawings and Maintenance	Yellow
4.0 to 4.x	Safety and Maintenance	Red

.2 Plastic tabs with typed insertions will not be accepted.

.5 Submit documents to the Engineer for approval prior to being turned over. At completion of project, hold a Seminar to instruct the Owner in operation and preventative maintenance of each piece of equipment and system supplied and installed.

1.20 RECORD DRAWINGS

.1 The Contractor shall keep on site, available to the Engineer at all times and particularly for each regularly scheduled site meeting, a complete set of prints, edge bound, that are to be updated daily showing any and all deviations and changes from the Contract Drawings. This set of drawings is to be used only for this purpose, and must not be used as the daily general reference set.

.2 Provide as-built drawings which identify location of smoke and fire dampers, major control lines, access doors, tagged valves, and actual room names or numbers. As well, deviations that are to be recorded shall include in general, items that are significant or are hidden from view (including all items in ceiling spaces) and items of major importance to future operations and maintenance, and to future alterations and additions including Clean-Outs and isolation valves.

.3 Mechanical record drawings shall be provided by the Contractor as follows:

.1 one electronic copy in PDF format; and,

.2 one set of hard copy drawings.

.4 Indicate valve tag numbers on Record Drawings.

1.21 IDENTIFICATION

.1 Identify piping and equipment throughout with labels and direction of flow arrows. Apply name and arrow labels at 15 metre (50 foot) intervals, before and after pipes pass through walls or floors, at access door openings, adjacent to all valves, or at intervals closer than 15 metres (50 feet) in equipment rooms as required for ease of tracing systems. Painted piping to be provided with commodity name and direction of flow arrows in black on light coloured piping, and white on dark coloured piping, with bands each side.

.2 Piping identification to be Brady self sticking vinyl pipe markers.

.3 All equipment has been assigned an equipment identification number. Provide 20mm (3/4") high black letters on white lamacoid with ID number and name.

.4 For all manual valves, provide 20mm (3/4") diameter [brass] [lamacoid] tags with number stamped in black and secured to valve wheel with key chain. Provide neat, typewritten directories giving valve number, valve service and the location of the valves. Frame one copy under glass for wall mounting. Include copies in operating and maintenance manuals.

.5 Tag automatic controls, instruments and relays and key to control schematic on which instruments are numbered in sequence.

.6 Identify electric starting switches and remote push-button stations with 6 mm laminated plastic plates.

.7 Identify the usage of duct access panels with self adhesive Brady stick-on coloured labels. The labels shall conform to the following schedule:

Item	**Identification**	**Background Colour**	**Identification Colour**
Cleaning and services access	-	Yellow	Black
Controls	C	Black	White
Dampers (back-draft, balancing, and control)	D	Blue	Black
Fire dampers	FD	Red	White

.8 Identify the location of the following items of equipment, which are concealed above a ceiling with Avery "Data Dots". The colours shall conform to the following schedule:

Item	**Dot Colour**
Concealed equipment and cleaning access	Yellow
Control equipment, including control dampers and valves, and heat sensors	Black
Fire, smoke, and sprinkler equipment	Red

Item	Dot Colour
Pipe mounted equipment with the exception of fire, smoke, sprinkler, and control equipment	Green

.1 When T-bar ceilings are installed adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

1.22 PAINTING

.1 All equipment such as pumps, tanks, fans, air conditioning units, convectors, access doors, louver dampers, motors, etc., shall have prime coat of paint applied at the factory before shipment. If this prime coat has been damaged during shipment or installation, touch up all parts with red lead or other suitable primer and leave ready for painting by the painting trade.

.2 Touch up any factory painted baked enamel finish with matching colours where same has been damaged during shipment or installation, subject to the approval of the Engineer and if not acceptable, replace. See painting section for painting of pipes, equipment, valves, tanks, apparatus and other mechanical components.

.3 Exposed piping to be banded with outdoor quality pipe marker system, using same colour schedule.

.4 Colours to be used in piping are specified in CGSB 1-GP-12C as:

MECHANICAL PRIMARY COLOURS FOR PIPE LINES/EQUIPMENT			
Blue	#502-204	Purple	#511-101
Green	#503-107	Black	#512-201
Yellow	#505-102	White	#513-101
Orange	#508-102	Aluminum	#515-101
Red	#509-102	Light Blue	#502-106
Grey	#501-107	Brown	#504-103

SECONDARY COLOURS FOR BANDS	
Yellow	to indicate materials inherently hazardous
Green	to indicate liquid materials of inherently low hazard
Blue	to indicate gaseous materials of inherently low hazard
Red	To indicate fire quenching materials
White	to indicate non-hazardous material
NOTE: Primary colours required only on un-insulated pipes.	

.5 This colour code is generally based on the classifications outlined in ASME A13.1-1996 "Scheme for the Identification of Piping Systems".

COLOR SCHEDULE						
Commodity	**Commodity Designation**	**Lettering colour**	**Pipe Colour**	**Band Colour**	**Stripe Over Band Color**	**Additional Designation**
Domestic Cold Water	DCW	White	Green	Green	-	-
Glycol Supply	GS	Black	Blue	Yellow	Red	-
Glycol Return	GR	Black	Blue	Yellow	Blue	-
Chilled Water Supply	CHS	White	Lt. Blue	Green	Red	-
Chilled Water Return	CHR	White	Lt. Blue	Green	Blue	-
Low Pressure Steam	LPS	Black	Purple	Yellow	-	xxx kPa
Low Pressure Condensate	LPC	Red	Purple	Yellow	-	-
High Pressure Steam	HPS	Red	Purple	Yellow	Black	xxx kPa

COLOR SCHEDULE						
Commodity	**Commodity Designation**	**Lettering colour**	**Pipe Colour**	**Band Colour**	**Stripe Over Band Color**	**Additional Designation**
High Pressure Condensate	HPC	Black	Purple	Yellow	Black	-
Sanitary	SAN	White	-	Black	-	-
Sanitary Vent	V	White	-	Black	-	-

.6 Application of painting for identification shall be according to the following:

Outside Diameter of Pipe or Covering	Letter Size	Band Width (mm)	Stripe Width (mm)
Up to 32mm (1¼”)	12mm (½”)	200mm (8”)	50mm (2”)
38mm to 50mm (1½” to 2”)	20mm (3/4“)		
65mm to 150mm (2½” to 6”)	32mm (1¼”)	300mm (12”)	
200mm to 250mm (8” to 10”)	65mm (2½”)	600mm (24”)	
300mm (12”)and over	90mm (3½“)	800mm (32”)	

.7 Mechanical Control Systems:

.1 Conduit banding, pull boxes, terminal boxes and junction boxes - GREY covers - GREY with black ‘C’.

.2 Main and secondary control panels, factory finish acceptable - control Contractor to install company label to identify.

.8 Ductwork:

.1 All ductwork to be identified as follows, complete with directional arrows:

Commodity	**Identification**
Return Air	RA
Supply Air	SA
Mixed Air	MA
Combustion Air	Comb Air
Relief Air	Relief Air
Exhaust Air	EA

.9 Equipment Markers

.1 Engrave Plastic Laminate Signs: Provide 1.5mm thick, engraving stock melamine plastic laminate, in the sizes indicated, engraved with engraver's standard letter style of the sizes and wording indicated.

.2 Size: Provide approximate 150mm x 100mm (6”x4”) markers, with 20mm (3/4”) high lettering.

.3 Colour coding: Provide signs for the following general categories of equipment and operational devices, and of color coding indicated:

EQUIPMENT TYPE	**LEGEND COLOR**	**BACKGROUND COLOUR**
HVAC Central Supply Equipment	White	Green
Heat Exchangers and Similar Equipment	White	Blue
Exhaust Fan Equipment	Black	Yellow

EQUIPMENT TYPE	LEGEND COLOR	BACKGROUND COLOUR
Pumps and Similar Equip	White	Blue
Reheat, Air Terminal Boxes	White	Blue
Tanks and Pressure Vessels	Black	White
Filters, Humidifiers, Water Treatment, and Similar Equipment	White	Blue

.4 Nomenclature: Include the following, matching terminology on schedules as closely as possible:

.1 Equipment number.

.5 Fasteners: Contact-type permanent adhesive.

.10 Equipment Bases/Housekeeping Pads - Paint Grey.

1.23 ACCESS DOORS

.1 Provide access doors for maintenance or adjustments purposes for all mechanical system components including:

Service	Minimum Size
Valves;	150 x 150
Volume and splitter dampers;	300 x duct width
Fire dampers;	600 x duct width
Clean-Outs and traps;	150 x 150
Controls, coils and terminal units;	600 x 300
Expansion joints;	600 x 300
Filters;	50mm larger than filter
Strainers	200 x 200 minimum or larger if needed to service strainer

.2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.

.3 Mark removable ceiling tiles used for access with colour coded dots.

1.24 TEMPORARY AND TRIAL USAGE

.1 Temporary or trial usage by the Owner of any mechanical machinery, apparatus, equipment or any other work or materials supplied under the Contract before final written acceptance by the Owner is not to be construed as evidence of the acceptance of same by the Owner. The Owner shall have the privilege of such temporary and trial usage as soon as Contractor shall claim that said work is completed. Any damage caused by defective material or workmanship through temporary or trail usage by the Owner shall be the responsibility of the Contractor.

.2 Do not use the permanent system for temporary heating purposes, without written permission from the Engineer.

.3 Thoroughly clean and overhaul permanent equipment used during the construction period, replacing worn or damaged parts. Exchange equipment or components operating improperly at final inspection with new equipment or components.

.4 Use of permanent systems for temporary heat shall not modify terms of warranty.

.5 Operate heating systems under conditions which ensure no temporary or permanent damage. Operate fans at proper resistance with filters installed. Change filters at regular intervals. Operate with proper safety devices and controls installed and fully operational. Operate water systems with proper water treatment.

.6 Where air systems are used during temporary heating, provide filter media on return and exhaust air outlets. Clean duct systems which have become dirty.

.7 When permanent systems are used for temporary heat, provide alarm indicating system failure.

.8 Replace mechanical seals in pumps used for temporary heating purposes with new mechanical seals, regardless of condition.

1.25 ELECTRICAL MOTORS

.1 Supply mechanical equipment complete with electrical motors.

.2 Motors to be complete with O.D.P. enclosure and shall operate at 1800 RPM unless otherwise specified.

.3 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, 1EEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch.

.4 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B.

.1 For non variable speed drive motors, motors driving high torque or high inertia loads may be EEMAC Design C or D.

.5 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.

.6 Provide motors with complete nameplate data.

.7 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.8 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.9 Refer to electrical drawings and specifications for voltage, frequency, and phase data. This shall take precedence over any reference in mechanical drawings and specifications.

.10 Provide all mechanical motorized equipment (unless otherwise specified) with motors equal to Gould “E-Plus” energy efficient motors. Minimum certified motor efficiency shall be as outlined in the following table.

MINIMUM EFFICIENCY (%)*				
HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	86.5	82.5
3	85.5	87.5	87.5	84.0
5	87.5	87.5	87.5	85.5
7.5	88.5	89.5	89.5	85.5
10	89.5	89.5	89.5	88.5
15	90.2	91.0	90.2	88.5
20	90.2	91.0	90.2	89.5
25	90.5	91.7	91.3	89.6
30	90.8	91.9	91.4	90.7

* As defined in CSA C390 or IEEE 112B Nominal Standards.

1.26 SERVICE PROVIDERS, MATERIALS. AND EQUIPMENT

.1 The price submitted for this Contract shall be based on the use of service providers, materials, and equipment as indicated on the drawings or in the specifications.

.2 If the Contractor wishes to quote on other service providers, materials, or equipment which has been specified and not included in the 'Approved Alternate List' he must, prior to quoting on such items, obtain written approval from the Engineer.

.1 Requests for approval for tendering purposes of equivalent service providers, materials, or equipment shall be submitted in duplicate, to the Engineer no later than seven (7) working days prior to the closing date of tender for mechanical trade, complete with all applicable technical data, including performance curves and physical details. Approval of requests shall only be given by addendum.

.2 The Contractor at his discretion may submit to the Engineer a request for approval on equipment or materials which has been included in the 'Approved Alternate List' but for which the Contractor is uncertain will meet the specification requirements. In this case the Contractor shall identify specifically his uncertainties with the request.

.3 Requests for approval for tendering purposes shall be submitted by fax to the Engineer. Applicable technical data will not be reviewed by the Engineer unless specifically requested by the Engineer.

.3 Where only one manufacturer or service supplier listed in the Approved Alternate List, this is not an indication of the Owner’s desire to base bid one service supplier or manufacturer (unless specifically noted otherwise as “Base Bid”). The Contractor is encouraged to submit requests for other service suppliers or manufacturers.

.1 If the term “Base Bid” is used in the Approved Alternative List, this indicates that this service provider, material, or equipment is to be sole sourced. No alternatives will be acceptable.

.4 The Contractor shall be fully responsible for any additional work or materials required by the mechanical trade or by other trades to accommodate approved equivalent services, materials, or equipment. Extras will not be approved to cover such work. This shall also apply to services, equipment, and materials listed in the 'Approved Alternate List'.

.5 A list of approved manufacturers and service suppliers has been included in the “Approved Alternate List”. The Contractor may quote on the listed services, materials, and equipment without prior written approval by the Engineer. However, the Contractor shall be fully responsible that the equipment and materials meet all the requirements of the equipment specified. The Engineer may reject shop drawings on any equipment and materials which do not comply with the specification, even though the manufacturers name has been included in the 'Approved Alternate List'.

.6 Equipment shall not exceed space limitations in any dimension.

.7 The Contractor shall replace any equipment or apparatus which does not meet the specification at no cost to the Owner. The Contractor shall assume full responsibility for the expense of redesign and adjustment to other parts of the project when tendering on approved equal or alternate equipment.

.8 APPROVED ALTERNATE LIST

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
General Mechanical Provisions	Maintenance Manuals	Contractor
	Record Drawings	Contractor
	Air and Water Balancing	Quality Air Air Flo Air Tech Management Air MD
Systems Demonstration	Systems Demonstration and Owner's Instruction	Contractor
Pipe & Pipe Fittings	Valves (General Service) : Gate, Globe, Swing Check, Ball	Grinnell Crane Jenkins Kitz
	Silent Check Valves	Grinnell Val-matic APCO Streamflo Center Line
	Drain Valves, Radiator Valves	Jenkins Crane Kitz
	Check Valves (Spring Loaded)	Grinnell Dezurik Mueller Singer M & G Center Line

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
	Butterfly Valves	Crane Grinnell Keystone Victaulic Jenkins Center Line
	Line Strainers	Armstrong Crane Mueller Kitz
	Grooved Mechanical Piping	Victaulic Gruvlok
	Automatic Flow Control Devices	Griswald Nexus
Supports, Anchors & Seals	Pipe Hangers & Supports	Grinnell Crane Unistrut
Meters & Gauges	Air Filter Gauges (Manometer)	Dwyer
	Air Filter Gauges (Dial)	Magnahelic
	Gauges & Indicators (Water pressure and temperature)	Ashcroft Trerice Weiss
Pumps	Base Mounted Pumps Triple Duty Valves and Suction Diffusers	Armstrong Bell & Gossett Aurora Taco
Expansion Compensation	Expansion Joints & Compensators	Flexonics Hyspan Twin City Hose, Flex Hose

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
	Metal Flexible Hose	United Flexible Metraflex Twin City Hose Flex Hose
	Flexible Connectors - Piping	Flexonics Tube-Turn Hyspan Hydroflex Metraflex Mason Twin City Hose Flex Hose
Vibration Isolation	Vibration Isolation	Amber Booth Korfund Vibro-Acoustics Vibron Mason Kinetics Noise Control Airmaster
	Inertia Bases	Kinetics Noise Control Vibro-Acoustics Airmaster
Pipe and Equipment Insulation	Pipe and Equipment Insulation	Fiberglas Canada Manville Manson Krauf
	Valve Body Blankets	ThermoHelp Canada Thermaxx Unitherm Reflex GlassCell Isofab
	Equipment Jackets	ThermoHelp Canada Thermaxx Unitherm Reflex GlassCell Isofab

REFERENCE SECTION	**ITEM**	**ACCEPTABLE MANUFACTURERS**
	Insulation Adhesives	Flintkote 3M
Duct Insulation	Acoustical Insulation	Fiberglas Johns-Manville Manson
	Ductwork Insulation	Fiberglas Canada Manville Manson Krauf
	Insulation Adhesives	Fiberglas Canada Manville Manson Krauf
Plumbing General	Roof & Floor Drains	Enpoco Zurn/Watts Ancon J. R. Smith
	Clean-Outs, Trap Drains, Water Hammer Arresters	J.R.Smith Zurn/Watts Ancon Enpoco
	Relief Valves	Watts Singer Watson McDaniel
	Regulators and Control Valves, Pressure Reducing Valves	**BASE BID** **Spence**
	Backflow Preventors	Febco Singer Watts Zurn Wilkins
	Vacuum Breakers	Febco Watts Zurn Wilkins

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
Preoperational Cleaning & Chemical Treatment	Chemical Treatment	Maxim Emerald Industries
Steam Specialties	Steam Traps Steam Air Vents Vacuum Breakers	Bell & Gossett Spirax Sarco Taco Armstrong Spence
	Steam Pressure Regulating Valves and Relief Valves	**BASE BID** **Spence**
	Condensate Return Units	Bell & Gossett Spirax Sarco
Hydronic Specialties	Air Vents	Armstrong Bell & Gossett ITT Grinnell Spirax Sarco Taco
	Air Separators	Taco Armstrong Bell & Gossett Caleffi Spirotherm Amtrol
	Glycol Feeders	Axiom Hydronic System Sentry
	Sidestream Filters	Filterite Axiom
Heat Exchangers	Heat Exchangers (Plate)	Alfa Laval Taco Armstrong Bell & Gossett

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
Terminal Heat Transfer Units	Cabinet & Unit Heaters, Convectors	Rittling Engineered Air Trane Sterling Sigma
	Baseboard Radiation	Rittling Trane Mark Hot Engineered Air Rosemex Slant Fin Sigma
	Radiant Ceiling Panels	Airtex Twa
Coils	Coils - Heating, Cooling, Glycol, Heat Recovery	McQuay Engineered Air Trane Scott Springfield York/JCI Bousquet Daikin Haakon
Air Handling Units	Air Handlers with Water Coils	McQuay Engineered Air Trane Scott Springfield York/JCI Bousquet Daikin Haakon
Energy and Heat Recovery Ventilators	Energy Recovery Ventilators	Aldes
Variable Air Volume Terminal Units	Variable and Constant Air Volume Terminal Units	E.H.Price Titus Trane Krueger

REFERENCE SECTION	**ITEM**	**ACCEPTABLE MANUFACTURERS**
Humidifiers	Steam-to-Steam	DriSteam Pure Steam Nortec
Ductwork	Flexible Ductwork	Flexmaster Thermaflex
Duct Accessories	Duct Access Doors	Krueger Milcor Titus J.R.Smith
	Fire Dampers	Canadian Advanced Air Controlled Air Ruskin Nailor
Air Outlets	Air Outlets	E.H. Price Titus Nailor Krueger
	Louvers	Airolite Westvent Ruskin Construction Specialty Ventex
Controls General Provisions	Contractors and Automatic Controls Systems	**BASE BID** **DMA Controls (HONEYWELL)**
	Control Dampers	T.A. Morrison Johnson Controls Alumavent
	Control Valves - Pressure Independent	Griswold Nexus
Input/Output Devices	Temperature Sensor (AI)	Greystone
	Relative Humidity Sensor (AI)	Greystone Hy-Cal General Eastern

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
	Pressure Sensors (AI)	Greystone Modus Selva
	Damper Motors	Belimo Johnson Honeywell
Variable Speed Drives	Variable Frequency Drives	Graham/Danfoss Allen-Bradley Cutler Hammer Schneider Electric Siemens Honeywell ABB

1.27 TENDER PRICE BREAKDOWN

.1 Submit a tender breakdown within thirty (30) days of tender closing and before first progress claim.

.2 The Progress Claim shall be submitted using this Tender Price Breakdown, or other form acceptable to the Engineer.

TENDER PRICE BREAKDOWN - MECHANICAL			
ITEM	DESCRIPTION	MATERIAL	LABOUR
1.	Bonding		
2.	Supervision		
3.	Mobilisation and Start-up		
4.	Project Overheads: Shack, Telephone, etc.		
5.	Documentation		

TENDER PRICE BREAKDOWN - MECHANICAL			
ITEM	**DESCRIPTION**	**MATERIAL**	**LABOUR**
6.	System Demonstration and Owners Instruction		
7.	Testing and Start-up		
8.	Balancing		
9.	Site Services		
10.	Pre-Operational Cleaning and Chemical Treatment		
11.	Water Softening Equipment		
12.	Plumbing		
13.	Tanks		
14.	Heating		
15.	Cooling		
16.	Ventilation & Air Conditioning		
17.	Humidification		
18.	Fire Protection		
19.	Insulation		
20.	Meters and Gauges		
21.	Duct Cleaning		
22.	Breeching and Chimney		
23.	Controls		
24.	Speciality Items (Specify)		
25.	Misc. Items (Specify)		

1.28 SEPARATE PRICES AND UNIT PRICES

.1 No separate prices or unit prices are called for in this contract.

- END OF SECTION -

PART 1.0 GENERAL

1.1 SCOPE

.1 Demonstration of equipment and systems operations.

.2 Instruction seminars for Owner's personnel.

1.2 QUALITY ASSURANCE

.1 Work specified shall be performed by the Contractor.

PART 2.0 PRODUCTS

Not Applicable

PART 3.0 EXECUTION

3.1 GENERAL

.1 The Contractor shall chair the demonstration and instruction sessions.

.2 Contractor shall arrange for presentation and demonstration of mechanical equipment and systems by appropriate specialists and shall ensure that required manufacturer's representatives are in attendance.

3.2 DEMONSTRATIONS

.1 Demonstrate specific starting and general maintenance requirements for each major piece of equipment. Ensure all labeling and identification is completed.

.2 Demonstrate the following systems, in the form of instruction seminars and contractor guided tour of the facility.

  .1 Hydronic Heating Systems;

  .2 Hydronic Cooling Systems;

  .3 Steam Systems; and,

  .4 Chemical Treatment Systems.

.3 Demonstrate the following pieces of equipment:

.1 Air Handling Unit;

.2 Energy Recovery Ventilator;

.3 Glycol Fill Tanks;

.4 PRV's;

.5 Automatic Flow Control Valves;

.6 Variable Air Volume Units;

.7 Terminal Air Units;

.8 Pumps; and,

.9 Heat Exchangers.

.4 Prepare a schedule identifying the proposed sequence of demonstration. Sequence of demonstration shall correspond to full system starting. Submit for review by Engineer one month prior to demonstration.

.5 Answer all questions raised by Owner at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Flexible pipe connections.

.2 Expansion joints and compensators.

.3 Pipe loops, offsets and swing joints.

1.2 REFERENCE STANDARD

.1 Conform to Standards of "Expansion Joint Manufacturers Association" and manufacturer's recommendations.

1.3 SHOP DRAWINGS

.1 Flexible pipe connector shop drawing data shall include maximum allowable temperature and pressure rating, overall face-to-face length, live length, hose wall thickness, hose convolutions per 300 mm and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.

.2 Expansion joint shop drawings including maximum allowable temperature and pressure rating, and maximum expansion compensation.

1.4 GENERAL REQUIREMENTS

.1 Base expansion calculation on 10°C installation temperature to 110°C for heating water and 60°C for domestic hot water supply, plus 30% safety factor in each case.

1.5 INSPECTION

.1 Provide inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturers' recommendations and connectors are performing satisfactorily.

PART 2.0 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTIONS

.1 Braided Spools for Copper Piping: Stainless steel inner core and braid braised to copper tube ends, suitable for 1030 kPa at 120°C.

.2 Braided Spools for Steel Piping: Stainless steel inner core and braid welded to steel pipe nipples, threaded for pipe up to 50mm diameter, flanged for 65mm diameter pipe and over. Suitable for service 1030 kPa at 120°C.

2.2 PIPE GUIDES

.1 Four finger spider inside a guiding sleeve formed of two halves suitable for clamping onto pipe.

.2 Guided sleeve formed of two parts, suitable to be bolted to supporting structure.

.3 Guide length to be minimum 300mm.

2.3 EXPANSION LOOPS

.1 See details on drawings.

2.4 CONNECTIONS

.1 Provide flexible pipe connectors and expansion joints suitable to connect to adjoining piping as specified for pipe joints. Use pipe sized units.

PART 3.0 EXECUTION

3.1 APPLICATION

.1 Install expansion joint loops and pipe guides where shown on drawings and where necessary to prevent stress on pipes or other building components.

.2 Provide flexible pipe connectors on pipes connected to equipment supported by vibration isolation.

.3 Provide structural work and equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide corrugated bellows type expansion joints where indicated or required.

.4 Provide pipe guides as required to ensure correct pipe alignment for expansion joints.

3.2 INSTALLATION

.1 Install flexible connectors and expansion joints in accordance with manufacturer's instructions.

.2 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.

.3 Rigidly anchor pipe to building structure at points shown, and where necessary provide pipe guides so that movement takes place along axis of pipe only.

.4 Do not compress or expand connector during installation.

- END OF SECTION -

PART 1 GENERAL

1.1 WORK INCLUDED

.1 Provide all required meters, gauges and taps shown on drawings and/or specified herein.

1.2 SUBMITTALS

.1 Submit shop drawings of products per Section 23 00 00.

.2 Submit data sheets on thermometers and pressure gauges indicating service, and temperature or pressure ranges to the Engineer for review.

PART 2 PRODUCTS

2.1 GENERAL

.1 Select gauges so that normal operating point is approximately mid-point of instrument range.

2.2 PRESSURE GAUGES

.1 Gauges shall be 100 mm diameter 1% accuracy aluminum case, aluminum ring, phosphor bronze bourdon tube, brass movement, and glass window.

.2 Dials shall read kPa.

.3 For gauges on liquid service provide a bronze pulsation damper and needle valve.

.4 For steam service provide a straight pigtail siphon and needle valve. Needle valve to be on system side of pigtail.

2.3 PRESSURE GAUGE TAPS

.1 Provide 6 mm NPT needle valve.

2.4 THERMOMETERS - LIQUID SYSTEMS

.1 Thermometers shall be 225 mm adjustable angle, cast aluminum case, red reading mercury, glass front and complete with 20mm NPT brass separable well, Celsius scale.

2.5 THERMOMETER WELLS

.1 Wells shall be machined from brass bar stock and complete with cap and chain and 15 mm NPT thread.

.2 On pipes 65mm and smaller, place well in tee used in lieu of an elbow to accommodate well.

2.6 STATIC PRESSURE GAUGES

.1 Moulded plastic inclined vertical manometer, accuracy within $\pm$ 3% of full scale, suitable for positive, negative or differential pressure measurement, complete with static pressure tips and mounting accuracy.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Enlarge pipe smaller than 65 mm for installation of thermometer wells.

.2 Provide one pressure gauge per pump, installing taps before strainers, on suction and discharge of pump and on discharge side of balancing valve (if provided). Pipe to gauge.

3.2 METERS AND GAUGES SCHEDULE

.1 In addition to the locations shown on the drawings and elsewhere in the specifications, provide meters and gauges as follows:

.2 Pressure Gauges

- .1 Pumps
- .2 Expansion Tanks
- .3 Pressure Tanks

.3 Stem Type Thermometers

- .1 Supply and Return Headers to Central Equipment
- .2 Coil Banks

.3 Heat Exchangers - Inlets and Outlets (minimum 4 per heat exchanger)

.4 Static Pressure Gauges

.1 Air Handling Unit Filter Banks

.2 Energy Recovery Ventilator Filter Banks

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Pipe hangers and supports.

.2 Duct hangers and supports.

.3 Flashing for mechanical equipment.

.4 Sleeving for mechanical equipment.

.5 Pipe anchors.

1.2 REFERENCE STANDARDS

.1 Pipe supports shall meet the requirements of ANSI B31.1, Power Piping.

.2 Automatic sprinkler pipe supports shall meet the requirements of NFPA No. 13 "Standard for the Installation of Sprinkler Systems".

.3 Standpipe and hose system pipe supports shall meet the requirements of NFPA No. 14 "Standard for the Installation of Standpipe and Hose Systems".

.4 Duct hangers shall follow the recommendations of the SMACNA duct manual.

1.3 GENERAL REQUIREMENTS

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, provide for expansion and contraction and to accommodate insulation; provide insulation protection saddles.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.4 Fasten hangers and supports to building steel or inserts in concrete construction.

.5 Provide and set sleeves required for equipment, including openings required for placing equipment.

.6 Provide sleeves for all pipe and duct penetrations through wall, ceilings, floors and footings.

.7 Di-electrically isolate dissimilar metals.

.8 Obtain written approval from the Structural Engineer prior to drilling for inserts and supports.

.9 Obtain written approval from the Structural Engineer prior to using percussion type fastenings.

.10 Use of piping or equipment for hanger supports is not permitted.

.11 Use of perforated band iron, wire or chain as hangers is not permitted.

.12 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the Engineer.

.13 Where deemed necessary by the Engineer the Contractor shall, at his own cost, employ a structural consultant to design equipment supports and/or pipe anchors.

PART 2.0 PRODUCTS

2.1 INSERTS

.1 Inserts shall be malleable iron case or galvanised steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.2 PIPE HANGERS AND SUPPORTS

.1 Hangers: Pipe sizes 12mm (1/2”) to 38mm (1 ½”) : Adjustable wrought steel ring.

.2 Hangers: Pipe sizes 50mm to 100mm (2” to 4”) and cold pipe sizes to 150mm (6”): Adjustable steel clevis.

.3 Hangers: Hot pipe sizes 150mm (6”) and over: Adjustable steel yoke and cast iron roll.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150mm (6”) and over.

.5 Wall Support: Pipe Sizes to 75mm (3”): Cast iron hook.

.6 Wall Support: Pipe Sizes 100mm (4”) and over: Welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 150mm (6”) and over.

.7 Vertical Support: Steel riser clamp.

.8 Floor Support: Pipe Sizes to 100mm (4”) and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, lock-nut nipple, floor flange and concrete pier to steel support.

.9 Floor Support: Hot Pipe Sizes 150mm (6”) and over: adjustable cast iron roll and stand, steel screws and concrete pier or steel support.

.10 Design hangers so they cannot become disengaged by movements of supported pipe.

.11 Provide copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping.

.12 Provide galvanised hangers and supports for galvanised piping.

.13 Support all piping below grade and under floor slabs in 3mm continuous cadmium plated channel. Support channel with cadmium plated clevis hangers and rods. Install supports on centres as specified in Execution - Pipe Hangers and Supports. Extend cadmium plated hanger rods 450mm above slab rebar and bend back over rebar so as to provide a minimum of 450mm of support in slab. Do not stress rod when bending.

2.3 HANGER RODS

.1 Hanger rods to be rolled steel all threaded.

2.4 DUCT HANGERS AND SUPPORTS

.1 Hangers:

.1 Galvanised steel band iron or rolled angle and 10mm (3/8”) rods.

.2 Wire rope hanging systems similar to “Gripple” systems with a 5:1 safety factor.

.2 Wall Supports: Galvanised steel band iron or fabricated angle bracket.

.3 Vertical Support at Floor: Rolled angle.

.4 Conform to SMACNA requirements.

2.5 FLASHING

.1 Steel Flashing: 0.55 mm galvanised steel.

.2 Safes: 25 kg/m² (5 lb/ft²) sheet lead or neoprene.

.3 Caps: Steel, 0.7 mm (22 ga) thickness minimum, 1.6 mm (14 ga) thickness at fire resistance structures.

2.6 SLEEVES

.1 Pipes through floors: Form from 1.2 mm (18 ga) galvanised steel.

.2 Pipes through beams, walls, fire proofing, footings and potentially wet floor: Form from steel pipe or 1.2 mm (18 ga) thickness galvanised steel.

.3 Round Ducts: Form sleeves from galvanised steel.

.4 Rectangular Ducts: Form sleeves from galvanised steel or wood.

.5 Size large enough to allow for expansion with continuous insulation.

2.7 FINISHES ON HANGERS AND SUPPORTS

.1 All steel hangers and supports shall be galvanised or factory primed with alkyd red oxide primer to CGSB 1-GP-40m.

PART 3.0 EXECUTION

3.1 INSERTS

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying piping over 100mm (4”) or ducts over 1500mm (60”) wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.2 PIPE HANGERS AND SUPPORTS

.1 Support horizontal steel, and copper piping as follows:

Nominal Pipe		Distance Between Supports		Hanger Rod Diameter	
12 mm	½”	1.8 m	6’	10mm	3/8”
20 mm	¾”	2.4 m	8’		
25mm	1”				
32mm	1 ¼”				
38mm	1 ½”				
50mm	2”	3.0 m	10’		
65mm	2 ½”				
75mm	3”	3.6 m	12’	16 mm	5/8”
100mm	4”				
150mm	6”	4.2 m	14’	22 mm	7/8”
200mm	8”				
250mm	10”				
300mm	12”				
350mm	14”	6.0 m	20’	25 mm	1”
400mm	16”				
450mm	18”				

.2 Install hangers to provide minimum 12mm (1/2") clear space between finished covering and adjacent work.

.3 Place a hanger within 300mm (12") of each horizontal elbow.

.4 Use hangers which are vertically adjustable 38mm (1 ½") minimum after piping is erected.

.5 Support horizontal soil pipe near each hub with 1.5 m (5') maximum spacing between hangers.

.6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub. Maximum spacing of supports shall be 6 m (20').

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Provide oversize hangers for insulated pipes such that pipe insulation is between support hangar and pipe. Provide 12 gauge saddle between hangar and insulation. On larger pipes, provide calcil insulation saddle between pipe and hangar.

Pipe Size	Sheet Metal Saddle	Calcil Insulation Saddle
Up to 38mm (up to 1½")	12 ga – 300mm long (12 ga – 12" long)	no
50mm to 75mm (2" to 3")	12 ga – 300mm long (12 ga – 12" long)	yes
100mm and larger (4" and larger)	12 ga – 300mm long (12 ga – 12" long)	yes

3.3 LOW VELOCITY DUCT HANGERS AND SUPPORTS

.1 Hanger Minimum Sizes:

Duct Width	Support Size	Hanger Spacing
Up to 750mm (30")	25mm x 1.6 mm	3 m (10')

	(1" x 14 ga)	
775 to 1200mm (31" to 48")	38mm x 1.6 mm (1 ½" x 14 ga)	
Over 1200mm (48")e		2.4 m (8')

.2 Horizontal Duct on Wall Supports Minimum Sizes:

Duct Width	Support Size	Hanger Spacing
Up to 450mm (18")	38mm x 1.6 mm (1 ½" x 14 ga) -or- 25 x 25 x 3mm (1" x 1" x 1/8")	2.4 m (8')
475 to 1000mm (19" to 40")	38 x 38 x 3mm (1½" x 1½" x 1/8")	
Over 1000mm (40")		1.2 m (4')

.3 Vertical Duct on Wall Supports Minimum Sizes:

Duct Width	Support Size	Hanger Spacing
Up to 600mm (24")	38mm x 1.6 mm (1 ½" x 14 ga)	3.6 m (12')
625 to 900mm (25" to 36")	25 x 25 x 3mm (1" x 1" x 1/8")	
925 to 1200mm (37" to 48")	32 x 32 x 3mm (1¼" x 1¼" x 1/8")	
Over 1200mm (48")e	50 x 50 x 3mm (2" x 2" x 1/8")	

.4 Vertical Duct Floor Supports Minimum Sizes, riveted or screwed to ducts:

Duct Width	Support Size	Hanger Spacing
Up to 1200mm (48”)	38 x 38 x 3mm (1½” x 1½” x 1/8”)	3.6 m (12’)
1225 to 1500mm (49” to 60”)	38 x 38 x 3mm (1½” x 1½” x 3/16”)	
Over 1500mm (60”)e	50 x 50 x 3mm (2” x 2” x 1/8”)	

3.4 MEDIUM VELOCITY DUCT HANGERS AND SUPPORTS

.1 Hanger Minimum Sizes:

Duct Width	Support Size	Hanger Spacing
Up to 900mm (36”)	2 @ 25mm x 1.6 mm (2 @ 1” x 14 ga)	3 m (10’)
925 to 1500mm (37” to 60”)	2 @ 25mm x 1.6 mm with 50 x 50 x 6mm trapeze (2 @ 1” x 14 ga with 2” x 2” x ¼” trapeze)	2.4 m (8’)
1525 to 3050mm (60” to 122”)	2 @ 38mm x 2.6 mm with 50 x 50 x 8mm trapeze (2 @ 1¼” x 12 ga with 2” x 2” x 3/8” trapeze)	
3075 to 6700mm (123” to 268”)	3 @ 10mm diameter with 65 x 65 x 8mm trapeze (3 @ 3/8 diameter with 2 ½ ” x 2 ½ ” x 3/8” trapeze)	1.2 m (4’)

.2 Round Duct Hangers Minimum Sizes:

Duct Diameter	Support Size	Hanger Spacing
Up to 450mm (18”)	25mm x 1.6 mm (1” x 14 ga)	3 m (10’)
475 to 900mm	25mm x 2.6 mm	

(19” to 36”)	(1” x 12 ga)	
925 to 1250mm (37” to 50”)	38mm x 2.6 mm (1 ¼ ” x 12 ga)	
1275 to 2100mm (51” to 84”)	2 @ 38mm x 2.6 mm (2 @ 1 ¼ ” x 12 ga) From girth reinforced angle	

.3 Vertical Duct Floor Supports Minimum Sizes:

Duct Width	Support Size	Hanger Spacing
Up to 1200mm (18”)	38 x 38 x 3mm (1½” x 1½” x 3/16”)	3 m (10’)
Over 1200mm (18”)	50 x 50 x 3mm (2” x 2” x 3/16”)	
NOTE : Rivet to duct and tie angles together with rod, angles or band iron.		

.4 Angle reinforcing may be used for support and trapezes may then be omitted.

3.5 EQUIPMENT BASES AND SUPPORTS

.1 Provide for major equipment and where otherwise shown on plans, reinforced concrete housekeeping bases poured directly on structural floor slab 100mm thick minimum, extended 100mm (4”) minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Rigidly anchor ducts and pipes immediately after vibration connections to equipment.

3.6 FLASHING

.1 Flash and counter-flash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 75mm (3”) minimum above roof.

3.7 SLEEVES

.1 Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

.2 Extend sleeves through potentially wet floors 75mm (3") above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Where piping or ductwork passes through floor, ceiling or wall, close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

.4 Where piping or ductwork penetrates a fire rated assembly, close off space between pipe or duct and construction with one-component ceramic fibre based putty. Material to be UL-listed and applied in sufficient thickness to maintain fire rating.

.5 Install chrome plated escutcheons where piping passes through finished surfaces.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Supply all labour, materials and equipment required and necessary to isolate and restrain the equipment as indicated on the drawings and specified herein and guarantee the function of the materials and equipment supplied.

1.2 REFERENCE STANDARD

.1 Provide and install mechanical equipment so that Average Noise Criteria Curves, as outlined in ASHRAE Guide, are not exceeded.

1.3 QUALIFICATIONS

.1 All vibration isolators and bases shall be supplied by an approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.2 Provide shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The drawings shall bear the stamp and signature of the responsible supplier's technical representative.

.3 The work shall be carried out in accordance with the specification and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

1.4 GENERAL REQUIREMENTS

.1 Supply vibration isolation equipment and materials by one supplier. Consider side loading of equipment and inertia bases when calculating maximum loads on isolators.

.2 Ensure equipment is sufficiently rigid for isolator point loading.

1.5 INSPECTION

.1 Provide inspection services by vibration isolation equipment and materials manufacturer's representative for final installation and provide written report that installation is in accordance with specifications and manufacturer's recommendations.

PART 2.0 PRODUCTS

2.1 ISOLATORS

.1 Spring isolators located out of doors or in humid areas shall have Rustoleum painted housing and neoprene coated springs, unless otherwise indicated on drawings.

.2 Isolation mounts for equipment with operating weights substantially different from the installed weights, such as chillers or boilers, shall have adjustable limit stops.

2.2 OPEN SPRING ISOLATORS

.1 Springs shall be “Iso-Stiff” having equal stiffness in the horizontal and vertical planes with a working deflection between 0.3 and 0.6 of solid deflection.

.2 Spring mounts shall be complete with leveling devices, minimum 6mm thick neoprene sound pads and zinc chromate plated hardware.

.3 Sound pads shall be sized for a minimum deflection of 1.2mm and shall meet the requirements for neoprene isolators.

2.3 CLOSED SPRING ISOLATORS

.1 Compression springs shall be used both for hangers and floor mount isolators.

.2 Springs shall be stable under operating conditions.

.3 Housings shall incorporate a minimum 6mm thick sound pad sized for a minimum static deflection of 1.2mm meeting the requirements for neoprene isolators.

.4 Floor mount units shall incorporate neoprene side stabilizers with a minimum 6mm clearance.

2.4 NEOPRENE ISOLATORS

.1 All neoprene isolators shall be tested to ASTM specifications.

.2 Where a ribbed pad is used, the height of the ribs shall not exceed 0.7 times the width of the rib. A steel layer shall be used to distribute the load in a multi-layered unit.

.3 Neoprene pads or elements shall be selected at the manufacturer's optimum recommended loading and shall not be loaded beyond the limit specified in the neoprene manufacturer's literature.

2.5 INERTIA BASES

.1 Inertia bases shall be constructed of concrete cast into fabricated inertia base frames, the steel members of which are designed and supplied by the isolator manufacturer. The concrete shall be poured into a welded steel frame, incorporating pre-located equipment anchor bolts, 1/2-in (13 mm) diameter reinforcing bars on nominal 8-in (203 mm) centers each way, and recessed isolator mounting brackets to reduce the mounting height of the equipment reduce the footprint of the base. The thickness of the base shall be a minimum of 8% of the longest span between isolators, at least 6 in (152 mm), or as indicated on the drawings. Where inertia bases are used to mount pumps, the bases shall be sized to support specified suction diffusers or piping elbows.

.2 Standard of Acceptance : Kinetics Noise Control type CIB-L

2.6 SPRING HANGERS

.1 Hangers capable of a 10° misalignment shall be provided unless otherwise specified.

2.7 TYPES OF ISOLATION

.1 INERTIA BASES

- .1 Type A: Integral structural steel fan and motor base with motor slide rails.
- .2 Type B: Slung structural steel base with gussetted brackets.
- .3 Type C: Reinforced 20 MPa concrete base with full depth perimeter structural channel frame, with gussetted brackets and anchor bolts.
- .4 Type D: Reinforced 20 MPa concrete base with chamfered edges without channel frame.

.2 VIBRATION ISOLATORS

- .1 Type 1: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.

.2 Type 2: Open spring mount with iso-stiff springs (horizontal stiffness equal to vertical stiffness).

.3 Type 3: Open spring mount with iso-stiff springs, heavy mounting frame and limit stop.

.4 Type 4: Closed spring mount with iso-stiff springs and limit stop.

.5 Type 5: Closed spring hanger with acoustic washer.

.6 Type 6: Closed spring hanger with 25 mm thick acoustic isolator.

.7 Type 7: Elastomer mount with threaded insert and hold down holes.

.8 Type 8: Neoprene jacketed pre-compressed moulded fibreglass.

.9 Type 9: Rubber waffle pads, 30 durometer, minimum 12 mm thick, maximum loading 280 kPa. Use neoprene in oily locations or outdoors.

.10 Type 10: Rubber-steel-rubber pads, 12 mm thick rubber waffle pads bonded to 6 mm thick steel plate.

.11 Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.

.12 Colour code spring mounts, springs selected to operate at no greater than 2/3 solid deflection and have 6 mm ribbed neoprene pads.

PART 3.0 EXECUTION

3.1 APPLICATION

.1 Provide vibration isolators for mechanical motor driven equipment throughout, unless specifically noted otherwise.

.2 Provide Isolation for the following equipment:

.1 Pumps : All base mounted and vertical in-line pumps shall be set on Type D Inertia base.

.2 Air Handling Units : Vibration isolation packaged with equipment.

.3 Energy Recovery Ventilator : Vibration isolation packaged with equipment.

.4 Unit Heaters : Not required.

.5 Force Flows : Not Required.

.3 Install 300mm long flex connection on all duct work connected to isolate equipment.

3.2 INSTALLATION

.1 Deflections 12mm and over shall use steel spring isolators.

.2 Deflections 6mm and under shall use neoprene isolators.

.3 Horizontal limit springs shall be provided on fans in excess of 1500 Pa static pressure except vertical discharge fans and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 270 N force.

.4 All equipment mounted on vibration isolators shall have a minimum clearance of 50mm to other structures, piping equipment , etc. All isolators shall be adjusted to make equipment level.

.5 Prior to making piping connections to equipment with operating weights substantially different from installed weights, the equipment shall be blocked up with temporary shims to the final heights. When full load is applied, the isolators shall be adjusted to take up the load just enough to allow shim removal.

.6 Adjustable, horizontal stabilizers on close spring isolators shall be adjusted so that the side stabilizers are clear under normal operating conditions.

.7 All piping connections to isolated equipment shall be supported resiliently for the following distances or to the nearest flexible pipe connector.

PIPE SIZE	DISTANCE
12mm to 35mm	3.0 m
50mm to 65mm	4.5 m
75mm to 100mm	7.0 m
150mm to 200mm	9.0 m
250mm	13.0 m

PIPE SIZE	DISTANCE
300 and larger	15 m

The three closest hangers to the vibration source shall be selected for the lesser of a 25mm deflection or the static deflection of the isolated equipment. The remaining isolators shall be selected for the lesser of the 25mm static deflection or 1/2 the static deflection of the isolated equipment.

.8 Spring hangers shall be installed without binding.

.9 Adjust isolators as required and ensure springs are not compressed.

.10 Provide neoprene side snubbers or retaining springs where side torque or thrust may develop.

.11 Where movement limiting restraints are provided, they shall be set in a position with minimum 6mm air gap. Restraints, isolator equipment and attachment points shall be designed to withstand the impact of the isolated equipment subjected to an acceleration not exceeding 3 g without permanent distortion or damage.

.12 Wiring connections to isolated equipment shall be flexible.

3.3 PERFORMANCE

.1 Install isolators of type and deflection according to the following table, whichever provides the greater deflection.

The required static deflection of isolators for equipment with motor exceeding 0.5 HP is indicated below. Spring isolators shall be “open spring”. Closed spring isolators shall only be used where specified.

Machine Speed	Basement		Upper Floor	
(RPM)	Under 20 HP	20 HP & Over	Normal	Critical
Under 400	Special*	Special*	Special*	Special*
400 - 600	25mm	50mm	90mm	Special*
600 - 800	12mm	25mm	50mm	90mm
800 - 1100	6mm	12mm	25mm	50mm
1100 - 1500	3mm	6mm	6mm	12mm

* :”Special” indicates as directed by the acoustical consultant.

- END OF SECTION -

This colour code is generally based on the classifications outlined in ASME A13.1-1996 "Scheme for the Identification of Piping Systems".

Refer to section 23 00 00 for additional information on pipe painting, identification, and banding.

Commodity	Commodity Designation	Lettering colour	Pipe Colour (pipe to be painted)	Sub-Band Colour	Band Colour	Stripe Over Band Colour	Additional Designation		Pipe or Sub-Band Colour	Stripe Over Band	Band Colour and Commodity Designation	Stripe Over Band	Pipe or Sub-Band Colour
Domestic Hold Water	DCW	White	-	Green	Green	-	-				DCW		
Glycol Supply	GS	Black	-	Blue	Yellow	Red	-				GS		
Glycol Return	GR	Black	-	Blue	Yellow	Blue	-				GR		
Chilled Water Supply	CHS	White	-	Lt. Blue	Green	Red	-				CHS		
Chilled Water Return	CHR	White	-	Lt. Blue	Green	Blue	-				CHR		

Commodity	Commodity Designation	Lettering colour	Pipe Colour (pipe to be painted)	Sub-Band Colour	Band Colour	Stripe Over Band Colour	Additional Designation		Pipe or Sub-Band Colour	Stripe Over Band	Band Colour and Commodity Designation	Stripe Over Band	Pipe or Sub-Band Colour
Low Pressure Steam & Humidification Steam	LPS	Black	-	Purple	Yellow	-	xxx kPa				**LPS**		
Low Pressure Condensate & Humidification Condensate	LPC	Red	-	Purple	Yellow	-	-				**LPC**		
High Pressure Steam	HPS	Red	-	Purple	Yellow	Black	xxx kPa				**HPS**		
High Pressure Condensate	HPC	Black	-	Purple	Yellow	Black	-				**HPC**		
Sanitary	SAN	White	-	-	Black	-	-				**SAN**		
Sanitary vent	V	White	-	-	Black	-	-				**V**		

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Balance, adjust and test air systems and equipment, and submit reports.

.2 Balance, adjust and test water systems and equipment, and submit reports.

.3 Obtain sound level reading and submit reports.

1.2 QUALITY ASSURANCE

.1 Testing and balancing shall be performed by an agency that specializes in total balancing of Work of this Section.

.2 Procedures in general shall comply with the NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems. Accuracy of measurements shall be in accordance with NEBB standards.

.3 Provide extended warranty of 90 days after completion of test and balance work. During this period the Engineer may request re-check, or resetting of outlets or fans as listed in test report. Provide technicians and instruments required.

.4 Begin testing and balancing after systems have been completed and are in full working order. Place systems and equipment into full operation and continue operation during each working day of testing and balancing.

1.3 SITE VISITS

.1 Regular site visits shall be made during construction. Site visits shall commence after the start of air and water distribution work and be spread over the construction period to the start of the balancing work.

.2 A review of the installation shall be made at the specified site visit and any additional dampers or valves required for proper balance shall be reviewed with the Engineer and the Contractors.

.3 Begin balancing after balancing preparation and after systems have been completed and are in full working order. Place systems and equipment into full operation and continue operation during each working day of balancing.

.4 After Total Completion allow 4 visits to site to adjust systems for seasonal changes and to check and reset fans and outlets during warranty. Coordinate time of visit with the Owner. Submit reports to Engineer.

1.4 BALANCING AGENDA

.1 General: Submit balancing agenda for approval within thirty days of award of Contract. Start balancing work after agenda has been approved. Include descriptive data, procedure data, and sample forms in agenda.

.2 General: Prior to commencement of balancing verbally review with the Engineer method and instruments to be used in balancing. Discussion shall include descriptive data, procedure data, and sample forms.

.3 Descriptive Data: Review design concepts and general function of each system including associated equipment and operation cycles. Confirm listings of flow and terminal measurements to be performed [and selection points for proposed sound measurements].

.4 Procedure Data: Outline procedures for taking test measurements to establish compliance with requirements. Specify type of instrument to be used, methods of instrument application and correction factors.

.5 Sample Forms: Submit forms showing application of procedures to typical systems.

.6 Test sheets required are as follows:

.1 Air Moving Equipment Test Sheet

.2 Diffuser and Grille Test Sheet

.3 Water Balance Element Test Sheet

.4 Duct Traverse Zone Totals Sheet

.5 Duct Traverse Readings Sheet.

1.5 BALANCING REPORT

.1 Submit draft copies of reports prior to final acceptance of project.

.2 Provide four (4) copies of final report for the Owner plus all required copies for inclusion in Operating and Maintenance Manuals. Provide one (1) additional copy of the final report for the Engineer.

.3 Include types, serial number and dates of calibration of instruments.

.4 Submit as part of report, fan and pump curves with operating condition plotted, and grille and diffuser shop drawings with diffusion factors.

.5 Each final report must bear the NEBB certification number and name of supervisor of the balancing firm.

1.6 BALANCING DATA

.1 Balance and equipment data shall be as follows:

- .1 Fire Dampers:
  - .1 Confirm open.
- .2 Air Handling Equipment Installation Data:
  - .1 Manufacturer and model;
  - .2 Size;
  - .3 Arrangement of discharge and class;
  - .4 Motor type, HP, RPM, voltage, phase, cycle and running full load amperage;
  - .5 Location and local identification data.
- .3 Air Handling Equipment Design Data:
  - .1 Total air flow rate;
  - .2 Static pressure;
  - .3 Motor HP, RPM and amps, voltage and phase;
  - .4 Outside air flow rate L/s;
  - .5 Fan RPM
  - .6 Inlet and outlet dry and wet bulb temperatures.

.4 Air Handling Equipment Recorded Data:

.1 Air flow rate;

.2 Static pressure;

.3 Fan RPM;

.4 Motor HP and type;

.5 Motor operating voltage, phase and amperage;

.6 Inlet and outlet dry and wet bulb temperatures.

.5 Duct Air Quantities - Mains, Branch, Outside Air and Exhaust, maximum and minimum:

.1 Duct sizes;

.2 Number of pressure readings;

.3 Sum of velocity measurements;

.4 Average velocity;

.5 Duct recorded air flow rate;

.6 Duct design air flow rate.

.6 Air Inlets and Outlets:

.1 Outlet identification, location and designation;

.2 Manufacturers catalogue identification and type;

.3 Application factors;

.4 Design and recorded velocities;

.5 Design and recorded air flow rates;

.6 Deflector vane or diffuser cone settings.

.7 Pump Installation Data:

.1 Manufacturer and model;

.2 Size;

.3 Type drive;

.4 Motor type, HP, RPM, voltage, phase and full load amperage.

.8 Pump Design Data:

.1 Flow rate;

.2 Total discharge head;

.3 RPM;

.4 HP;

.5 Voltage, phase, amperage.

.9 Pump Recorded Data:

.1 Discharge and suction pressures at full flow and at shut off;

.2 Operating head;

.3 Operating flow rate;

.4 Motor type;

.5 Motor operating, voltage, phase and amperage.

.10 Expansion Tank Installation Data:

.1 Manufacturer, size and capacity;

.2 Pressure reducing valve setting;

.3 Pressure relief valve setting.

.11 Heating Equipment Design Data:

.1 Heat transfer rate;

.2 fluid flow rate;

.3 Entering and leaving fluid temperatures;

.4 Fluid pressure drop.

.12 Heating Equipment Recorded Data:

.1 Element type and identification;

.2 Entering and leaving fluid temperature;

.3 Fluid pressure drop;

.4 Fluid flow rate.

.13 Air Heating and Cooling Equipment Design Data:

.1 Heat transfer rate;

.2 Fluid and air flow rates;

.3 Fluid pressure drop;

.4 Air static pressure drop;

.5 Entering and leaving fluid temperatures;

.6 Entering and leaving air dry and wet bulb temperatures.

.14 Air Heating and Cooling Equipment Recorded Data:

.1 Element type and identification;

.2 Entering and leaving air dry and wet bulb temperatures;

.3 Entering and leaving fluid temperatures;

.4 Fluid pressure drop;

.5 Air static pressure drop;

.6 Air and fluid flow rate;

.7 Adjusted temperature rise or drop.

1.7 ACCEPTANCE

.1 Mechanical systems shall not be considered ready for final inspection until balancing results acceptable to the Engineer are obtained.

.2 If it is found that the specified air or fluid flows cannot be achieved on portions of the system, the actual conditions shall be reported to the Engineer for consideration of corrective action before continuing the balancing procedure on the affected system.

.3 If measured flow at final inspection shows deviation of 10% or more from the certified report listings in more than 10% of selected areas, the report shall be rejected.

.4 If report is rejected, systems shall be re-balanced and a new certified report submitted at no extra cost to the Owner.

PART 2.0 PRODUCTS

2.1 INSTRUMENTS

.1 Instruments used for balancing of systems must have been calibrated within a period of six months and checked for accuracy prior to start of work.

.2 The agency shall submit to the Engineer a list of equipment which will be used for the balancing of systems and the accuracy test certification.

.3 Recalibration or use of other instruments may be requested when accuracy of reading is questionable.

PART 3.0 EXECUTION

3.1 GENERAL PROCEDURES

.1 Permanently mark, by stick-on labels, settings on valves, splitters, dampers, and other adjustment devices.

.2 Subsequent to correctional work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.

.3 Balancing shall be performed to the following accuracies:

.1 Air-terminal outlets $\pm$ 10%

.2 Air-handling equipment $\pm$ 5%

.3 Hydronic-terminal outlets ± 10%

.4 Hydronic-pumps and central equipment ± 5%

.4 Air system balancing shall be accomplished in a manner to first minimize throttling losses, then fan speed shall be adjusted to meet design flow conditions. Balancing procedures shall be in accordance with the National Environmental Balancing Bureau (NEBB). Procedural Standards (1983), the Associated Air Balancing Council (AABC), National Standards (1982) or equivalent procedures.

.1 Exception: Damper throttling may be used for air system balancing with fan motors of 1 HP or less.

.5 Hydronic system balancing shall be accomplished in a manner to first minimize throttling losses, then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions.

.1 Exception: Valve throttling may be used for hydronic system balancing under any of the following conditions:

.1 Pumps with pump motors of 10 HP or less.

.2 To reserve additional pump pressure capability in open circuit piping systems subject to fouling. Valve throttling pressure drop shall not exceed that expected for future fouling.

3.2 FIRE DAMPER PROCEDURE

.1 Fire dampers are to be put in place with the fusible links installed.

.2 The air balancer is to confirm all fire dampers are in the open position, and to mark each damper checked with a label including date checked.

3.3 AIR SYSTEM PROCEDURE

.1 Perform balancing, adjusting and testing with building doors and windows in their normal operation position.

.2 The following procedure shall be adopted for central systems:

.1 Ensure dampers or volume control devices are in fully open position.

.2 Balance central apparatus to ± 10% air flow.

.3 Balance branches, mains to ± 10% air flow.

.4 Recheck central apparatus.

.5 Balance all terminal air outlets to ± 10%

.6 Rebalance central apparatus to ± 5%.

.7 Recheck all air outlets.

.8 Perform acoustical measurements.

.3 When balancing air outlets:

.1 Rough balance furthest outlets and then balance sequentially back to source.

.2 Fine balance furthest outlet back to source.

.4 Take static pressure readings and air supply temperature readings at 10 points on each air system.

.5 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. If readings are inconsistent across duct, relocate to two duct diameters or widths, and re-do traverse.

.6 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control only by duct internal devices such as dampers and splitters.

.7 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

.8 Where modulating dampers are provided, take measurements and balance at extreme conditions. (Balance variable volume systems at maximum air flow rate (full cooling), and at minimum air flow rate (full heating.)

.9 The final balanced condition of each area shall include testing and adjusting of pressure conditions. Test and record building pressurization levels in variable volume systems throughout full range of fan delivery rates, under both heating and cooling conditions. Full multi-storey building test pressure conditions at ground, intermediate and upper levels. Front doors, exits, elevator shafts, should be checked for air flow so that exterior conditions do not cause excessive or abnormal pressure conditions. Document abnormal building leakage conditions noted.

.10 Complete balancing to achieve positive building pressure unless otherwise instructed. A positive pressure relative to outside of 10 Pa minimum and 25 Pa maximum shall be achieved, measured with negligible outside wind velocity.

3.4 BALANCING OF HYDRONIC SYSTEMS

.1 Open all valves (excepting pressure bypass must be closed) to fully open position including balancing valves, isolation valves, and control valves.

.2 Execute air balance prior to initiating hydronic balance (if coils are provided).

.3 Set pumps to deliver 10% excess flow if possible.

.4 Adjust flows through each boiler or chiller to ensure equal flow.

.5 Check and adjust flows and temperatures at inlet side of coils.

.6 Position and mark all automatic valves, hand valves and balancing cocks for design flow through all coils, connectors and all items in system requiring circulation of chilled water, hot water or glycol.

.7 Upon completion of flow readings and coil adjustments, mark setting and record data.

.8 Coordinate shaving of impeller to operating condition on pumps larger than 1 HP.

.9 Ensure all bypass valves are tightly closed.

.10 After making all terminal unit adjustments, recheck settings at pumps. Readjust as required.

.11 Calibrate all pressure and temperature gauges.

.12 Install pressure gauges on each coil then read pressure drop through coil and set flow rate on call for full flow through coil. Set pressure drop across bypass valve to match coil full flow pressure drop.

.13 For all parallel pumping systems, check all flows through boiler, chiller, heat exchanger, and pumps under the following situations.

.1 With two pumps operating.

.2 With one pump operating - repeat for each pump.

.3 With controls demanding no heating or cooling.

.14 For each pump, plot maximum and minimum flows on curve.

.15 Verify pressure drops and flows through pressure control bypass valves at full operating range.

3.5 BALANCING REPORT

.1 Record test data on drawings made from the latest available revised set of mechanical drawings and submit four (4) copies upon completion of the balancing contract for inclusion in equipment and maintenance manuals.

.2 Install at each piece of mechanical equipment a “Data Register” showing significant operating temperatures, pressures, amperes, voltage, and brake horsepower. “Data Register” to be enclosed in a plastic holder securely attached to the equipment or to a wall in the adjacent area.

.3 Submit with report, fan and pump curves with operating conditions plotted. Submit grille and diffuser shop drawings and diffusion factors.

.4 Report shall be indexed as follows:

AIR

- Summary
- Procedure
- Instrumentation
- Drawings
- Equipment Summary
- Fan sheets
- Fan curves

- Fan profile data
- Static data
- Air monitoring station data
- Traverse data and schedule
- Terminal unit summary
- Outlet data summary and schematics (per system)
- Building pressurization data diagnostic

WATER

- Summary
- Procedure
- Instrumentation
- Drawings

PUMP DATA

- Pump curves
- Flow stations
- Coils
- Equipment data
- Element data summary and schematics (per system)
- Diagnostic

- END OF SECTION -

PART 1.0 GENERAL

1.1 SCOPE

.1 Prepare the facility for balancing.

PART 2.0 PRODUCTS

Not applicable.

PART 3.0 EXECUTION

3.1 BRING WORK TO OPERATING STATE

.1 Bringing the work to an operating state and ready for balancing, including:

.1 Clean equipment and ductwork.

.2 Install air terminal devices.

.3 Provide temporary filters in air handling equipment and carry out a rough air balance to ensure all equipment performs required function.

.4 Replace filters with specified filters prior to balancing.

.5 Verify lubrication of equipment.

.6 Install permanent instrumentation.

.7 Clean piping systems and strainers, clean systems as per Sections 23 25 00 “Preoperational Cleaning and Chemical Treatment”, drain and fill with clean heat exchange fluid.

.8 Complete the “start-up” of equipment.

.9 Adjust stuffing boxes and packing glands on pumps and valves.

.10 Check rotation and alignment of rotating equipment and tension of belted drives.

.11 Verify ratings of overload heaters in motor starters.

.12 Set control points of automatic apparatus, check-out sequence of operation.

.13 Make available control diagrams and sequence of operation.

.14 Clean work, remove temporary tags, stickers, and covering.

.15 Make available one (1) copy of Maintenance Manuals especially for use in balancing.

.16 Provide Balancing Agency a complete set of mechanical drawings and specifications and all approved changes thereto.

3.2 COOPERATE WITH THE BALANCING AGENCY AS FOLLOWS:

.1 Make corrections as required by Balancing Agency.

.2 Allow Balancing Agency free access to site during construction phase. Inform Balancing Agency of any major changes made to systems during construction and provide a complete set of record drawings for their use.

.3 Operate automatic control system and verify set points during balancing.

3.3 BALANCING VALVES AND DAMPERS

.1 Provide and install balancing valves, dampers and other materials requested by the Balancing Agency and/or necessary to properly adjust or correct the system to design flows, without additional cost to Owner.

3.4 PULLEYS AND SHEAVES

.1 Provide and install pulleys and sheaves for rotating equipment, as required to properly balance the systems to design flows, at no additional cost. Adjustable sheaves are not acceptable.

3.5 SHAVING OF PUMP IMPELLERS

.1 Allow in the contract price shaving of impellers as required to balance the pumps to design flow at operating condition.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Test glycol piping.

.2 Test chilled water piping.

.3 Test domestic water piping.

.4 Test sanitary sewer piping.

.5 Test ductwork.

.6 Test Steam Piping.

1.2 QUALITY ASSURANCE

.1 Test equipment and material where required by specification, drawings or authority having jurisdiction to demonstrate its proper and safe operation.

.2 Testing will be in accordance with applicable portions of ASME, ANSI, ASHRAE, and other recognized test codes as far as field conditions permit.

.3 Perform tests on site to the satisfaction of the Engineer.

.4 Piping, fixtures or equipment shall not be concealed or covered until inspected and approved by the Engineer. Provide ample written notice (five working days) to the Engineer before tests.

.5 Coordinate with Engineer at start of project, those tests that will require witnessing by the Engineer.

1.3 EXCLUSIONS

.1 Flexible connections downstream of VAV boxes.

1.4 REFERENCES

.1 SMACNA HVAC Air Duct Leakage Test Manual, latest edition.

1.5 DUCT TEST PROCEDURES

.1 Maximum lengths of ducts to be tested to be consistent with capacity of test equipment.

.2 Section of duct to be tested to include:

.3 Fittings, branch ducts, tap-ins.

.4 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.

.5 Base partial system leakage calculations on Reference Standard.

.6 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

1.6 TESTING AGENCY

.1 Installing Contractor.

1.7 SUBMITTALS

.1 Obtain certificates of approval, acceptance, and comply with rules and regulations from authorities having jurisdiction and include in Operating and Maintenance Manuals.

.2 Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemize each test as to time performed and personnel responsible. Include in Operating and Maintenance Manuals.

1.8 CONTRACTOR'S RESPONSIBILITY

.1 Take charge of plant during tests, assume responsibility for damages in event of injury to personnel, building or equipment and bear costs for liability, repairs, and restoration in this connection.

PART 2.0 PRODUCTS

Not applicable.

PART 3.0 EXECUTION

3.1 PRESSURE TESTS

.1 Provide equipment, materials and labour for tests and pay expenses. Use test instruments by approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install test gauges and thermometers just prior to tests to avoid possible changes in calibration.

.2 Carry out hydraulic tests for 8 hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and retest.

.3 Where tests required by the Authority Having Jurisdiction vary from those noted below, the more stringent testing shall apply.

.4 Glycol, heating, chilled, and condenser water piping: Test at 1.5 times design pressure or 1000 kPa water pressure, whichever is greater.

.5 Low Pressure Steam and Condensate Piping: Test at 860 kPa water pressure.

.6 High Pressure Steam and Condensate Piping: 1.5 times design pressure, and to requirements of Saskatchewan Department of Labour, Boiler Inspection Branch.

.7 Domestic water piping: Test to 1000 kPa water pressure measured at system low point.

.8 Low velocity ductwork: Test for tightness such that leakage is inaudible and not detectable by feel. Test systems up to 500 Pa with a maximum leakage of 2%.

.9 Medium velocity ductwork: Test for tightness as specified by the SMACNA manuals with maximum leakage of 1% at any branch or main duct at 1000 kPa static pressure. Construct free of audible leaks.

.10 Duct Testing Instruments

- .1 Testing agency to provide instruments for tests.
- .2 Test apparatus to include:
  - .1 Fan capable of producing required static pressure.

.2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.

.3 Flow measuring instrument compatible with the orifice plate.

.4 Calibration curves for orifice plates used.

.5 Flexible duct for connecting to ductwork under test.

.6 Smoke bombs for visual inspections.

.3 Test apparatus to be accurate to within +/- 3 % of flow rate and pressure.

3.2 PROCEDURES

.1 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air or nitrogen test medium and halide torch for refrigerant medium.

.2 During heating and cooling piping system tests, check linear expansion at elbows, U-bends, expansion joints, and offsets for proper clearance.

.3 When using water as the test medium for system not designed for water or steam, evacuate and dehydrate the piping and certify the lines are dry. Use agency specializing in this type of work.

.4 When using nitrogen as the test medium, the system shall be vented to outside the building after completion of the test.

.5 Specific procedures must be followed for systems that are pneumatically tested. Maximum initial pressure should be 175 kPa, with subsequent rise of 175 kPa maximum. Allow time at each increase for strains to equalize and for leak checks to be done. Procedures to be approved by the Engineer.

.6 Underground sections of all lines must be tested before the line is backfilled.

.7 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by remaking joints in screwed fittings, cutting out and re-welding welded joints, remaking joints in copper lines. Do not caulk.

3.3 PERFORMANCE TESTS

.1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, adjustments, and replacements required as tests may indicate prior to operating tests.

.2 Make operating tests for minimum of 5 days during heating season and cooling season of first year of operation, and at times when directed, for proper settings of controls under peak load conditions.

.3 Conduct final operating tests in presence of the Engineer. Vary loads to illustrate start-up and shutdown, sequence, and simulate emergency conditions for safety shutdowns, with automatic and manual reset. Repair and test defects until satisfactory. Make final adjustments to suit exact building conditions.

.4 Provide services of one job mechanic, ladders, tools and associated equipment required to assist the Engineer in final tests.

.5 Duct Pressure Test Reports

- .1 Prepare report of results and submit to Engineer within 24 hours of completion of tests. Include:
  - .1 Schematic of entire system.
  - .2 Schematic of section under test showing test site.
  - .3 Required and achieved static pressures.
  - .4 Orifice differential pressure at test sites.
  - .5 Permissible and actual leakage flow rate (L/s) for test sites.
  - .6 Witnessed certification of results.
- .2 Include test reports in final Balancing Report.

- END OF SECTION -

PART 1.0 GENERAL

1.1 Definitions

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as defined herein.

.3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

1.2 Shop Drawings

.1 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

1.3 Samples

.1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

1.4 Manufacturer's Instructions

.1 Submit manufacturer's installation instructions. Installation instructions to include procedures to be used, installation standards to be achieved.

1.5 Qualifications

.1 Installer to be specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.

1.6 Delivery, Storage and Handling

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.2 Protect from weather and construction traffic.

.3 Protect against damage from any source.

.4 Store at temperatures and conditions required by manufacturer.

PART 2.0 PRODUCTS

2.1 Fire and Smoke Rating

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 Insulation - Thermal

.1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24C mean temperature when tested in accordance with ASTM C 335.

.3 TIAC Code C-1: Rigid mineral fibre board to CAN/CGSB51.10, with without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

.4 TIAC Code C-2: Mineral fibre blanket to CAN/CGSB-51.11 faced with without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).

.1 Mineral fibre: to CAN/CGSB-51.11.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/CGSB-51.11.

2.3 Jackets

.1 Canvas:

.1 220 gm/m 2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.

.2 Lagging adhesive: Compatible with insulation.

2.4 Accessories

.1 Vapour retarder lap adhesive:

.1 Water based, fire retardant type, compatible with insulation.

.2 Indoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C 449.

.4 Contact adhesive: quick-setting

.5 Canvas adhesive: washable.

.6 Banding: 12 mm wide, mm thick stainless steel.

.7 Fasteners: 2 mm diameter pins with 35 mm clips, length to suit thickness of insulation.

2.5 Duct Liner

.1 General:

.1 Fibrous glass duct liner: air stream side faced with mat facing.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.

.3 Liner shall be installed with antimicrobial coating.

.2 Rigid:

.1 Use on flat surfaces and where indicated.

.2 25 mm thick, to CGSB 51-GP-10M, fibrous glass rigid board duct liner.

.3 Density: 36 kg/m3minimum.

.4 Thermal resistance to be minimum 0.76 m2. deg C/W for 25 mm thickness when tested in accordance with ASTM C177, at 24 deg C mean temperature.

.3 Flexible:

.1 Use on round or oval surfaces and where surfaces indicated.

.2 25 mm thick, to CGSB-51-GP-11M, fibrous glass blanket duct liner.

.3 Density: 24 kg/m3 minimum.

.4 Thermal resistance to be minimum 0.37 m2. deg C/W for 12 mm thickness when tested in accordance with ASTM C177, at 24 deg C mean temperature.

.4 Adhesive

.1 Meet the requirements of NFPA 90A and NFPA 90B, ASTM E-84, UL723, and ASTM C-916 type II. Also the material shall be LEED qualified and water based.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 deg C to plus 93 deg C.

.5 Fasteners

.1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

.6 Joint Tape

.1 Poly-Vinyl treated open weave fibreglass membrane 50 mm wide.

.7 Sealer

.1 Low odour lagging adhesive and protection coating. Meet the requirements of NFPA 90A and NFPA 90B, UL723, ASTM E-84. Material shall also be LEED qualified.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range -68°C to 93°C.

PART 3.0 EXECUTION

3.1 Pre-installation Requirements

.1 Pressure testing of ductwork systems to be complete, witnessed, and certified.

.2 Surfaces to be clean, dry, free from foreign material.

3.2 Installation

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers' instructions and this specification.

.3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports to be outside vapour retarder jacket.

.5 Supports, Hangers in accordance with Section 23 05 40 "Supports Anchors Seals".

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.6 Fasteners: At 300 mm o.c. in horizontal and vertical directions, minimum two rows each side.

3.3 Ductwork Insulation Schedule

.1 Insulation types and thicknesses: Conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Supply, return and exhaust ducts exposed in space being served			none
Outside air ducts to mixing plenum	C-1	yes	25
Mixing plenums	C-1	yes	25
Exhaust duct between dampers and louvres	C-1	no	25
Acoustically lined ducts	none	none	As noted

.2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.2 Finishes: Conform to following table:

	TIAC Code	
	Rectangular	**Round**
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

3.4 Duct Recovering

.1 Provide ductwork recovering as follows:

.1 Indoor ductwork concealed : none

.2 Indoor ductwork exposed : Canvass.

3.5 Duct Liner

.1 Do work in accordance with recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as specified otherwise.

.2 Line inside of ducts as follows:

.1 Where indicated on the drawings.

.2 Downstream of Supply Fans and Air Handling Units - 3 m downstream of supply fans or units.

.3 Upstream of return and exhaust fans - 3m upstream of fans.

.4 Upstream and downstream of Roof Top Units - 3m from unit or fan, both upstream and downstream.

.5 Upstream and downstream of single fan air handling units - 3m from unit or fan, upstream and downstream.

.6 Upstream and downstream of transfer fans - 3m from unit or fan, upstream and downstream.

.7 All transfer ducts in their entirety.

.3 Duct dimensions, as indicated, are clear inside duct lining.

.4 Install in accordance with manufacturer's recommendations, and as follows:

.1 Fasten to interior sheet metal surface with 100% coverage of adhesive.

.2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres.

.5 Joints

.1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:

.1 Bed tape in sealer.

.2 Apply two coats of sealer over tape.

.2 Replace damaged areas of liner at discretion of Engineer.

.3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Piping insulation.

.2 Equipment insulation.

.3 Adhesive, tie wires, tapes.

.4 Recovery jacket.

1.2 QUALITY ASSURANCE

.1 Have insulation installed by skilled workmen specializing in this type of work.

.2 Materials shall meet fire and smoke hazard ratings as stated in this Section and defined in Saskatchewan Building Code.

.3 No exposed fibreglass insulation is permitted in return air plenums such as ceiling spaces. All such insulation, including all ends and joints, is to be taped, encapsulated, or otherwise sealed.

1.3 SUBMITTALS

.1 Shop drawings indicating complete material data, list of materials proposed for this project and thickness of material for individual services.

.2 [Submit samples of proposed insulating and jacketing materials.]

1.4 JOB CONDITIONS

.1 Deliver material to job site in original non-broken factory packaging, labelled with manufacturer's product density and thickness information.

.2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Separation of joints or cracking of insulation due to thermal movement or poor workmanship shall be made good.

PART 2.0 PRODUCTS

2.1 GENERAL

.1 Adhesives, insulation materials, vapour barrier facings, tapes and recovery jackets: Composite fire and smoke hazard ratings shall not exceed 25 for Flame Spread and 50 for Smoke Developed. Adhesives shall be waterproof.

.2 Insulating materials and accessories must withstand service temperatures without smouldering, glowing, smoking or flaming when tested in accordance with ASTM C411-82.

.3 All insulation materials shall meet Building Code Standards and packages or containers of such materials shall be appropriately labelled.

.4 Insulate fittings and valve bodies with pre-formed insulated fittings.

2.2 MATERIALS

.1 Mineral Fibre Insulation for Hot Pipes: Formed rigid mineral fibre insulation sleeving to CGSB 51-GP-9M. Factory applied all-purpose jacket of a white kraft bonded to a metalized polyester, reinforced with glass scrim. Maximum "k" value at 24°C to be 0.035 W/m.°C, with service temperature up to 150°C.

.2 Mineral Fibreboard Insulation for Hot Equipment: Rigid mineral fibreboard to CGSB 51-GP-10M. Maximum "k" value at 24°C to be 0.035 W/m.°C, with 20°C to 120°C service temperature.

.3 Mineral Fibre Insulation for Hot Equipment: Flexible mineral fibre blanket insulation to CGSB 51-GP-11M. Maximum "k" value at 24°C to be 0.035 W/m.°C, with 20°C to 120°C service temperature.

.4 Mineral Fibre Insulation for Cold Pipes: Formed rigid mineral fibre insulation sleeving to CGSB 51-GP-9M. Factory applied vapour barrier jacket to CGSB 51-GP-52M, Type 1, with longitudinal lap seal. Maximum "k" value at 24°C to be 0.035 W/m.°C, with -14°C to 100°C service temperature.

.5 Mineral Fibreboard Insulation for Cold Equipment: Rigid mineral fibreboard to CGSB 51-GP-10M. Factory applied vapour barrier jacket to CGSB 51-GP-52M, Type 1. Maximum "k" value at 24°C to be 0.035 W/m.°C, with -14°C to 100°C service temperature.

.6 Mineral Fibre Insulation for Cold Equipment: Flexible mineral fibre blanket to CGSB 51-GP-11M. Factory applied vapour barrier jacket to CGSB 51-GP-52M, Type 1. Maximum "k" value at 24°C to be 0.035 W/m.°C with -14°C to 100°C service temperature.

.7 Recovery:

.1 Aluminum jacket to be 0.5 mm thick to CSA HA Series M-1980, with longitudinal slip joints.

.2 PVC jacketing to be to CGSB 51-GP-53M, 0.38 mm thick, off-white colour with one-piece pre-molded fitting covers.

.8 Accessories:

.1 Contact adhesive to be quick-setting to adhere mineral fibre and fibreboard insulation in place.

.2 Canvas adhesive to be washable, for cementing canvas jacket onto insulation.

.3 Lap seal adhesive to be quick-setting, for jointing and lap sealing of vapour barriers. Joint tape to be self-adhesive, 100 mm wide with vapour barrier.

.4 Finishing cement to be mineral fibre hydraulic setting thermal insulating and finishing cement to CAN/CGSB-51.12-M86, Type 1, for use up to 650°C.

.5 Insulating cement to be mineral fibre thermal insulating cement to CAN/CGSB-51.12-M86, Type 1, for use up to 870°C.

2.3 INSULATING BLANKETS (REUSABLE FLEXIBLE INSULATION COVERS) : SERVICE TO 232C.

.1 Before reusable flexible insulation covers are installed any required surface protection applications and tracing must be performed and installed.

.2 Each reusable Flexible Insulation Cover shall have a close contour fit for a neat appearance and to ensure proper thermal performance. Overlapping seams are not acceptable.

.3 Reusable flexible insulation covers for flanged valves and equipment shall be designed to cover adjacent mating flanges and overlap line insulation by a minimum of 50 mm past the top of the bevel. Allowance of one stud length plus 25 mm from the flange face of the mating flange to the top of the bevel shall be used to calculate the cut back distance of line insulation. Draw cord flaps shall not be considered as part of the overlap.

.4 Blankets on valves shall be designed to cover the valve body and the bonnet flange of the valve.

.5 Blankets for pumps shall include the suction and discharge flanges.

.6 Blankets for vessel trim shall include isolation valves.

.7 Blankets for pressure gauges include block and bleed valve.

.8 Blankets for PRV's shall include the outlet flange. Blanket shall cover entire spring chamber.

.9 Provide a 50mm (2“) overlap over the adjacent insulation. Allow bolt length plus 25mm (1”) from the centre of the valve/line flanges for the insulation termination. For grooved mechanical couplings, allow 50mm (2”) overlap over the insulation (assuming the insulation termination is at the edge of the Victaulic clamp so as to allow for easier access to the bolts on the grooved mechanical couplings.

.10 All equipment shall be field measured by blanket supplier. Measurements shall be performed after equipment is installed. All necessary allowances for the blankets shall be coordinated between all appropriate trades.

.11 Multiple piece construction is acceptable.

.12 Individual covers or pieces thereof shall not weigh more than 25 kilograms.

.13 The total thickness of the reusable flexible insulation covers shall be a minimum thickness of 25mm and a maximum thickness of 50mm.

.14 Construction Details

  .1 Reusable flexible insulation cover closure and penetration flaps shall be installed to provide water shed.

  .2 Reusable flexible insulation covers shall be sewn with thread suitable to withstand the full process temperature with a minimum seven stitches per 25mm.

.3 Stainless steel hog rings shall be used only to reinforce high temperature seam closures, reinforce end caps, and join large or thick cover sections and end caps. Joined sections and end caps using hog rings must have a welting buried in the seam to help hide the hog ringed seam.

.4 All cut-outs and penetrations shall be covered with a tri-fold of cloth material to encase the jacket edge. Cut jacket edges shall not be exposed to the elements. All seams and edges shall be hemmed seams.

.5 With the exception of cut-outs and penetrations wind-flaps and plackets shall be incorporated into the jacket as one continuous piece of cloth.

.6 Insulation within the reusable flexible insulation cover shall be mechanically fastened in place to prevent shifting using through cover stainless steel quilting pins located on maximum 500mm centers. The ends of all pins must be capped or pigtailed to protect workers, tracing and equipment.

.7 The following fastening techniques are acceptable and shall be used to hold the cover correctly in place:

.1 On covers 25mm thick: Cinch belt shall be made of outer jacket material, 25mm wide Two-Fold double stitch belting with hook and loop connecting to an adjacent belt with two stainless steel D-ring fasteners. These fasteners shall be set a minimum of 250mm apart; the manufacturer shall use as many fasteners as are necessary to ensure the cover will be adequately secured.

.2 On Covers more than 25mm thick use stainless steel lacing anchors in combination with the cinch belts noted above using the same spacing.

.3 On cover areas where there is not adequate space to allow a cinch belt, stainless steel lacing anchors and wire may be used without cinch belt.

.8 With the exception of the parting seam and access slots for penetrations all ends and openings larger than 50mm which will be exposed to the elements must utilize wind-flaps to repel moisture and excessive convective heat loss. The wind-flap shall be constructed from the same material as the cold face fabric. Polyester cord shall be installed within the wind-flap in such a way it will not be pulled out.

.9 Plackets on parting seams and penetration access slots are to be finished with Hook and Loop fastening system.

.15 Identification Tag

.1 Each Reusable flexible insulation cover or piece thereof shall have an identification tag firmly attached to the outer jacket.

.2 The tag shall be made of aluminium or stainless steel.

.3 The following information should be etched or stamped on the tag:

.1 Fabricator or contractor name

.2 Equipment to be covered

.3 Location of equipment (ISO, P&ID, or GA Number and Line Number)

.4 Serial number of cover (for ease of reordering damaged covers or follow up for warranty)

.16 Material Specifications

.1 Outer Jacket Material : Teflon coated fibreglass cloth: 16.5 ounces per square yard with a maximum service temperature of 232C. Base fabric : Fibreglass satin weave. Coating " Grey Fluorocarbon.

.2 Inner Jacket Material : as outer jacket material.

.3 Insulation material : Fibreglass mat: Thermal insulation shall be composed of 100% Type E needled glass fibber. Density of the matt shall be no less than 11 pounds per cubic foot. The glass shall not contain any binders and shall be used up to 650C. Alkalinity shall be 0.15% or less.

.4 Sewing Thread Material : sewing thread 10C to 232C: E18 Teflon coated fibreglass thread.

PART 3.0 EXECUTION

3.1 PREPARATION

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 INSTALLATION

.1 Ensure insulation is continuous through non-fire-rated inside walls. Pack around pipes with fire proof self-supporting insulation materials, properly sealed.

.2 Insulate fittings. Do not insulate unions, flanges, and strainers except on chilled water lines. Do not insulate flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.3 Finish insulation neatly at hangers, supports and other protrusions.

.4 Pipe hangars and supports shall not penetrate insulation or recovering. Provide insulation shields to protect insulation from crushing.

.5 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.6 Stagger butt joints where multi-layered insulation is used.

.7 On vertical piping with diameters 25 mm and larger, use insulation supports welded or bolted to pipe directly above lowest pipe fitting. Repeat supports on 4.5 m centres and at each valve and flange.

.8 Tightly fit insulation sections to pipe to make smooth and even surfaces. Cut insulation for proper fit where weld beads protrude. Bevel away from studs and nuts to allow their removal without damage to insulation. Trim closely and neatly around extending parts of pipe saddles, supports, hangers, clamp guides and seal with insulating/finishing cement.

.9 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, pipe shafts and suspended ceiling spaces is not considered exposed. Make smooth uneven insulated surfaces before recovering.

.1 Steam and condensate : Aluminium.

.2 Chilled Water : PVC.

.3 Heating Water (Glycol) : PVC.

.4 Domestic Hot, Cold, and Recirculation : PVC.

.10 Where insulation is installed in ductwork or plenums (including ceiling spaces, etc.), no exposed glass fibre or mineral wool is permitted.

3.3 HOT PIPES

.1 Insulate the following with Mineral Fibre Insulation for Hot Pipes:

MINIMUM PIPE INSULATION (mm)						
COMMODITY	**NOMINAL PIPE DIAMETER**					
	Runouts* up to 50mm	**25mm & smaller**	**30mm to 50mm**	**65mm to 100mm**	**150mm**	**200mm & larger**
Glycol Heating & Hot Water Heating to 95°C	12mm	38mm				
Humidifier Steam Piping	-	25mm				
Humidifier Condensate piping	-	25mm to 1 meter from unit or dispersion tube				

MINIMUM PIPE INSULATION (mm)						
COMMODITY	**NOMINAL PIPE DIAMETER**					
	Runouts* up to 50mm	**25mm & smaller**	**30mm to 50mm**	**65mm to 100mm**	**150mm**	**200mm & larger**
Low Pressure Steam and Low Pressure Condensate	25mm	38mm		50mm		90mm
High Pressure Steam and High Pressure Condensate	32mm	65mm		75mm	90mm	

* Run-outs to individual terminal units, 4 m max.

** Domestic water pipe insulation for piping installed in 100 x 50 wall cavity can be reduced to 12mm for pipe sizes 40mm to 65mm. Install insulation to thickness specified for piping outside the wall cavity.

.2 Apply mineral fibre insulation when pipe surface temperatures are 50°C minimum. Apply insulation and recovery over full length of pipe without penetration of hangers, nor interruption at sleeves and fittings. Apply adhesive to ends of butt joints, then seal joint seams with 100 mm wide joint tape. Terminate at each end of unions and flanges. Trowel finish cement into bevel. Cover fittings and valves with equivalent thickness of finishing cement. Apply finishing cement over exposed fittings and valves before application of canvas recovery. Cut insulation layers straight on 10 metre centres with 25 mm gap for expansion. Pack void tightly with insulation and protect joints with aluminum sleeves.

.3 Flare out staples may be used to secure jacket laps on hot systems. Staples are to be applied on 100mm centres.

.4 Do not insulate heating piping within radiation enclosures, except for mains.

3.4 COLD PIPES

.1 Insulate the following with Mineral Fibre Insulation for Cold Pipes:

MINIMUM PIPE INSULATION (mm)						
COMMODITY	**NOMINAL PIPE DIAMETER**					
	Runouts* up to 50mm	**25mm & smaller**	**30mm to 50mm**	**65mm to 100mm**	**150mm**	**200mm & larger**
Domestic Cold Water	12mm**	25mm	25mm**	32mm**	32mm	32mm
Chilled Water	12mm	12mm	20mm	25mm	25mm	25mm
Plumbing Vents	25mm	25mm	25mm	25mm	25mm	25mm

* Run-outs to individual terminal units, 4m max.

** Domestic water pipe insulation for piping installed in 100 x 50 wall cavity can be reduced to 12mm for pipe sizes 40mm to 65mm. Install insulation to thickness specified for piping outside the wall cavity.

.2 Apply mineral fibre insulation and recovery over full length of pipe without penetration of hangers nor interruption at sleeves and fittings. Apply adhesive to ends of butt joints, then seal joint seams with 100 mm wide joint tape. Cover fittings and valves with equivalent thickness of finishing cement. Cover finishing cement with open mesh glass cloth and adhesive. Seal lap joints with 100 mm wide joint tape, then seal the assembly with adhesive.

.3 Insulate 2 metre portion of plumbing vents measured from roof outlet back, and through all cold spaces. Do not insulate remaining vent piping.

3.5 VALVES AND FITTINGS

.1 Insulate fittings and valves.

.1 Do not insulate unions or flanges.

.2 Do not insulate flexible connections or expansion joints.

.3 Insulate valve bodies with preformed removable insulating blankets or preformed insulated fittings.

.4 For valves 65mm and larger, insulate valve bodies with removable insulating valve blankets.

.5 Terminate insulation neatly with plastic material towelled on a bevel.

3.6 EQUIPMENT

.1 Provide removable insulating blankets on the following equipment and devices:

.1 Plate and frame heat exchangers.

.2 Flash Tank

.3 Air Separator

.4 Condensate receiver

.5 Steam System Strainers

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Provide material and labor required to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures. Provide information and assistance required, cooperate with test, adjust and balance services.

.2 Comply strictly with specified procedures and manufacturers' recommendations when starting mechanical systems.

1.2 QUALITY ASSURANCE

.1 Use factory trained representatives and submit manufacturer's check sheets for starting the following speciality equipment:

.1 Air handling units

.2 Energy Recovery Ventilators

.3 Pumps

.4 Variable speed drive units

.5 Control components

.6 Chemical cleaning and treatment

.2 Prior to starting testing, balancing, adjusting and cleaning processes, verify with Engineer any tests required to be witnessed. Provide sufficient notice to Engineer prior to commencement of procedures.

.3 Engineer shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.

.4 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.

.5 Prior to starting equipment or systems, secure and review manufacturer's installation, operation, and starting instructions. Read in conjunction with procedures defined herein.

.6 Use manufacturer's or supplier's starting personnel where required to ensure integrity of manufacturer's warranty.

.7 Compare installations to published manufacturer's data and record discrepancies. Items proving detrimental to equipment performance shall be corrected prior to equipment starting.

.8 Some processes involved in starting procedures defined in this section may be duplications of Authorities verification. To facilitate expedient completion of project, arrange for Authorities to assist or witness these procedures.

.9 All starting, testing procedures shall be in accordance with applicable portions of ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM and ASPE.

.10 Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the reading and tests.

.11 Assume all liabilities associated with starting, testing and balancing procedures.

PART 2.0 PRODUCTS

Not applicable.

PART 3.0 EXECUTION

3.1 GENERAL

.1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs and adjustments required prior to operating tests.

.2 Where required by the Authority having jurisdiction, gas fired appliances rated in excess of 120 kW (400 MBH) shall be subjected to an operational test established by the Authority and shall pass this test before being approved for operation.

.3 Meet with Division 26 manufacturers, suppliers and other specialists as required to ensure all phases of work are properly coordinated prior to the commencement of each particular testing procedure. Establish all necessary manpower requirements.

.4 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.

.5 Confirm voltages and operating amperages at full load.

.6 Failure to follow instruction pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by the Owner at the Contractor’s expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

3.2 PROCEDURES

.1 The procedure shall be identified in the following five (5) distinct phases:

.1 Pre-starting: Visual Inspection

.2 Starting: Actual starting procedure.

.3 Post-starting: Operational testing, adjusting or balancing, and equipment run-in phase.

.4 Pre-Interim Acceptance of the Work: Final cleaning, re-testing, balancing and adjusting, and necessary maintenance.

.5 Post-Interim Acceptance of the Work: Repeat tests and fine-tuning resulting from corrective action of deficiency clean-up.

3.3 START-UP PROCEDURES

.1 Bearings: Inspect for cleanliness, clean and remove foreign materials. Verify alignment. Replace defective bearings, and those which run rough or noisy. Grease as necessary, and in accord with manufacturer's recommendations.

.2 Drives: Adjust tension in V-belt drives, for proper equipment speed. Adjust drives for alignment of sheaves and V-belts. Clean and remove foreign materials before starting operation.

.3 Motors: Check each motor for amperage comparison to nameplate value. Correct conditions which produce excessive current flow, and which exist due to equipment malfunction. Ensure correct size overload heaters are installed in motor starters.

.4 Pumps: Check mechanical seals for cleanliness and adjustment before running pump. Inspect shaft sleeves for scoring. Inspect mechanical faces, chambers, and seal rings, replace if defective. Verify that piping system is free of dirt and scale before circulating liquid through the pump.

.5 Cast steel equipment bases: Millwright to check and correct for "soft leg" and include test results in his report. Ensure mounting bolts are tightened to correct torque.

.6 Control Valves: Inspect both hand and automatic control valves, clean bonnets and stems. Tighten packing glands to assure no leakage, but permit valve stems to operate without galling. Replace packing in valves to retain maximum adjustment after system is complete. Replace packing on any valve which continues to leak. Remove and repair bonnets which leak. Coat packing gland threads and valve stems with a surface preparation of "Moly-Cote" or "Fel-Pro", after cleaning. Verify that control valve seats are free from foreign material, and are properly positioned for intended service.

.7 Open steam traps and air vents: Remove operating elements and clean thoroughly, replace internal parts and put back into operation.

.8 Remove rust, scale and foreign materials from equipment and renew defaced surfaces.

.9 Set and calibrate draft gauges of air filters and other equipment.

.10 Inspect fan wheels for clearance and balance. Provide factory-authorized personnel for adjustment when needed.

.11 Check each control circuit to assure that operation complies with specifications and requirements to provide the desired performance.

.12 Inspect each pressure gauge and thermometer for calibration. Replace items which are defaced, broken, or which read incorrectly.

.13 Repair damaged insulation.

.14 Vent gases trapped in any part of systems. Verify that liquids are drained from all parts of gas or air systems.

.15 Check piping for leaks at every joint, and at every screwed, flanged, or welded connection, using "Leak-Tek" or other approved compound.

.16 Tighten flanges after system has been placed in operation. Replace flange gaskets which show any sign of leakage after tightening.

.17 Promptly remake each screwed joint which appears to be faulty, do not wait for rust to form. Clean threads on both parts, apply compound and remake joints.

.18 After system has been placed in operation, clean strainers, dirt pockets, orifices, valve seats and headers in fluid systems, to assure they are free of foreign materials.

.19 Check specified and shop drawing data against installed data.

.20 Check the installation is as defined by contract documents and as per manufacturer's recommendations including manufacturer's installation check sheets.

3.4 ADJUSTMENTS

.1 Provide such periodic continuing adjustment services as necessary to insure proper functioning of mechanical systems after occupancy of the Project, and for a period of one year after Date of Final Acceptance by the Owner.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Includes all piping, valves and accessories for the following systems:

- .1 Fire Protection Systems:
  - .1 Fire Protection Piping
  - .2 Sprinkler Piping
- .2 Plumbing Water Supply Systems:
  - .1 Domestic Cold Water Piping
- .3 Plumbing Systems Inside Building:
  - .1 Sanitary Piping
  - .2 Plumbing Vent Piping
- .4 Standard Heating and Cooling Systems:
  - .1 Chilled Water Supply and Return Piping
  - .2 Glycol Supply and Return Piping
- .5 Equipment Drains and Overflow Piping
- .6 Humidifier Steam and Condensate Piping
- .7 Low Pressure Steam Piping
- .8 High Pressure Steam and Condensate Piping
- .9 Low Pressure Condensate and Pumped Condensate Piping

1.2 SUBMITTALS

.1 Submit copies of valves "ordering schedule" for approval before ordering valves.

.2 Submit detailed shop drawings clearly indicating make, model, type, size, pressure rating, materials of construction, and intended service of valves.

1.3 WELDING

.1 Welding materials, fabrication standards and labour qualifications must conform to ANSI/ASME B31.1, ANSI B16.25, ASME Section IX, and the Provincial Board of Labour Regulations.

.2 Use welders fully qualified and licensed by Provincial Authorities.

1.4 QUALITY ASSURANCE

.1 Domestic water, drainage and vent piping: Saskatchewan Plumbing Code.

.2 Copper pipe, direct connections: ULC approval; brazing in accordance with Copper Development Association Copper Tube Handbook.

.3 All below grade steel piping shall be yellow jacketed.

.4 Non-specified pipe joining and pipe fitting methods such as T-drill and press fit are not permitted in any piping system covered under Division 15.

PART 2.0 PRODUCTS

2.1 PIPING, VALVING AND ACCESSORIES

.1 All piping, valving, and accessories for each system identified on drawings shall be as specified on the following line service code sheets.

.2 Control valves are as specified in the controls specification sections.

.3 Provide valves of same manufacturer throughout where possible.

.4 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

.5 Use factory fabricated butt welded fittings for welded steel pipes.

.6 Use long radius elbows for steel and cast iron water piping, including grooved mechanical fittings.

.7 Flange bolting (unless specified otherwise in commodity schedules):

 .1 For systems up to 120°C (250°F): carbon steel stud bolts, semi-flushed and heavy hex nuts, ASTM A307-GrB.

.2 For systems up to 205°C (400°F): alloy steel bolts ASTM A193-GrB7, and semi-finished heavy hex nuts ASTM A194-Gr2H.

.8 Where permitted by the Engineer (see Commodity Schedules), use grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some angular deflection, contraction and expansion. Couplings consist of malleable iron housing-clamps, C-shaped composition sealing gasket EPDM Grade 'E' (unless otherwise specified) and steel bolts. Use galvanized couplings for galvanized pipe, and copper couplings for copper pipe.

.9 All piping, valves, fittings, and accessories are to be rated for the operating conditions and media (pressure, temperature, and fluid).

2.2 COMMODITY PIPING REQUIREMENTS

.1 The following tables list the requirements for piping associated with each type of commodity being carried in the piping.

COMMODITY CODE:	**F** FIRE PROTECTION PIPING **SPR** SPRINKLER PIPING **P.SPR** PREACTION SPRINKLER PIPING **D.SPR** DRY SPRINKLER PIPING
LOCATION :	ABOVE GROUND AND INSIDE BUILDING
DESIGN PRESSURE :	1200 kPa (175 psi)
MAXIMUM TEMPERATURE:	35ºC (95ºF)

ITEM	**SIZES**	**GENERAL DESCRIPTION**
Pipe	All	Ferrous : to NFPA 13. Minimum schedule 10. Copper : to NFPA 13.
Fittings	All	Ferrous : screwed, welded, flanged, or rolled groove Copper : screwed, soldered, brazed.
Couplings	150mm & smaller (6" & smaller)	steel, Victaulic Style 005 Firelock with Grade E (Type A) gasket.
Gate Valves	50mm (2") smaller	Bronze body, threaded ends, OS&Y, rising stem, threaded bonnet, solid wedge, rating 1380 kPa (200 psi) water, ULC listed. Jenkins Figure 820.
	65mm (2½") & larger	Cast iron body, flanged ends, OS&Y, rising stem, bronze trim, solid wedge, wheel handle, rating 1380 kPa (200 psi). ULC listed. Jenkins Figure 825A.
	Gate Valves Underground	Cast iron body, mechanical joint or flanged ends, inside screw, non-rising stem, bronze trim, solid wedge, square operating nut, rating 1380 kPa (200 psi) water, Underwriters listed. Indicator post operator, ULC listed. Jenkins Figure 2397AU, Figure 2452-AU, Figure 345-A indicator post.
Butterfly Valves	All sizes	FM and ULC listed, cast iron lug-wafer body, bronze disc, BUNA-N liner, 1380 kPa (200 psi) at 65°C. Jenkins Figure 2232 BU.
Swing Check Valves	50mm (2") & smaller	Bronze body threaded ends, threaded cap, renewable composition disc rating 2060 kPa (300 psi) WOG Jenkins Figure 4475.

ITEM	SIZES	GENERAL DESCRIPTION
	65mm (2½”) & larger	Cast iron body, flanged ends, bolted cover, regrind-renew bronze disc and seat ring, rating 1200 kPa (175 psi) water. ULC listed. Jenkins Figure 477-RD.
Hose Valves	50mm (2”) & smaller	Gate valve, 860 kPa (125 psi) threaded, bronze body brass trim. Use only at monitor connections and hose reels.
	65mm (2½”) & larger	Gate valve, 1200 kPa (175 psi) flat face flanged, cast iron body bronze trim.

NOTES :

1. All fittings, valves, piping and connected equipment to be ULC approved.
2. All pre-action systems piping and fittings shall be galvanized.

COMMODITY CODE:	**DCW** DOMESTIC COLD WATER
LOCATION :	INSIDE BUILDING ABOVE GROUND
WORKING PRESSURE:	600 kPa (90 psi)
MAXIMUM TEMPERATURE:	60ºC (140ºF)

ITEM	**SIZES**	**GENERAL DESCRIPTION**
Pipe	75mm (3") & smaller	CSA HC.7.6 Type L hard drawn seamless copper water tube.
	100 (4") to 250mm (10")	Ductile Iron centrifugally cast. ANSI/AWWA C151/A21.51. No steel piping allowed for domestic hot water.
	75mm (3") & smaller	ANSI B16.22 wrought copper.
	100 (4") to 250mm (10")	ASTM A234, Schedule 40, grooved mechanical couplings.
Joints	50mm (2") & smaller	Soldered with lead-free tin-nickel-silver-antimony-copper alloy "Bridgit". Plastic range 240°C (460°F) to 330°C (635°F).
	65 to 75mm (3")	Threaded
Couplings	100 to 250mm (2")	3450 kPa (500 psi) IPS grooved coupling, Victaulic style 71 with Type E gasket.
Unions	100mm (4") & smaller	1380 kPa (200 psi) bronze, ground joint. Dielectric when jointing dissimilar metals.
Flanges	100 to 250mm (2")	1750 kPa (250 psi) split flange. Victaulic Style 741 with Type E gasket.
Shut Off Valves	50mm (2") & smaller	Ball Valves : Bronze body, chrome plated bronze ball, threaded or solder ends, PTFE seat and packing. 4130 kPa (600 psi) (600 psi) non shock WOG rating. Grinnell figure 171N and 171S.

ITEM	SIZES		GENERAL DESCRIPTION
	65 (2½“ to 75mm (3”)		Butterfly Valves: Cast iron wafer full-lug body, 300 Series stainless steel shaft, bronze disc, replaceable EPDM seat., lever lock handle operator with multiple position lock plate for valve sizes to 100mm (4”), heavy duty gear hand-wheel operator with position indicator for valve sizes 150mm (6”) and over. Minimum rating 1200 kPa (175 psi) WOG. Grinnell figure LC-1281-3 and LC-1282-3.
	100mm (4”) & larger		Gate Valves: See below.
Other Valves (use only where specified)	Gate Valves	50mm (2”) & smaller	Bronze body, inside screw, travelling stem, solid wedge, threaded bonnet, threaded ends. Rating 860 kPa (125 psi) (125 psi) steam, 1380 kPa (200 psi) WOG. Grinnell figure 3010.
		65mm (2½”) & larger	Cast iron body, bronze trim, OS&Y, rising stem, solid wedge, flanged ends. Rating 860 kPa (125 psi) steam, 1380 kPa (200 psi) WOG. Grinnell figure 6020A.
	Globe Valves	50mm (2”) & smaller	Bronze body, threaded bonnet, threaded ends. Rating 1030 kPa (150 psi) steam, 2060 kPa (300 psi) WOG. Grinnell figure 3240
		65mm (2½”) & larger	Cast iron body, flanged ends, OS&Y, renewable seat ring, no. 294-S renewable composition disc. Rating 860 kPa (125 psi) steam. Jenkins Figure 142.
Swing Check Valves	50mm (2”) & smaller		Bronze body threaded cap, renewable Teflon disc, threaded ends. Rated 860 kPa (125 psi) steam, 1380 kPa (200 psi) WOG. Grinnell Figure 3310.
	65mm (2½”) & larger		Cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring. Rating 860 kPa (125 psi) steam, 1380 kPa (200 psi) WOG. Grinnell figure 6300A.
Hose Bibbs	All sizes		Bronze or red brass, replaceable hexagonal disc, hose thread spout, chrome plated where exposed. Non-freeze type with polished bronze wall plate, recessed box, hose thread spout, removable key.

NOTES :

1) Grooved mechanical couplings or joints shall be used only in mechanical rooms. Provide soldered fittings in other locations.

2) For domestic hot water systems, all composition disc valves shall be fitted with discs suitable for hot water.

COMMODITY CODE:	**SAN** SANITARY **V** PLUMBING VENT
LOCATION :	INSIDE BUILDING
WORKING PRESSURE:	TO PLUMBING CODE
MAXIMUM TEMPERATURE :	60ºC (140ºF)

ITEM	SIZES		GENERAL DESCRIPTION
Pipe	SAN, ST, V	200mm (8") & smaller	Above Ground : CSA B-70-M cast iron DWV solid pipe plain end or Copper Tube[1] DWV hard ASTM B306 Above Ground : PVC XFR[2] piping to CSA B181.2 and listed to CAN/ULC S102.2-10. Maximum Flame Spread Rating of 25 and maximum Smoke Developed Classification of 50.
			Below Ground: PVC DWV to CAN-3B-182
Fittings	SAN, ST, V	200mm (8") & smaller	Cast Iron: CSA B70-M Cast iron DWV plain end (bituminous coated for buried) Copper: CSA B158.1 or ANSI B16.29 PVC-DWV: Solvent Weld
Joints	SAN, ST, V	All sizes	Cast Iron - mechanical joint coupling - neoprene sleeve with centre rib; stainless steel shield. 2 clamps per side (4 clamps total). PVC - Solvent Weld Copper: CSA B158.1 or ANSI B16.29

1 Copper Tube not permitted for the fixture drain or the portion of the vent below the floor level rim of a flush valve operated urinal.
2 PVC XFR piping is permitted only where acceptable to the Authorities Having Jurisdiction. PVC XFR piping is not permitted in vertical shafts as defined by the National Building Code of Canada.

COMMODITY CODE:	**CHS** CHILLED WATER SUPPLY **CHR** CHILLED WATER RETURN **GS** GLYCOL SUPPLY **GR** GLYCOL RETURN
LOCATION :	ALL
WORKING PRESSURE:	860 kPa (125 psi)
MAXIMUM TEMPERATURE:	105ºC (220°F)

ITEM	**SIZES**		**GENERAL DESCRIPTION**
Pipe	50mm (2") & smaller		ASTM A53, standard weight ERW. Type 'L' Hard copper ASTM B88M (above ground) Type 'K' Soft copper ASTM B88M (below ground) - no joints permitted
	65mm (2½") & larger		ASTM A53, grade B, standard weight ERW, schedule 40 steel.
Fittings	steel	50mm (2") & smaller	Cast Iron, ASTM A126, 860 kPa (125 psi), threaded with Teflon steel tape.
		65mm (2½") & larger	Carbon Steel, ASTM A234 grade WPB, standard weight butt weld.
	copp er	all sizes (above ground only)	Threaded Soldered with lead-free tin-nickel-silver-antimony-copper alloy "Bridgit". Plastic range 240ºC to 330ºC.
Flanges	50mm (2") & smaller		1000 kPa (150 psi) raised face, standard weight, butt weld. 3.1 mm thick SS/ASB SP WD, 1000 kPa (150 psi) gaskets.
	65mm (2½") & larger		1000 kPa (150 psi) raised face, standard weight, butt weld. 3.1 mm thick SS/ASB SP WD, 1000 kPa (150 psi) gaskets.

ITEM	SIZES	GENERAL DESCRIPTION
Gate Valves	50mm (2") & smaller	Bronze body, inside screw, travelling stem, solid bronze wedge, threaded bonnet. Rated 860 kPa (125 psi) steam, 1380 kPa (200 psi) WOG. Grinnell figure 3010 and 3010SJ.
	65mm (2½") & larger	Cast iron body, flanged ends, OS&Y, rising stem, bronze trim, solid bronze or cast iron (with bronze facings) wedge. Rated 860 kPa (125 psi) steam, 1380 kPa (200 psi) WOG. Grinnell 6020A.
Butterfly Valves	All sizes	Cast iron wafer full-lug, 300 series stainless steel shaft, bronze disc, replaceable EPDM seat, lever lock handle operator with multiple position lock plate for valve sizes to 100mm (4"), heavy duty gear hand-wheel operator with position indicator for valve sizes 150mm (6") and over. Minimum rating 1200 kPa (175 psi) @ 120°C (250°F). Grinnell figure LC-1281-3 and LC-1282-3.
Globe Valves	50mm (2") & smaller	Bronze body, threaded bonnet, threaded ends. Rated 1030 kPa (150 psi) steam, 2060 kPa (300 psi) WOG. Grinnell figure 3240 and 3240 SJ.
	65mm (2½") & larger	Cast iron body, flanged ends, OS&Y, renewable bronze seat and disk. Rated 860 kPa (125 psi) steam, 1380 kPa (200 psi) WOG. Grinnell Figure 6200A.
Ball Valves	50mm (2") & smaller	Bronze body, chrome plated bronze ball, threaded ends, twin-seal PTFE seats and seals, AO@ ring, lever handle, rating 4130 kPa (600 psi) (600 psi) WOG. Grinnell figure 171N.
Swing Check Valves	50mm (2") & smaller	Bronze body and disc, regrinding swing check, threaded cap, threaded ends. Rated 860 kPa (125 psi) steam, 1380 kPa (200 psi) WOG. Grinnell figure 3300.
	65mm (2½") & larger	Cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring. Rated 860 kPa (125 psi) steam, 1380 kPa (200 psi) WOG. Grinnell figure 6300A.
Silent Check Valves for Pump Discharge	50mm (2") to 100mm (4")	Wafer style, cast iron body, Teflon disc and seat, 304ss spring, stainless steel bushing, stainless steel set screw. Dual rated 1380 kPa (200 psi) and 2760 kPa (400 psi) (400 psi). Grinnell 400 series.

ITEM	SIZES	GENERAL DESCRIPTION
	150mm (6”) & larger	Flanged globe style, cast iron body. Stainless steel seat , plug, spring and bushing. Stainless steel set screws. Rated 1380 kPa (200 psi). Grinnell 500 series.
Strainers	50mm (2”) & smaller	Threaded brass or iron body, Y pattern with 0.8mm stainless steel perforated screen.
	65mm (2½”) to 100mm (4”)	Flanged iron body, Y pattern with 1.0mm stainless steel perforated screen.
	100mm (4”) & larger	Flanged iron body, Y pattern with 3.2mm stainless steel perforated screen.
Automatic Flow Control Devices	All Sizes	Griswald automatic flow control valves with strainer and gauge ports. Provide integral valve where specified.

NOTES:
1) Butterfly valves, 65mm (2½”) and larger, may be used for service shut off in lieu of gate valve. Style to be suitable for end service.
2) Grooved mechanical couplings may be used in mechanical rooms only.

COMMODITY CODE:	EQUIPMENT DRAINS AND OVERFLOWS (ATMOSPHERIC PRESSURE)
LOCATION :	ALL
WORKING PRESSURE:	
MAXIMUM TEMPERATURE:	

ITEM	**SIZES**	**GENERAL DESCRIPTION**
Pipe	All	Schedule 40, galvanized steel, ASTM A120, Type L hard copper
Fittings	Steel, All	Galvanized, banded malleable iron
	Copper, All	Threaded or copper
Drain Valves	up to 20mm (3/4")	Forged brass body, brass cap, stem and ball. Teflon stem seals and Teflon seat. Hose thread end. Working pressure 1720 kPa (250 psi) @ 120°C (250°F). Dahl 50.430.
	25mm (1") & larger	Bronze body ball valve, chrome plated bronze ball, threaded ends, twin-seal PTFE seats and seals, AO@ ring, lever handle, rating 4130 kPa (600 psi) WOG. Grinnell figure 171N.
	Terminal units	Brass T-body drain valve, wheel handle, ground-bonnet joint, renewable disc, brass chain, forged brass gasketted cap. Working pressure 1720 kPa (250 psi) A 120°C (250°F). Dahl 21.616.

COMMODITY CODE:	**HUMS** HUMIDIFIER STEAM PIPING **HUMC** HUMIDIFIER CONDENSATE PIPING Humidifier Steam piping between Humidifiers and Dispersion Tubes
LOCATION :	ALL
WORKING PRESSURE:	-
MAXIMUM TEMPERATURE:	-

ITEM	**SIZES**	**GENERAL DESCRIPTION**
Pipe	All	Type L hard copper
Fittings	All	Soldered or threaded 90º elbows shall not be used - use 2 45º degree fittings.

COMMODITY CODE:	**LPS** LOW PRESSURE STEAM
LOCATION :	ABOVE GROUND AND INSIDE BUILDING
DESIGN PRESSURE :	Low Pressure - 105 kPa (15 psi)
MAXIMUM TEMPERATURE:	Low Pressure - 120ºC (250°F)

ITEM	**SIZES**	**GENERAL DESCRIPTION**
Pipe	50mm (2”) & smaller	ASTM A53, standard weight ERW, schedule 40
	65mm (2½”) and larger	ASTM A53, grade B, standard weight ERW, schedule 40 steel.
Fittings	50mm (2”) & smaller	Cast Iron, ASTM A126, 860 kPa (125 psi), threaded with Teflon steel tape.
	65mm (2½”) and larger	Wrought Steel, ASTM A234 grade WPB, standard weight butt weld.
Flanges	65mm (2½”) and larger	1000 kPa (150 psi) raised face, standard weight, butt weld. 3.1 mm thick SS/ASB SP WD, 1000 kPa (150 psi) gaskets.
Gate Valves	50mm (2”) & smaller	Bronze body, inside screw, travelling stem, solid bronze wedge, stainless steel seats, threaded bonnet, threaded ends. Rated 2060 kPa (300 psi) steam, 4130 kPa (600 psi) WOG. Grinnell 3135.
	65mm (2½”) & larger	Cast iron body, flanged ends, OS&Y, rising stem, bronze trim, solid bronze (or cast iron with bronze facings) wedge. Rated 860 kPa (125 psi) steam, 1370 kPa (200 psi) WOG. Grinnell figure 6020A.
Globe Valves	50mm (2”) & smaller	Bronze body, rising stem, bronze disc holder, Teflon disc, threaded bonnet, threaded ends. Rated 1030 kPa (150 psi) steam, 2060 kPa (300 psi) WOG. Grinnell figure 3240.
	65mm (2½”) & larger	Cast iron body, bronze trimmed, bolted bonnet, flanged ends, OS&Y, renewable bronze disc and seat. Rated 860 kPa (125 psi) steam, 1370 kPa (200 psi) WOG. Grinnell figure 6200A.

ITEM	SIZES	GENERAL DESCRIPTION
Ball Valves	50mm (2") & smaller	Bronze body, chrome plated bronze ball, threaded ends, twin-seal PTFE seats and seals, O-ring, lever handle, rating 4130 kPa (600 psi) WOG. Grinnell figure 171N.

COMMODITY CODE:	**HPS** HIGH PRESSURE STEAM **HPC** HIGH PRESSURE CONDENSATE
LOCATION :	ABOVE GROUND AND INSIDE BUILDING
DESIGN PRESSURE :	1370 kPa (200 psi)
MAXIMUM TEMPERATURE:	210ºC (410°F)

ITEM	**SIZES**	**GENERAL DESCRIPTION**
Pipe	All	ASTM A53, XS weight, schedule 80 steel, continuous, ERW or seamless.
Fittings	All	Cast Iron, ASTM A 234 Grade WPB extra strong butt weld.
Flanges	50mm (2”) to 250mm (10”)	Cast Iron, 1700 kPa raised face, extra strong weight, butt weld. 3.1 mm thick SS/ASB SP WD, 2000 kPa (300 psi) gaskets.
Ball Valves	12mm (1/2”) to 50mm (2”)	Three piece carbon steel pressure steam service ball valve. CF-Reinforced PTFE seat. Grinnell 3920.
Gate Valves	50mm (2”) & smaller	Bronze body, inside screw, travelling stem, solid bronze wedge, stainless steel seats, threaded bonnet, threaded ends. Rated 2060 kPa (300 psi) steam, 4130 kPa (600 psi) WOG. Grinnell 3135.
	65mm (2½”) & larger	Cast iron body, flanged ends, OS&Y, rising stem, bronze trim, solid bronze (or cast iron with bronze facings) wedge. Rated 1720 kPa (250 psi) steam, 3440 kPa (500 psi) WOG. Grinnell figure 6100A.
Globe Valves	50mm (2”) & smaller	Bronze body, rising stem, full plug stainless steel disc with stainless steel seat ring, screw over bonnet, threaded ends. Rated 2060 kPa (300 psi) steam, 4130 kPa (600 psi) WOG. Grinnell figure 3270.
	65mm (2½”) & larger	Cast iron body, bronze trimmed, bolted bonnet, flanged ends, OS&Y, renewable bronze disc and seat. Rated 1720 kPa (250 psi) steam, 3440 kPa (500 psi) WOG. Grinnell figure 6250A.
Butterfly	75mm (3”) & larger	Carbon steel wafer sphere full-lug, 316 stainless steel shaft, 316 stainless steel disc, replaceable filled-TFE seat,

ITEM	SIZES	GENERAL DESCRIPTION
Valves		lever lock handle operator with multiple position lock plate for valve sizes to 100mm (4”), heavy duty gear hand-wheel operator with position indicator for valve sizes 150mm (6”) and over. Minimum rating 1580 kPa (230 psi) @ 150°C (300°F). Jamesbury 815W-11-2236MT.

COMMODITY CODE:	**LPC** LOW PRESSURE CONDENSATE **PC** PUMPED CONDENSATE
LOCATION :	ABOVE GROUND AND INSIDE BUILDING
DESIGN PRESSURE :	105 kPa (15 psi)
MAXIMUM TEMPERATURE:	120°C (250°F)

ITEM	**SIZES**	**GENERAL DESCRIPTION**
Pipe	50mm (2") & smaller	ASTM A53, XS weight, schedule 80 steel, continuous ERW or seamless
	65mm (2½") & larger	ASTM A53, standard weight, schedule 40 steel, continuous ERW or seamless
Fittings	50mm (2") & smaller	ASTM A105, 1030 kPa (150 psi), threaded with Teflon
	65mm (2½") & larger	ASTM A234 grade WPB, standard weight butt weld.
Flanges	50mm (2") to 250mm (10")	1000 kPa (150 psi) raised face, standard weight, butt weld. 3.1 mm thick SS/ASB SP WD, 1000 kPa (150 psi) gaskets.
Gate Valves	50mm (2") & smaller	Bronze body, inside screw, travelling stem, solid bronze wedge, stainless steel seats, threaded bonnet, threaded ends. Rated 2060 kPa (300 psi) steam, 4130 kPa (600 psi) WOG. Grinnell 3135.
	65mm (2½") & larger	Cast iron body, flanged ends, OS&Y, rising stem, bronze trim, solid bronze (or cast iron with bronze facings) wedge. Rated 860 kPa (125 psi) steam, 1370 kPa (200 psi) WOG. Grinnell figure 6020A.
Globe Valves	50mm (2") & smaller	Bronze body, rising stem, full plug stainless steel disc with stainless steel seat ring, threaded bonnet, threaded ends. Rated 2060 kPa (300 psi) steam, 4130 kPa (600 psi) WOG. Grinnell figure 3270.

ITEM	SIZES	GENERAL DESCRIPTION
	65mm (2½") & larger	Cast iron body, bronze trimmed, bolted bonnet, flanged ends, OS&Y, renewable bronze disc and seat. Rated 860 kPa (125 psi) steam, 1370 kPa (200 psi) WOG. Grinnell figure 6200A.
Ball Valves	50mm (2") & smaller	Bronze body, chrome plated bronze ball, threaded ends, twin-seal PTFE seats and seals, "O" ring, lever handle, rating 4130 kPa (600 psi) WOG. Grinnell figure 171N.

2.3 SPECIAL PROVISIONS

.1 Plumbing fixture trap seals shall be protected from siphonage and back pressure by venting in accordance with the plumbing code. Vent pipes shall be as direct as possible, and shall be graded to drip back to the waste pipe by gravity through the fixture connections.

2.4 VALVE OPERATORS

.1 Provide suitable hand wheels for gate, globe or angle, radiation and drain valves and inside hose bibs.

.2 Provide valves larger than 100mm (4") located more than 2.1m (7') from floor in equipment rooms with chain operated sheaves. Extend chains to 1.5m (5') above floor and hook to clips to arrange to clear walking aisles.

2.5 STRAINERS

.1 Screen free area shall be minimum three times area of inlet pipe.

PART 3.0 EXECUTION

3.1 PREPARATION

.1 Ream pipes and tubes. Clean scale and dirt from pipe before assembly. Remove welding slag or other foreign material from piping.

.2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the Engineer, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

3.2 CONNECTIONS

.1 Make threaded joints with full cut standard taper pipe threads with approved non-toxic joint compound applied to male threads only.

.2 Make joints for plain and pipe with gasket and clamp type mechanical fastener.

.1 Mechanical joint coupling to consist of a neoprene sleeve with centre rib and stainless steel shield. 2 clamps per side (4 clamps total).

.3 Clamp cast iron water pipe at fittings with 20mm (3/4") rods and properly anchor and support.

.4 Use galvanized couplings with galvanized pipe.

.5 Use main sized saddle type branch connections or directly connected branch connections in steel pipe provided that main is at least one size larger than branch for 200mm (8") and larger main. Do not project branch pipes inside the main pipe.

.6 Use grooved mechanical couplings and mechanical fasteners only in mechanical rooms, and only on piping systems only where specifically noted as acceptable in this specification. Use galvanised couplings with galvanised pipe, and copper couplings on copper pipe.

.7 Make connections to equipment, specialty components, and branch mains with unions or flange sets.

.8 Provide non-conducting type connections wherever jointing dissimilar metals.

.9 Provide dielectric type connections wherever joining dissimilar metals in open systems. Brass adapters and valves are acceptable.

.10 Use insulating plastic spacers for copper pipe installation in metal studs.

3.3 ROUTE AND GRADES

.1 Route piping in orderly manner to maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furrings to a minimum.

.2 Slope pressure water piping at 0.2% upward in direction of flow and arrange to drain at low points and vent at high points.

.1 Equip low points with 20 mm (3/4") drain valves and hose nipples.

.2 Provide air collection chambers with automatic or manual air vent at all high points of system. Collection chambers to be 25mm (1”) diameter or line size whichever is greater and 150mm (6”) high minimum. Square tees may only be used to assist with complete venting and draining.

.3 Make reductions in water pipe sizes with eccentric reducing fittings installed to provide drainage and venting. Top flat for water, bottom flat for steam.

.4 Grade horizontal drainage and vent piping 2% down in direction of flow unless specifically noted otherwise.

.5 Unless specifically noted otherwise, or otherwise required by Code, pipe the discharge from all relief valves, safety valves, vents, drains, equipment blow-downs, water columns and overflows to the nearest building drain. Pipe to glycol recovery tanks for a glycol based system.

.1 Where required by Code, pipe the discharge from all relief valves, safety valves, vents, drains, equipment blow-downs, water columns and overflows to the outside, at sizes specified in the appropriate Code.

.2 Steam relief valves are to be piped to the outdoors.

3.4 INSTALLATION

.1 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.2 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.3 Install piping material specified as inside the building to 1.2m (4’) outside of building.

3.5 VALVES

.1 Install valves with stem upright or horizontal, not inverted.

.2 Install butterfly valves only where indicated on drawings. Provide threaded lug type valves for equipment isolation service. Provide wafer or threaded lug type valves for zone shut-off service.

.3 Where permitted by codes, butterfly valves may be used in fire protection systems.

.4 Use eccentric plug valves in water systems for throttling/balancing service.

.5 Unless shown otherwise use memory radiator balancing valves in water and glycol systems terminal heat transfer unit balancing service. For radiant panels provide circuit balancing valves on return line for each central zone; and a ball valve for shut-off service, unless shown otherwise.

.6 Provide drain valves at main shut-off valves, low points of piping and apparatus and terminal units.

.7 Size drain lines and drain valves equal to size of apparatus drain connection.

.8 For pipe sizes 20mm (3/4”) and over, minimum drain size to be 20mm (3/4”).

.9 Provide hose thread connection with cap and chain for 20mm (3/4”) drain valves located in ceiling and public areas.

.10 Provide male NPT nipples with threaded pipe cap for drain sizes over 20mm where not piped directly to floor drains.

.11 Provide valved drain and hose connections off the bottom of all strainers.

3.6 WELDED PIPE BRANCH CONNECTIONS

.1 Make branch connections according to the following schedule:

HEADER SIZE (mm) \ BRANCH SIZE (mm)	15	20	25	32	38	50	65	75	100	150	200	250	300
15	T												
20	T	T											
25	T	T	T										
32	T	T	T	T									
38	T	T	T	T	T								
50	S	S	S	T	T	T							
65	S	S	S	S	T	T	T						
75	S	S	S	S	S	T	T	T					
100	S	S	S	S	S	T	T	T	T				
150	S	S	S	S	S	W	T	T	T	T			
200	S	S	S	S	S	W	W	W	T	T	T		
250	S	S	S	S	S	W	W	W	W	T	T	T	
300	S	S	S	S	S	W	W	W	W	W	T	T	T

LEGEND

T	Forges tee or reducing tee
S	Socolet
W	Weldolet

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Manual and automatic air vents.

.2 Air separators.

.3 Combination valves and pump fittings.

.4 Pressure safety valves.

1.2 QUALITY ASSURANCE

.1 Comply with Provincial Regulations and have CSA approval.

1.3 SUBMITTALS

.1 Provide shop drawings and schedules for review where requested.

PART 2.0 PRODUCTS

2.1 MANUAL AIR VENTS

.1 Construct manual air vent from short section (150mm min.) of vertical line diameter pipe (25mm min. pipe size) to form air chamber. Provide 3 mm brass needle valve at top of chamber.

2.2 AUTOMATIC AIR VENTS

.1 Provide automatic float type with isolating valve, brass or semi-steel body, copper float, stainless steel valve and valve seat, suitable for system operating temperature and pressure.

.2 Provide automatic washer type, all brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shutoff and integral spring loaded ball check valve to prevent water leakage.

2.3 AIR SEPARATORS

.1 Provide line size centrifugal type with 860 kPa WSP steel tank, galvanized steel 5 mm perforated strainer, perforated stainless steel air collector tube and drain connection.

2.4 PRESSURE SAFETY VALVES

.1 Provide ASME rated direct spring loaded type, lever operated nonadjustable factory set discharge pressure 10% above normal maximum operating pressure.

2.5 COMBINATION CHECK, SHUT-OFF AND BALANCING VALVE

.1 Provide angle or straight type with ANSI 860 kPa flanged cast iron body, bronze disk and seat, calibrated balancing valve and system flow meter.

.2 Unit complete with brass readout valves with integral check and to be rated for 1200 kPa working pressure and 120^{o}C operating temperature.

2.6 COMBINATION PUMP INLET AND STRAINER FITTING

.1 Provide angle type suction guide fitting with screwed (50 mm size only) or ANSI 1000 kPa flanged cast iron body, adjustable support leg, steel straightening vanes and removable 16 mm mesh bronze start-up strainer.

.2 Unit to be rated for 1200 kPa working pressure and 120^{o}C operating temperature.

PART 3.0 EXECUTION

3.1 AIR VENTS

.1 Provide manual type at system high points.

.2 Provide petcock on pipe to all automatic vents, for servicing and manual operation option.

.3 Use automatic float type at heating units and system high points not readily accessible for servicing.

.4 Use automatic washer type for convection type heating units.

.5 Where large air quantities can accumulate provide enlarged air collection standpipes.

.6 For float type air vents in ceiling spaces or other concealed locations provide vent tubing to nearest drain.

3.2 AIR SEPARATOR

.1 Provide on suction side of system circulation pump. Provide large capacity automatic air vent on air outlet.

3.3 PRESSURE SAFETY VALVES

.1 Provide pressure safety valves on pressure tanks, low pressure side of pressure regulating valves, heating convertors, expansion tanks, and where indicated.

.2 Drain relief valve to nearest floor drain, or to floor which is sloped to a drain.

.3 System relief valve capacity shall equal makeup pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.

.4 Where one line vents several relief valves, cross sectional area shall equal sum of individual vent areas.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Mixing tank, storage drums, manual transfer pump.

.2 System expansion tanks.

.3 Propylene glycol solution.

1.2 QUALITY ASSURANCE

.1 Comply with Provincial Regulations and have CSA approval.

1.3 SUBMITTALS

.1 Submit shop drawings and schedules for review. Submit test results in neat typewritten copy.

1.4 GLYCOL SYSTEM

.1 Provide propylene glycol antifreeze for building heating systems.

.2 After system acceptance, provide antifreeze solution lost from the systems from any cause other than neglect by the Owner during the first year of operation.

.3 Perform tests determining strength of glycol solution before system is turned over to the Owner. Provide test prior to end of guarantee and replenish as required. Provide written test results for review.

PART 2.0 PRODUCTS

2.1 MIXING TANK

.1 Provide glycol mixing tank with valved hose bibb makeup on wall above tank.

.2 Construct tank with all necessary tapping for installation of accessories and piping connection.

2.2 GLYCOL SOLUTION

.1 Provide 30% propylene glycol/water solution.

.1 The heat transfer fluid at fifty percent glycol by volume shall have a "start-freezing" point of minus -14 degrees C. A "start-freezing" point is defined as the point when initial ice crystals begin to form.

.2 Provide inhibitors such as borax and sodium nitrite to control degradation of glycol when exposed to oxygen and elevated temperatures.

.3 Dilution water shall be either distilled, softened, or de-mineralised, limited to 50 parts per million maximum concentrations of chlorine ions and sulphate ions.

.4 Heat transfer fluid when used for building heating will be heated to 110°C maximum. At 90°C the heat transfer fluid shall have the following physical characteristics:

	Propylene Glycol
Specific Gravity	0.99
Vapour Pressure	56 kPa
Viscosity	0.9 Centipoises

PART 3.0 EXECUTION

3.1 INSTALLATION

.1 Provide necessary piping to complete installation as shown on the drawings and as specified.

.2 Heat transfer fluid shall only be admitted into piping systems and components constructed of carbon steel, copper, or aluminium. Prior to charging of the heating circuits, all piping and components shall be cleaned and preconditioned.

.3 Feed glycol from mixing tanks to system through makeup line.

.4 Rinse charging tank with clean water after charging operation.

.5 Provide one extra 170 litre drum of premixed 30% glycol on site beside the mixing tank. This drum is to be in addition to the glycol needed for complete final fill of the system.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 All pumps except where integral with a manufactured piece of equipment.

.2 Pump controls where self-contained.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 15010.

.2 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

.3 Submit shop drawings of pump curves for review.

.4 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

1.3 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into Operation and Maintenance Manual specified in Section 15010.

1.4 QUALITY ASSURANCE

.1 Pumps shall be aligned by qualified millwright and provide written alignment certification. Include written certification in Operating and Maintenance Manuals.

.2 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of midpoint of published maximum efficiency curve.

PART 2.0 PRODUCTS

2.1 GENERAL

.1 Statically and dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

.3 Pumps shall be electrical motor driven and shall operate at 1750 RPM unless specified otherwise.

.4 Pump connections shall be flanged unless specifically noted otherwise.

.5 Supply pumps of suitable construction for fluids being pumped and for correct temperature range.

.6 Refer to Section 23 00 00 for motor specifications.

.7 Motors shall be high efficiency.

2.2 VERTICAL IN-LINE END SUCTION PUMPS

.1 Centrifugal in-line single or double suction as specified.

.2 Pumps shall be split spacer coupling type where specified.

.3 Volute of cast iron rated for 1225 kPa or ductile iron for 2500 kPa. Provide the following casing accessories: drain plug, flanged inlet and outlet, separate tapped flush line, and gauge connections.

.4 Bronze dynamically balanced impeller sized for not more than 90% of maximum impeller diameter casing can accommodate, keyed to shaft, held in place by self-locking bronze cap screw.

.5 Direct coupled pumps shall have steel shaft with bronze stainless steel shaft sleeve. Split spacer coupled pumps shall have stainless steel shaft connected with factory balanced, rigid aluminium coupling and guard.

.6 Direct coupled pumps shall have carbon/nickel resist mechanical seal. Spacer coupling pumps shall have tungsten carbide outside mechanical seal. all pumps shall be fitted with flush lines piped from pump discharge to mechanical seals.

.7 Exit velocities shall not exceed 4.6 m/s.

2.3 SEALS AND PACKING

.1 Unless otherwise noted, all pumps shall be supplied with mechanical seals as detailed in individual sections. Where packing glands are specified on schedule, provide a stuffing box integral with the pump casing and provide with lantern rings. Stuffing box shall be suitable for four rings Teflon coated material. Provide shield over stuffing box to prevent water spray. Where packing glands are used, provide stainless steel shafts on associated pumps.

2.4 FILTERS

.1 Unit to consist of filter, flow indicator, flow control valves and filter cartridges.

.2 Stainless steel shell of single centre bolt construction with cast nickel-plated brass head, drain plug and air vent. Flow indicator, cast bronze body plug and air vent. Flow indicator, cast bronze body with two sight glasses of high temper, thermo shock-resistant glass and nylon rotor on stainless steel pin. Flow control valves, cast bronze globe valves, 20mm female NPT thread.

.3 Filter Cartridge: For each cartridge filter provide:

  .1 100 micron filter for start-up and 50 micron filter for polishing.

  .2 Provide 2 spare 20 micron filters.

PART 3.0 EXECUTION

3.1 INSTALLATION

.1 In line circulators: install as indicated by flow arrows. Support at flanges or near unions on outlets of unit. Install with bearing lubrication points accessible. Check rotation.

.2 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

.3 Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump section and discharge line sizes 100mm and over.

.4 Provide drains for bases and stuffing boxes piped to and discharging into floor drains.

.5 Provide air cock and drain connection on horizontal pump casings.

.6 Check and align pumps prior to start-up.

3.2 SEALS

.1 Make seal recirculation connections from the pump casing or flange on the discharge of the pump, with external piping to the seal flushing connection. Install the flushing connection complete with regulating valve suitable for service and working pressure of pump served.

.2 The Contractor will co-operate to expose the seal internals for the inspection of the conduit prior to take over by the Owner; if the condition so warrants, replace the seals at no expense to the Owner. Similarly for packing glands, replace pump shaft sleeves if damaged.

.3 Provide one spare set of seals for each pump. Turn over to owner at completion of project.

3.3 FILTERS

.1 Install side stream filters as follows:

.1 all heating or glycol pumps

.2 at locations shown on drawings

.2 Change filters after system has been cleaned and flushed, and on a regular basis until system turnover.

3.4 START UP

.1 General

.1 In accordance with manufacturer's recommendations.

.2 Procedures:

.1 Before starting pump, check that protective devices are installed and operative.

.2 After starting pump, check for proper, safe operation.

.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.4 Check base for free floating, no obstructions under base.

.5 Run in pumps for 12 continuous hours.

.6 Verify operation of over temperature and other protective devices under low and no flow condition.

.7 Eliminate air from scroll casing.

.8 Adjust water flow rate through water cooled bearings.

.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.

.10 Adjust alignment of piping and conduit to ensure true flexibility at all times.

.11 Eliminate cavitation, flashing and air entrainment.

.12 Adjust pump shaft seals, stuffing boxes, glands.

.13 Measure pressure drop across strainer when clean and with flow rates as finally set.

.14 Replace seals if pump used to degrease system or if pump used for temporary heat.

.15 Verify lubricating oil levels.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Expansion tanks.

.2 Accessories and connection to piping system.

.3 Saddles and structural supports.

1.2 STANDARDS

.1 Construct tanks to ASME, CSA, ULC and API Codes.

.2 Comply with Provincial Government regulations.

1.3 SUBMITTALS

.1 Provide shop drawings for all tanks and tank accessories per Section 23 00 00.

1.4 INSPECTIONS

.1 Obtain inspection certificates for pressure vessels from Provincial Authorities. Obtain certificates for Underground Tanks from Authorities prior to backfilling.

PART 2.0 PRODUCTS

2.1 GENERAL REQUIREMENTS

.1 Tanks shall be constructed with all necessary tappings for installation of piping connections and accessories. Include inlet, outlet, drain, vent or relief, overflow, gauge glass and level controls as required for a particular tank application.

.2 Tanks shall be provided with cradles, pipe legs or other support structures and lift lugs as necessary for installation of a particular tank arrangement.

.3 Inspection Openings:

.1 Tanks 300 mm or less inside diameter shall have at least two removable pipe connections not less than 20 mm pipe size.

.2 Tanks over 300 mm and less than 900 mm inside diameter shall have at least two handholes, minimum size of 100 mm x 150 mm.

.3 Tanks 900 mm to 1500 mm inclusive inside diameter shall have a manhole, minimum size of 280 mm x 380 mm elliptical or 380 mm diameter circular.

.4 Tanks over 1500 mm inside diameter shall have at least one manhole, minimum size of 610 mm diameter.

2.2 EXPANSION TANKS

.1 Diaphragm type tanks to be with adjustable precharge of air to accommodate liquid system expansion.

.2 Tanks shall be closed type, welded steel rated for working pressure, cleaned, prime coated and supplied with steel support saddles.

.3 Assembly to be 860 kPa working pressure, unless specified otherwise.

.4 Construct tank with necessary tappings for installation of accessories.

.5 Provide quick connect air inlet of automatic tire valve type on top of tank and tank drain hose bibb on bottom of tank.

.6 Provide pressure relief valve, and automatic cold water fill assembly complete with positive displacement meter pressure reducing valve, reduced pressure double check back pressure valve with test cocks, strainer, vacuum breaker and valved bypass around reducing valve only, as shown on drawings.

.7 Design and construction shall be as per ASME Section VIII unless specifically noted otherwise.

.8 Tanks shall be steel with painted finish.

PART 3.0 EXECUTION

3.1 INSTALLATION

.1 All tank openings except vent to be plugged or capped before delivery to site, and kept sealed during construction.

.2 Support tanks inside building from building structure as indicated on drawings.

.3 Provide 100mm high housekeeping bases on floor mounted tanks.

.4 Flush and clean fuel tank prior to delivery to site and keep sealed during construction.

3.2 PROTECTION

.1 All closed tanks in pressure systems shall be fitted with a pressure safety valve, rated for a room fire occurrence while system valve to tank may be closed for service.

.2 Pressure safety valve may be pipe mounted, on tank side of shut off valve, if tank tappings cannot accommodate the valve.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Steam Traps

.2 Steam Air Vents

.3 Steam Pressure Reducing Valves

.4 Steam Relief Valves

.5 Condensate Transfer Units

1.2 QUALITY ASSURANCE

.1 Design and manufacture shall conform to CSA, ULC, ASME, and provincial regulations.

.2 Steam pressure designation shall be as follows:

.1 Low pressure steam and condensate is that at and below 105 kPa.

.2 High pressure steam and condensate is that above 105 kPa.

.3 Be responsible for the selection and operation of components furnished.

1.3 SUBMITTALS

.1 Submit shop drawings which indicate equipment piping connections, valves, control assemblies, auxiliaries and hardware. Show final location and type of field assembly for piping, valves, controls and fittings which are shipped loose. Show dimensions, and recommended method of installation.

.2 For equipment with electrical components, provide technical brochures and detailed composite diagrams for systems showing factory installed wiring and components on packaged equipment, or required for controlling devices of ancillaries, accessories and controllers.

.3 Provide maintenance data for equipment for incorporation into maintenance manual.

1.4 START-UP

.1 Provide start-up service, make adjustments and instruct the Owner's operating personnel.

PART 2.0 PRODUCTS

2.1 FLOAT AND THERMOSTATIC TRAPS

.1 Fully modulating float and thermostatic traps suitable for continuous operation.

.2 Cap and body: cast iron, rated to 1200 kPa.

.3 Float and mechanism: stainless steel.

.4 Valve: heat treated chrome steel.

.5 Vent: balanced pressure phosphor bronze disc, diaphragm type, stainless steel valve and seat.

.6 Pipe connections shall be in the body and the entire trap mechanism attached to the cap.

2.2 BUCKET TRAPS

.1 Inverted bucket trap suitable for intermittent operation.

.2 Body and cover: cast iron rated to 1700 kPa.

.3 Bucket, linkages, pins, seats: stainless steel.

2.3 STEAM AIR VENTS

.1 Balanced pressure thermostatic air vents rated at 860 kPa.

.2 Body: cast bronze.

.3 Thermostatic element: charged multi-convolution phosphor bronze bellows caged in stainless steel.

.4 Valve and seat: stainless steel, renewable.

2.4 STEAM PRESSURE REGULATING VALVES

.1 Regulators shall be of the pilot actuated, diaphragm operated type with the pilot mounted on the upper body and the diaphragm housing below. The main valve shall be single-seated with stainless steel trim, and the valve body shall be cast iron. Rated for 1720 kPa.

.2 The main valve seat and plug shall be completely replaceable.

.3 Travel of the main valve seat shall be controlled by internal positive stops and shall be automatically set by the control stem.

.4 The main valve control stem shall be internally guided and pressure shall be positively communicated between the outlet and the upper diaphragm chamber.

.5 The diaphragm shall be of 2-ply construction.

.6 The pressure pilot shall be capable of being mounted on the main valve and shall have hardened corrosion resistant stainless steel seat.

.7 The pilot diaphragm shall be 2-plys construction.

.8 The pilot shall be capable of being repairable without removing from the system.

2.5 STEAM RELIEF VALVES

.1 Safety valve with ANSI 1720 kPa raised face flanged inlet, threaded outlet.

.2 Body: bronze or cast iron

.3 Trim: bronze/brass with stainless steel disc and semi-nozzle.

.4 Drip pan elbow.

2.6 CONDENSATE TRANSFER UNITS - LOW PRESSURE

.1 Condensate transfer units shall consist of one receiver, (2) water pumps, pump controls.

.2 Condensate receiver: close grained cast iron construction warranted for 20 years against failure due to corrosion.

.3 Water pumps: two stage, centrifugal, permanently aligned and vertical flange mounted on the receiver.

  .1 Each pump shall be bronze fitted with enclosed bronze impeller, axial flow bronze first stage impeller, bronze straightening vanes, renewable bronze case wear ring, and stainless steel shaft.

  .2 Mechanical seal shall be BUNA/Ceramic suitable for temperatures up to 120°Cfor maximum life.

.3 Each pump shall be close coupled to a vertical drip proof motor.

.4 Each pump shall be sized for two times system return rate and shall deliver rated capacity at 6 kPa NPSHR.

.4 Receiver shall have an inlet, vent and an overflow to provide a means of secondary venting. Two externally adjustable two pole float switches shall be provided, one for each pump.

.5 The unit shall be factory tested as a complete unit.

.6 Accessories:

.1 Discharge Pressure Gauges

.2 Inlet Basket Strainer with large dirt pocket

.3 Butterfly Suction Valves

.4 Gauge Glass

.5 Dial Thermometer

.6 High Level Alarm Float Switch, independent of pump float switches

.7 Control Cabinet shall contain CSA listed components per the following list:

.1 Combination Magnetic Starter with Fusible Disconnects

.2 115 Volt Control Transformer for each motor

.3 Electrical Alternator

.4 Selector Switches (Auto-OFF-Hand) for each pump.

.5 Pump Running Pilot Lights for each pump.

.8 Control Cabinet shall be a NEMA 2 Control Panel, factory mounted and wired on the receiver with liquid light conduit.

.9 Pump control circuits shall be independent of one another.

.10 The electric alternator shall provide the following control functions:

.1 Alternate the pump operating sequence automatically after each cycle.

.2 Energise the second pump should the first pump fail to energize or should the first pump not have sufficient capacity.

PART 3.0 EXECUTION

3.1 GENERAL

.1 Install according to manufacturer's installation instructions.

3.2 STEAM TRAPS

.1 Furnish and install steam traps on all steam equipment. Float and thermostatic drip traps shall also be installed at the end of all steam lines, at the base of all risers, ahead of all steam temperature and pressure regulators, on all steam headers, at all steam system low points, where condensate may collect, and at least every 90 m along the length of the steam mains.

.2 All steam traps shall be installed at least 375 mm below the equipment condensate outlet.

.3 A capped dirt pocket and Y type strainer with a blow down valve installed on the drain connection, shall be installed in the piping ahead of the trap. Dirt pocket shall be a minimum of 250 mm in length and shall be of the same size as the steam pipe.

.4 Shut off valves shall be installed in the trap inlet and outlet piping.

.5 A test valve shall be installed in the trap discharge piping to test the trap operation.

.1 On traps having two outlet trappings, the test valve shall be installed in the second trap outlet. On traps without the second outlet trap the test valve shall be installed in a tee fitting between the trap outlet and the shut off valve.

.6 Unions or flanges shall be installed at both sides of the trap to allow for removal.

.7 When traps discharge into wet return line, or have a lift in the discharge piping, a check valve shall be installed in the trap discharge line between the trap outlet and the shut off valve. Lifts will not be allowed in the trap discharge piping for equipment having a modulating temperature regulator.

.8 Size steam traps as follows:

.1 Float and Thermostatic, low pressure: 1.5:1 safety factor.

.2 Float and Thermostatic, high pressure: 2:1 safety factor.

.3 Bucket: 2:1 safety factor.

.4 The trap seat pressure rating must be equal to or greater than the steam supply to the equipment.

.5 The trap capacity must be determined at the minimum possible differential pressure.

.6 When used on equipment having a modulating temperature regulator the trap capacity shall be determined at 3.5 kPa differential.

.9 The trap shall be installed at least 375 mm below the equipment to be drained which will provide 3.5 kPa static head at the trap inlet.

.10 The trap discharge piping must drain by gravity to a dry return line.

.11 Install thermostatic elements in traps only after system has been operated and dirt pocket cleaned.

3.3 STEAM AIR VENTS

.1 Install as shown on drawings, and at highest point of steam chambers, with inlet connections to the vents higher than the highest points of the chambers.

3.4 STEAM PRESSURE REDUCING VALVES

.1 Steam pressure reducing valves shall be installed with isolation valves on both sides of units, strainers complete with blow-off valves, pressure gauges on each side of station (upstream of inlet isolation valves, and downstream of outlet isolation valves).

.2 Install pilot operator line downstream so as to sense true pressure.

.3 Relief valves shall be rated for the steam pressure upstream of the valves. Units to be sized for full installed capacity of reducing station, and shall be set at not more than 15% above reduced pressure, or as otherwise shown on the drawings.

3.5 RELIEF VALVE INSTALLATION

.1 Terminate relief valve vent lines to outdoors unless specifically noted otherwise.

.2 Headers may be used to connect more than one relief valve vent, only with the written approval of the Engineer. Where headers are permitted, the header area cross section shall be no less than the sum of the cross sectional areas of all pipes feeding into the header.

.3 Extend drains from drip pan elbows to floor drain or trench drain.

3.6 CONDENSATE RETURN UNITS

.1 Locate equipment upon arrival on site into place, level and secure, and make connections in accordance with manufacturers' instructions.

.2 Inspect internal and external components against details and layout drawings. Clean and remove foreign matter.

.3 Extend all vents to the outside. Extend overflows to drain.

.4 Prepare for start-up by having manufacturer's field representative supervise testing, including co-ordination of ancillaries, accessories, and controls.

.5 Prior to testing ensure that connections are complete and correct. Protect relief pressure components during test procedure. Ensure controls are located and installed according to approved shop drawings and manufacturers' instruction. Check that nameplate data agrees with power supply and pre-wiring conforms to design connections. Test factory piping system for leaks.

- END OF SECTION -

PART 1.0 GENERAL

1.1 SCOPE

.1 This section specifies the requirements for cleaning, degreasing, and chemically treating:

.1 chilled water systems;

.2 glycol hydronic systems; and,

.3 steam and condensate systems.

.2 Provide equipment to add chemicals to the water systems.

.3 Provide equipment to operate and control the systems.

.4 CSA and NEMA Compliance: Provide electrical components required as part of treatment equipment, which are CSA listed and labeled, and comply with NEMA standards.

.5 Chemical Standards: Provide only chemical products which are acceptable under federal, provincial and local pollution control regulations.

1.2 QUALITY ASSURANCE

.1 Provide chemical treatment, chemicals and equipment by an agency that specialises in this type of work. The Contractor shall take full responsibility for providing suitable working systems.

.1 Standard of Acceptance : Maxim Chemical International Ltd.

.2 Perform the cleaning operation on site, witnessed by the Consultant, prior to substantial completion.

.3 Provide chemical treatment and records of this chemical treatment from the time of commissioning to the time of acceptance by the Owner.

.4 Chemicals shall not in any way harm equipment, devices, or systems through which they flow.

1.3 SUBMITTALS

.1 Provide an outline of the proposed chemical cleaning procedure at least two weeks prior to the cleaning operations.

.2 Provide a written log of the cleaning procedure including times, system status, problems encountered and condition of the water.

.3 Provide a report of water tests on the systems every 14 days from the time of commissioning to acceptance.

.4 Provide a report every 14 days on meter readings of the amount of water added to each system and the amount of chemicals added from the time of commissioning to acceptance.

1.4 WARRANTY

.1 Visit the site during the warranty period to check treatment, take samples and advise building staff on treatment procedures.

.1 There shall be one site visit in January to review the hot water, glycol, and steam heating systems.

.2 There shall be one site visit in August to review the chilled and condenser water systems.

.3 There shall be one site visit in January, and one site visit in August to review the heat pump loop system.

.2 Submit a written report within one week of each visit. Report shall contain system(s) condition and problems encountered.

.3 Provide all treatment chemicals required to fully protect systems during the warranty period. In the case of steam systems provide start-up quantities of treatment chemicals only.

PART 2.0 PRODUCTS

2.1 MATERIALS

.1 Provide sufficient chemicals to treat the systems from the time of commissioning to acceptance of the building.

2.2 Chemical Products

.1 Products which may contact finished areas through leakage shall be colourless.

.2 New hydronic systems cleaner : Alkaline compound which, in solution, removes grease and petroleum.

.1 Standard of Acceptance : Maxim WT-728/WT-727

.3 Existing hydronic system cleaner : Acidic compound which, in solution, removes scale, sludge and other build-up from piping.

.1 Standard of Acceptance : Maxim WT-749

.4 Steam and condensate systems : Boil-out and degrease.

.1 Standard of Acceptance : Maxim WT-725

.5 Hydronic systems treatment : Contingent on water conditions.

.1 Standard of Acceptance : Maxim WT-565

.6 Glycol systems : Inhibited ethylene glycol. Dilution water to be analysed to determine suitability, or to be of softened or demineralized quality. Apply appropriate treatments as recommended by the treatment agency and as approved by the Consultant.

.7 Steam and condensate systems treatment : Apply appropriate treatment products to control scale, corrosion, foaming, sludge, and acid attack contingent on local water supply.

2.3 POT FEEDER

.1 Provide one pot feeder for each of the following systems:

.1 glycol hydronic system

.2 Provide pot feeder of five gallon capacity constructed of steel, for introducing chemicals into system(s).

.1 Provide funnel with shutoff valve on top, air release valve on top, drain valve on bottom, and recirculating shutoff valves on side.

.2 Construct for [860 kPa] working pressure.

.3 20mm inlet and outlet lines, 20mm drain valve, 40mm fill.

.3 Standard of Acceptance : Maxim FA-700 By Pass Feeder.

PART 3.0 EXECUTION

3.1 GENERAL

.1 Install water treatment system in accordance with manufacturer’s written instructions.

.2 Co-ordinate plumbing and piping work as necessary to interface components of water treatment system properly with systems.

3.2 SYSTEM CLEANING

.1 Contractor is to ensure that debris, dirt and other foreign material are prevented from entering piping system during construction.

.2 Install adequate drain connections to completely drain each system in one hour.

  .1 When filling each system, use a water meter to record the water volume in each system. Record volume and forward to Consultant. Provide one copy of information for each system in each maintenance manual.

.3 Provide adequate drain connections to completely drain each system in one hour. Record water meter readings for each fill cycle.

.4 Install temporary strainers in the system during the cleaning. Provide temporary strainers on pumps that do not have permanent strainers. Provide pressure gauges on the strainers to detect plugging. Remove and clean strainers after cleaning the system.

.5 Control valves to be operational before cleaning to permit circulation through terminal units. Protect control devices from the systems being cleaned.

.6 System pumps may be used for the cleaning provided that the system is manually pre-flushed with potable water.

  .1 Dismantle and inspect the pumps after use and replace seals; turn over used seals to Engineer. Install new gaskets. Check rotation of pumps.

.7 The system to be completely operational, all safety devices functional, and any hydraulic tests completed before cleaning.

.8 For each glycol system:

.1 Introduce to the system via the pot-feeder, 3 to 5 kg of hydronic systems cleaner per 1,000 litres of system capacity or as directed by chemical representative.

.2 Circulate this mixture for 12 to 18 hours at 70 to 80°C.

.3 Flush the system to drain from the lowest points with a minimum of 5 system volumes, or until the water is clear, free of all foam and pH. Conductivity and alkalinity readings of the flush water match the raw water (acceptability of system flush to be confirmed by chemical supplier).

.4 Change micron side-stream filter cartridge frequently until the treatment agency is fully satisfied that the system is ready for glycol installation.

.5 Treat system immediately as required by treatment agency and to the approval of the Consultant.

.9 For the steam system:

.1 The boiler(s) shall not be fired until the boil-out chemicals have been added.

.2 The boiler manufacturer's instructions for firing, venting, and boil-out shall be followed.

.3 Prior to boiling-out, a thorough inspection of the boiler by the Contractor and chemical treatment supplier shall be made to ensure removal of debris. Excessive oil or dirt shall be removed by wiping.

.4 Provisions to vent the boiler to atmosphere shall be made prior to the boil-out.

.5 The factory supplied gauge glass shall be replaced by a temporary glass that will be discarded after the boil-out.

.6 The boiler(s) shall be isolated from the stream distribution system.

.7 Contractor shall boil-out the boiler to remove remaining grease, oil, dirt, and other contaminants using the steam and condensate systems boil-out and degreaser, at a dosage of 3 – 5 kg per 1,000 litres of water capacity in the boiler. Use softened make-up water where available for this procedure.

.8 Boiler shall be operated at sufficient pressure (approximately 50% of normal operating pressure) to ensure good circulation.

.9 The boil-out shall be for a minimum of 8 to 12 hours or until all contaminants are removed.

.10 Boiler shall be thoroughly flushed with fresh water after the boil-out, inspected for cleanliness, and immediately treated as specified by the treatment agency supplier, as approved by the Consultant.

.11 Make systems completely operational, filled, started and thoroughly vented.

.12 Use neutralising agents on recommendation of the treatment agency and to approval of the Consultant.

.10 When cleaning is completed and system filled for hot water and chilled water circuits, establish circulation, adjust expansion tank level and set pressure control.

.11 Drain steam and condensate piping until it is clear and free of suspended matter.

.12 Furnish one year's supply of the recommended chemicals for scale, corrosion, and bacterial growth protection.

3.3 Systems Treatment

.1 Glycol systems:

.1 Treatment agency shall analyse a sample of the local water supply proposed for filling the system to ensure glycol compatibility. Where local water conditions are determined unsuitable for use with glycol, the system will be filled with water from an acceptable source (softened or demineralized).

.2 Glycol shall be added immediately after cleaning and flushing. If this is not possible, each system shall be treated as per "Hydronic Systems" until glycol is added.

.3 Treat systems with closed system inhibitor introduced through pot-feeder when required or indicated by test.

.2 Steam and condensate systems:

.1 Apply appropriate treatments as recommended by the treatment agency and as approved by the Consultant.

3.4 Mechanical Products Installation

.1 Install pot-feeders complete with isolating and drain valves across circulating pumps.

.2 Install side-stream filters and flow indicators complete with isolating valves across circulating pumps.

.3 Provide mechanical products specified to suit system requirements and to provide workable systems.

3.5 TESTING

.1 Sample systems with chemical treatment at one-week intervals after start-up for period of 5 weeks and prepare certified test report for each required water performance characteristic. Comply with the following standards, where applicable.

.1 ASTM D 859 Tests for Silica in Water and Waste Water

.2 ASTM D1066 Sampling Steam

.3 ASTM D1067 Tests for Acidity or Alkalinity of Water

.4 ASTM D1068 Tests for Iron in Water

.5 ASTM D 1126 Tests for Hardness in Water

.6 ASTM D1888 Tests for Particulate and Dissolved Matter in Water

.7 ASTM D3370 Practices for Sampling Water

3.6 TRAINING OF OWNER'S PERSONNEL

.1 Provide services of supplier's technical representative to instruct Owner's personnel in operation, maintenance and testing procedures of water treatment system.

- END OF SECTION -

PART 1.0 GENERAL

1.1 Work Included

.1 Ductwork and plenums.

.2 Fasteners.

.3 Sealants.

.4 Duct cleaning.

1.2 Definitions

.1 SMACNA Standards in the specification refer to the SMACNA standards "HVAC Duct Construction Standards – Metal and Flexible" (latest addition), and "HVAC Air Duct Leakage Test Manual" (latest addition).

.2 Low Pressure: Static pressure in duct less than 500 Pa and velocities less than 10 m/s.

.3 Medium Pressure: Static pressure in duct less than 1500 Pa and velocities greater than 10 m/s.

.4 High Pressure: Static pressure in duct over 1500 kPa and less than 2500 kPa and velocities greater than 10 m/s.

.5 Duct Sizes: Inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

.6 For this project:

.1 All supply ductwork upstream of VAV boxes is to be constructed to medium pressure ductwork standards. All other supply ductwork is to be construction to low pressure ductwork standards.

.2 All return ductwork in the mechanical penthouse is to be constructed to medium pressure ductwork standards. All other return ductwork is to be constructed to low pressure ductwork standards.

.3 All exhaust ductwork is to be constructed to low pressure ductwork standards.

1.3 Quality Assurance

.1 Ductwork shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems, NFPA No. 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems [and NFPA No. 96, Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapours from Commercial Cooking Equipment].

.2 Fabricate in accordance with recommendations of SMACNA duct manuals and ASHRAE handbooks.

.3 Flexible air duct shall conform to NFPA 90A and UL181 standard for factory made air duct materials and air duct connectors.

1.4 Alternatives

.1 Size round ducts installed in place of rectangular ducts indicated from ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration of shape or sizes permitted except by written permission from the Engineer.

PART 2.0 PRODUCTS

2.1 Ductwork

.1 Provide galvanised steel low, medium and high velocity distribution ductwork for building supply, return and exhaust air systems.

.2 Construct ducts of galvanized steel of lock forming quality and having zinc coating to:

- .1 Indoors : ASTM A525, G60 designation for both sides.
- .2 Outdoors : ASTM A525, G90 designation for both sides.

.3 Fastening on all ductwork is to meet SMACNA standards.

.4 Low Pressure Ductwork - to 500 Pa

- .1 Galvanized Steel
  - .1 Thickness, fabrication, and reinforcement: to SMACNA.
  - .2 Joints to SMACNA.

.2 Duct Leakage

.1 In accordance with SMACNA HVAC Duct Leakage Manual.

.5 Medium and High Pressure Ductwork - from 500 Pa to 2500 Pa

.1 Material

.1 Thickness: to SMACNA.

.2 Construction - round and oval:

.1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.

.2 Transverse joints up to 900 mm: slip type with sealant.

.3 Transverse joints over 900 mm: Flanged.

.4 Fittings:

.1 Elbows: smooth radius or five piece (for 90º bends) or three piece (for 45º bends). Centreline radius: 2.5 x diameter.

.2 Branches: conical transition with conical branch at 45^0 and 45^0 elbow.

.3 Construction - rectangular:

.1 Ducts: to SMACNA.

.2 Transverse joints: SMACNA seal Class A and B.

.3 Fittings:

.1 Elbows: smooth radius; centreline radius 2.5 x width of duct. No vanes.

.2 Branches: with conical branch at 45^0 and 45^0 elbow.

.6 Use water resistant and fire resistive duct sealant which is compatible with mating materials. Sealant to be (or be equivalent to) Design Polymerics 1010 water based duct sealant with a curing time of 24 to 72 hours, LEED qualified, with zero VOCs.

.1 In specific instances where approved in writing by the Engineer , Polyken 360-17 (or equivalent) foilastic butyl seal and repair tape tested to UL723 may be used where the curing time of the duct sealant is not compatible with system downtimes."

.7 Kitchen exhaust ducts are to be constructed to the requirements of NFPA-96, latest edition.

.1 Kitchen exhaust ducts to be fabricated of 1.6 mm galvanized steel and 1.2 mm stainless steel where exposed.

.2 Fabricate seams and joints in kitchen exhaust ducts liquid tight with continuous external welds.

.8 Where specified as stainless steel, construct ducts of type 304 stainless steel. Provide all welded joints throughout.

2.2 Flexible Ductwork

.1 Comply with requirements of ULC "Standards for Safety, Air Ducts", ULC-181 Class I, and NFPA 90A.

.2 Provide 25 mm mineral fibre insulation with factory applied vapour barrier on ducting systems which require insulation.

.3 Flexible Duct - Low Pressure

.1 Insulated flexible air duct shall be used where shown on drawings. Length of flexible duct shall not exceed 1200mm. Flexible duct shall be polymeric liner banded to a steel wire helix, wrapped with fibreglass insulation and outer fibreglass reinforced metallized vapour barrier jacket. Flexible duct rated for 730 m/s velocity and pressure rated for 500 Pa positive and 500 Pa negative.

.2 Standard Acceptance: Thermaflex M-KE.

.4 Flexible Duct - Medium Pressure

.1 Length of flexible duct shall not exceed 300mm. Flexible duct shall be woven and vinyl coated fibreglass liner bonded to a steel wire helix. Where flexible air duct is attached to metal insulated duct, furnish flexible air duct with fibreglass insulation and outer fibreglass reinforced metallized vapour barrier jacket. Flexible duct rated for 730 m/s velocity and pressure rated for 1500 Pa positive and 730 Pa negative.

.2 Standard Acceptance: Insulated - Thermaflex M-KC

.5 Flexible duct shall not be used to connect terminal units to metal duct.

2.3 Fabrication

.1 Fabricate metal ducts complete with no single partition between ducts. Where width of duct exceeds 450 mm cross break for rigidity. Open corners are not acceptable.

.2 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.3 Construct tees, bends, and elbows with centreline radius of not less than 1.0 times the width of duct in plane of rotation. Where not possible, use mitred elbows with air foil double wall turning vanes.

.4 Increase duct sizes gradually, not exceeding 15 degree divergence and 30 degree convergence.

.5 Rigidly construct low pressure metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with approved duct sealant during duct assembly.

.6 Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10% of duct area, split into two ducts maintaining original duct area.

.7 Provide necessary baffling in mixed air plenums to ensure good mixed air temperature with cross sectional variations of not more than 5°C under all operating conditions.

.8 Fabricate medium pressure round and oval ductwork to SMACNA standards.

.9 Fabricate plenums to configurations shown on drawings and to SMACNA standards. Plenums to be constructed with double walled casing.

.10 Provide 75mm to 100mm thick reinforced concrete curb for plenum walls and floor mounted casings. At floor, rivet panels on 200mm centers to angles. Where floors are acoustically insulated, provide liner at 1.2mm thick galvanized expanded metal mesh, turned up 300mm at sides with sheet metal shields.

.11 Reinforce door frames with angle iron tied to horizontal and vertical plenum supporting angles. Install hinged access doors where shown, specified or where required for access to equipment for cleaning and inspection.

.12 Fabricate acoustic plenums of galvanized steel to SMACNA standards for double wall casing. Fabricate with perforated metal liner. Construct panels 50mm thick packed with 72 kg/m^3 mineral fibre media on inverted channels on 75 mm to 100mm thick reinforced concrete curb.

2.4 Materials

.1 Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts. Weld kitchen exhaust ducts.

.2 Sealant: Water resistant, fire resistive, compatible with mating materials.

PART 3.0 EXECUTION

3.1 Installation

.1 Fabricate ductwork from field measurements and not from plans and shop drawings exclusively. Failure to do so will not constitute an extra to the Contract.

.2 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 300mm, cross-bracing permitted on ductwork up to 1000 Pa per SMACNA standards. Open corners are not acceptable.

.3 Provide floor drains in fresh air and humidifier sections with deep seal traps.

.4 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.5 Clean duct systems and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.]

.6 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

.7 Install duct in accordance with SMACNA standards.

.8 Protect galvanised ductwork exposed to outside elements by painting or coating with suitable weather resistant material.

.9 Install balancing dampers at all branch ducts and as indicated and where indicated by Balancing Contractor.

.10 Anchor all risers.

.11 Install fire dampers to NFPA 90A and the National Building Code.

.12 Install airtight access door and clean-outs on upstream side of all reheat coils and at all fire dampers.

.13 Support flexible ducts at 1200 centers. Ensure bends are not tighter radius than standard 1.5 times duct width.

.14 Co-ordinate the location of duct access doors. Refer to “Duct Accessories” Sections.

.15 Interrupt duct linings at fire, balancing, and back-draft so as not to interfere with operation of devices. Provide sheet metal edge protection over linings on both sides of damper device.

.16 Shield ductwork from dust and construction material during construction. Clean any ductwork found to be dirty at no extra cost to the Contract.

.17 Install ducts associated with fans subject to forced vibration with flexible connections immediately adjacent to equipment. Refer to Section 23 33 00 “Duct Accessories”.

3.2 Watertight Duct

.1 Provide watertight ductwork for "wet" air exhaust at humidifiers for 3 metres in all directions, at fresh air intake, and at relief ducts under roof hoods, goosenecks or louvered penthouses.

.2 Form bottom of duct without longitudinal seams. Solder or weld joints of bottom sheets and sides. Solder or weld transverse joints and caulk.

.3 Fit base of risers with 150 mm deep drain sump, 30 mm drain connection, with deep seal trap and valved drain line to open funnel drain. Where ducts convey freezing air, provide remote trap.

3.3 Duct Sealing

.1 All supply, return and exhaust duct joints, longitudinal as well as transverse, should be sealed using:

.1 Low Pressure Ductwork:

.1 Slip Joints: Apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.6mm use heavy mastic type sealant.

.2 Flanged Joints: Soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.

.3 Other Joints: Heavy mastic type sealant.

.2 Medium Pressure Ductwork: Combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.

.2 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.

.3 Prior to sealing all ductwork, demonstrate sealing of a section of each type of duct and obtain approval from the Engineer.

.4 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application.

.5 Low and medium pressure supply ductwork which is located outside of the conditioned space is to be sealed in accordance with SMACNA Seal Class C.

.6 Duct tape as a sealing method is not permitted without the express written permission of Engineer, and only under the circumstances as outlined in paragraphs 2.1 “Ductwork” above.

- END OF SECTION -

PART 1.0 GENERAL

1.1 Work Included

.1 Access doors.

.2 Fire dampers.

.3 Balancing dampers.

.4 Splitter dampers.

.5 Backdraft dampers.

.6 Flexible connections.

.7 Turning vanes.

1.2 Quality Assurance

.1 Fire dampers shall be ULC listed and constructed in accordance with ULC Standard S 112 "Fire Dampers".

.2 Fusible links on fire dampers shall be constructed to ULC Standard S505.

.3 Demonstrate resetting of fire dampers to Authorities Having Jurisdiction and Owner's representative. Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.

.4 Access doors shall be ULC labelled.

.5 Accessories shall meet the requirements of NFPA 90A, "Air Conditioning and Ventilating Systems".

.6 Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.

1.3 Submittals

.1 Shop drawings of factory fabricated assemblies.

.2 Samples of shop fabricated assemblies when requested.

.3 Manufacturer's printed installation instructions.

PART 2.0 PRODUCTS

2.1 Access Doors

.1 Fabricate rigid and close fitting doors of galvanized steel with sealing gaskets and suitable quick fastening locking devices. Install minimum 25mm thick insulation with suitable sheet metal cover frame for insulated ductwork. Doors shall be minimum 400x300 oval unless indicated otherwise on drawings or duct maximum dimension is less than 350mm.

.2 Standard of acceptance : Metu type “RD” or “RRD” with polyethylene gasket and POM knobs. For insulated ducts us Metu “IRD” or IRRD-3PL”. Provide retaining cables on medium and high pressure supply ductwork.

2.2 Fire Dampers

.1 Fabricate of galvanized steel or prime coated black steel weighted to close and lock in closed position when released by fusible link.

.2 Fire dampers in all ductwork to be multi-blade, curtain type.

.3 Curtain type fire dampers shall have blades retained in a recess so free area of connecting ductwork is not reduced.

.1 Fusible links shall be set for 72ºC.

2.3 Single Blade Volume Dampers

.1 Low velocity system single blade volume dampers shall be limited to maximum duct depths of 275mm.

.2 Manual volume dampers shall be ssuitable for horizontal or vertical applications and shall be constructed to SMACNA standards.

.1 Standard of Acceptance : Everlock damper handle and ROSSI HVAC Hardware.

.3 Locking Hardware Component

.1 Bracket: Cold Rolled Steel (ASTM A-1008), 18 gauge. Single cut and formed bracket for use with 38mm or 50mm (1.5” or 2.0”) insulation wrapping or any other such stand-off applications. Finished with a white chromate plating process for corrosion resistance. Auto Planting ASTM B-633 Type II (white) class FE/ZN8 or SC2 Thickness of 0.0003.

.2 Handle and Thumb Trigger: Polyamide 66 (PA66), Flame Retardant, Glass Reinforced, "Zytel" polymer by Dupont. PA66 shall be used for all non-metallic components as specified in the UL 1995 Standards Code for Heating & Cooling (CSA-C22.2 No. 238 UL 1995) with the required flammability rating of 5VA.

.3 Compression Spring: Stainless Steel.

.4 Retaining Spring: External Self-Lock TX-75ST-ZF Carbon Steel SAE 1074 with Zink Bright Plating. C-Scale Rockwell Hardness 47 to 51.

.4 Blades (or Discs)

.1 100mm to 400mm (4" to 16") diameter single blade or disc. ASTM-A527 LFO G90, 22 gauge reinforced to equal strength of 20 gauge material.

.2 9.5mm (3/8") full length bar fits through formed channel in center of damper blade.

.5 Bars: 9.5mm (3/8") square Aluminium bar

.6 Bearings

.1 Bearings are to be made of Polyamide 66 (PA66).

.2 Snap-in bearings shall be used in medium and low pressure systems.

.3 Clip-on bearings shall be used in high pressure system.

.4 B-Lined bearings are to be used for lined ductwork.

2.4 Multiple Blade Volume Dampers

.1 Use multi-blade dampers where damper width exceeds 300 mm (12").

.1 Dampers to be Tamco Series 9000-BF (thermally insulated damper with thermally broken frames) when on an outside wall or Tamco Series 1000 when not on an outside wall.

.2 Frames shall be welded construction mild steel or aluminium channels, maximum size 1200 x 1800 mm. Larger sizes shall be made up of damper sections connected together vertically and horizontally. Frame net area shall equal duct area.

.3 Blades shall be 2.0mm thick extruded aluminium with widths varying from 150 to 200mm. Blade edges shall be formed 12 x 12mm channel. Blades shall be centre reinforced to take axle rods.

.4 Synthetic bearings for each damper axle shall be press fitted into frame. Centre bar linkage shall be fitted with bearings interconnecting the blades with 8mm tie-rods to provide opposed blade action.

.5 Each damper section shall have side, top and bottom stops welded to frame.

.6 Fit extruded rubber seals to damper sections used for total shutoff application, and face and bypass applications. Opposed blade arrangement to be rated at 0.6% leakage at 2500 Pa static. Operating arrangement to be -40°C to 90°C.

.7 Manual dampers shall have a locking quadrant control. Motorized dampers shall operate external linkage on single section dampers and centre bar linkage on multiple sections. All steel components to be cadmium plated.

2.5 Splitter Dampers

.1 Where splitter dampers are utilized to control the flow of air to branch ducts they shall be constructed of minimum 1.5 mm thick cold rolled steel, with ball joint fitting attached to the duct.

.2 Damper rod shall pass through the ball joint which swivels to adjust to proper angle to accommodate the control rod and locked in place with a set screw.

.3 Control rod shall be attached to the blade with a 4-way adjustable bracket to insure smooth non-binding operation of the damper.

.4 Fixed end of the damper shall have two hinges to secure damper to duct.

2.6 Backdraft Dampers

.1 Fabricate multi-blade, parallel action gravity balanced backdraft dampers with blades a maximum of 150 mm width having felt or flexible vinyl sealing edges, linked together in rattle-free manner and with balance adjustment device to permit setting for varying differential static pressure.

2.7 Flexible Connections

.1 Provide where indicated, at fans and at air handling units, neoprene coated flame proof fabric, minimum density 1.22 kg/m^2, factory fabricated, not more than 150 mm long between metal parts and installed with just sufficient slack to prevent vibration transmission. Allow 100 mm movement to medium pressure fans and 50 mm movement to low pressure fans.

2.8 Turning Vanes

.1 Provide small arc air foil hollow vanes for square elbows. Where acoustical lining is provided, provide turning vanes of perforated metal type with fibreglass core. Where centreline radius is less than 1½ times turning dimension of duct, provide splitter vanes constructed and spaced according to the latest SMACNA manuals.

PART 3.0 EXECUTION

3.1 Application

.1 For all rectangular ducts and all round ducts over 250mm diameter, provide access door minimum 600mm x 350mm, or 50mm smaller than duct dimension for cleaning and inspection at positions indicated by drawings and as follows:

- .1 At 12m intervals in all duct systems.
- .2 At the base of all duct risers.
- .3 Both sides of turning vanes in all ducts.
- .4 At each fire damper location.
- .5 At each side of all heating or cooling coils.
- .6 At all locations of internally duct mounted devices including automatic dampers, damper motors and control sensors and devices.

.2 Provide 100 x 100 mm quick opening access doors for inspection at balancing dampers on all rectangular ducts and on all round ducts over 250 mm diameter.

.3 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated building components, and where required by Authorities Having Jurisdiction. Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.4 At each point where ducts pass through partitions, the joints around the duct shall be sealed with non-combustible material.

.5 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger duct and as required for proper air balancing.

.6 Provide balancing dampers on medium pressure systems where indicated.

.7 Splitter dampers shall only be used where indicated on the drawings. Splitter dampers shall not be used on medium pressure systems.

.8 Install flexible connections in ducts connected to fans and equipment subject to forced vibration, immediately adjacent to equipment and where indicated on the drawings.

.9 For connection to medium pressure fans, install 12 mm thick neoprene pad over fabric and hold in place with additional metal straps.

.10 Install all accessories in accordance with manufacturers' recommendations.

- END OF SECTION -

PART 1.0 GENERAL

1.1 Work Included

.1 Axial fans.

.2 Cabinet fans.

.3 Fan accessories.

1.2 Quality Assurance

.1 Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

.2 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.

1.3 Submittals

.1 Shop drawings including acoustical data and fan curves showing fan performance with fan and system operating point plotted on curves.

.2 Maintenance data for incorporation into Project Operating and Maintenance Manual.

.3 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of most direct suppliers, with list of specialised tools necessary for adjusting, repairing or replacing equipment.

1.4 Job Conditions

.1 Do not operate fans for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated and fan has been run in under close supervision.

1.5 Alternates

.1 Equivalent fan selections shall not decrease motor wattage, increase noise level, increase tip speed by more than 10%, or increase inlet air velocity by more than 20% from that specified.

PART 2.0 PRODUCTS

2.1 General

.1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.

.2 Provide fixed sheave pulleys only; variable sheaves will not be considered acceptable.

.3 Fans shall be capable of accommodating static pressure variations of 10% with no objectionable operating characteristics.

.4 All fans to be complete with drive motors.

2.2 Axial Fans

.1 Provide die formed blades with belt drive and motor mounted outside air stream.

.2 Extend lubrication fittings to outside of fan casing. Electrical terminal box shall be external.

.3 Housing shall have flanges for connection of ductwork. When not connected to ducting, provide inlet or outlet cones.

.4 Provide easy access to fan wheel for varying blade angle setting during air balancing.

PART 3.0 EXECUTION

3.1 Installation

.1 Where inlet or outlet is exposed, provide safety screen, bolted to permit removal.

.2 Provide belt guards with tachometer openings on all belt driven fans with exposed drives or in cabinets large enough for personnel entry.

.3 Supply and install sheaves as necessary for final air balance.

.4 Suspension must be four part hanger type, ceiling flange, top hanger, bottom hanger and vibration isolator with take-up for levelling.

.5 Install flexible connector bands at fan inlets and outlets. Ensure that metal bands of connectors are parallel and not touching. Inlet flex connectors shall be positioned minimum 500 mm upstream of axial flow blade tips.

3.2 Priming

.1 Factory prime coat fan wheels and housing inside and outside. Prime coating on aluminium parts is not required.

- END OF SECTION -

PART 1.0 GENERAL MECHANICAL CONDITIONS

1.1 WORK INCLUDED

.1 Basic terminal units.

.2 Variable volume regulators complete with damper motor operator.

.3 Sound attenuator.

.4 Heating coils.

1.2 QUALITY ASSURANCE

.1 The terminal units shall be tested and certified in accordance with applicable ADC equipment test codes.

.2 Insulation materials, coatings, vapour barrier facings, tapes and adhesives: Composite fire and smoke hazard rating shall not exceed 25 for flame spread and 50 for smoke developed.

1.3 LABELLING

.1 Label units with capacities as factory adjusted including minimum maximum ratings of volume regulators.

1.4 SUBMITTALS

.1 Include discharge and radiated sound power level schedules with shop drawings, for each of second through sixth octave bands and inlet pressures of 0.3" to 4".

.2 Provide for inclusion in maintenance manuals, instructions for resetting constant volume regulators.

1.5 DAMPER OPERATORS

.1 Terminal unit damper operators shall be provided by the control trade.

PART 2.0 PRODUCTS

2.1 GENERAL

.1 Include factory fabricated components for volume regulation independent of varying inlet static pressure conditions.

.2 Label units with capacities as factory adjusted including minimum range of volume regulator.

.3 Comply with specified requirements for line duct work for internal lining of terminal units.

2.2 VARIABLE AIR VOLUME TERMINAL UNIT

.1 Pressure independent variable or constant air volume control assemblies of the size and capacities as indicated on the schedules.

.2 Provide sealed and gasketted leak-proof construction of 20 Ga. galvanized steel, internally lined with minimum 25mm (1 inch) thick 24 kg/m^3 (1.5 lb/ft^3) density acoustical thermal insulation.

.3 Provide damper blades, shafts in rust proof Delrin self-lubricating bearings. Seat damper again gasketted stops. Maximum damper leakage 2% at 750 Pa (3 in.w.g.) pressure and shut-off.

.4 Maximum inlet static pressure for all sizes: 1250 Pa (5 in.w.g.).

.5 Provide standard length attenuators unless otherwise indicated on all supply air boxes, multi-outlet or remotely mounted where indicated.

.6 Install the control devices to maintain constant flow regardless of inlet flow deflection. Incorporate the flow sensor to maintain flow within 10% of factory minimum and maximum settings regardless of inlet duct angle.

.7 Do not exceed 40 Pa (0.15 in.w.g.) static pressure drop through control box and discharge attenuator at an inlet velocity of 10 m/s (2000 feet per minute).

.8 Where reheat coils are indicated, and unless noted otherwise, provide factory mounted coils with capacity to raise 50% of the noted maximum supply air volume from 12°C to 30°C (55°F to 85°F) when supplied with fluid at 95°C (203°F), leaving at 80°C (176°F).

   .1 Maximum allowable pressure drops:

.1 Water side : 30 kPa (10 ft. water)

.2 Air Side : 40 Pa (0.16 in.w.g.)

PART 3.0 EXECUTION

3.1 INSTALLATION

.1 Arrange for suitable ceiling access to units. Provide access doors or locate above easily removable ceiling components.

.2 Install units individually from the structure. Do not support from adjacent duct work.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Diffusers.

.2 Grilles and Registers.

.3 Outside Louvers.

.4 Door Grilles.

.5 Diffuser Boots.

.6 Roof Hoods.

1.2 QUALITY ASSURANCE

.1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes and ASHRAE standards.

.2 Unit ratings shall be approved by ADC.

.3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

1.3 SUBMITTALS

.1 Shop drawings showing schedule of outlets, outlet size, finish and type of mounting.

1.4 JOB CONDITIONS

.1 Review requirements of outlets as to size, finish and type of mounting prior to submitting shop drawings and schedules of outlet.

.2 Positions indicated are approximate only. Check location of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

PART 2.0 PRODUCTS

2.1 GENERAL

.1 Base air outlet application on space noise level of NC 35 maximum, and maximum pressure drop of 37 kPa..

.2 Provide supply outlets with sponge rubber seal around the edge.

.3 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

.4 Provide plaster frame for diffusers located in plaster surfaces.

.5 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

2.2 SUPPLY GRILLES

.1 Sidewall supply grilles shall have streamlined and individually adjustable blades.

2.3 RETURN AND EXHAUST GRILLES

.1 Sidewall and ceiling exhaust grilles shall have streamlined blades.

.2 Provide exhaust grilles, where not individually connected to exhaust fans, with integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.4 GRID CORE RETURN AND EXHAUST GRILLE

.1 Fabricate fixed grilles of 12 x 12 x 12 mm louvers.

.2 Fabricate of aluminium.

2.5 RECTANGULAR SUPPLY DIFFUSER

.1 Provide rectangular, adjustable pattern, stamped, diffuser to discharge air in 360 deg. pattern with sectorizing baffles where indicated or required.

.2 Fabricate of steel with baked enamel finish.

2.6 OUTSIDE LOUVRES

.1 Louvers 100 mm deep with blades on 45 degree slope, with heavy channel frame. Construction to be all welded aluminium.

PART 3.0 EXECUTION

3.1 PRIMING

.1 Paint ductwork visible behind air outlets matt black.

3.2 SIZING

.1 Size outside air openings as indicated on drawings.

.2 Size air outlets as indicated on drawings.

- END OF SECTION -

PART 1.0 GENERAL

1.1 REFERENCE STANDARDS

.1 Conform to ASME Section VIII, CSA B51 and provincial pressure vessel regulations.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 23 00 00.

1.3 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into Operation and Maintenance Manual specified in Section 23 00 00.

PART 2.0 PRODUCTS

2.1 PLATE TYPE HEAT EXCHANGERS

.1 Plates shall be constructed with type 316 stainless steel with EPDM (For Hi-Temp) gaskets suitable for intended service.

.2 Gasket shall be suitable for 125°C minimum (unless specified otherwise) and fluid types used. Allow for 50% more plate on frame.

.3 Design pressure 860 kPa or 12 times working pressure, whichever is the greater.

.4 Inlet and outlet connections, ANSI 150 flanges.

.5 Maximum allowable pressure drop (either side) 35 kPa.

.6 Design fouling factor (either side): 0.0005, except for condenser water application use 0.001.

2.2 HEAT EXCHANGER TRIM

.1 Provide thermometer wells and pressure gauge tappings in inlet and outlet.

.2 Provide an ASME rated pressure and temperature relief valve on heated fluid discharge and on heating fluid inlet on downstream side of control valve.

.3 Heat exchangers to be fully drainable and are to be complete with drain valve.

PART 3.0 EXECUTION

3.1 INSTALLATION

.1 Install in accordance with Manufacturer's instructions.

.2 Install level and firmly anchored to supports as indicated.

.3 Install with safety relief valve piped to drain.

.4 Pipe drain valves to drain, both sides.

.5 Install to facilitate servicing.

3.2 OWNER'S INSTRUCTIONS

3.3 Provide instructions to the Owner on the operation and maintenance of the heat exchangers.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Packaged air handling units.

1.2 QUALITY ASSURANCE

.1 Units and major components shall be product of manufacturer regularly engaged in production of such units who issues complete catalogue data on such products.

.2 Unit shall be factory built and tested.

.3 Fans shall conform to AMCA Bulletins regarding construction and testing and shall bear AMCA certified rating seal.

.4 Filter media shall be ULC listed, Class I or Class II, as approved by local authorities.

1.3 SUBMITTALS

.1 Fan curves showing fan performance with fan and system operating point plotted on curves.

.2 Shop drawings and manufacturer's product data showing conformance with performance criteria.

.3 Maintenance data for incorporation into Project Operating and Maintenance Manuals.

.4 List of individual manufacturers' recommended spare parts for equipment such as bearings and seals, addresses of most direct suppliers, with list of specialized tools necessary for adjusting, repairing or replacing equipment.

1.4 ALTERNATIVES

.1 Size, efficiency, initial and final resistance of alternate manufacturer's filters shall be same as types specified.

.2 Number of tube rows, air and water pressure drops, and such features as cleanability, drainability, same or opposite end connections, support and venting of alternate manufacturer's coils shall be same as type specified.

PART 2.0 PRODUCTS

2.1 TYPE

.1 Provide draw-through or blow-through type air handling units of unitary design suitable for medium pressure operation in configurations shown on the drawings.

.2 Units shall consist of basic fan or fan and coil section plus accessories, including heating coil , mixing box section, filter section, cooling coil section, and humidifier section.

2.2 CASING

.1 Construct casings and components of 1.2 mm galvanized steel panels with baked enamel finish, 2.0 mm thick framing and supports to ensure rigidity under normal handling.

.2 Provide hinged access doors and panels to provide access to both sides of sections and components requiring servicing, complete with Camlock fasteners and gasket seals.

.3 Drain pans shall be heavy gauge one piece galvanized steel with welded corners. Provide drain pans under coils.

  .1 Units with humidifier section shall have drain pan under entire fan section to drain water carried over from humidifier.

2.3 INSULATION

.1 Insulate unit panels with 25 mm thick rigid mineral fibreboard faced with neoprene.

.2 Insulate all sections of the air handling unit.

2.4 FAN

.1 Install fans on solid or hollow steel shafts as required. Mount on self-aligning ball bearings. Extend lubrication fittings to exterior of fan casing.

.2 Provide only fixed sheaves. Variable sheaves will not be permitted.

2.5 FILTERS

.1 Media: 50 mm thick fibrous glass blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.

.2 Holding Frames: 1.2 mm galvanized frame with expanded metal grid on leaving air side and steel rod grid on air entering side, hinged with pull and retaining handles.

.3 Arrangement: flat or angle filter section to limit filter velocity, based on gross area to less than 2 m/s. Provide access doors minimum size 450 x 450 mm on both sides of unit.

2.6 MIXING BOX

.1 Casing box with two sets of opposed blade steel dampers on steel shafts in nylon bearings. Arrange dampers for mixing of air streams.

2.7 COILS

.1 Enclose coils in coil section with headers and U-bends fully contained within the casing.

.2 Refer to "Coils" Section of this specification for further details.

2.8 HUMIDIFIERS

.1 Refer to "Humidifiers" Section of this specification for further details.

PART 3.0 EXECUTION

3.1 ASSEMBLY

.1 Assemble low and medium pressure units by bolting sections together to make single unit.

.2 Isolate Fan Section with flexible duct connections.

.3 Install unit on vibration isolators.

.4 Provide fixed sheaves for final air balance.

- END OF SECTION -

PART 1.0 GENERAL

1.1 Work Included

.1 Packaged air-to-air fixed plate Energy recovery ventilator (ERV).

.2 ERV must include the following components :

.1 a fixed plate air-to-air energy recovery core;

.2 a fresh air blower;

.3 an exhaust air blower;

.4 filters ahead the core in both fresh and exhaust air circuits;

.5 an insulated cabinet for an indoor/outdoor installation; and,

.6 sensors and microprocessor controls for an autonomous operation.

.3 The ERV must be capable of transferring both sensible and latent energy.

.4 The ERV must be designed to be used as a stand-alone unit or as a component in a dedicated HVAC system or as complete ventilation/HVAC unit.

.5 The unit must be complete, fully assembled with gauges and controls, ready to be field wired.

1.2 Quality Assurance

.1 The fixed plate energy recovery core must be AHRI certifies for the 1060 standard.

.2 The unit must be tested as per ANSI/UL 1995 and CAN/CSA C22.2 No. 236, Fourth Edition, October 14, 2011.

.3 The unit must be ETL certified.

.4 The insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.

.5 Unit must be free of fabrication defect and maintain proper operation under normal use for a period of two years from purchasing date.

.6 Unit must be fully tested before delivery.

PART 2.0 PRODUCTS

2.1 Construction

.1 Cabinet

.1 The cabinet must have a double wall construction with a 25 mm (1”) fibreglass insulation.

.2 The floor of the unit must be insulated 25mm (1”) with fibreglass and protected with a 22 ga galvanized steel sheet metal.

.3 The interior and external walls must be made of G90 galvanized steel 22 ga.

.4 The interior wall must be designed to support the structural loads of the cabinet.

.5 The structural base of the unit must be constructed with 14 gauge galvanized steel.

.6 The peripheral base must be equipped with lifting lugs.

.7 The access doors must be equipped with ¼ turns handles with integrated locks.

.8 The access doors must be equipped with 180° hinges.

.9 The cabinet must be constructed in a manner that there are no screw tips inside the unit.

.10 Every joint must be sealed with polyurethane based high strength elastomeric sealant that contains no solvents or isocyanates.

2.2 Fixed Plate Energy Recovery Core

.1 The energy recovery section must be of the fixed plate air-to-air type.

.2 The energy recovery fixed plated core must be made of a polymeric membrane to recover both sensible and latent heat. The core must use antimicrobial construction and materials.

.3 The fixed plate air-to-air Energy recovery core must be easily cleanable.

.4 The core efficiency must be rated as per AHRI-1060 and certified by AHRI.

2.3 Fans

.1 The supply and exhaust fans to be double inlet forward curve.

.2 The bearings must be sealed and permanently lubricated.

.3 The fans must be dynamically and statically balanced.

.4 The drive assembly must be with pulley and adjustable sheave mounted on an 11 gauge galvanized steel base.

.5 The performances of the fans must be tested as per AMCA-210 standard

2.4 Motors

.1 Motors must have an open enclosure, drip proof high efficiency (EPACT), inverter rated 10:1 with a service factor 1.15.

.2 The motors must be mounted on an adjustable base to adjust the fan belt bending and alignment.

.3 The fan drive must be by pulley and trapezoidal belt with a fixed pitch driving pulley and a fixed pitch driven pulley.

  .1 A variable pitch pulley may be supplied for balancing purposes, but a fixed pitch pulley is required post balancing.

.4 Motors must be Premium efficiency.

2.5 Filters

.1 Each air circuit must have 2 inches thick pleated and replaceable filters.

.2 Filters must be installed ahead the Energy recovery core in both air stream to protect the core against dust and airborne contaminant that may reduce its efficiency.

.3 Fresh air circuit filters must be MERV13 rated when tested as per ASHRAE 52.2 standard.

.4 Exhaust air circuit filters must be MERV13 rated when tested as per ASHRAE 52.2 standard.

2.6 Electrical Wiring

.1 The Unit Must Have A Single Point Power Connection.

.2 The Unit Must Be Equipped With A Non-Fused Disconnect NEMA 4.

2.7 Frost Control

.1 Defrost must be controlled with a temperature sensor.

.2 Exhaust only defrost cycles. On a temperature reference, the unit will stop the fresh air blower until the core is defrosted.

2.8 Unit Control

.1 The unit shall be provided with factory mounted and factory wired microprocessor control and sensors.

.2 The unit shall be able to be controlled by Dry contact.

.3 The controls shall be on low voltage 24VAC.

.4 Every component shall be properly protected against current overload.

.5 Each motor must have its own magnetic contactor and thermal overload.

2.9 Accessories

.1 Dirty filters contacts: Each set of filters in the unit must be equipped with an air pressure drop switch that closes when the filters are dirty.

.2 Motorized dampers: Motorized dampers on the fresh air exhaust air duct made of extruded aluminium insulated and activated with an actuator. Dampers must be low leakage and have integrated thermal breaks.

PART 3.0 EXECUTION

3.1 ASSEMBLY

.1 Isolate unit from ductwork with flexible duct connections.

.2 Install unit on vibration isolators.

.3 Provide fixed sheaves for final air balance.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

.1 Heating and cooling coils.

.2 Coil installation.

.3 Coil piping and accessories.

1.2 ALTERNATES

.1 Number of tube rows, air and water pressure drops, and such features as cleanability, drainability, same or opposite end connections, support and venting of approved manufacturer's coils shall be same as type specified.

1.3 QUALITY ASSURANCE

.1 Coils shall be the product of manufacturer regularly engaged in production of coils who issues complete catalogue data on such products.

1.4 SUBMITTALS

.1 Shop drawings showing capacities, components, accessories, and installation.

PART 2.0 PRODUCTS

2.1 GENERAL CONSTRUCTION

.1 Ratings to be certified by ARI and manufacturer. Submit with shop drawings actual fluid entering and leaving conditions for stated air side requirements.

.2 Unless otherwise shown, preheat coils shall be rated for 2.5 m/s (500 ft/sec) face velocity.

.3 Circuit heating coils for water side pressure differential of 15 kPa (5 ft.w.g.) maximum unless specified otherwise. Glycol velocity in coils shall not exceed 1.2 m/s (4 ft/sec). Under 0.6 m/s (2.0 ft/sec) turbulators may be used if that is standard practice of manufacturer.

.4 Cleanable tube coils shall have steel or cast iron headers and straight tubes.

.5 Plate fin coils to have tubes mechanically bonded to fins. Spiral wound fin coils to be soldered to tubes.

.6 All reheat coils and cooling coils to fitted with non-ferrous tubes and headers, with brazed assembly.

.7 Maximum tube length to be three metres unless specified otherwise.

.8 Coil casings to be die formed 1.6 mm thick galvanised sheet steel designed for slip fit into channel rails for ease of maintenance. Tube supports shall allow for expansion and contraction and be steel channel or double angle frames. Provide brass supports for copper coils. Provide blank off plates of similar material to prevent air bypass.

.9 Coils shall be factory tested with air under water.

2.2 GLYCOL HEATING COILS

.1 Design for maximum operating limits of 1400 kPa (200 psi) and 150°C (300°F).

.2 Provide cleanable tube coils with straight tubes, steel or cast iron headers and water boxes.

PART 3.0 EXECUTION

3.1 INSTALLATION

.1 Support coil sections on steel channel or double angle frames and secure to casings. Arrange supports for cooling coils so they do not pierce or short circuit drip pans. Level serpentine coils and install drainable or cleanable tube coils with pitch inside casings. Arrange galvanised steel casings for bolting to other section, ductwork or unit casings. Provide airtight seal between coil and duct or unit cabinets.

.2 Make necessary connections to coils, including valves, air vents, unions and connections from drip pans. Provide gate valve on supply line and balancing valve on return line to each glycol coil.

.3 Locate glycol supply at bottom of supply header and return connection at top to provide self-venting arrangement. Provide automatic air vents complete with stop valve at piping high points. Ensure coils are drainable and provide drain connection at piping low points.

.4 Protect coils so fins and flanges are not damaged. Replace loose and damaged fins. Comb out bent fins unless required to be replaced.

3.2 PERFORMANCE

.1 Where glycol is listed as the heating or cooling medium, it is to be 30% propylene glycol/water mix by volume.

- END OF SECTION -

PART 1.0 GENERAL

1.1 Work Included

.1 Steam-to-Steam Humidifier.

.2 Distribution manifold.

.3 Controls.

.4 Low pressure steam and condensate piping.

.5 Water and drain piping.

1.2 Quality Assurance

.1 Conform to requirements of CSA, ULC, Provincial and Municipal Codes.

.2 Units shall be product of Canadian manufacturer regularly engaged in production of such units who issues complete catalogue product data.

1.3 Submittals

.1 Manufacturer's shop drawings and product data showing dimensions, connections, arrangement, accessories and controls.

.2 Manufacturer's installation instructions.

.3 Manufacturer's literature, operating instructions and suggested spare parts list.

1.4 General Requirements

.1 Factory assemble units prior to shipment.

PART 2.0 PRODUCTS

2.1 Steam-to-Steam Humidifiers

.1 Provide wall (or floor, see schedules) mounted, factory assembled steam fired evaporation humidifier which directly injects steam into ducted air for humidification. Unit complete with items as noted below.

.2 Stainless Steel Construction: Vaporising chamber, cover and fittings shall be constructed of stainless steel with heli-arc welded seams.

.3 Quick Removal Cover: The cover shall be secured by quick removal threaded knobs. The gasket shall be held in place by flanges that are formed as part of the cover and as part of the evaporating chamber. These flanges shall interlock in such a way that the sealing gasket is locked between them.

.4 Cleanable Design: Vaporising chamber cover and/or front clean-out plate shall be easily removable for access to the vaporising chamber for removal of loose scale.

.5 Heat Exchanger (non-deionised water): constructed of stainless steel (tubes and headers) with welded joints and shall be Teflon coated to allow continuous shedding of scale, or constructed of a special scale shedding copper.

.6 Steam Valve: Valve shall be a normally closed modulating type with modified linear flow characteristics, stainless steel trim, and actuator. Valve shall be furnished by humidifier manufacturer.

.7 Steam Trap and Strainer: Humidifier shall be provided with a float and thermostatic trap and a steam supply line strainer.

.8 Electronic Water Level Control: System shall provide for automatic refill and skimmer bleed-off functions. System shall consist of:

   .1 A water level sensing unit comprised of three metallic probes screwed into a threaded probe head. Probe head shall incorporate probe isolation skirts to eliminate short circuiting between probes caused by mineral coating of probe head.

   .2 Probe head shall be mounted on the front of the vaporising chamber.

   .3 A solenoid operated fill valve shall be factory mounted on the front of the humidifier.

.9 Surface Skimmer: Surface skimmer shall be provided which is field adjustable to provide for optimum mineral removal with minimum water waste.

.10 Control Cabinet: Shall be UL/CSA Listed JIC enclosure. Control devices shall be mounted on a sub-panel within the enclosure. Control devices shall include electronic water level control, control circuit transformer, numbered terminal strip, all internal wiring and electrical diagram.

.11 The cabinet will be shipped loose and all interconnecting wiring between cabinet and humidifier shall be installed and connected on site.

.12 Microprocessor Control System: Shall be factory mounted and wired in the humidifier control panel with humidity sensors to be shipped loose for field installation. Mounting instructions and a wiring diagram shall be included and provide the following features and functions:

.1 Water make-up valve control and low water safety shutdown.

.2 Auto drain/flush sequence whereby microprocessor accumulates actual humidifying “ON” time, and activates auto drain/flush sequence.

.3 End of season drain function which activates when there has been no demand for humidification over a 72 hour period.

.4 Alphanumeric digital display.

.5 Keypad.

.13 Modulating Electronic Control Valve: Valve shall be a normally closed modulating type with an electronic actuator.

.14 Air Flow Proving Switch Vane Type: A vane operated “sail switch” shall be provided for field installation.

.15 VAV Control Package: Two modulating electronic humidity (one space mounted the other duct mounted downstream of the humidifier). Both shall transmit to the Microprocessor Control System, modulating humidifier output and maintaining the highest desired space humidity possible, at all air flow volumes, without saturation of the air stream.

.16 Factory Insulation: Humidifier shall be covered with 3/4" thick, rigid, foil faced fibreglass insulation. Insulation shall be covered with reinforced aluminium foil. All surfaces except front face panel shall be covered.

.17 Support Legs: Four support legs, of length to provide 24" between underside of humidifier and floor, shall be provided.

.18 Dispersion Tube System: Furnish and install where indicated and of component sizes noted on the drawings. Tube bank shall consist of a horizontal header/separator and designated quantity of vertical dispersion tubes necessary to achieve the required steam capacity and absorption distance. Header/separator shall span the width of the duct, be constructed of stainless steel and be fitted with nipples for dispersion tube connections. The dispersion tubes shall extend the height of the duct and shall be fitted with two rows of tube-lets centred on the diametric line and spaced 40mm apart. These tube-lets shall be made of non-metallic material designed for steam temperatures. Each tube-let shall extend through the wall of and into the centre of the dispersion tube and incorporate a properly sized calibrated orifice.

.1 Maximum Dispersion Distance: 300mm unless specifically noted otherwise.

PART 3.0 EXECUTION

3.1 Installation

.1 Provide galvanised steel rods to support distribution manifolds in air system plenums.

.2 Mount humidifiers securely on wall (for wall mount) or floor for floor mount.

.3 Install steam distributors in duct work or air handling unit where shown with sufficient length of insulated copper steam pipe and condensate pipe as per manufacturer's recommendations. Connect water supply piping with external service shut off valve and pipe drain line to floor drain. Provide access door to allow servicing of steam distributors.

- END OF SECTION -

PART 1.0 GENERAL

1.1 Scope

.1 Complete and fully operational system of full DDC automatic controls, including all materials and labour.

1.2 Work by Other Trades

.1 Division 26 (Electrical Sub-Trade) shall provide all wiring above 120V.

.2 Division 23 Sub-trade shall install thermal wells, control valves and devices on piping, furnished by Division 25.

.3 Division 25 contractor is to provide all 120v and lower control wiring unless specifically noted otherwise in Division 16. This includes wiring from breaker panels to Control Panels, SCU's and Central Computer Equipment.

.4 Unless noted otherwise in contract documents, control dampers integral with the air handling units are supplied by air handling unit manufacturer. Damper operators are supplied by Division 25 and installed by the air handling unit manufacturer at the factory. All other control dampers are supplied by Division 25.

.5 Refer to Points Schedule for supply, rough-in, and install Contractor or Vendor.

.6 Fully co-operate with other trades for compatibility and installation location of all devices.

1.3 Abbreviations

.1 BMS Building Automation System

.2 OIU Operator Interface Units

.3 SCU Standalone Control Unit

.4 CCU Central Computer Unit

1.4 Codes and Standards

.1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, and latest CSA Electrical Bulletins.

1.5 Quality Assurance

.1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, and latest CSA Electrical Bulletins.

.2 The equipment manufacturer shall have trained service representatives resident in the Province where project is located.

.3 The following components shall be stocked locally:

- .1 Replacement SCU and internal components
- .2 Replacement IP's
- .3 Replacement Sensors and Actuators

1.6 Submittals

.1 Submit shop drawings in accordance with Section 23 00 00.

.2 Shop drawings are to include a detailed description of the Building Management System (BMS) and its components, both hardware and software. At a minimum the following is required:

- .1 A block diagram of the BMS showing overall configuration and identifying all major components;
- .2 A list, along with technical data of every hardware component to be provided, including Stand alone panels, interface devices, communications devices, sensors, relays, transducers, etc.
- .3 A detailed description of the operating system and Operator Control Language (OCL) software, and a list of description of all alarm, reporting, and trending routines, and other application software to be supplied.
- .4 Operational data (i.e. set-points, calibration, etc.)

.5 System drawings, including network diagram specific to this installation.

.6 Wiring diagrams specific to this installation.

.7 Detailed operational description of sequences.

.8 Trend logs.

.9 Systems Graphics.

.3 Submit approved shop drawings to mechanical contractor for inclusion in operations and maintenance manuals.

1.7 Owner Orientation

.1 Contractor to provide three weeks written notice to the Engineer and building Owner prior to commencing formal training sessions.

.2 Formal training sessions shall commence only after "record" drawings have been completed, reviewed and approved by the Engineer and shall be in addition to 15010 requirements.

.3 Provide for operator training according to the following schedule.

.1 A one day seminar/workshop covering all aspects of system use as follows:

.1 operation of hardware components

.2 system software configuration

.3 user/system interaction

.4 calibration of sensors and system

.5 trouble shooting of system and components

.6 preventative maintenance

.2 A review workshop at one month after system acceptance.

.3 A seminar after six months of operation for clarification of system operating techniques for building operators.

.4 Allow for one (1) additional one day training seminars, in addition to the above seminars, within the first year of operation. These seminars are to be scheduled at owner selected dates and times.

.5 Controls contractor to provide three complete sets of training manuals to the Owner prior to commencing of the training session, plus one manual to the Engineer.

1.8 Warranty

.1 The warranty provisions shall commence for one year from the date of final acceptance and shall include at no cost all material and labour required to correct control system equipment failures that occur during the one year period.

.2 In addition to warranty call backs provide four service and calibration inspections; allow a minimum duration of 8 hours each. These calls will be initiated by the Owner.

.3 The contractor shall supply and install at no cost all system software and hardware updates and upgrades occurring prior to the expiration of the warranty period.

1.9 System Activation

.1 Submit control calibration check sheet prior to system acceptance. Check sheets to include unit identification, controller/transmitter tag numbers, device controlled, controller PID settings, interlock devices and wire tag numbers.

.2 Set damper linkages, static pressure/volume controls as required by the Balancing Trade.

.3 Adjust and calibrate all room thermostats 30 days prior to system acceptance.

1.10 Acceptance Testing

.1 A final operational acceptance test of seven consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the specifications.

.2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialised control programs and algorithms, diagnostics and all other software.

.3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven failure-free consecutive test days have occurred.

.4 After successful completion of the acceptance test, the Engineer will issue written acceptance of the control system.

.5 Prior to acceptance of the work, submit hard copy and electronic copy on diskette of final data base listings.

1.11 Record Drawings

.1 Before the certification of substantial performance will be issued the contractor must provide the Engineer with as-built drawings as follows:

  .1 One set of full size drawings indicating all site changes in detail and stamped "RECORD DRAWINGS".

  .2 In addition to the hard copy, record drawings are to be provided in PDF format for insertion into the electronic maintenance manual.

.2 Maintain as-built data on the data gathering and automatic control equipment schedule and panel schedules.

PART 2.0 PRODUCTS

2.1 Control Panels

.1 Provide control panel of unitised cabinet type construction. Mount relays, switches and control point adjustment in cabinet and pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face

.2 Fabricate panels from 12 gauge rolled sheet metal sheet with baked enamel finish, flush fitting, gasketted doors hung on piano type hinges and three point latches and locking handles. CSA approved for line voltage applications.

.3 Mount panels on vibration free wall or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.

.4 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.

.5 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 volt supply.

.6 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.

.7 Identify all wiring by means of stamped markings on heat shrinkable tubing. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.

.8 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.

.9 Install "Hand-Off-Auto" selector switches such that safety controls and electrical over current protection are not overridden when selector switch is in the "Hand" position.

2.2 Wire

.1 Control wiring for digital functions shall be 18 AWG minimum with 300 Volt insulation.

.2 Control wiring for analogue functions shall be 18 AWG minimum with 300 Volts insulation, twisted and shielded, 2 or 3 wire to match analogue function hardware.

.3 Sensor wiring shall be 18 AWG minimum twisted and shielded, 2 or 3 wire to match analogue function hardware or 16 AWG as required by code.

.4 Transformer current wiring shall be 16 AWG minimum.

.5 For other wiring conform to electric specification and drawing requirements.

2.3 Conduits and Cables

.1 All exposed wiring shall be in conduit or trays.

.1 Conform to Electrical specification and drawing requirements for conduit and tray specifications.

.2 Seal conduit where such conduit leaves heated areas and enters unheated area.

.3 Run low level signal lines in separate conduit from high level signal and power transmission lines.

.2 Wiring running in ceiling spaces may run exposed in trays, or can be installed tied using non-stressed ties and tied neatly to building elements. Wiring laying on top of ceilings is not acceptable.

.3 Identify each cable and wire at every termination point.

.4 Where applicable, mount field interface equipment (i.e. relays, transducers, etc.) in local device cabinets adjacent to field interface panels.

.5 Colour code all conductors and conduits by permanently applied colour bands.

.1 Use orange jacketted main bus wiring.

2.4 Identification

.1 Provide the SCU cabinets with nameplates or nameplate tag as follows:

.1 Permanently attached to the component

.2 Black and white lamacoid plastic with 1/4" bold lettering

.2 Provide and install plastic credit card type nameplates for all discrete items of equipment supplied including:

.1 sensors

.2 transmitters

.3 output devices

.4 status points

.3 Provide self-adhesive lamacoid labels, white letters on red background stating:

WARNING
This Equipment Operates Under Computer Control and May Start At Any Time.
Phone For Instructions Before Operating.

.1 Attach these labels to operating equipment under computer control as directed by Engineer.

.2 Submit sample for approval by Engineer.

2.5 Related Accessories

.1 Provide and install all necessary transducers, interposing relays, interface devices, contractors, and starters to perform control functions required.

.2 It is the responsibility of the Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

.3 Items required but not identified at the time of tender acceptance shall be the Contractor's responsibility.

2.6 Freeze stats

.1 Safety low limit protection thermostats (freeze-stats) shall be manual reset type with 450mm elements. Provide multiple thermostats for large duct cross-sectional areas. (Mount thermostats on the outside of the ductwork and no higher than 1500mm above the floor). Provide DPDT contacts for connection to SCU.

.2 Remote bulb elements shall be either averaging type of suitable length for air or rigid bulb type for liquids.

2.7 Electric Thermostats

.1 Electric room thermostats shall be low profile type with heavy duty metal covers with set-point adjustment, and tamperproof guard.

2.8 Electronic Rooms Temperature Sensors (Thermostats)

.1 The sensor may be either RTD or thermistor type providing the following minimum performance requirements are met:

.1	Accuracy	±2°C
.2	Operating Range	1°C to 45°C
.3	Set-point Adjustment Range	1°C to 29°C
.4	Set-point Modes	Heating, Cooling, Night Setback
.5	Calibration Adjustments	None required

.2 Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller.

.3 Each room sensor shall also include the following auxiliary devices:

.1 Set-point adjustment dial

.2 Temperature indicator

.3 Override Switch

.4 The set-point adjustment dial shall allow for modification of the temperature by the occupant.

.5 The temperature indicator shall be a bi-metal or mercury thermometer and shall be visible without removing the sensor cover.

.6 An override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant.

.7 The set-point adjustment and night setback override switch may be locked out, overridden or limited through software, at the BMS central terminal, or portable operators terminal.

.8 Provide tamper proof thermostat guards for all areas except private offices. Temperature indication would be visible through the guard, but a key would be required to access temperature adjustment.

2.9 Electronic Relative Humidity Sensors

.1 Bulk polymer sensing element, for wall or duct installation as required. Provide space humidity sensors complete with temper proof covers.

.1	Accuracy	±2%, 20 to 95% RH including hysteresis, linearity and repeatability
.2	Operating Range	5-90% RH
.3	Operating Temperature	-1°C to 54°C
.4	Temperature Effect	Less than 0.06% per °C
.5	Output Signal	4-20 mAdc, 0-100% linear, proportional
.6	Voltage Requirement	12 to 36 Vdc

2.10 Terminal Box Controller (TBC)

.1 Each TBC shall operate as a Stand alone controller, independent of other controllers in the network. Each TBC shall be a microprocessor based, multi-tasking real-time digital control processor.

.2 Each TBC shall be able to interface with the BMS.

.3 Features:

.1 PID control

.2 Unique control algorithm for the application

.3 Diagnostics through portable operator's terminal at the room sensor, TBC, or SCU

.4 Return from power failure without operator intervention

.5 No calibration requirements

.6 No battery backup requirements to store set-points and control parameters

.4 The TBC shall be powered from a 24 VAC source and shall function normally under an operating range of 18 to 28 VAC (-25% to +17%), allowing for power source fluctuations and voltage drops. The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range. The controllers shall also function normally under ambient conditions of 0°C to 50°C and 10% to 95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

.5 The TBC shall interface with a matching room temperature sensor. The controller shall function to maintain space temperature to within 1°C of set-point at the room sensor location.

2.11 Thermowells

.1 Provide brass wells for chilled and heating water applications.

.2 Provide stainless steel wells for domestic water, and all other liquid applications.

2.12 Dampers

.1 Automatic dampers shall be extruded aluminium multiple blade mounted in extruded aluminium flanged frame. Individual blades shall not exceed 150mm in width or 1200mm in length. Provide interlocking edges and compressible seals. Provide oil impregnated bronze or nylon bearings with additional thrust bearings for vertical blades. Damper configuration to be as shown on drawings.

.2 Mixing dampers of parallel blade construction arranged to mix streams. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor. Dampers shall have less than 1/2% leakage based on 600m/s at 100 Pa (2000 fps at 4" w.g.).

.3 Dampers to be Tamco Series 9000-BF (thermally insulate damper with thermally broken frames) when on an outside wall or Tamco Series 1000 when not on an outside wall.

2.13 Damper Operators

.1 Electronic Damper Operators : Spring return, 24 VAC operating voltage, 0-10 Vdc input signal, 0-10 Vdc position output signal, 70 seconds max. running time for 90° opening and 30 seconds max. closing time.

.2 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one damper operator per damper section.

2.14 Control Valves

.1 Two-way and three-way valves for liquids: Two-way valves shall have equal percentage characteristics and three-way valves shall have linear characteristics. Size two-way valve operators to close against maximum pump shut-off head. Ball valves as control valves are not acceptable.

.2 Size control valves as per following criteria:

- .1 Select control valves in equipment room to supply varying water temperature to the system at 24 kPa or less pressure drop.
- .2 Select two-way control valves for coils, heat exchanger, terminal units, etc., with a minimum pressure drop of 30 kPa and a maximum pressure drop of 60 kPa.
- .3 Select three-way control valves for coils, heat exchanger, terminal units etc., for pressure drop equal to three times the equipment pressure drop up to maximum 60 kPa.

.3 Valves shall "fail-safe", spring return to normal position.

.4 Provide valves complete with electronic operators.

.5 Two Way Valves for Terminal Reheat and Radiation

- .1 Globe valve, threaded ends, bronze body, stainless steel trim, 689 kPa rated, double O-ring packing.
- .2 Maintenance free, spring return electronic actuator, modulating, 24 Vac operating voltage, 0-10 Vdc position output signal. Manual adjustment knob with indication of stroke. 30 seconds running time, 8 seconds spring return. Fail open upon power outage.

.6 Two Way Valves for Air Handling Unit Coils

.1 1/2" to 2": Globe valve, threaded ends, bronze body, stainless steel trim, 1720 kPag rated.

.2 22" and up: Globe valve, flanged ends, cast iron body, bronze trim, 860 kPag rated.

.3 Spring return, electronic actuator, modulating, 24 Vac operating voltage, 0-10 Vdc input signal, 0-10 Vdc position output signal, 70 seconds running time, fail open for heating, and fail-closed for cooling.

.7 Three Way Valves

.1 1/2" to 2": Globe valve, threaded ends, bronze body, stainless steel trim, 1720 kPag rated.

.2 22" and up: Globe valve, flanged ends, cast iron body, bronze trim, 860 kPag rated.

.3 Spring return, electronic actuator, modulating, 24 Vac operating voltage, 0-10 Vdc input single, 0-10 Vdc position output signal, 70 seconds running time, fail open for heating, and fail-closed for cooling.

PART 3.0 EXECUTION

3.1 Installation

.1 Verify location of thermostats and other exposed control sensors with drawings before installation. Locate thermostats at same elevation as light switches.

.2 Install damper motors on outside of ducts. Do not locate in air stream, except for roof mounted equipment.

.3 Wire "hand/off/auto" selector switches such that automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.

.4 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.

.5 Install all safety limits at the operators level.

- END OF SECTION -

PART 1.0 GENERAL

1.1 SCOPE

.1 Smart Stand-Alone Control units provided for this facility are to be fully compatible with the existing facility DDC BMS system.

1.2 SYSTEM SPARES

.1 The system shall have an additional 10% of the total point types, at each SCU (Standalone Control Unit), provided and identified, as hardware spares in this Contract.

PART 2.0 PRODUCTS

2.1 LOCKS

.1 All cabinets shall have identical key and lock sets.

PART 3.0 EXECUTION

3.1 INSTALLATION

.1 Install all equipment, accessories, conduit, interconnecting wiring and piping in a neat manner using the latest standards of the industry.

.2 Perform installation with personnel having the relevant skill and experience.

.3 Install equipment stable and fixed to wall or floor. Provide anti-vibration mounts for the proper isolation of the equipment.

.4 Install equipment to allow for easy maintenance access such that it does not interfere with access to adjacent equipment and personnel traffic in the surrounding space.

- END OF SECTION -

PART 1.0 GENERAL

1.1 SCOPE

.1 No new operator interface devices are required for this project. Existing devices on facility DDC BMS system are to be configured to include all interface requirements for the new system.

- END OF SECTION -

PART 1.0 GENERAL

1.1 SCOPE

.1 Software Capabilities

PART 2.0 PRODUCTS

2.1 SOFTWARE FOR CCU

.1 Operating System and Utilities

.1 Latest version of Microsoft Windows 7 operating system complete with all available commands and functions.

.2 The application program and dynamic colour graphics software shall run in the Microsoft Windows environment. Programs that are Windows-like but not written for Microsoft Windows, will not be acceptable.

.2 Application Program

.1 Provide software to interface between mass storage device and SCU network, which will allow the following functions:

.1 Complete saving to disk, of all volatile information in control system, including database, user control programs, analog point loop information, operator access information, trends, and other setup information (Battery backed RAM is considered volatile for these purposes).

.2 Complete loading of all information specified above.

.3 Provide editing features which will allow editing of database, passwords, user control language programs, trends and their setups, logs and their setups and analog point loop parameters.

.2 Provide the capability in the system of accepting database and user control language programs created and edited via a software package running on Windows based PC.

.3 At the end of the warranty period, provide latest versions of software or firmware for:

.1 Operating System/Utilities

.2 Application Programs

.3 Dynamic Colour Graphics Software

.1 Dynamic colour graphics package which allows user to create, modify and delete graphics through use of a mouse and pull down windows or their equivalent.

.2 Graphics package shall provide:

.1 Owner creation of symbols which can be stored for future use.

.2 Control of symbol location of screen.

.3 Control of line drawing.

.4 Control of infill colour

.5 Control of alpha numeric texts and information windows.

.3 Multi-colour capability for dynamic graphic display.

.4 Mechanism for copying and editing graphics of similar layouts.

.5 Dynamic data display on each graphic which can, accommodate any combination of dynamic (analog or digital) information, graphic symbols and text, displayed at any location on the entire screen.

.6 Automatic update of dynamic data and provide user-defined update internals down to one second.

.7 Manual or automatic display of graphics. Automatic display to occur as a result of user-definable:

.1 Alarm occurrence.

.2 Change of state.

.3 Specific time, day or date

.4 Provide a copy of all software (and associated manuals) used in the development of programming, graphics, etc., including:

.1 Operating system (Windows)

.2 Controls Operating Software

.3 Controls Development Software

.4 Controls Graphics (operating and development) software.

2.2 SOFTWARE

.1 Operator Access

.1 The OIU shall provide full system access to the networked SCU's through a split screen formatted, self-prompting, menu driven English language interface.

.2 The menu format shall consist of a main menu and as many sub-us as required to provide full system access and control.

.3 Each menu layer shall be capable of being security protected as defined under the operator access levels.

.4 After system sign on has been completed correctly with user ID and password at the access level the main menu shall automatically appear.

.5 The main menu shall direct the operator further into the system by selection of a menu item number and pressing the return key or using the highlight and return key.

.6 The operator shall be allowed to go backwards through the sub-menu's to the main menu by pressing the ESC key.

.7 From the main menu the operator shall be allowed to the level of access approval:

.1 Direct access any one single point.

.2 Access and modify all information related to a single SCU such as point definitions, control parameters, schedules and system programs.

.3 Set-up log capabilities to include analog and digital trend logs and tem entry/exit logs.

.1 Analog trend logging to be both graphic and hard copy with a minimum of 4 points being logged at one time. Operator to be allowed to set sample time, start/stop time and select 4 separately ranged sensors for logging at any given time.

.2 X, Y AXIS for graphics to automatically self-define on selection of sensor.

.3 Operator to be allowed to set start/stop time and date for digital logs.

.4 Operator to have the option of committing any trend log to a history file prior to it being over written.

.4 Determine the operating condition of all SCU's on the system.

.5 Define critical and non-critical alarms for the purpose of having critical alarms designated to the modem for remote annunciation.

.1 Alarm summaries to automatically print point descriptor, time of alarm, type of alarm, and value or status at alarm condition.

.2 Alarms shall show up on the bottom of the screen on all menu's and access levels.

.6 Set-up the operating system time and date, define access levels, system descriptors, auxiliary hardware (printer, modem, phone) phone numbers for modem access and menu formats.

.7 Return back to the user access level.

.8 Menu items having no requirement for a sub-menu on selection will automatically provide the information on the screen.

.9 All required operational changes such as modify, edit, delete, add, and save shall be available through the split screen format on each individual menu and sub-menu.

.2 Operator Access Levels

.1 Provide a minimum of four operator access levels to the system through the use of user-defined passwords.

.1 Level 0 - Normal operator functions such as log and display request, alarm acknowledgement.

.2 Level 1 -All level 0 functions plus analog limit changes, time schedules, point lockouts command functions, modifications or changes to point descriptors, user names, set-up of trend logs, defining of critical and non-critical alarms.

.3 Level 2 -All lower level functions plus access to add, modify or delete user defined parameter, modifications to calculations and access levels.

.4 Level 3 - All lower level functions plus master diagnostics and system access should previous three access levels be accidentally deleted. Level three access to be by the system installer only.

.3 Data Base Creation and Modification

.1 Provide software for data base creation and modification at the central computer and the terminal

.2 Provide the capability of creating non physical, virtual points which be manipulated in the same manner as analog output and digital output hardware points, and which can store 16 bit floating point mathematics.

.3 Allow for creation of 2 virtual points per hardware point available in the minimum SCU configuration.

.4 The user shall have the minimum data base manipulation capability using one mnemonic for each point in system, while on line, to edit any point, as follows:

.1 Add and delete points.

.2 Modify any point parameter.

.3 Change, point mnemonics.

.4 Change, add or delete engineering units.

.5 Change, add or delete points in start/stop sequences, trend logs, summaries, etc.

.6 Select analog alarm limits.

.7 Adjust analog alarm differentials.

.8 Select points for totalization.

.9 Adjust "change of value" reporting differentials.

.4 Point Control Loops

.1 Provide analog point control loops, resident in each SCU including three term, proportional, integral, derivative, (PID) control algorithm.

.2 Provide, in each control loop, the following control term "tuning constants" control loop parameters.

.1 Direct or reverse acting.

.2 Physical sensor zero and span calibration.

.3 Output value to control component.

.4 Default set point.

.5 Proportional gain.

.6 Integral gain.

.7 Derivative gain.

.8 Sampling time - variable from 1 to 60 seconds.

.9 Output low limit.

.10 Output high limit.

.11 Control loop basis.

.3 Provision shall exist for the modification of "tuning constants" by custom-control programs and/or operator while on-line through a terminal.

.5 User Control Language

.1 Provide a single user control language that permits free formatted equations, expressions and comments.

.1 Assembler-style languages or languages that are formatted by calling and linking of library routines are not acceptable.

.2 Language compiler shall have compiler error checking diagnostic features. Compiler shall prevent any un-executable expression from being compiled.

.2 The system shall allow the user to add, delete and modify the user control language, in any SCU on the network, at any terminal including from a remote location via modem.

.3 User control language shall be totally resident in SCU. Central computer shall not contain any portion of user control language.

.4 The control language shall allow the user to develop and program custom operational sequences, unique control algorithms, interactive point relationships, custom calculations and other relational and logical operators as listed.

.5 Any expression (line of software) shall be able to be composed of 10 mathematical and/or logical operators in any desired order and proportion. Expression shall allow 5 levels of parenthesis and have a minimum logical line length of 128 characters.

.6 Provide mixed mode mathematics (combined use of mathematic and logic operators).

.7 Provide for floating point calculations using following operators:

.1 Addition, Subtraction

.2 Multiplication, division

.3 Roots, exponentials

.4 Natural logarithms

.8 Provide following logical and relational operators in the control language.

.1 and, or, not, xor

.2 equal to, not equal to

.3 less than, greater than, between

.4 if - then, else

.9 Provide following functions (or subroutines) for inclusion in the user control software:

.1 Minimum value from a group of values.

.2 Maximum value from a group of values.

.3 Timers and delay timers, selectable in seconds, minutes, hours, days.

.10 Provide capability in the SCU to accept any of the system connected point values as valid real time inputs. Also provide capability in SCU to relate real time inputs to user-programmed input values for time of day, day of week, date, constants and previous calculation results.

.11 As a result of software calculations by processor, SCU shall activate system changes such as:

.1 On-off commands.

.2 Changing system set point and analog output values.

.3 Activating application programs.

.4 Enabling alarm functions.

.5 Defaulting analog control loops.

.6 Enabling/disabling trend logs.

.12 Provide for following types of operational sequences, control algorithms, point relationships and custom calculations:

.1 Calculate and download mixed air temperature set points to mixed air damper control loop.

.2 At calculation result of X or alarm condition of Y close dampers, start circulation pump.

.3 At a true result of a number of logical expressions, start motor one wait three minutes, start motor two.

.4 Calculate equipment output and energy consumption.

.5 Calculate differential temperature and degree days.

.6 Calculate metered energy costs.

.6 Monitoring Functions

.1 System Initiated:

.1 Alarm Processing and Reporting: Provide alarm processing and sorting to user-defined peripherals.

.2 Digital Alarms: Define which contact state is alarm state. Provide automatic disabling of alarm at shut down and adjustable time delay during start-up.

.3 Analog Alarms: Provide for each analog point user-definable high/low alarm limits which automatically adjust with change in set point. Provide automatic disabling of alarm at shut down and adjustable time delay during start-up.

.4 Critical vs. Non-Critical: Provide the capability for the user to differentiate between critical and non-critical alarms. Critical alarms shall acknowledged by user.

PART 3.0 EXECUTION

3.1 INSTALLATION

.1 Perform following functions with mass storage device:

.1 Acquire information from, process, and transfer information to the SCU's and system peripherals as required.

.2 Provide control system backup function by saving to mass storage, database, user control language programs and other required information.

3.2 GRAPHIC INSTALLATION

.1 Provide fully installed dynamic graphics for each system, including one screen per approximately 1500m² of floor plate for terminal units such as heat pumps, VAV boxes, one screen per air handling unit, one screen per VAV box, etc.

.2 The dynamic graphics will indicate all points as contained in the points list.

.3 The above noted graphic displays may be reorganized, to improve the system illustration.

- END OF SECTION -

PART 1.0 GENERAL

1.1 GENERAL

.1 This section specifies the Field Instrumentation, Sensing Devices and Actuators.

.2 For general requirements relating to all sections see Section 25 09 00.

PART 2.0 PRODUCTS

2.1 GENERAL

.1 Provide field instrumentation and sensing devices analogue or digital as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the SCU terminal strip that conform to the input requirements.

.2 Provide output devices and actuators which convert the digital or analogue output signal from the SCU to activate relays or open and close valves, dampers, etc.

.3 The end to end accuracy called for in Subsection 2.2 includes the combined effect of sensitivity, hysterisis, linearity and repeatability between the measured variable and the input to the analogue-to-digital converter in the SCU or between the SCU input to the digital-to-analogue converter and the controlled variable for the full sensing range.

.4 The letter under the "Type" column in Subsection 2.2 is the same used in the points list.

.5 Where manufacturers and model numbers are used, they are indicated as a standard of acceptance only. Other acceptable manufacturers of input/output devices are listed in Section 23 00 10.

2.2 ANALOG INPUT SENSORS

.1 Temperature

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct Mounted	TD	-46°C to 50°C	±0.4°C @ 21°C	Platinum or nickel element. Length to suit duct size. Standard of Acceptance: JCL TE6300 series
Pipe Well Mounted	TP	-46°C to 50°C	±0.4°C @ 21°C	Platinum or nickel element. c/w stainless or bronze thermal wells. Standard of Acceptance: JCL TE6300 series
Thermowell	TW	n/a	n/a	c/w stainless or bronze thermal wells. Standard of Acceptance: JCL WZ series
Duct Averaging	TDA	-46°C to 50°C	±1.7°C @ 21°C	Platinum or nickel element. Length to suite duct size. Standard of Acceptance: JCL TE6300 series
Space Temperature	TR	0°C to 55°C	±0.4°C @ 21°C	Platinum or nickel element. Single set point adjustment, push-button override. w/o temperature indicator. c/w tamper-proof cover where specified. Standard of Acceptance: JCL TE6400 series

Application	Type	Operating Range	End to End Accuracy	Remarks
Outside Air	TO	-46°C to 50°C	±0.4°C @ 21°C	Platinum or nickel element. c/w solar-shield Standard of Acceptance: JCL TE6300 series
Surface Temperature	TU	-18°C to 52°C	±1.0°C	Platinum or nickel element. Sensing element encased in epoxy filled, adhesive backed, aluminium mounting block. Standard of Acceptance: JCL TE6000-10

.2 Relative Humidity

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct Mounted	HD	5-95% RH non condensing 0°C to 60°C	±3% RH for 5-95% RH	Standard of Acceptance: JCL HE6310 series
Space	HR	5-95% RH non condensing 0°C to 55°C	±3% RH for 5-95% RH	c/w tamper-proof cover where specified. w/o set point adjustment or override push-button. Standard of Acceptance: JCL HE6400 series
Outside Air	HO	5-95% RH non condensing -40°C to 100°C	±3% RH for 5-95% RH	sensor mounted outside, transmitter mounted inside. Standard of Acceptance: Graystone RH300

Note : HD & HR sensors can be combined with TD and TR sensors into single unit where applicable.

.3 Pressure

Application	Type	Operating Range	End to End Accuracy	Remarks
Static-Water	PW	as required	±1% @ 21EC	Standard of Acceptance: JCL P99
Static-Air	PA	as required	±1%	differential pressure sensor with one leg open to ambient Standard of Acceptance: JCL DPT2640/2641

.4 Velocity Pressure

Application	Type	Operating Range	End to End Accuracy	Remarks
Velocity Pressure Monitoring Station – air - insertion Type	PVAi	as required Max pressure 35 kPa @ 10m/s -28 to 70°C 0 to 100% RH	±2% of actual flow for velocities over 100 fpm	Multi-point static & total pressure sensing element. Self-averaging manifold. Anodized aluminum element. Standard of Acceptance : Paragon FE-1000.
Velocity Pressure Monitoring Station – air – fan inlet airflow	PVAf	as required Max pressure 35 kPa @ 10m/s -28 to 70°C 0 to 100% RH	±2% of actual flow for velocities over 100 fpm	Not to be used where fan inlet cone is less than 300mm diameter. Multi-point static & total pressure sensing element. Self-averaging manifold.

Application	Type	Operating Range	End to End Accuracy	Remarks
				Anodized aluminum element. Standard of Acceptance : Paragon FE-1050.
Differential Pressure and Airflow Signal Processor	-	0 to 60°C 0 to 90% RH	±1% full scale	Provide on for each PVAi and each PVAf. Unit complete with 8 line display, network communication (to BMS system standard), and auto zero option. Standard of Acceptance : Honeywell P7640

.5 Electrical

Application	Type	Operating Range	End to End Accuracy	Remarks
Current Transformers	IE	As Required	±0.25% Full Scale	Veris

Note : Watt meters supplied and installed by Division 16 contractor, wired to BMS by Division 15960.

2.3 ANALOG OUTPUT DEVICES

Application	Type	Maximum Stroke Time	Remarks
Damper Motors	DM	120 seconds end-to-end (unless noted otherwise)	End switches and spring return where specified. Provide sufficient damper motors to achieve unrestricted movement with a minimum of one damper motor per section.

Application	Type	Maximum Stroke Time	Remarks
Valve Actuators	VM	90 seconds end-to-end (unless noted otherwise)	End switches and spring return where specified.

2.4 DIGITAL INPUT DEVICES

Application	**Type**	**Operating Range**	**Remarks**
Pressure Switch – Air	PS	As Required	Adjustable set-point & differential. Automatic reset. Standard of Acceptance: JCL P32 series
Differential Pressure Switch – Water	PDS	As Required	Adjustable set-point & differential. Automatic reset. Stainless steel bellows. Standard of Acceptance: JCL P74 series
Temperature Switch	TS	As Required	Adjustable set-point & differential Automatic reset Normal reset for freeze protection
Current Sensing Relays	IR	As Required	Adjustable trip c/w LED Status Indication Standard of Acceptance: Veris H708/900
Motor or Other Status Relays	MC C	As Required	Auxiliary Contacts on MCC
Damper or Valve End Switch	ESO ESC	As Required	Auxiliary Contacts O = Open C = Closed
Temperature (Freeze)	TZ	As Required	Auxiliary Contacts. Manual Reset. Standard of Acceptance: JCL A70 series
Flow Switch – Water	FS	As Required	Auxiliary Contacts Standard of Acceptance: JCL F61 series
Sail Switch - Air	FSA	As Required	Auxiliary contacts Standard of Acceptance: JCL F62 series

Application	Type	Operating Range	Remarks
Dry Contact	YX	N/A	Contactor to be provided by equipment vendor.

2.5 DIGITAL OUTPUT DEVICES

Application	Type	Operating Range	Remarks
Relays	YX	N/A	Double voltage DPDT plug-in type with terminal base contacts rated at 5 Amp 120 VAC
Damper Motors	DM	Maximum Stroke Time : 120 seconds end-to-end (unless noted otherwise)	End switches and spring return where specified. Provide sufficient damper motors to achieve unrestricted movement with a minimum of one damper motor per section.
Valve Actuator	VM	Maximum Stroke Time : 90 seconds end-to-end (unless noted otherwise)	End switches and spring return where specified.

2.6 OTHER (INPUTS & OUTPUTS, DIGITAL & ANALOG)

Application	Type	Remarks
Pseudo Point	PP	Pseudo (software) point
Variable Frequency Drive	VFD	Connect to appropriate terminal board in VFD.

PART 3.0 SIGNAL TRANSMISSION

3.1 GENERAL

.1 Provide a digital transmission network to communicate between all SCU's as required.

- END OF SECTION -

PART 1.0 GENERAL

1.1 SCOPE

.1 Supply and install fully operational variable frequency drives (VFDs) as specified herein.

.2 This section applies to all variable frequency drives except drives specified as, and packaged with, pumps.

1.2 CODES AND STANDARDS

.1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, and latest CSA Electrical Bulletins.

1.3 QUALITY ASSURANCE

.1 The equipment manufacturer shall have trained service representatives resident in the Province where project is located.

.2 To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.

.3 All optional features shall be functionally tested at the factory for proper operation.

1.4 WARRANTY

.1 The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labour, travel costs, and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

1.5 SUBMITTALS

.1 Submit shop drawings in accordance with Section 23 00 00.

.2 Submit manufacturer’s performance data including dimensional drawings, power circuit diagrams, warranty description, VFD's FLA rating, certification agency file numbers, and catalogue information.

.3 Harmonic filtering.

.1 The Contractor shall, with the aid of the electrical power single line diagram, perform an analysis to initially demonstrate the supplied equipment will met the IEEE standards after installation.

.2 If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid.

.3 A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC).

.4 The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

.4 Include in the Operations and Maintenance Manuals:

.1 Approved shop drawings.

.2 Provide a user's manual with the following:

.1 Preliminary checks

.2 Design and Operation

.3 Technical characteristics

.4 Installation

.5 Connections

.6 Recommendations for use of the motor/speed drive combination

.7 Initial setting up and maintenance

.3 Provide a trouble shooting guide with the following:

.1 Observation, fault code

.2 Possible causes

.3 Checks to be made

.4 Result

.5 Remedial action

.6 Comments

1.6 OWNER ORIENTATION

.1 Contractor to provide three weeks written notice to the Engineer and building Owner prior to commencing formal training sessions.

.2 Provide for a seminar/workshop for operator training covering all aspects of system use as follows:

.1 operation of hardware components

.2 system software configuration

.3 user/system interaction

.4 calibration of sensors and system

.5 trouble shooting of system and components

.6 preventive maintenance

PART 2.0 PRODUCTS

2.1 GENERAL

.1 Drives shall be fully compatible with supplied motors. See section 23 00 00 for motor specifications.

.2 Furnish complete VFDs as specified herein for the fans and pumps designated in the equipment schedules to be variable speed. Designation of either “VFD” or “VSD” indicates a variable frequency drive is required.

.1 Packaged pump VFDs are to be supplied by the pump manufacturer, along with pump logic controllers. Unless otherwise specified, VFD’s are to be factory pre-wired to pump logic controller and pumps.

.2 All other pump VFD's and all fan VFD's are to be supplied and installed by the mechanical sub-trade.

.3 All standard and optional features shall be included within the VFD enclosure, unless otherwise specified.

.1 VFD shall be housed in a metal NEMA 1 enclosure, or other NEMA type according to the installation and operating conditions at the job site.

.2 The VFD's UL listing shall allow mounting in plenum or other air handling compartments.

.3 If a NEMA 12 enclosure is required for the plenum rating, the manufacturer must supply a NEMA 12 rated VFD.

.4 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor de-rating.

.5 With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

.6 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

.7 The VFD and options shall be tested to ANSI/UL Standard 508 and be CSA or C-UL listed. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Assembly of the option panels by a third-party panel shop is not acceptable. The appropriate UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel. Both VFD and option panel shall be manufactured in ISO 9001 certified facilities.

.8 The VFD shall be CE marked, and conform to product standard EN 61800-3.

.9 The VFD shall have a dual 5% DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the drive from power line transients. The reactor shall be non-saturating (linear) to provide full harmonic filtering throughout the entire load range. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

.10 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

.11 The VFD shall be able to provide full torque at any selected frequency from 29 Hz to base speed to allow driving direct drive fans without de-rating.

.12 An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.

.13 Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.

.14 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.

.15 Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.

.16 VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.

.17 All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.

2.2 PROTECTIVE FEATURES

.1 A minimum of Class 20 I^2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.

.2 Provide protection against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, under-voltage, VFD over-temperature and motor over-temperature. The VFD shall display all faults in plain English. Codes are not acceptable.

.3 Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 164 V AC for 208/230 volt units, 313 V AC for 460 volt units, and 394 volts for 600 volts units.

.4 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.

.5 VFD package shall include semi-conductor rated input fuses to protect power components.

.6 To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise the VFD manufacturer must ensure that inverter rated motors are supplied and installed.

.7 VFD shall include a “signal loss detection” circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.

.8 VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.

.9 VFD shall catch a rotating motor operating forward or reverse up to full speed.

.10 VFD shall be rated for 100,000 amp interrupting capacity (AIC).

.11 VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

.12 VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt units, 539 V AC on 460 volt units, and 690 volts on 600 volt units.

2.3 INTERFACE FEATURES

.1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.

.2 The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.

.3 The VFD shall provide digital manual speed control. Potentiometers are not acceptable.

.4 Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.

.5 The keypads for all sizes of VFDs shall be identical and interchangeable.

.6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.

.7 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

.8 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.

.9 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to a Johnson Controls N2 Metasys, Siemens FLN or Modbus RTU system at no additional cost to the owner. The use of gateways is not acceptable. The connection shall be software selectable by the user.

.10 As a minimum, the following points shall be controlled and/or accessible:

.1 VFD Start/Stop

.2 Speed reference

.3 Fault diagnostics

.4 Meter points:

.1 Motor power in HP

.2 Motor power in kW

.3 Motor kW-hr

.4 Motor current

.5 Motor voltage

.6 Hours run

.7 Feedback signal #1

.8 Feedback signal #2

.9 DC link voltage

.10 Thermal load on motor

.11 Thermal load on VFD

.12 Heat sink temperature

.11 Four additional Form C 230 volt programmable relays shall be available for factory or field installation within the VFD.

.12 A communications protocol boards shall be provided compatible with the DDC BMS system.

.13 Two set-point control interface (PID control) shall be standard in the unit. VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.

.14 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

.15 Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.

.16 Sleep mode shall be provided to automatically stop the VFD when its speed drops below set “sleep” level for a specified time. The VFD shall automatically restart when the speed command exceeds the set “wake” level.

.17 The sleep mode shall be functional in both follower mode and PID mode.

.18 Run permissive circuit shall be provided to accept a “system ready” signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.

.19 The following displays shall be accessible from the control panel in actual units:

.1 Reference Signal Value in actual units

.2 Output Frequency in Hz or percent

.3 Output Amps

.4 Motor HP

.5 Motor kW

.6 kWh

.7 Output Voltage

.8 DC Bus Voltage

.9 VFD Temperature in degrees

.10 Motor Speed in engineering units per application (in GPM, LPS, CFM, etc.)

.1 VFD will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.

.20 The display shall be programmed to read in Pascals (Pa) for an air handler application, Kilo-Pascals (kPa) for a pump application, and temperature (°C) for a cooling tower application.

.21 VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.

.22 If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.

.23 The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses. At low loads or low ambients the fans may be off even when the drive is running.

.24 The VFD shall store in memory the last 10 faults and related operational data.

.25 Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

.26 Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.

.27 Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.

.28 Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24 V DC status indication.

.29 Standard programmable firefighter's override mode allows a digital input to control the drive and override all other local or remote commands and ignoring most normal drive safety circuits.

.1 If equipped with bypass, the VFD may be programmed to switch to bypass immediately or only if the drive fails. The VFD's keypad shall display FIREMODE whenever in firefighter's override mode, even when running in bypass.

.30 A real-time clock shall be available, mounted in the drive, displaying through the keypad. The clock shall not require a battery, eliminating the need for battery replacement. Twenty programmable time periods, with individually selectable ON and OFF functions shall be available. All drive faults shall be time stamped to aid troubleshooting.

2.4 ADJUSTMENTS

.1 The VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.

.2 Sixteen preset speeds shall be provided.

.3 Four acceleration and four deceleration ramps shall be provided. Acceleration and deceleration time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.

.4 Four current limit settings shall be provided.

.5 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset:

.1 Under-voltage

.2 Overvoltage

.3 current limit

.4 inverter overload

.6 The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

.7 An automatic "on delay" may be selected from 0 to 120 seconds.

2.5 BYPASS

.1 Provide an optional, manual 3-contactor bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors.

.1 In the DRIVE position, the motor is operated at an adjustable speed from the VFD.

.2 In the OFF position, the motor and VFD are disconnected.

.3 In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the VFD so that service can be performed.

.4 In the TEST position, the motor is operated at full speed from the AC line power while power is applied to the input of the VFD. This allows the VFD to be given an operational test while continuing to run the motor at full speed in bypass.

.5 In case of an external safety fault, a normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode.

.2 Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power. This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.

2.6 OTHER

.1 Elevation to 3,300 feet without de-rating.

.2 AC line voltage variation, -10 to +10% of nominal with full output.

.3 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

2.7 SPECIAL FEATURES

.1 The following special features shall be included in the VFD enclosure, and shall not effect the CSA rating of the drive:

.1 A manual bypass shall provide all the circuitry necessary to transfer the motor from the VFD to the power line, or from the line to the controller. The bypass circuitry shall be mounted in a separate section of the VFD enclosure. Motor overload protection shall be provided in both drive and bypass modes.

.2 A door interlocked, pad lockable drive disconnect switch shall be provided to disconnect power from the VFD only.

.3 A second fused disconnect switch or circuit breaker shall be provided as a means of disconnecting all power to both the VFD and bypass circuits, as well as providing short circuit and locked rotor protection to the motor while in the bypass mode.

.4 The disconnect and bypass functions may be accomplished via disconnects, capacitors, and overloads, or with a four position DRIVE/OFF/LINE/TEST switch with motor starter and bypass fuses.

.2 Line Reactors:

.1 All VFDs to include input line reactors.

.2 All VFDs to include output load reactors.

PART 3.0 EXECUTION

3.1 INSTALLATION

.1 Coordinate with all trades for proper installation and operation of the Variable Frequency Drive.

.2 Coordinate with the Division 25 09 00 Contractor for proper controls and interlocks with the Variable Frequency Drive.

.3 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation.

.1 The VFD shall not be operated while the unit is covered.

.4 The Contractor to verify that job site conditions for installation meet factory recommended and code required conditions for VFD installation prior to start-up. These shall include, but are not limited to:

.1 Clearance spacing.

.2 Temperature, contamination, dust, and moisture of the environment.

.3 Separate conduit installation of the motor wiring, power wiring, and control wiring.

.4 Installation per the manufacturer's recommendations.

.5 The ground bus shall be connected to the building ground system by the electrical sub-trade.

3.2 START-UP SERVICE

.1 The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.

.2 Start-up services shall include checking for verification of proper operation and installation of the VFD, its options, and its interface wiring to the building automation system. This service shall include, but is not limited to:

.1 Verification of wire terminations to the VFD and associated devices.

.2 Installation verification for proper operation and reliability of the VFD, the motor being driven, and the building automation system.

.3 Up to one hour of customer operator training on operation and service diagnostics.

.4 Measurement for verification of proper operation on each of the following items:

.1 Motor voltage and frequency. Verification of proper motor operation.

.2 Control input for proper building automation system interface and control calibration.

.3 Calibration check, and adjustments as necessary, for the following set points:

.1 Minimum speed.

.2 Maximum speed.

.3 Acceleration and deceleration rates.

- END OF SECTION -

PART 1.0 GENERAL

1.1 GENERAL

.1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 The relationships between the points, systems and building are described in the control sequences.

.3 Consult with the Consultant during the shop drawing stage to finalize the control sequences for each system.

.4 All set-points noted herein are to be operator adjustable.

.5 The Division 25 09 00 Contractor is responsible to ensure all equipment tie-in points are provided by the equipment manufacturers.

PART 2.0 PRODUCTS

2.1 Not Applicable

PART 3.0 EXECUTION

3.1 Provide data base for all hardware points listed for system operation to meet specification operating sequences.

3.2 Where future provision for future points is noted, provide for connection of hardware to panels such that no additional hardware interface devices will be required within the panels. Software, including set-up and programming sequences, need not be provided at this time.

PART 4.0 CONTROL SEQUENCES AND POINTS LISTS

4.1 UNIT HEATERS AND FORCE FLOWS

.1 The wall mounted electric thermostat complete with tamper-proof cover shall cycle the fan motor on a drop in space temperature.

.2 No connections to the BMS are required from any unit heater or force flow.

4.2 BASEBOARD RADIATION AND RADIANT PANELS

.1 Thermostat shall modulate two-way normally open heating control valve. Valves shall be of the fail-last-position type.

.2 Where baseboard radiation and radiant panels are associated with VAV boxes, the reheat valves shall be sequenced with the variable volume terminal units.

.3 Points List : The following points, as a minimum, shall be provided associated with each section of baseboard radiation or radiant panel. Each point shall also be shown on an individual system graphic.

.1	Room temperature sensor reading	AI
.2	Room temperature set-point	PP
.3	Valve set-point	AO

4.3 REHEAT COILS

.1 Thermostat shall modulate two-way normally open heating control valve. Valves shall be of the fail-last-position type.

.2 Where reheat coils are associated with VAV boxes, the reheat valves shall be sequenced with the variable volume terminal units.

.3 Reheat Coil Points List : The following points, as a minimum, shall be provided associated with each non-VAV box associated reheat coil. Each point shall also be shown on an individual reheat coil system graphic.

.1	Room temperature sensor reading	AI
.2	Room temperature set-point	PP
.3	Reheat valve set-point	AO

4.4 HEATING SYSTEM

.1 All heating system controls are to be on the emergency power system.

.2 Heat Exchangers HX-1 and HX-2

.1 HX-1 and HX-2 are to operate in sequence to provide heating to the building hydronic heating system.

.2 Lead/lag the pumps on 100 operating hour intervals (operator adjustable).

.3 On a call for heating:

.1 The lead heat exchanger small control valve shall modulate open to meet the hot water (glycol) supply water temperature set-point.

.2 If the above valve fails to meet satisfy the set-point temperature, the lag heat exchanger small control valve shall modulate open to meet the hot water supply water temperature set-point.

.3 If the above valve fails to meet satisfy the set-point temperature, the lead heat exchanger large control valve shall modulate open to meet the hot water supply water temperature set-point.

.4 If the above valve fails to meet satisfy the set-point temperature, the lag heat exchanger large control valve shall modulate open to meet the hot water supply water temperature set-point.

.4 Supply water temperature to building heating loop is reset as follows:

Outdoor Air Temperature	Hot Water Supply Temperature
-25°C or less	95°C
-25°C to 10°C	Ramp from 95°C to 60°C
10°C and Higher	60°C

.3 Heating Pumps P-1A and P-1B

.1 P-1A and P-1B are 100% capacity each and are normally activated via the building automation system and a lead/lag algorithm.

.2 When outdoor temperature drops below 18°C, one pump shall start.

.3 Lead/lag the pumps on 100 operating hour intervals (operator adjustable).

.4 If the lead pump fails to start, the lag pump shall start, and an alarm shall be initiated at the OWS.

.5 The pump speed shall modulate via the variable frequency drive to maintain the system pressure set-point.

.1 The system pressure set-point shall be determined during the commissioning of the DDC BMS system.

.4 Condensate Return Tank CR-1

.1 The condensate return tank has an integral control package, and does not need to be controlled by the BMS system.

.2 Tie control points for monitoring back to the BMS as noted below.

.5 Heating System Points List : The following points, as a minimum, shall be provided associated with the heating system. Each point shall also be shown on the heating system BMS system graphic.

.1 High Pressure Steam Pressure upstream of reducing station — AI

.2 Low Pressure Steam Pressure downstream of reducing station — AI

.3 Low Pressure Steam Pressure in penthouse upstream of heat exchanger control valves — AI

.4 Low Pressure Steam Pressure in penthouse upstream of HX-1 — AI

.5 Supply Water Temperature HX-1 — AI

.6	Return Water Temperature HX-1	AI
.7	HX-1 condensate return temperature (alarm on temperature below 10°C and either HX-1 valves are open)	AI
.8	HX-1 small valve position	AO
.9	HX-1 large valve position	AO
.10	Low Pressure Steam Pressure in penthouse upstream of HX-2	AI
.11	Supply Water Temperature HX-2	AI
.12	Return Water Temperature HX-2	AI
.13	HX-2 condensate return temperature (alarm on temperature below 10°C and either HX-1 valves are open)	AI
.14	HX-2 small valve position	AO
.15	HX-2 large valve position	AO
.16	Supply Water Temperature Set-Point	PP
.17	Pump P-1A start/stop	DO
.18	Pump P-1A status	DI
.19	Pump P-1A flow	from pump VFD
.20	Pump P-1A upstream pressure	from pump VFD
.21	Pump P-1A downstream pressure	from pump VFD
.22	Pump P-1B start/stop	DO
.23	Pump P-1B status	DI
.24	Pump P-1B flow	from pump VFD
.25	Pump P-1B upstream pressure	from pump VFD
.26	Pump P-1B downstream pressure	from pump VFD

.27	Supply water temperature at P-1A/P-1B	AI
.28	Return water temperature from HC-1 downstream of 3-way valve return water connection	AI
.29	Return water temperature from main heating loop (radiant panels and heating coils)	AI
.30	Return water temperature (common)	AI
.31	ET-1 pressure	AI
.32	Glycol fill tank low level alarm	DI
.33	CR-1 pump 1 operating	
.34	CR-1 pump 2 operating	
.35	CR-1 high level alarm.	

4.5 AIR HANDLING UNITS AHU-1 and ENERGY RECOVERY VENTILATOR

.1 Day/Night Modes

.1 The system will provide day/night temperature set-point capability for each zone, with manual override at zone level.

.2 System Start/Stop

.1 The air handling units will normally be energized via the BMS.

.2 The supply air isolation dampers shall be opened first.

.3 Once the end switches have proven open, the return fan shall be energized.

.4 After a 30 second time delay, the mix air dampers shall be energized and opened to their minimum position.

.5 This will be followed by supply fan energization.

.6 On system shut-down, after both supply fan and return fan are de-energized, and after a suitable time delay, the supply air isolation dampers shall be de-energized.

.3 Minimum Outdoor Damper Quantity

.1 Minimum outdoor air quantity is to be initially set to 20% of maximum AHU-1 supply air quantity.

.2 The value calculated above, in Litres per Second, is to be the minimum outdoor air quantity throughout the volumetric range of the air handling unit.

.1 The outdoor air quantity shall be calculated as the air volume through the outdoor air dampers plus the air volume supplied by the ERV.

.3 If the supply air temperature drops below 9°C, modulate the outdoor air dampers closed to maintain a 9°C supply air temperature set-point and send an alarm to the BMS head end indicating “LOW OUTDOOR AIR VOLUME DUE TO LOW SUPPLY AIR TEMPERATURE”.

.4 Freeze Stats

.1 Provide averaging type freeze stat. Upon sensing a low temperature, the supply fan shall stop, and all outdoor and exhaust air dampers shall close. The return fan shall remain energized. The freeze stat must be reset manually.

.5 Mixed Air Economizer Control

.1 Mix air dampers position shall be optimized by computing the enthalpy of outdoor air and return air.

.6 Purge and Warm-Up modes

.1 Purge and warm-up mode shall be energized 60 minutes before normal occupancy on occupied week-days.

.2 Cooling Purge Mode

.1 If the temperature detected at more than five VAV box thermostats exceeds 24°C (operator adjustable), the air handling unit will be placed on a building purge mode.

.1 Set mix air set point at 5°C

.2 Set supply air temperature set-point at 18°C

.3 De-energize cooling coil

.4 Allow all variable air volume boxes to full open position

.5 Energize all washroom and general exhaust fans

.3 Morning Warm-Up Mode

.1 If the temperature detected at more than five VAV box thermostats is less than 21°C (operator adjustable), the air handling unit will be placed on a building warm-up mode.

.2 In this mode, system will operate at 100% recirculation, air handling unit burners will modulate to maintain a supply temperature of 21°C. All variable air volume boxes will be allowed to open fully. Radiation valves and reheat coil valves will modulate open to maintain space temperature set point.

.7 Variable Air Flow Volume Control

.1 High static pressure sensors shall be provided in medium pressure duct supply mains, and when activated shall control the maximum air volume of the supply fans through the supply fan variable frequency drive controller.

.1 Duct static pressure sensors shall be located as follows:

.1 Basement, east end duct main by basement classroom.

.2 The supply fan speed shall be controlled to maintain a minimum constant static pressure set point at any one of the remote supply duct location.

.2 The return fan shall be modulated to maintain a constant air flow differential between the supply fan airflow and the air being exhausted/relieved from the building.

.1 The supply air flow shall be as measured at the supply air flow air monitoring pressure transducer.

.2 The air being exhausted/relieved from the building shall be the sum of:

.1 The air flow measured at the ERV exhaust air flow air monitoring pressure transducer; plus,

.2 The difference between the air flow measured at the return air fan air monitoring pressure transducer and the air flow measured at the recirculation air flow monitoring pressure transducer.

.3 The volume differential between supply and return fans shall be re-settable through the BMS.

.3 The fans shall stay on minimum speed and shall gradually modulate to their final control position. Ramping shall be provided to minimize cycling during start-up.

.4 On operation of the freeze stat and provided the supply fan stops with the return fan left running, the return fan speed shall be returned to a minimum position to provide some return air through the system. When the supply fan starts, the return fan inlet speed shall return to automatic control.

.8 Heating Coil and Cooling Coil

.1 Supply water temperature to building heating loop is reset as follows:

Outdoor Air Temperature	Supply Temperature Air
-25°C or less	18°C
-25°C to 12°C	Ramp from 18°C to 12°C
12°C and Higher	12°C

.1 Cooling Coil

.1 P-2A and P-2B are 100% capacity each and are normally activated via the building automation system and a lead/lag algorithm.

.2 When outdoor temperature drops rises above 12°C and the supply air temperature is above set-point, one pump shall start.

.3 Lead/lag the pumps on 100 operating hour intervals (operator adjustable).

.4 If the lead pump fails to start, the lag pump shall start, and an alarm shall be initiated at the OWS.

.5 The pump speed shall modulate via the variable frequency drive to maintain the supply air temperature set-point.

.6 When one of the cooling coil pumps is energized, the heating coil 3-way valve shall be in the by-pass position.

.7 Minimum pump run-time : 5 minutes.

.2 Heating Coil

.1 Modulate the three way valve to maintain supply air temperature set-point.

.2 When the three way valve is open beyond 0% (i.e. less than 100% bypass), the cooling coil pumps shall be de-energized.

.3 If the BMS system calls for both cooling coil pump energization and heating coil valve opening, an alarm shall sound at the BMS head end. The system shall revert to heating mode.

.9 Energy Recovery Ventilator (ERV)

.1 When the supply fan is energized, the ERV shall be energized.

.1 When the supply fan is de-energized by the freeze stat, the energy recovery ventilator shall de-energize. Once the supply fan is re-energized, the energy recovery ventilator shall re-energize automatically.

.2 The ERV has internal controls that operate the defrost cycle, outdoor air damper, and exhaust air damper.

.3 Provide the following alarms at the BMS:

.1 When the unit is in the defrost cycle.

.2 When the exhaust air flow drops below 1000 LPS, the unit is energized, and the unit is not in a defrost cycle.

.3 When the outdoor air flow drops below 1000 LPS and the unit is energized.

.4 When the exhaust air dirty filter dry contact closes.

.5 When the outdoor air dirty filter dry contact closes.

.4 Heating Coil

.1 Modulate the three way valve to maintain supply air temperature set-point.

.2 When the three way valve is open beyond 0% (i.e. less than 100% bypass), the cooling coil pumps shall be de-energized.

.10 Humidification

.1 The humidifier has an integral control package to control steam output.

.2 Provide an analogue signal to humidifier controller. This analogue signal shall be based on the difference between the humidity set-point and the average of the three room humidity sensors (see drawings for locations).

.1 If one of the room humidity sensors is faulty, automatically remove the faulty sensor from the averaging calculation.

.3 Limit maximum relative supply air humidity to 95%.

.11 Basement Electrical Room Temperature Control (cooling)

.1 When the basement electrical room temperature is above set-point and AHU-1 is not energized:

.1 Close AHU-1 outdoor air and relief air dampers, and open recirculation dampers (i.e. full recirculation mode).

.2 Energize the supply air and return air fan.

.3 Energize the ERV.

.4 Set outdoor air minimum requirement to air volume reading on the ERV outdoor air air monitoring station.

.12 AHU-1 Points List : The following points, as a minimum, shall be provided associated with the air handling unit. Each point shall also be shown on the AHU BMS system graphic.

.1	System run : Manual input from operator	PP
.2	Supply fan Start/Stop	DO
.3	Supply fan status	DI
.4	Supply fan speed set-point	AO
.5	Supply fan speed	AI
.6	Supply Fan VFD Alarm	DI
.7	Return fan Start/Stop	DO
.8	Return fan status	DI
.9	Return fan speed set-point	AO
.10	Return fan speed	AI
.11	Return Fan VFD Alarm	DI
.12	ERV start-stop	DO
.13	ERV alarm – defrost cycle	DI
.14	ERV alarm – low supply air flow	PP
.15	ERV alarm – low outdoor air flow	PP
.16	ERV alarm – dirty filters – exhaust air	DI
.17	ERV alarm – dirty filters – outdoor air	DI
.18	ERV exhaust air flow	AI
.19	ERV supply air flow	AI
.20	ERV Heating coil control valve position	AO
.21	Heating coil control valve position	AO

.22	Supply fan air flow	AI
.23	Return fan air flow	AI
.24	Recirculation air flow (between return air stream and supply air stream)	AI
.25	Mixed air flow (upstream of ERV connection)	AI
.26	ERV supply air flow	AI
.27	ERV exhaust air flow	AI
.28	Total airflow being exhaust / relieved from the building	PP
.29	Outdoor air flow though AHU-1 outdoor air dampers	PP
.30	Heating coil return water temperature immediately downstream of coil	AI
.31	Chilled water supply temperature at building entry	AI
.32	Chilled water supply temperature entering coil	A1
.33	Chilled water supply temperature leaving coil	A1
.34	Lead pump hours to run before change-over	PP
.35	Pump time to shut-down (based on minimum pump run-time)	PP
.36	Pump P-2A start/stop	DO
.37	Pump P-2A status	DI
.38	Pump P-2A flow	from pump VFD
.39	Pump P-2A upstream pressure	from pump VFD
.40	Pump P-2A downstream pressure	from pump VFD

.41	Pump P-2B start/stop	DO
.42	Pump P-2B status	DI
.43	Pump P-2B flow	from pump VFD
.44	Pump P-2B upstream pressure	from pump VFD
.45	Pump P-2B downstream pressure	from pump VFD
.46	Humidifier start/stop	DO
.47	Humidifier status	DI
.48	Humidifier load	AO
.49	Humidifier alarm	DI
.50	Supply air temperature	AI
.51	Supply air temperature set-point	PP
.52	Return air temperature	AI
.53	Mixed air temperature	AI
.54	ERV supply air outlet temperature	AI
.55	ERV exhaust air inlet temperature	AI
.56	ERV exhaust air outlet temperature	AI
.57	Basement Electrical Room Temperature	AI
.58	Basement Electrical Room temperature set-point	PP
.59	Supply air humidity	AI
.60	Return air humidity	AI
.61	Room humidity – basement	AI
.62	Room humidity – main floor	AI
.63	Room humidity – second floor	AI

.64 Humidity set-point PP

.65 Supply air humidity maximum set-point PP

.66 Outdoor Air Damper AO

.67 Relief Damper AO

.68 Return Damper AO

.69 Minimum Outdoor Air Percentage PP

.70 Supply air duct pressure AI

4.6 COMPUTER ROOM AIR CONDITIONING UNITS (EXISTING)

.1 Existing units are provided complete with packaged controls.

.2 There are no requirements to tie in these units fan to the BMS system other than room temperature monitoring as noted below.

.3 Points List : The following points, as a minimum, shall be provided associated with the system.

.1 Room temperature AI

4.7 UPS ROOM AIR CONDITIONING UNITS (EXISTING)

.1 Existing units are provided complete with packaged controls.

.2 There are no requirements to tie in these units fan to the BMS system other than room temperature monitoring as noted below.

.3 Points List : The following points, as a minimum, shall be provided associated with the system.

.1 Room temperature AI

4.8 DIGITAL VAV BOX CONTROL

.1 A digital controller shall be provided for the control of each VAV box to maintain a set flow and provide auxiliary control of the reheat and/or associated radiation vales, to maintain overall control of the space temperature. The unit shall have stand-alone capability and also communicate with the BMS.

.1 One full cooling, damper shall be fully open. As cooling load drops, damper shall modulate to its minimum closed position.

.2 As heating load increases, reheat coil valve modulates from full closed to full open.

.3 On further increase in heating load, air volume shall increase to maximum heating position (initially to be set to 50% of the maximum cooling load volume).

.2 At the room sensor location a plug-in facility shall be provided to allow for connection of a hand-held module to allow for monitoring and loading new parameters. All the parameters shall also be able to be loaded/monitored at the digital VAV box controller and at the central operator station of the BMS.

.3 VAV Box Points List : The following points, as a minimum, shall be provided associated with each VAV Box. Each point shall also be shown on a BMS system graphic, one graphic per VAV box.

.1	Room Temperature	AI
.2	Air Volume	AI
.3	Minimum Volume Setting	PP
.4	Maximum Volume Setting	PP
.5	Maximum Heating Volume Setting	PP
.6	Room Temperature Set Point	PP
.7	Day/Night Mode	PP
.8	Heating Valve Position	AO
.9	Damper Operator Position	AO

.4 A room sensor input, with local reset, and a velocity pressure transmitter shall provide the basic inputs, with an electronic motor to operate the air valve as an output.

.5 The digital controller and actuator shall be supplied by the Division 15900 contractor and mounted at the Division 15674 manufacturer's factory.

.6 Normal day settings are 21°C for heating and 24°C for cooling.

.7 Day/night mode selection is through BMS. In the night mode set-point is setback to 13°C and set-up to 29°C. A manual override switch is provided at the sensor.

4.9 DOMESTIC HOT WATER SYSTEM

.1 Domestic hot water is supplied by the central plant.

.2 There are no requirements to tie in this system units fan to the BMS system other than temperature monitoring as noted below.

.3 Points List : The following points, as a minimum, shall be provided associated with the system.

.1 Domestic hot water temperature entering building AI

4.10 MISCELLANEOUS SENSORS

.1 Provide the following miscellaneous monitoring points, as a minimum. Each point shall be shown on an individual system graphic.

.1 Outdoor Air Temperature AI

.2 Outdoor Air Humidity AI

.2 The above points are to be new sensors located on/in this building.

- END OF SECTION -

1. GENERAL

1.1 General Requirements

.1 This Section covers items common to Sections of Division 26, 27, 28 (Electrical Divisions). This section supplements requirements of Division 1.

1.2 Codes and Standards

.1 Do complete installation in accordance with CSA C22.1-2012 except where specified otherwise.

.2 Do overhead and underground systems in accordance with CSA C22.3 No.1-M1987 except where specified otherwise.

1.3 Care, Operation and Start-Up

.1 Instruct operating personnel in the operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.

1.4 Voltage Ratings

.1 Operating voltages: to CAN3-C235-83.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.5 Permits, Fees and Inspection

.1 Notify Engineer of changes required by Electrical Inspection Department prior to making changes.

.2 Furnish Certificates of Acceptance from Electrical Inspection Department and authorities if provided having jurisdiction on completion of work to Engineer.

1.6 Materials and Equipment

.1 Provide materials and equipment in accordance with Section 01 61 00 - Common Product Requirements.

.2 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department.

.3 Factory assemble control panels and component assemblies.

1.7 Electric Motors, Equipment and Controls

.1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.

.2 Control wiring and conduit is specified in Electrical Division except for conduit, wiring and connections below 50 V which are related to control systems specified in Mechanical Division and shown on mechanical drawings.

1.8 Finishes

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.2 Paint indoor switchboards and distribution enclosures light grey ASA 61.

.3 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.4 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

1.9 Equipment Identification

.1 Identify electrical equipment with nameplates and labels as follows:

.2 Nameplates:

.1 Lamecoid 3 mm thick plastic engraving sheet, black, blue, or red face, white core, mechanically attached with self tapping screws.

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.3 Labels:

.1 Embossed plastic labels with 6 mm high letters unless specified otherwise.

.4 Allow for average of twenty-five (25) letters per nameplate and label.

.5 Identification to be English.

.6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

.8 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics and be identified as per Government of Canada and existing identification standards.

.9 All new equipment shall labelled and identified as per Government of Canada and existing identification standards.

1.10 Wiring Identification

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

1.11 Conduit and Cable Identification

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
600 V and up	Yellow	Red
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Other Security Systems	Red	Yellow

1.12 Wiring Terminations

.1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

1.13 Manufacturers and CSA Labels

.1 Visible and legible, after equipment is installed.

1.14 Warning Signs

.1 As specified and to meet requirements of Electrical Inspection Department and Consultant.

.2 Decal signs, minimum size 175 x 250 mm.

1.15 Single Line Electrical Diagrams

.1 N/A

1.16 Location of Outlets

.1 Locate outlets in accordance with drawings and specifications.

.2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

.4 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

1.17 Mounting Heights

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1200 mm.

.2 Wall receptacles:
.1 General: 300 mm.
.2 Above top of counters or counter splash backs: 175 mm.
.3 In mechanical rooms: 1400 mm.

.3 Fire alarm stations: 1200 mm.

.4 Fire alarm horn/strobe: 2100 mm.

1.18 Load Balance

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads.

.3 Submit, at completion of work, report listing phase and neutral currents on panelboard and motor control centre, operating under normal load. State hour and date on which each load was measured and voltage at time of test.

1.19 Conduit and Cable Installation

.1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: plastic, sized for free passage of conduit, and protruding 50 mm.

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

1.20 Field Quality Control

.1 All electrical work shall be carried out by qualified, licensed electricians or apprentices as per the conditions of the Provincial Act respecting manpower vocational training and qualification. Employees registered in a provincial apprentices program shall be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks - the activities permitted shall be determined based on the level of training attained and the demonstration of ability to perform specific duties.

.2 The work of this division to be carried out by a contractor who holds a valid Master Electrical contractor license as issued by the Province of Saskatchewan.

.3 Conduct and pay for following tests:

.1 Power distribution system including phasing, voltage, grounding and load balancing.
.2 Lighting and its control.
.3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.4 Systems: fire alarm system.

.4 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

.1 Insulation resistance testing.
.2 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
.3 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
.4 Check resistance to ground before energizing.
.5 Document tests to satisfaction of Consultant.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.6 Submit test results for Consultant's review.

1.21 Co-Ordination of Protective Devices

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

1.22 As-Built Drawings

.1 The electrical contractor shall provide as-built drawings in hard copy format. Maintain, on a daily basis, a complete set of marked-up white prints as record drawings that show in complete detail the final arrangement and location of all electrical components and the interconnecting wiring. These are to be maintained in a neat and substantial manner so as to properly and fully illustrate the way in which the installation has been completed.

.2 The record drawings will be reviewed by the Consultant. Final submission of As-built Drawings shall be provided by the contractor in the form of marked up drawings.

2. PRODUCTS

2.1 Not Used

.1 Not Used.

3. EXECUTION

3.1 Not Used

.1 Not Used.

END OF SECTION

1. GENERAL

1.1 Section Includes

.1 Materials and installation for wire and box connectors.

1.2 References

.1 Canadian Standards Association (CSA International) (Latest Editions)

  .1 CAN/CSA-C22.2No.18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  .2 CSA C22.2No.65, Wire Connectors.

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

  .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

.3 National Electrical Manufacturers Association (NEMA)

2. PRODUCTS

2.1 Materials

.1 Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as required.

.2 Fixture type splicing connectors: with current carrying parts of copper sized to fit copper conductors #10 AWG or less.

.3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:

  .1 Connector body and stud clamp for round copper conductors.
  .2 Clamp for round copper conductors.
  .3 Stud clamp bolts.
  .4 Sized for conductors as indicated.

.4 Clamps or connectors for armoured cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required.

3. EXECUTION

3.1 Installation

.1 Remove insulation carefully from ends of conductors and:

  .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
  .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.
  .3 Install fixture type connectors and tighten. Replace insulating cap.
  .4 Install bushing stud connectors in accordance with NEMA.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.2 References

.1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.

.2 CAN/CSA-C22.2 No. 131-M89(R1994), Type TECK 90 Cable.

1.3 Product Data

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

2. PRODUCTS

2.1 Building Wires

.1 All conductors shall be copper, minimum No. 12 gauge, 75 degrees C unless specifically noted otherwise.

.2 All conductors # 12 AWG to # 8 AWG shall be rated for minimum 600V RW-75 XLPE. Conductors # 6 AWG and larger shall be rated for minimum 1000V RW-75 XLPE. All conductor for motor feeds from variable frequency drives, shall be rated for minimum 1000V RW-75 XLPE. Wiring in channel back of fluorescent fixtures shall be 600 volt Type GTF or TEW. Size, grade of insulation, voltage and manufacturer’s name shall be marked at regular intervals.

.3 Wiring for major feeders may be NUAL aluminum and shall be installed only where specifically noted on the drawings.

.4 Conductor utilized in conduit run under slab on grade or in conduit underground shall be Type ’RWU-75’.

.5 Wire shall be as manufactured by Nexans, Alcan, Pirelli, BICC General Wire or Superior Essex.

2.2 Teck Cable

.1 Cable: to CAN/CSA-C22.2 No. 131.

.2 Conductors:

.1 Grounding conductor: copper.
.2 Circuit conductors: copper, size as indicated.

.3 Insulation:

.1 Chemically cross-linked thermosetting polyethylene rated type RW75, 600V to 1000V as noted above.

.4 Fastenings:

.1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
.2 Channel type supports for two or more cables.
.3 Threaded rods: 6 mm dia. to support suspended channels.

.5 Connectors:

.1 Watertight approved for TECK cable.

3. EXECUTION

3.1 Installation Of Building Wires

.1 Termination for #8 AWG and larger shall be by means of approved solderless connector lug. For parallel conductors, a common lug with separate termination for each conductor shall be employed.

.2 Conductor splices shall be made in accordance with specifications. Provide sufficient length for joint remake, and no less than 200 mm spare length. On through wiring, leave 300 mm loop.

.3 Wiring in cabinets, pull boxes, panels and junction boxes shall be neatly trained and held with nylon cable ties.

.4 Conductors shall be tag identified where passing through junction boxes.

3.2 Installation of Teck Cable 0 -1000 V

.1 Install cables.

.1 Group cables wherever possible on channels.

.2 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0-1000V.

.3 All cables shall be terminated and spliced with suitable compression type connectors, as recommended by the cable manufacturer. The connectors shall satisfy the bonding and grounding requirements at the supply end.

.4 All cables shall be single conductor and copper, unless otherwise specified.

.5 All cable shall be rated for 1000 volts, insulated with cross-linked polyethylene and rated for operation at 75 degrees C. Cable shall have a FT6 rated outer jacket.

.6 All cable shall meet the CSA requirements for cold bend and impact testing at minus 40 degrees C.

.7 All cable shall be protected by a corrugated aluminum sheath or by interlocked aluminum armour. PVC jackets shall be required on all metallic sheathed cables.

.8 The jackets shall meet the FT6 flame spread requirements and be identified on the P.V.C. jacket.

.9 All cables shall be installed in accordance with the manufacturers recommendations, in suitable cable tray as specified within the specifications.

.10 The cables shall be terminated at the supply end on a non-ferrous metallic plate and at the load end on a non-metallic rigid fibre board plate. The cable sheaths shall be bonded at the supply end only.

.11 All cable installed in cable tray shall be installed at one diameter spacing.

.12 When single conductor cables are direct earth buried they shall be spaced 150 mm apart.

.13 Cables shall be manufactured by Nexans, Alcan, Superior Essex, General Wire or Pirelli.

3.3 Installation of Armoured Cables

.1 Group cables wherever possible.

.2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

.3 Conductors: insulated, copper, size as indicated.

.4 Type: AC90 - Armour: interlocking type fabricated from aluminum strip.

.5 Type: ACWU90 - jacket over armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.

.6 Connectors: as required.

.7 Multi conductor cables shall be color coded during manufacture. Single conductor cables shall be color coded with adhesive colour coding tape. The tape shall be applied for a minimum of 75 mm at all terminations. Cables shall not be painted under any condition. Color coding shall be as follows:

Phase ’A’ - Red	Neutral - White
Phase ’B’ - Black	Ground - Green or Bare
Phase ’C’ – Blue	

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Section 26 05 01 - Common Work Results - Electrical.

1.2 References

.1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

  .1 ANSI/IEEE 837-1989 (R1996), Qualifying Permanent Connections Used in Substation Grounding.

.2 Canadian Standards Association, (CSA International)

.3 CAN/CSA Z32-1999, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

2. PRODUCTS

2.1 Equipment

.1 Grounding conductors: bare stranded copper.

.2 Insulated grounding conductors: green

.3 Ground bus: copper, complete with insulated supports, fastenings, connectors.

.4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

  .1 Grounding and bonding bushings.
  .2 Protective type clamps.
  .3 Bolted type conductor connectors.
  .4 Thermit welded type conductor connectors.
  .5 Bonding jumpers, straps.
  .6 Pressure wire connectors.

.5 All ground conductors shall be bare or insulated, stranded, medium hard drawn copper wire. All insulated ground wires shall be green.

.6 Exposed copper shall be cleaned to a bright surface, and shall be finished with two coats of clean, insulating varnish.

.7 Connect ground conductor to copper water pipe at least twice (minimum 40 mm diameter), utilizing a Burndy Type GAR pipe clamp. Provide jumper across water meter.

.8 All connections to the ground bus or risers shall be thermowelded, or shall utilize the Burndy Hy-Ground compression connections. Clamp type connections shall only be allowed to individual pieces of equipment.

3. EXECUTION

3.1 Installation General

.1 Electrical equipment and wiring shall be grounded in accordance with the Canadian Electrical Code, and local inspection authority’s rules and regulations.

.2 All metallic raceways and conduits for communications, cable and conductors shall be grounded.

.3 All motors with flexible connections shall have separate ground wire run bridging the flexible connections. This ground wire shall be run from the motor back to the nearest junction box or motor control centre where the termination can be readily inspected. Insulation for this wire shall be green.

.4 Lay-in trays and feeder conduits shall be connected to the ground bus.

.5 All 347/600 volt wiring shall be run in rigid conduit, or may be run in EMT if a separate ground wire is run from the panel or switch to each piece of equipment. The ground conductor shall be connected to the housing of each piece of equipment and the outlet box. Where rigid conduit is employed, all terminations of these conduit runs are to be with double locknuts, grounding bushings with jumper wires run between the bushing lug and the box or panel enclosure. Care shall be taken in conduit runs to ensure that all rigid pipe couplings and fittings are wrench tight.

.6 All panel feeds at 600 volt and 208 volt shall include a building network ground conductor.

.7 All grounding conductors outside the electrical rooms and closets shall be insulated and installed in conduits, unless otherwise noted.

.8 Install connectors in accordance with manufacturer’s instructions.

.9 Protect exposed grounding conductors from mechanical injury.

.10 Use mechanical connectors for grounding connections to equipment provided with lugs.

.11 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.12 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.13 Structural steel and metal siding to ground by welding copper to steel.

.14 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections unless indicated otherwise.

.15 Use mechanical connectors for grounding connections to equipment provided with lugs.

.16 Soldered joints not permitted.

.17 Install separate ground conductor to outdoor lighting standards.

.18 Make grounding connections in radial configuration only. Avoid loop connections.

.19 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

.20 Ground secondary service pedestals.

3.2 System and Circuit Grounding

.1 Install system and circuit grounding connections to neutral of secondary systems.

3.3 Equipment Grounding

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, duct systems, frames of motors, starters, control panels, structure steel work, and distribution panels.

3.4 Communication Systems

.1 Install grounding connections for telephone, fire alarm, Data systems as follows:

.1 Telephones: make telephone grounding system in accordance with SaskTel’s requirements.

.2 Fire alarm, Data systems as indicated and as recommended by system manufacturer.

3.5 Field Quality Control

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Perform tests before energizing electrical system.

.3 Disconnect ground fault indicator during tests.

.4 All grounding conductors outside the electrical rooms and closets shall be insulated and installed in conduits, unless otherwise noted.

.5 Connections to neutral points and equipment shall be made with thermowelds or brass, bronze or copper bolts and connectors.

.6 Equipment grounds and transformer system grounds shall be connected to the building grounding network. All non-current carrying metallic parts of equipment shall be connected to the ground network.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Section 26 05 01 - Common Work Results - Electrical.

2. PRODUCTS

2.1 Support Channels

.1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted suspended or set in poured concrete walls and ceilings.

3. EXECUTION

3.1 Installation

.1 Secure equipment to poured concrete with expandable inserts.

.2 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.3 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

.4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.5 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
.2 Two-hole steel straps for conduits and cables larger than 50 mm.
.3 Beam clamps to secure conduit to exposed steel work.

.6 Suspended support systems.

.1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
.2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.7 For surface mounting of two or more conduits, use channels spaced as required by C22.1.

.8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.10 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer.

.12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

1. GENERAL

1.1 Shop Drawings and Product Data

.1 Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 - Submittal Procedures.

2. PRODUCTS

2.1 Splitters

.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three spare terminals on each set of lugs in splitters.

2.2 Junction and Pull Boxes

.1 Welded steel construction with screw-on flat covers for surface mounting.

.2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3 Cabinets

.1 Sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.

3. EXECUTION

3.1 Splitter Installation

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 Junction, Pull Boxes and Cabinets Installation

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Mount cabinets with top not higher than 2 m above finished floor.

.3 Install terminal / bix block where indicated in cabinets.

.4 Only main junction and pull boxes are indicated. Provide others as required by code. Install pull boxes so as not to exceed 30m of conduit run between pull boxes.

3.3 Identification

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Install size 2 identification labels indicating system name, voltage and phase, Emergency, or Normal power.

END OF SECTION

1. GENERAL

1.1 References

.1 CSA C22.1-2002, Canadian Electrical Code, Part 1.

2. PRODUCTS

2.1 Outlet and Conduit Boxes General

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Provide blank cover plates for boxes without wiring devices.

.5 Provide combination boxes with barriers where outlets for more than one system are grouped.

.6 Each outlet box installed in steel stud and gyproc walls shall be mounted on Caddy #BHA, series SGB or TSGB screw gun brackets. Wood strapping with steel studs shall not be utilized for supporting outlet boxes

.7 Use condulets where 90° turn required on wall mounted conduit. They shall be of the type where cover screws do not enter the wire chamber and covers are left accessible.

.8 Each outlet box installed in acoustic tile ceilings shall be mounted on double Caddy "Tee Bar Hanger" #512 in such a manner that the outlet box will not twist in any direction.

.9 Where boxes are surface mounted in unfinished areas, such as furnace or boiler rooms, stamped galvanized steel 100 mm square box to accept #8300 series raised covers shall be used.

.10 Where surface wiring methods are allowed and approved in finished areas, use Hubbell or Wiremold boxes as per drawings c/w suitable adapter for wireway entrance.

.11 Outdoors or damp locations, boxes shall be cast Feraloy or aluminum type 'FS', with threaded hubs and vapourproof covers.

.12 Indoors, stamped zinc cadmium plated steel boxes shall be provided and set for each fixture, switch, wall receptacle or other types of outlets, adapted to suit its respective location and designed to accept its particular components.

.13 Standard octagon boxes shall be 100 mm diameter, 53 mm deep minimum. Increase depth where area fill requires. Equip each box used for fixture hanging with a fixture stud.

.14 Two gang or larger shall be solid type with raised cover for tile, block or gyproc finish.

.15 Wood strapping with steel studs shall not be utilized for supporting outlet boxes.

.16 Set boxes plumb and level within 6 mm of finished surface. Mats not permitted.

.17 Where required, provide voltage separation barriers.

2.2 Sheet Steel Outlet Boxes

.1 Electro-galvanized steel multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

.2 Standard octagon boxes shall be 100 mm diameter, 53 mm deep minimum. Increase depth where area fill requires. Equip each box used for fixture hanging with a fixture stud.

.3 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished walls.

.4 102 mm square or octagonal outlet boxes for lighting fixture outlets.

.5 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster walls.

2.3 Masonry Boxes

.1 Electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.4 Concrete Boxes

.1 Electro-glavanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 Conduit Boxes

.1 Outdoors or damp locations, boxes shall be cast Feraloy or aluminum type ’FS’, with threaded hubs and vapourproof covers.

.2 Indoors, stamped zinc cadmium plated steel boxes shall be provided and set for each fixture, switch, wall receptacle or other types of outlets, adapted to suit its respective location and designed to accept its particular components.

.3 Standard octagon boxes shall be 100 mm diameter, 53 mm deep minimum. Increase depth where area fill requires. Equip each box used for fixture hanging with a fixture stud.

.4 Two gang or larger shall be solid type with raised cover for tile, block or gyproc finish.

.5 Wood strapping with steel studs shall not be utilized for supporting outlet boxes.

.6 Set boxes plumb and level within 6 mm of finished surface. Mats not permitted.

.7 Where required, provide voltage separation barriers.

2.6 Fittings - General

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

3. EXECUTION

3.1 Installation

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

.5 Outlet boxes shall be supported independently of conduit capable of supporting weight of fixture or other device. Conduit entering the back of a box shall not enter the centre knockout.

.6 For recessed fixtures in suspended ceilings, outlet box shall be accessible when fixture is removed.

.7 Flexible conduit to fixture shall be minimum 12 mm diameter, and shall not emanate from outlet box cover. Maximum length of flexible conduit from outlet box to fixture shall be 3000 mm. Outlet box for fixture shall not be located above ducts, pipes, etc. Outlet box shall be within 750 mm (vertically) of the fixture.

.8 Provide and set all special communications type back boxes associated with systems specified under Electrical Divisions.

.9 In placing outlets, allow for overhead pipes, ducts, etc., and for variation in wall and ceiling finishes, door and window trim, panelling, etc.

.10 Location of receptacle outlets in equipment rooms shall be finalized during construction to give optimum arrangement. Consultant to approve locations before installation.

1. GENERAL

1.1 References

.1 Latest Edition of the following Canadian Standards Association (CSA) documents

.1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.

.2 CSA C22.2 No. 45, Rigid Metal Conduit.

.3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.4 CSA C22.2 No. 83, Electrical Metallic Tubing.

.5 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.

.6 CAN/CSA C22.2 No. 227.3, Flexible Nonmetallic Tubing.

2. PRODUCTS

2.1 Conduits

.1 Rigid metal conduit: to CSA C22.2 No. 45, hot dipped galvanized steel threaded.

.2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.

.3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.

.4 Rigid PVC conduit: to CSA C22.2 No. 211.2.

.5 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

.6 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3

.7 Conduit for use in corrosive atmospheres shall be rigid PVC or rigid steel with extruded PVC jacketed. Refer to drawings for areas requiring PVC.

.8 Condulets shall be of a type wherein cover screws do not enter the wire chamber.

.9 Flexible conduit connections to all mechanical equipment shall be of 'Sealtite' manufacture.

.10 Flexible conduit connectors shall be of the insulated throat type.

.11 Condulets with suitable covers shall be used where condulets are exposed. Each conduit fitting shall be of a type suitable to its particular use, and of a type which will allow installation of future conduits without blocking covers of existing condulets.

.12 Expansion joints shall be installed with ground jumper.

.13 All conduits shall be terminated with a suitable bushing.

.14 Flexible conduit and Rigid conduit entering boxes or enclosures shall be terminated with nylon insulated steel threaded bushings, grounded type.

2.2 Conduit Fastenings

.1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1.5 m oc.

.4 Threaded rods, 6 mm dia., to support suspended channels.

2.3 Conduit Fittings

.1 Fittings: manufactured for use with conduit / raceway specified. Coating: same as conduit / raceway.

.2 Factory "ells" where 90º bends are required for 25 mm and larger conduits / raceways.

2.4 Expansion Fittings for Rigid Conduit

.1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.

.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.

.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 Fish Cord

.1 Polypropylene.

3. EXECUTION

3.1 Installation

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Conduits and cables shall be supported, at regular intervals, with corrosion resisting clamps. Lead anchors or expansion bolts shall be used to attach clamps to masonry walls.

.3 Conduit and cables shall be installed to avoid proximity to water and heating pipes. They shall not run within 150 mm of such pipes, except where crossings are unavoidable, in which case they shall be kept at least 25 mm from covering of pipe crossed.

.4 Cap ends of all conduits to prevent entrance of foreign matter during construction. Manufactured caps shall be employed.

.5 Conduit shall be installed as close to building structure as possible so that where concealed, necessary furring can be kept to a minimum.

.6 Empty conduits, installed under this Division but in which wiring will be installed by others, shall be swabbed out with "Jet Line" foam packs, and be c/w Polypropylene pull wire or polytwine.

.7 Conduits shall be installed at right angles or parallel to building lines, accurate in line and level.

.8 Conduit shall not be bent over sharp objects. Improperly formed bends and running threads will not be accepted. Bends and fittings shall not be used together. Proper supports of manufactured channels shall be provided where exposed conduits and cable runs are grouped.

.9 Under no condition will EMT be allowed exposed within 1200 mm of floor, outdoors, or in areas where explosive, corrosive or moist atmosphere exists.

.10 Not more than four (4) 90 degree bends or equivalent offsets will be permitted between pull boxes. When maximum number of bends are used, the total run between pull boxes shall not exceed 18000 mm.

.11 PVC conduit shall not pass through a fire partition or floor separation. Where it is necessary for PVC conduits to pass through a fire barrier, a transition to rigid steel conduit shall be provided for 2000 mm on either side of the fire barrier.

.12 Surface mount conduits except where noted otherwise.

.13 Use rigid PVC conduit in corrosive areas or as indicated on plans.

.14 Use flexible metal conduit or Teck90 for connection to motors.

.15 Use liquid tight flexible metal conduit or Teck90 for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.16 Use explosion proof flexible connection for connection to explosion proof motors.

.17 Minimum conduit size for lighting and power circuits: 19 mm.

.18 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter. Mechanically bend steel conduit over 19 mm dia.

.19 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.20 Install pulltwine in all empty conduits / raceways and conduits / raceways that are less than 40% filled.

.21 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.22 Dry conduits out before installing wire.

Conduits/Cabling/raceways are not to be run within concrete floors/ceilings. Any conduits/cabling/raceways required to be run along the concrete slabs shall be surface run and not recessed into the concrete. Any instances where cabling is required to be run vertically within concrete poured walls, coreline may be used as the raceway but it shall be transitioned to EMT or Rigid Steel (where required) with interfacing connectors or junction boxes being provided as required. This specification contains references to cast in place conduits. This is only applicable where specifically called for in certain locations within the documents.

3.2 Surface Conduits

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on surface channels.

.5 Do not pass conduits through structural members except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.3 Concealed Conduits

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Section 26 05 01 - Common Work Results - Electrical.

1.2 References

.1 Canadian Standards Association (CSA International)

.1 CSAC22.2No.26, Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings.

1.3 Product Data

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

2. PRODUCTS

2.1 Wireways

.1 Wireways and fittings: to CSA C22No.26.

.2 Sheet steel with hinged cover to give uninterrupted access.

.3 Finish: baked grey enamel.

.4 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

3. EXECUTION

3.1 Installation

.1 Install wireways and auxiliary gutters.

.2 Keep number of elbows, offsets, connections to minimum.

.3 Install supports, elbows, tees, connectors, fittings.

.4 Install barriers where required.

.5 Install gutter to full length of equipment.

END OF SECTION

1. GENERAL

1.1 Section Includes

.1 Materials and installation for standard and custom breaker type panelboards.

1.2 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 26 05 01 - Common Work Results - Electrical.

.3 Section 26 28 21 - Moulded Case Circuit Breakers.

1.3 References

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2No.29-M1989(R2000), Panelboards and enclosed Panelboards.

1.4 Shop Drawings

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

2. PRODUCTS

2.1 Panelboards

.1 All panels shall be of the dead front, molded case circuit breaker type, as shown, sized and located on the drawings.

.2 Panel trim shall be furnished for flush or surface mounting as indicated on the drawings. Panel trim shall be removed for painting, and allowed to dry before final placement.

.3 Surface mounted panels shall have manufacturer’s standard trim, and shall be finished with two coats of grey ASA #61.

.4 Panels shall be equipped with a flush type combination lock-latch. Two keys shall be provided for each panel, and all locks shall be keyed alike.

.5 Panels shall have mains of voltage and capacity and shall be complete with branch breakers, spares and spaces, as shown on the drawings. "Spaces" shall be understood to include necessary bus work such that Owners, at a later date, need buy only breakers.

.6 Panelboards: to CSA C22.2No.29 and product of one manufacturer.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements manufacturer’s nameplate must show fault current that panel including breakers has been built to withstand.

.7 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.8 Each panel shall be complete with a typed directory, which shall be mounted inside the door in a metal frame with clear plastic cover.

.9 Flush panels shall have concealed hinges and flush type combination lock-latch. Doors shall open minimum 135 degrees. Trims shall have fasteners concealed.

.10 Cabinets shall be fabricated of code gauge steel, with ample wiring gutters for all wiring connections.

.11 All panels shall have main bus bar equipped with solderless lug and be capable of accepting any arrangement of single, two or three pole breakers.

.12 Branch circuit breaker shall have quick-make, quick-break toggle mechanism with single, two or three pole common trip thermal magnetic units in ampere ratings as designated on the drawings. Breaker handles shall have three positions: 'on', 'off' and 'tripped'. All circuit breakers and panel bus shall have an interrupting capacity of 10,000 amps symmetrical.

.13 Panels for 120/208 volt, 3 phase, 4 wire systems, shall be complete with bolt-in type breakers, with a minimum nominal width of 20 mm per pole, and a bus of sufficient capacity to feed the number of branch circuit breakers indicated.

.14 All panels shall be specification grade and of the same manufacture. Load centres are not acceptable.

.15 All branch circuit spaces shall be fitted with filler plates.

.16 All panels serving bedrooms shall be equipped with arc fault circuit interrupters where shown on the drawings.

.17 Each panel shall be equipped with a ground bus suitable for terminating one ground conductor per load circuit.

.18 Panels shall be Siemens, Cutler Hammer or Schneider Electric.

2.2 <u>Breakers</u>

.1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.

.2 Lock-on devices for fire alarm circuits.

2.3 <u>Equipment Identification</u>

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results – Electrical.

.2 Nameplate for each panelboard size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

3. EXECUTION

3.1 <u>Installation</u>

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards in accordance with Section 06 10 10 - Rough Carpentry. Where practical, group panelboards on common backboard.

.3 Electrical panels shall, where possible, be mounted with top of trim at uniform height of 2000 mm.

.4 Panels, shown adjacent to other panels, shall have adjacent edges of different panels mounted parallel to each other with a gap of 75 mm.

.5 Connect neutral conductors to common neutral bus.

END OF SECTION

PART 1 General

1.1 RELATED WORK

.1 Section 26 05 01 - Common Work Results - Electrical.

1.2 REFERENCES

.1 Canadian Standards Association (CSA)

  .1 CAN/CSA-Q9000-92, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

1.3 PRODUCT DATA

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit product data sheets for sills, busbars and compartments. Include product characteristics, physical size and finish.

.3 Manufacturers Instructions: Provide to indicate special handling criteria, installation sequence, and cleaning procedures.

1.4 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures .

.2 Indicate:

  .1 Outline dimensions
  .2 Configuration of identified compartments.
  .3 Floor anchoring method and dimensioned foundation template.
  .4 Cable entry and exit locations.
  .5 Dimensioned position and size of busbars and details of provision for future extension.
  .6 Schematic and wiring diagrams.

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Include data for each type and style of starter.

.3 Provide voltage waveforms taken at the motor terminals.

1.6 EXTRA MATERIALS

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Include: for each variable frequency drive, provide two (2) sets of fusing specifically used for the drives.

PART 2 Products

2.1 SUPPLY CHARACTERISTICS

.1 208 V, 60Hz, WYE connected, 3 phase, 4 wire where indicated.

.2 Single phase motors shall be 120 or 208 volt.

.3 Coordinate with Mechanical division for exact requirements.

2.2 GENERAL DESCRIPTION

.1 Compartmentalized vertical sections with common power busbars.

.2 Floor mounting, free standing, enclosed dead front.

.3 Indoor NEMA 1 gasketed enclosure, mounting as shown on drawings.

.4 Each motor control centre shall be equipped with a separate control wiring bay with a 12 position terminal block wired to each starter with all user connection points run to the MCC's central control bay. In some cases, it may be necessary to add a cell or vertical section to house the control wiring terminal blocks.

2.3 VERTICAL SECTION CONSTRUCTION

.1 The control centres shall generally consist of vertical sections, nominally 508 mm deep by 508 mm wide by 2300 mm high, joined together to form a rigid, free standing, completely dead front enclosed control assembly. Power shall be distributed by means of a continuous bus. Continuous floor sills and lifting angles shall be provided to facilitate installation of the control centre.

.2 Each vertical section shall be fabricated of code gauge steel, shaped and reinforced to form a rigid, free-standing structure. Each section will be sized so that control units may be readily removed or added as required. Provision shall be made for mounting starters in the front half. Provide barriered vertical and horizontal wire ways.

.3 Each vertical section shall be provided with flange formed doors with concealed hinges for all starting units. Removable flange formed covers shall enclose the back of the section with front mounted starters only.

.4 The top of each vertical section shall be equipped with removable cover plates to facilitate access to main bus and horizontal wiring compartment.

.5 The side of each vertical section shall be equipped with cutouts in top and bottom to facilitate horizontal wiring.

.6 A full height, vertical wiring trough with cable support shall be provided for unit wiring. Isolating barriers between units shall be easily removed to facilitate installation of outgoing wiring.

.7 All bus work shall be suitably braced to withstand maximum short circuit currents of 42,000 amps symmetrical at 600 volts or 42,000 amps symmetrical at 208 volts.

.8 Bus supports shall be formed of high dielectric strength, low moisture absorption, molded compound with low creepage surface.

.9 Starter units shall be of the switch and fuse combination type, with all components and wiring readily accessible for ease of maintenance. All starters shall be minimum NEMA size 1 or 20 amp IEC. An external operating handle for the fusible quick-make, quick-break switch shall be interlocked with the unit door so that the handle must be in the 'off' position before the door can be opened. The handle shall be arranged for padlocking in either the 'on' or 'off' positions, with from one to three padlocks. The overload relays shall be the ambient temperature compensated type, and the trip rating of a specific heater element shall be field adjustable over a range of approximately 85% to 115% of its respective rating.

.10 Each vertical bay shall be capable of housing up to but not exceeding a maximum of six Size 1 (or 20 amp IEC) starter units. Each starter unit shall be connected to the vertical bus by means of 'stab-on' connectors, providing a positive silver-to-silver contact with both sides of the bus at all times. The unit shall be easily removable by turning two speed latches, loosening terminal connections and withdrawing from the vertical section. All units shall be readily interchangeable to facilitate rearranging of the control centre after installation. Means shall be provided in the stationary structure for supporting and aligning starter units during their removal or replacement.

.11 All fusing shall be Form I, NEMA "J", HRC, 200,000 amps current limiting type.

2.4 BUSBARS

.1 All bus, except ground bus, shall be tin plated aluminum or copper, and shall be sized as shown on the drawings.

.2 Vertical bus shall be sized the same as the horizontal bus, unless otherwise noted.

.3 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.5 GROUND BUS

.1 Copper ground bus extending entire width of motor control centre.

2.6 MOTOR STARTERS AND DEVICES

.1 See Section 26 29 10 - Motor Starters to 600V.

2.7 STARTER UNIT COMPARTMENTS

.1 Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

.2 Unit mounting:

- .1 Engaged position - unit stabbed into vertical bus.
- .2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
- .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
- .4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.

.3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.

.4 Hinge unit doors on same side.

.5 Overload relays manually reset from front with door closed.

.6 Pushbuttons and indicating lights mounted on door front.

.7 Devices and components by one manufacturer to facilitate maintenance.

.8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.8 WIRING IDENTIFICATION

.1 Provide wiring identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

2.9 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.1 Motor control centre main nameplate: size No. 7, engraved

.2 Individual compartment nameplates: size No. 5, engraved as indicated.

2.10 FINISHES

.1 Apply finishes in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Paint motor control centre exterior light gray and interiors white.

2.11 SOURCE QUALITY CONTROL

.1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.

.2 Engineer Consultant to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.

.3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-Q9000.

PART 3 Execution

3.1 INSTALLATION

.1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.

.2 Make field power and control connections as indicated.

.3 Ensure correct overload heater elements are installed.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Ensure moving and working parts are lubricated where required.

.3 The ground bus shall be connected to the ground system.

.4 Set all motor control centres on 100 mm high concrete housekeeping pads.

.5 Within 900 mm of each motor, provide flexible Sealtite conduit in areas where water or moisture may be prevalent, such as crawl spaces and mechanical equipment rooms.

.6 Where flexible connections are utilized, provide a separate ground wire bridging the flexible connections.

.7 Operate starters in sequence to prove satisfactory performance of motor control centre.

.8 Provide sprinkler guards on top of motor control centres. All conduit entering top of motor control centre shall be c/w water tight connectors with silicone based caulking to provide a degree of water tightness in the event of a sprinkler system failure.

.9 The motor control equipment manufacturer shall provide factory personnel to assist in the equipment start-up and commissioning on site. Prior to any equipment being started, the manufacturer must certify in writing to the Consultant that the equipment, installation and motors being controlled have been reviewed and that the entire arrangement meets with the requirements of the contract documents and the manufacturer’s recommendations.

.10 The Owner's operating and maintenance personnel shall be instructed in the operation and maintenance of the system for a minimum period of one (1) hour.

END OF SECTION

1. GENERAL

1.1 Section Includes

.1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 26 05 01 - Common Work Results - Electrical.

1.3 References

.1 Latest Edition of the following Canadian Standards Association (CSA International) documents:

  .1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.

  .2 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).

  .3 CSA-C22.2 No.55, Special Use Switches.

  .4 CSA-C22.2 No.111, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.4 Shop Drawings And Product Data

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

2. PRODUCTS

2.1 Switches

.1 15 A, 120 V, single pole, three-way switches where required on drawings.

.2 Manually-operated general purpose ac switches with following features:

  .1 Terminal holes approved for No. 10 AWG wire.

  .2 Silver alloy contacts.

  .3 Urea or melamine molding for parts subject to carbon tracking.

  .4 Suitable for back and side wiring.

  .5 White toggle.

.3 Toggle operated fully rated for tungsten filament and fluorescent lamps.

.4 All wiring devices specified shall be of the same manufacture throughout the project.

.5 Switches controlling motors shall be K.W. (H.P.) rated and approved for motor control service.

.6 Set switches flush in all finished areas, or in surface box where conduit or wireway is exposed.

.7 Refer to drawing symbol schedule for further requirements.

.8 Switches and receptacles shall comply with requirements of CSA and NEMA Standards.

.9 Switches shall be specification grade from one of the following manufacturers: Cooper, Leviton, Hubbell or Pass & Seymour.

2.2 Receptacles

.1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, with following features:

.1 White high impact chemical resistant molded nylon or polycarbonate face.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Break-off links for use as split receptacles.

.4 Eight back wired entrances, four side wiring screws.

.5 Triple wipe contacts and riveted grounding contacts.

.6 Specification grade from one of the following manufacturers: Cooper, Leviton, Hubbell or Pass & Seymour.

.2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:

.1 White high impact chemical resistant molded nylon or polycarbonate face.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Four back wired entrances, 2 side wiring screws.

.4 Specification grade from one of the following manufacturers: Cooper, Leviton, Hubbell or Pass & Seymour.

.3 Other receptacles with ampacity and voltage as indicated.

.4 Receptacles shall be of one manufacturer throughout project.

.5 Set receptacles flush in all finished areas, or in surface box where conduit or wireway is exposed

.6 All emergency powered convenience outlets shall be red but as specified above.

2.3 Special Wiring Devices

.1 **Ground Fault Circuit Interrupter** - shall have a nylon face and a thermoplastic backbody. They must have a feed-through capability for protecting receptacles downstream on the same circuit. They must be Class A rated with a 5 milliampere ground fault trip level and a 20 ampere feed through rating. GFCI receptacles shall have 'Safe Lock' protection such if critical components are damaged and ground fault protection is lost, power to the receptacle is disconnected. GFCI receptacles shall be equipped with LED trip indicator light, NEMA configuration 5-15R, side wired and one of the following manufacturers: Cooper #XGF15-V, Leviton #8599-I or Pass & Seymour #1594-I, Hubbell 'Autoguard' GFR Series

.2 **Fractional HP/KW Manual Starters** - to be non-reversing, toggle operated, suitable for mounting in a surface or flush box, single or two pole to suit 120 or 208 volt application, c/w pilot light and thermal overload to adequately protect motor. Flush mount to have stainless steel or white cover plates to match other flush mount wiring devices. To be of one of the following manufacturers: Cooper, Leviton, Hubbell or Pass & Seymour.

.3 **Illuminated Switches** - shall be quiet specification grade, 120 volts, back and side wiring with toggle lit in the "OFF" position, accepting up to #10 copper conductor and of one of the following: Cooper, Leviton, Hubbell or Pass & Seymour.

2.4 Cover Plates

.1 Cover plates for wiring devices.

.2 Cover plates from one manufacturer throughout project.

.3 Wall plates shall be designed and manufactured in accordance with performance and dimensional requirements of the following industry standards:

CSA Standard C22-2 No. 42

U.S. Federal Specification WP455

NEMA Standard WD-1

.4 Wall plates shall be manufactured by one of the following:

Cooper, Arrow Hart, Eagle, Hubbell, Leviton or Pass & Seymour.

.5 Blank cover plates in finished ceiling areas shall be Columbia Electric #9002 baked white enamel for white ceilings, or painted to match colored finishes.

.6 Stainless Steel wall plates shall be provided for all switches, receptacles, blanks, telephone and special purpose outlets. The wall plates shall be of suitable configuration for the device for which it is to cover with color matched mounting screws. Use ganged plate where more than one device occur at one location.

.7 Where surface wiring methods need to be employed in a high finish area because of renovations to existing structure, wall plates shall be used in conjunction with Wiremold surface box to suit the device.

.8 Where outlets occur in an unfinished area such as boiler or furnace room and surface conduit and boxes are specified, stamped galvanized steel wall plates shall be used to suit configuration.

.9 Exterior outlets shall be fitted with weatherproof die cast aluminum cover plates to suit wiring device, c/w rubber gasket to provide positive seal. Duplex cover plates shall have two independent flaps. Weatherproof covers shall provide protection in wet and damp locations.

3. EXECUTION

3.1 Installation

.1 Switches:

.1 Install single throw switches with handle in "UP" position when switch closed.

.2 Install switches in gang type outlet box when more than one switch is required in one location.

.3 Switches shall be as located on the drawings, mounted up 1200 mm, and ganged where more than one occurs in the same location.

.2 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Convenience outlets shall be as located on the drawings, and mounted up 450 mm, unless otherwise noted.

.3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

.4 Outlets over counter tops shall be mounted 150 mm above counter, or immediately above backsplash. Co-ordinate with architectural drawings for location of all counter tops, millwork and feature walls, to ensure proper location and mounting height.

.5 Coordinate with the location of all mechanical convectors and mount convenience outlets up 100 mm above heating convectors.

.6 All convenience outlets shall meet tension tests as per CSA requirements, and will be subjected to 'on site' tests during final inspection.

.3 All plug-in type receptacles shall be identified by means of a Lamecoid label fixed with self tapping screws on the cover plate. Each cover plate shall contain the panel and circuit number. Those receptacles fed from ground fault interrupters shall have 'GFI' labeled adjacent to the panel and circuit number. Those receptacles designated for housekeeping purposes shall have 'HOUSEKEEPING' labeled adjacent to the panel and circuit number.

.4 The circuits controlled by all switches on all levels, shall be neatly printed with waterproof ink on the side of the switch outlet box so that the panel and circuit number are clearly legible when the cover plate is removed. It shall not be necessary to remove the switch from the outlet box in order to read the panel or circuit number.

.5 Cover plates:

.1 Protect cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

END OF SECTION

1. GENERAL

1.1 Section Includes

.1 Materials for moulded-case circuit breakers, and ground-fault circuit-interrupters.

1.2 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

1.3 References

.1 Canadian Standards Association (CSA International).

.1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 Submittals

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include time-current characteristic curves for breakers with ampacity of 50 A and over and with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

2. PRODUCTS

2.1 Breakers General

.1 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg C ambient.

.2 Common-trip breakers: with single handle for multi-pole applications.

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips.

.4 Circuit breakers with interchangeable trips as indicated.

.5 Circuit breakers to have minimum of 10,000 A symmetrical rms interrupting capacity rating in breaker panelboards.

.6 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers to have adjustable trips.

2.2 Thermal Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 Solid State Trip Breakers

.1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous, tripping for ground fault short circuit protection.

3. EXECUTION

3.1 Installation

.1 Install circuit breakers as indicated.

END OF SECTION

1. GENERAL

1.1 Section Includes

.1 Materials and installation for fused and non-fused disconnect switches.

1.2 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 26 05 01 - Common Work Results - Electrical.

.3 Section 26 28 14 - Fuses - Low Voltage.

1.3 References

.1 Canadian Standards Association (CSA International).

  .1 CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.

  .2 CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.

1.4 Submittals

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

2. PRODUCTS

2.1 Disconnect Switches

.1 Fusible and non-fusible disconnect switch in CSA Enclosure , size as indicated.

.2 Mechanically interlocked door to prevent opening when handle in ON position.

.3 Fuses: size as indicated, in accordance with Section 26 28 14 - Fuses - Low Voltage. Switch fuse units shall be available in 30 through 1200 amp standard industry sizes. They shall be readily removable and interchangeable without modification to bus work or mounting rails

.4 Fuseholders: suitable without adaptors, for type and size of fuse indicated.

.5 Quick-make, quick-break action.

.6 Fusible switches shall be quick-make, quick-break, visible blades, integral handle mechanism, deionizing arc quenchers, front operation, high pressure fuse clips and recessed live parts.

.7 Operating handles to have provision for padlocking in either ’on’ or ’off’ position.

.8 Handle to be marked to clearly indicate switch contact positions.

.9 Switch fuse units shall be available in 30 through 1200 amp standard industry sizes.

.10 Shall be readily removable and interchangeable without modification to bus work or mounting rails.

.11 All switches shall be manufactured by Siemens, Cutler Hammer or Schneider Electric.

2.2 Equipment Identification

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Lamecoid nameplates, approximately 75 mm x 25 mm, shall be provided on front doors of each switch for identification, showing the name and rating.

3. EXECUTION

3.1 Installation

.1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Section 26 05 01 - Common Work Results - Electrical.

1.2 References

.1 National Electrical Manufacturers Association (NEMA)

1.3 Shop Drawings And Product Data

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate:

- .1 Mounting method and dimensions.
- .2 Starter size and type.
- .3 Layout of identified internal and front panel components.
- .4 Enclosure types.
- .5 Wiring diagram for each type of starter.
- .6 Interconnection diagrams.

1.4 Closeout Submittals

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Include operation and maintenance data for each type and style of starter.

1.5 Extra Materials

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Provide listed spare parts for each different size and type of starter:

- .1 2 contacts, auxiliary.
- .2 1 operating coil.
- .3 2 fuses.

2. PRODUCTS

2.1 Materials

.1 For all motors, provide circuit and thermal protection on all lines except neutral.

.2 For all pumps not controlled by VFD’s, provide hour meters for each visible on the motor control centre doors. All magnetic starters located outside of motor control centres shall contain hour meters.

.3 All contactors shall be NEMA rated contactors.

2.2 Manual Motor Starters

.1 Single or Three phase manual motor starters as shown of size, type, rating, and enclosure type as indicated, with components as follows:

.1 Switching mechanism, quick make and break.

.2 overload heater(s) for each phase, manual reset, trip indicating handle.

.3 Thermal switches for small fractional KW motors shall be single or 2 pole as required.

.4 In all cases, locate within 9000 mm and in sight of motor

.2 Accessories:

.1 Toggle switch: industrial standard type labelled as indicated.

.2 Indicating light: standard neon type and colour as indicated.

.3 Locking tab to permit padlocking in "ON" or "OFF" position.

.4 thermal relay

2.3 <u>Full Voltage Magnetic Starters</u>

.1 Combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated, rapid action type.

.2 Motor overload protective device in each phase, manually reset from outside enclosure.

.3 Wiring and schematic diagram inside starter enclosure in visible location.

.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.5 All starters shall be combination starters c/w quick-make, quick-break, switch, fuse and magnetic starter c/w red and green indicator lights

.6 H.O.A. switch operator controls

.7 Provide primary fuse for control transformer.

.8 Starters shall not be equipped with an automatic thermal overload reset.

.9 Tin plated stab on connectors are acceptable.

.2 Combination type starters to include fused disconnect switch with operating lever on outside of enclosure to control disconnect, and provision for:

.1 Locking in "OFF" position with up to 3 padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to "ON" position while enclosure door open.

.4 Fusing shall be Form I, NEMA "J", HRC, 200,000 amps current limiting type.

.3 Accessories:

.1 Pushbuttons and Selector switches: standard labelled as indicated.

.2 Indicating lights: standard type and color as indicated.

.3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

.4 The overload relays shall be the ambient temperature compensated type, and the trip rating of a specific heater element shall be field adjustable over a range of approximately 85% + 115% of its respective rating.

2.4 Full Voltage Reversing Magnetic Starters

.1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated, rapid action type.

.2 Motor overload protective device in each phase, manually reset from outside enclosure.

.3 Wiring and schematic diagram inside starter enclosure in visible location.

.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.5 All combination starters shall be quick-make, quick-break, switch, fuse and magnetic starter c/w red and green indicator lights

.6 H.O.A. switch operator controls

.7 Provide primary fuse for control transformer.

.8 Starters shall not be equipped with an automatic thermal overload reset.

.2 Combination type starters to include fused disconnect switch with operating lever on outside of enclosure to control disconnect, and provision for:

.1 Locking in "OFF" position with up to 3 padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to "ON" position while enclosure door open.

.4 Fusing shall be Form I, NEMA "J", HRC, 200,000 amps current limiting type. See Section 16475 for further fuse requirements.

.3 Accessories:

.1 Pushbuttons and Selector switches: standard labelled as indicated.

.2 Indicating lights: standard type and color as indicated.

.3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

.4 The overload relays shall be the ambient temperature compensated type, and the trip rating of a specific heater element shall be field adjustable over a range of approximately 85% + 115% of its respective rating.

2.5 Control Transformer

.1 Single phase, dry type, control transformer with primary voltage as indicated and 120V secondary, complete with secondary fuse, installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.6 Finishes

.1 Apply finishes to enclosure in accordance with Section 26 05 01 - Common Work Results - Electrical.

2.7 Equipment Identification

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

.3 The plates shall be attached with two self-tapping metal screws.

3. EXECUTION

3.1 Installation

.1 Install starters, connect power and control as indicated.

.2 For each motor controlled by a variable frequency drive, provide a grounding conductor from the motor case to the motor central centre internal grounding terminal.

.3 Ensure correct fuses and overload devices elements installed.

.4 Each manufacturer shall have a local Saskatchewan service capability.

.5 All motor control equipment shall be of the same manufacture.

.6 Install starters, connect power and control as indicated.

.7 Ensure correct fuses and overload devices elements installed.

.8 The drives shall be cleared of all ambient construction dust prior to commissioning or the energizing of the drive.

.9 Provide a disconnect for each motor within the room or area that the motor is located. All disconnects shall be sized in accordance with kilowatt ratings of the motor being isolated and shall be quick-make, quick-break type, equipped with lock-off feature.

.10 Within 900 mm of each motor, provide flexible Sealtite conduit. Provide a separate ground wire bridging the flexible connections.

.11 All conduit entering top of motor starter shall be c/w water tight connectors with silicone based caulking.

.12 Control wiring shall be stranded TEW 105°C (220°F) rise.

.13 Terminal blocks for remote interface shall be Weidmueller SAK6N or approved equal.

.14 Provide wire markers at both ends of all control wires, Electrovert Type Z or approved equal

.15 Provide separate conduits for VFD control wiring from input and output power wiring.

.16 Provide #6 bare copper ground from each grounding point on AHU’s with packaged VFD to the building ground grid. DO NOT loop or series connect multiple VFD ground cables.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and manufacturer’s instructions.

.2 Provide factory certified copies of production test results to the Consultant prior to shipment of the equipment.

.3 Operate switches, contactors to verify correct functioning.

.4 Perform starting and stopping sequences of contactors and relays.

.5 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION