

PROJECT MANUAL

FOR

**GOVERNMENT OF CANADA
MULTI PURPOSE TRAINING FACILITY
MECHANICAL RENOVATION**

DATE: December 19, 2016

PREPARED BY:

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Project No 2016041.01

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PART 1 WORK COVERED BY THE CONTRACT DOCUMENTS

- 1.1 Work of this Contract comprises installation of ventilation systems at the **Multi Purpose Training Facility** in **Regina, Saskatchewan**.

PART 2 WORK BY OTHERS

- 2.1 The Owner reserves the right to let other contracts in connection with other parts of the Project, of which the Work pursuant to this Contract is a part, and the Contractor shall, in conjunction with the Consultant, schedule his Work with that of the Other Contractor(s) and/or the Owner.
- 2.2 If any part of the Contractor's Work depends for its proper execution or result upon the Work of any Other Contractor or the Owner's own forces, the Contractor shall in writing report promptly to the Owner any defect in the work of such Other Contractor as may interfere with the proper execution of the Contractor's Work.
- 2.3 Should the Contractor fail to adequately inspect or report defects as set out above, he shall have no claim against the Owner by reason of the defective or unfinished Work of any Other Contractor or Owner's own forces except as to latent defects not reasonably observable at, or prior to commencement of the Contractor's Work.
- 2.4 In letting separate contracts the Owner shall be responsible for the co-ordination of fire and other insurance coverage.
- 2.5 The Owner reserves the right to do work with his own forces in connection with the Project, subject to the above conditions.
- 2.6 Work of the Project executed prior to the start of the Work of this Contract, and which is specifically excluded from this Contract, includes:
- 2.6.1 None.
- 2.7 Work of the Project which will be executed during the Work of this Contract, and which is specifically excluded from this Contract, includes:
- 2.7.1 None.

PART 3 WORK SEQUENCE

- 3.1 Cooperate and coordinate with Other Contractor(s) doing work within the Building, and outside of the Building.
- 3.2 It is anticipated that the work will be completed by June 30, 2017.

PART 4 HOURS OF WORK

- 4.1 The building will be occupied and remain functional while construction is being completed.
- 4.2 The Contractor may only work in occupied areas of the building outside of normal office hours (i.e. from 5:00 p.m. to 8:00 a.m.), plus all day Saturdays, Sundays, and Holidays.
- 4.3 Work may be performed in occupied areas of the building during normal office hours and over the noon hour only with the specific permission of the Owner.
 - 4.3.1 The Owner will provide on a regular and updated basis the training schedules for all areas of the building outlining which areas of the building will be occupied, and when. The Contractor will be required to not work in the areas where training is taking place in accordance with these schedules.
 - 4.3.2 If working in public corridors during occupied hours, a path is to be kept clear for movement of people through the corridor.
 - 4.3.3 The Contractor may work in other parts of the building at any time.
- 4.4 All noisy work must be done outside of normal office hours.

PART 5 PROJECT COORDINATION

- 5.1 Coordinate progress of the Work, progress schedules, submittals, use of site, temporary utilities, and construction facilities.

PART 6 LAYOUT OF WORK

- 6.1 Prior to commencing the Work, establish existing building lines, check and examine site conditions, confirm accuracy of bench marks and evaluation of existing grades, and obtain and confirm site and building dimensions. Notify the Consultant in writing of any and all matters which could prejudice the proper execution of the Work.
- 6.2 Commencement of Work, or any part thereof, constitutes acceptance of site conditions and indicates that dimensions have been verified and are acceptable.
- 6.3 Lay out main lines and levels of Work in relation to designated reference points and bench marks.
- 6.4 Be responsible for movement and/or damage and replace reference points and bench marks.

PART 7 CUTTING AND PATCHING

7.1 APPROVALS

7.1.1 Submit written request in advance of cutting or alteration which affects:

7.1.1.1 Structural integrity of any element of the Project.

7.1.1.2 Integrity of weather-exposed or moisture-resistant elements.

7.1.1.3 Efficiency, maintenance, or safety of any operational element.

7.1.1.4 Visual qualities of sight-exposed elements.

7.1.1.5 Work of Owner or Other Contractor(s).

7.2 INSPECTION

7.2.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

7.2.2 After uncovering, inspect conditions affecting performance of Work.

7.2.3 Beginning of cutting or patching means acceptance of existing conditions.

7.3 EXECUTION

7.3.1 Execute cutting, fitting, and patching to complete the Work.

7.3.2 Remove and replace defective and non-conforming Work.

7.3.3 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical work.

7.3.4 Execute Work to avoid damage to other work.

7.3.5 Prepare proper surfaces to receive patching and finishing.

7.3.6 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.

7.3.7 Restore Work with new products in accordance with Contract Documents.

7.3.8 Fit work airtight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.

7.3.9 At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with fire-rated material specified in the Contract Documents, full thickness of the construction element.

- 7.3.10 Refinish surfaces to match adjacent finished; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

PART 8 PROJECT MEETINGS

- 8.1 The Consultant will schedule and administer Project progress meetings throughout the progress of the Work.
- 8.2 The Owner will provide physical space and make arrangements for meetings.
- 8.3 The Consultant will record and distribute the meeting minutes.

PART 9 SUBMITTALS

9.1 ADMINISTRATIVE

- 9.1.1 Submit to Consultant submittals listed for review. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in the Work.
- 9.1.2 Work affected by the submittal shall not proceed until review is complete.
- 9.1.3 Review submittals prior to submission to the Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with the requirements of the Work and the Contract Documents.
- 9.1.4 Verify field measurements and affected adjacent Work are coordinated.

9.2 SHOP DRAWINGS AND PRODUCT DATA

- 9.2.1 The term Shop Drawings shall include shop drawings, setting drawings, diagrams, illustrations, schedules, charts, materials, data and other information or related notes used by manufacturers and fabricators to detail and clarify portions of the Work.
- 9.2.2 The Contractor shall prepare a schedule, fixing the dates for the submission of Shop Drawings for the beginning of manufacture and installation of materials and for the completion of the various parts of the Work.
- 9.2.3 The Contractor shall furnish to the Consultant, at proper times, all Shop Drawings which the Consultant may deem necessary.
- 9.2.4 The Contractor shall review and thoroughly check all Shop Drawings before they are submitted to the Consultant and so indicate by stamping and signing all Shop Drawings submitted. By so doing the Contractor represents that it has verified all measurements and field construction conditions and has examined the material requirements and has checked and coordinated each Shop Drawing with the requirements of the Work and the Contract Documents. Prior to submitting the Shop

Drawings, the Contractor shall alert the Consultant in writing of any departures in the Shop Drawings from the requirements of the Contract Documents.

- 9.2.5 The Consultant shall review the Shop Drawings noting his comments and changes thereon and the Contractor shall make any changes which the Consultant may require consistent with the Contract Documents, and shall submit sufficient copies of the revised Shop Drawings to the Consultant for review, all but four of which shall be returned to the Contractor if found to be acceptable by the Consultant.
 - 9.2.6 The Consultant shall review the revised Shop Drawings noting his comments and changes thereon. Should additional changes be called for, the Contractor shall make all such changes and resubmit in the same manner as outlined above and, if necessary, repeat the process until all required changes are made and "Review Completed" is noted on the Shop Drawings.
 - 9.2.7 The Consultant's review of Shop Drawings or the revised Shop Drawings shall not relieve the Contractor from responsibility for errors made by the Contractor therein or for changes made from the Consultant's Plans or Specifications not covered by a Contractor's written notification to the Consultant.
 - 9.2.8 The review of Shop Drawings by the Consultant is for the purpose of confirming general configuration only. The Contractor shall be solely responsible for actual measurements and dimensions.
 - 9.2.9 Submit one electronic copy in PDF format of shop drawings to the consultant for review. Maximum sheet size 8 ½" x 14".
- 9.3 SAMPLES
- 9.3.1 The Contractor shall furnish, for the Consultant's approval, such samples as the Consultant may require. The Work shall be in accordance with approved samples. Materials, methods, finishes utilized in the Work shall at all time be consistent with the approved samples.
- 9.4 OPERATION AND MAINTENANCE MANUALS
- 9.4.1 The Contractor shall supply three (3) hard bound copies of operating and maintenance manuals and manufacturers' instructions to the Consultant, in reference to the Plant, material and equipment installed, for delivery to the Owner prior to Substantial Completion. Manuals shall be prepared under the following headings and shall include:
 - 9.4.1.1 Introduction - explain, in general, the purpose of the equipment and provide a schematic drawing of the complete system with a brief outline of its operation and limitations.
 - 9.4.1.2 Equipment List - itemize the various pieces of equipment, giving the name, type and model number and other information that will be pertinent for the

- operation of the equipment, and locating the piece of equipment in the Work and explaining its functions relevant to the operation of the Plant.
- 9.4.1.3 Equipment Setting and Adjustment - outline the latitude of various manual adjustments and settings that can be made and the effect of such changes on the operation of the equipment and the Work.
- 9.4.1.4 Preventative Maintenance - detail the requirements and provide an annual schedule for the minimum preventative maintenance required and the timing for each activity, necessary for warranty maintenance and economical longevity of operation for each piece of equipment. Information shall include but not be limited to: the types of lubricants needed, and frequency of application; calibration requirements; filter changes; treatment, and additives.
- 9.4.1.5 Parts List - include a breakdown of each piece of equipment detailing the parts that may be replaced and indicating the part number.
- 9.4.1.6 Shop Drawings - as related.
- 9.4.2 In addition to the three hardbound copies, also submit one copy in electronic (PDF format).
- 9.4.3 The Contractor shall provide training to the Owner's operating and maintenance personnel, in the method of operation, adjustment and maintenance of all mechanical and electrical equipment and systems, all to the Owner's satisfaction. Instructions shall be in the form of prepared lectures and on site demonstration to fully acquaint the staff in the operation and maintenance of heating, ventilation, air conditioning, refrigeration, fire protection, plumbing controls, and electrical systems, or other systems or equipment as may be pertinent, and as applicable to the Work.
- 9.4.4 The Owner shall not be responsible for takeover of equipment until the Contractor's responsibilities this section have been fulfilled.
- 9.4.5 During the tenth month following Substantial Completion, the Contractor shall examine the mechanical services and re-adjust and/or re-balance the systems as required to compensate for the drift in settings over the break-in period, generally attributed to newly configured systems. The Contractor shall immediately thereafter submit a brief technical report to the Consultant describing the findings and related actions taken.

9.5 RECORD DRAWINGS

- 9.5.1 The Contractor shall keep one copy of all Plans, Specifications and approved Shop Drawings of the Work, at the Site, in good order, and available to the Consultant and his representatives.

- 9.5.2 The Contractor shall maintain one complete set of all Plans exclusively to record as-built information and shall indicate thereon neatly, each and every field change, change in the Work from that set forth in the original Contract Documents, or component of the Work being covered which may require future access, as it occurs.
- 9.5.2.1 At project completion, this set of drawings shall be turned-over to the Consultant.
- 9.5.2.2 In addition to the drawing set noted above, the as-built drawings shall be scanned, and an electronic copy in PDF format shall be turned over to the Consultant on CD-ROM.
- 9.5.3 Inaccuracies in the information provided to the Consultant will be the responsibility of the Contractor. Costs to the Owner of rectifying the inaccuracies in the as-built drawings will be withheld from the Contractor's contract price.
- 9.5.4 The Contractor will be responsible for providing as-built Shop Drawings.
- 9.5.5 The Contractor cannot retain the Consultant for the preparation of the as-built drawings without the prior written consent of the Owner.

PART 10 SCHEDULE

10.1 SCHEDULES REQUIRED

- 10.1.1 Construction Progress Schedule.
- 10.1.2 Submittal Schedule for Shop Drawings, product data and samples.

10.2 FORMAT

- 10.2.1 Prepare schedule in the form of a horizontal bar chart.
- 10.2.2 Provide a separate bar for each trade of operation.
- 10.2.3 Provide a horizontal time scale identifying the first work day of each week.

10.3 SUBMISSION

- 10.3.1 Submit initial schedules within 15 days after award of Contract.
- 10.3.2 Submit one opaque reproduction, plus 2 copies to be retained by Consultant.
- 10.3.3 Consultant will review schedule and return reviewed copy within 10 days after receipt.
- 10.3.4 Resubmit finalized schedule within 7 days after return of reviewed copy.

PART 11 QUALITY CONTROL

11.1 INSPECTION

- 11.1.1 The Owner and the Consultant shall have access to the Work.
- 11.1.2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Consultant instructions, or the law of the place of Work.
- 11.1.3 If the Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have the inspections or tests satisfactorily completed and make good such Work.

11.2 INDEPENDENT INSPECTION/TESTING AGENCIES

- 11.2.1 Independent inspection/testing agencies shall be engaged by the Contractor for the purpose of inspecting and/or testing portions of Work. All costs of such services will be borne by the Contractor.
- 11.2.2 Employment of inspection/testing agencies does not relax the Contractor's responsibility to perform Work in accordance with the Contract Documents.
- 11.2.3 Allow the inspection/testing agencies access to all portions of the Work and manufacturing and/or fabrication plants. Cooperate to provide reasonable facilities for such access.
- 11.2.4 Notify the appropriate agency and Consultant well in advance of the requirements for tests, in order that attendance arrangements can be made.
- 11.2.5 Submit samples and/or materials required for testing as requested in the specifications. Submit with reasonable promptness and in an orderly sequence so as to cause no delay in the Work.
- 11.2.6 If defects are revealed during inspection and/or testing, the inspection/testing agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defects and irregularities as advised by the Consultant, at no cost to the Owner. Pay all costs for retesting and re-inspection.
- 11.2.7 The Consultant shall have the right to conduct, or engage independent inspection/testing agencies to conduct, such additional inspections and tests as the Consultant deems necessary. The cost for such testing shall be borne by the Owner.

11.3 REPORTS

- 11.3.1 Submit copies of inspection and test reports promptly to the Consultant and the Owner.

- 11.3.2 Provide copies to Sub-Contractor of Work being inspected/tested and manufacturer/fabricator of material being inspected/tested.

PART 12 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

12.1 INSTALLATION/REMOVAL

- 12.1.1 Provide construction facilities and temporary controls in order to execute the Work expeditiously.

- 12.1.2 Remove from site all such work after use.

12.2 HOARDING

- 12.2.1 Provide hoarding for the construction as necessary to complete the work.

12.3 WEATHER ENCLOSURES

- 12.3.1 Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.

- 12.3.2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work area for temporary heat.

12.4 DUST TIGHT SCREENS

- 12.4.1 Provide dust tight screens or partitions to localize dust generating activities, and for the protection of workers, finished areas of Work and the public.

- 12.4.2 Maintain and relocate protection until such Work is complete.

12.5 SITE ACCESS, STORAGE AND LOADING

- 12.5.1 Vehicle access to the Site shall be along the routes to be later identified by the Owner. Contractor shall not use other routes without the prior consent of the Owner.

- 12.5.2 Confine the Work and the operations of employees to within the facility. There shall be no laydown or storage area outside of the building. Do not unreasonably encumber the premises with Products.

- 12.5.3 The Owner will provide limited non-electrified parking for contractor employees on a gravelled surface.

- 12.5.4 Do not load or permit to be loaded any part of the Work with a weight or force that will endanger the Work.

12.6 TEMPORARY HEATING

- 12.6.1 Provide temporary heating required during construction period, until such time as permanent heating is available, including attendance, maintenance and fuel.
- 12.6.2 Construction heaters used inside the building must be vented to the outside or be flameless type. Solid fuel salamanders not permitted.
- 12.6.3 Maintain the following minimum temperatures in the building:
 - 12.6.3.1 10°C in areas where construction is in progress but are not occupied.
 - 12.6.3.2 20°C for occupied areas of the building, whether or not construction is taking place in the area.
- 12.6.4 Ventilate heated areas and keep building free of exhaust or combustion gases.
- 12.6.5 Maintain temporary heat in completed areas of the Work to prevent damage of the Work, including but not limited to damage due to freezing of sub-grade soil, sub-base fills and base course materials below grade supported concrete slabs and footings.

12.7 OTHER TEMPORARY FACILITIES

- 12.7.1 The Contractor shall provide and maintain a seasonally appropriate waterproof temporary office at the Site of sufficient size for the use of Consultant, Contractor, and Sub-Contractors, equipped with electric lights, heating equipment, plan table and plan racks, weather-tight windows and door, and necessary locks.
- 12.7.2 Locate temporary office on Site where directed, and remove when Work is completed.
- 12.7.3 The Contractor shall, at a location or locations directed, provide and maintain in a sanitary condition temporary toilet(s) as necessary.
- 12.7.4 The Contractor shall supply and furnish all equipment, plant, tools, machinery such as temporary ramps, barriers, stairs, ladders and other such construction materials, all of substantial construction, required to carry out the Work, and maintain these throughout the term of the Contract in good repair.
- 12.7.5 The Contractor shall arrange for and furnish at his own expense, all water, electricity, lighting, heating, and other utilities necessary for construction purposes. Temporary lighting shall be adequate for the use of Sub-Contractors during the construction. No part of any temporary system or temporary equipment shall be incorporated in the finished Work.
- 12.7.6 The Contractor shall remove all temporary work from the Site on or before Completion of the work.

12.7.7 The Contractor shall provide the Owner with written notice of at least ten (10) working days in advance if any interruption of utility service with confirmation 48 hours in advance.

12.8 EQUIPMENT/TOOL/MATERIALS STORAGE

12.8.1 Provide and maintain, in a clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.

12.8.2 Locate materials not required to be stored in weatherproof sheds on site in a manner to cause the least interference with work activities.

12.9 PROJECT CLEANLINESS

12.9.1 In addition to removal of rubbish, the Contractor shall replace any broken glass, remove stains, spots, marks and dirt from any finished Work, clean hardware, remove paint spots and smears from all surfaces, clean all fixtures, and wash all concrete and resilient floors, remove all errant spots, soil and paint by Completion.

12.9.2 In case of dispute, the Owner may remove all rubbish and perform all of the requirements of this section and deduct the cost of the clean-up from the Contract Price.

12.9.3 Remove waste material and debris from the site and deposit in waste container at the end of each working day.

PART 13 MATERIAL AND EQUIPMENT

13.1 PRODUCT AND MATERIAL QUALITY

13.1.1 Unless otherwise specified, the Contractor shall arrange, provide and pay for all supervision, labour, equipment, services, materials, Plant, real property, tools, transportation, utilities and other facilities and services necessary for the execution of the Work.

13.1.2 The Contractor shall employ in the Work only new materials and of the highest quality, consistent with those specified and acceptable to the Consultant and the Contract Documents.

13.1.3 The Contractor shall provide such temporary sheds, space or cover as required to adequately store, protect, and otherwise shelter materials and appliances delivered to, and accepted by the Contractor, at the Site.

13.1.4 The Contractor shall keep such records of all materials, Plant and real property referred to above as the Owner from time to time requires and shall satisfy the Owner, when requested, that such material, Plant and real property are at the place and in the condition in which they ought to be.

- 13.1.5 All materials and workmanship must comply with the latest edition of the National Building Code and revisions to date, Province of Saskatchewan Statutes and Regulations, and local By-laws.
- 13.1.6 Use products of one manufacturer for material and equipment of same type or classification unless otherwise specified.
- 13.1.7 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.
- 13.1.7.1 Notify Consultant in writing of any conflict between these specifications and manufacturers' instructions so that the Consultant may establish the course of action.
- 13.1.7.2 Improper installation or erection of products, due to failure in complying with these requirements, authorizes the Owner to require removal and re-installation at no increase in Contract Price.
- 13.1.8 Products, materials, equipment and articles (referred to as Products throughout the Specifications) incorporated in the Work shall be new, not damaged or defective, and of the best quality (compatible with Specifications) for the purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
- 13.1.9 Defective products, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is a precaution against oversight or error. Contractor shall remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.
- 13.1.10 Should any dispute arise as to the quality or fitness of Products, the decision rests strictly with the Consultant based upon the requirements of the Contract Documents.
- 13.2 STORAGE, HANDLING AND PROTECTION
- 13.2.1 Handle and store Products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- 13.2.2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact.
- 13.2.3 Store Products subject to damage from weather in weatherproof enclosures.
- 13.3 MANUFACTURERS' INSTRUCTIONS
- 13.3.1 Install or erect Products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.
- 13.3.2 Notify the Consultant in writing, of conflicts between the Specifications and manufacturer's instructions, so that the Consultant may establish the course of action.

- 13.3.3 Improper installation or erection of Products, due to failure in complying with these requirements, authorizes the Consultant to require removal and re-installation at no increase in Contract Price.

13.4 WORKMANSHIP

- 13.4.1 Workmanship shall be the best quality, executed by workers experienced and skilled in the respective duties for which they are employed. Immediately notify the Consultant if required Work is such as to make it impractical to produce required results.

- 13.4.2 Do not employ any unfit person or anyone unskilled in their required duties.

- 13.4.3 Decisions as to the quality or fitness of workmanship in cases of dispute rest solely with the Consultant, whose decision is final.

13.5 CONCEALMENT

- 13.5.1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.

- 13.5.2 Before installation, inform the Consultant if there is a contradictory situation. Install as directed by Consultant.

PART 14 FINAL CLEANING

- 14.1 Vacuum clean and dust building interiors, behind grilles, louvres and screens.

- 14.2 Broom clean and wash exterior walks, steps and surfaces.

PART 15 CODES, STANDARDS, AND PERMITS

- 15.1 Perform work in accordance with National Building Code of Canada (NBC) and Supplements, Fire Commission of Canada, provincial and municipal codes, and other codes or documents as specified with the text of the specifications. In any case of conflict or discrepancy, the more stringent requirements shall apply.

- 15.2 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.

- 15.3 Changes and alterations required by any authorized inspector or any authority having jurisdiction, shall be carried out at no additional cost.

PART 16 OWNERSHIP OF PLANS AND MODELS

- 16.1 Plans, Specifications, models and copies thereof furnished to the Contractor are the property of the Consultant and are not to be used on other projects.

PART 17 PUBLICITY RELEASES

- 17.1 The Contractor, Sub-Contractor and their staff shall not make any public presentation with regard to the Project without the prior written approval of the Owner.
- 17.2 There shall be no publicity releases in connection with the Project without prior approval in writing of the Owner.

PART 18 CONSTRUCTION SIGN(S)

- 18.1 The Contractor shall not permit any sign to be posted on or adjacent to the Site, without written consent of the Owner, and in accordance with details submitted to and approved by the Owner. All such supplementary signage shall be paid for by the requesting party.

PART 19 CUTTING, PATCHING AND DIGGING

- 19.1 The Contractor shall do all cutting, fitting or patching of the Work that may be required to make it fit to receive or be received by work of the Other Contractor(s) shown upon, or reasonably implied by, or in the Contract Documents.
- 19.2 The Contractor shall not endanger any existing Work by cutting, digging or otherwise, and shall not cut or alter the Work of any Other Contractor save with the consent of the Consultant.
- 19.3 Prior to digging all underground utilities and services shall be located by the Contractor.
- 19.4 Contractor shall be responsible for damages caused by cutting, digging or alterations.

PART 20 CERTIFICATION INSPECTIONS AND TAKEOVER PROCEDURES

- 20.1 Where the Contractor's judgement the value of outstanding Work and deficiencies may permit the Certification of Substantial Performance in accordance with the Builders' Lien Act, the Contractor shall provide reasonable notice to the Consultant requesting an inspection for Certification. Before Substantial Performance can be requested all as-built drawings, warranties and operating manuals etc. must be completed, submitted and reviewed by the Consultant.
- 20.2 Following receipt of the Contractor's written request, the Consultant shall, if he deems the Work ready for inspection, advise the Contractor of the date that the inspection shall take place.

- 20.3 Inspections shall require in addition to the presence of the Contractor, Consultant and Owner's representative, the attendance of Sub-Contractors and Sub-Consultants, related to the specific examination and having full knowledge of the Work to that point.
- 20.4 Prior to the issuance of a Substantial Performance Certificate, the Consultant shall jointly, with his Sub-Consultants, prepare a written list of deficiencies and outstanding Work which shall be distributed to all those who attended the inspection and the Owner. Failure to include an item on the list does not alter the responsibility of the Contractor to complete the requirements of the Contract Documents relating to that item. The inspection report shall list Work that has not been completed due to special conditions, stating what these special conditions are and may specify a suitable completion holdback pursuant to the Builders' Lien Act.
- 20.5 Where the certified value of outstanding work and deficiencies negate the issuance of Certificate of Substantial Performance, following further progress by the Contractor and upon further notice, a subsequent inspection will be made to determine if deficiencies have been corrected and a supplementary inspection report will be issued. The cost and expenses of the Consultant for repeat inspections will be deducted from the Contract Price by the Owner.
- 20.6 When the outstanding Work and remaining deficiencies have been corrected to the degree required under the Builders' Lien Act, and certified acceptable to the Consultant, the latter shall issue a Certificate of Substantial Performance.
- 20.7 Upon the receipt of the Certificate of Substantial Performance, the Contractor shall submit his request for holdback release, which shall be administered in accordance with the Builder's Lien Act.
- 20.8 Prior to the submission of the final request for payment provide certified copies of all extended warranties to the Owner.

PART 21 CORRECTION AFTER SUBSTANTIAL PERFORMANCE

- 21.1 Subject to any special provisions in the Contract Documents, and extensions for latent deficiencies, the Contractor shall remedy any defects due to faulty materials or workmanship appearing within a period of one year from the date of the Certificate of Substantial Performance and shall pay for any consequential damage to other work resulting there from which appears within such period.
- 21.2 This article shall not be deemed to restrict any liability of the Contractor arising out of any law in force in the Province of Saskatchewan.

PART 22 WARRANTY PERIOD EXAMINATION

- 22.1 Ten months following the date on the Certificate of Substantial Performance, the Contractor, the Owner and the Consultant shall together examine the building to determine any deficiencies in materials or workmanship which have occurred or become apparent since the date of Substantial Performance.

- 22.2 The Consultant shall list all deficiencies and notify the Contractor to rectify such deficiencies within the two month period prior to the end of the one year warranty period.
- 22.3 Immediately before the end of the one year warranty period the Consultant, the Owner and the Contractor shall make a final examination of the Work to assure that the deficiencies recorded at the ten month examination have been corrected by the Contractor.
- 22.4 The warranty shall be extended beyond one year after notice of a deficiency in accordance with this section until such time as the deficiency is certified by the Consultant as remedied.

- END OF SECTION -

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 SECTION INCLUDES

- .1 Shop fabricated ferrous metal items galvanized and prime painted.

1.2 RELATED SECTIONS

- .1 Section 08 11 00 – Hollow Metal Doors and Frames.
- .2 Section 09 90 00 - Painting: Paint finish.

1.3 REFERENCES

- .1 ASTM A36 - Structural Steel.
- .2 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- .3 ASTM A283 - Carbon Steel Plates, Shapes, and Bars.
- .4 ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
- .5 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures.
- .6 CSA W47.2 - Certification of Companies for Fusion Welding of Aluminum.
- .7 CSA W55.3 - Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.
- .8 CSA W59 - Welded Steel Construction (Metal Arc Welding).
- .9 SPCC - Society for Protective Coatings (formerly Steel Structures Painting Council):
 - .1 Steel Structures Painting Manual.

1.4 SUBMITTALS FOR REVIEW

- .1 Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
- .2 Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

1.5 QUALITY ASSURANCE

- .1 Conform to CSA W47.1, CSA W47.2, CSA W55.3, CSA W59.

Part 2 PRODUCTS

2.1 MATERIALS - STEEL

- .1 Steel Sections: ASTM A36.

- .2 Steel Tubing: ASTM A500, Grade B.
- .3 Plates: ASTM A283.
- .4 Pipe: ASTM A53, Grade B Schedule 40.
- .5 Bolts, Nuts, and Washers: ASTM A325.
- .6 Welding Materials: Type required for materials being welded.

2.2 FABRICATION GENERAL

- .1 Fit and shop assemble items in largest practical sections, for delivery to site.
- .2 Fabricate items with joints tightly fitted and secured.
- .3 Continuously seal joined members by continuous welds.
- .4 Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- .5 Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- .6 Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.3 FABRICATION TOLERANCES

- .1 Squareness: 3 mm maximum difference in diagonal measurements.
- .2 Maximum Offset Between Faces: 1.5 mm.
- .3 Maximum Misalignment of Adjacent Members: 1.5 mm.
- .4 Maximum Bow: 3 mm in 1.2 m.
- .5 Maximum Deviation From Plane: 1.5 mm in 1.2 m.

2.4 FINISHES - STEEL

- .1 Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- .2 Do not prime surfaces in direct contact with concrete or where field welding is required.
- .3 Prime paint items with one coat.

Part 3 EXECUTION

3.1 EXAMINATION

- .1 Verify that field conditions are acceptable and are ready to receive work.

3.2 PREPARATION

- .1 Clean and strip primed steel items to bare metal where site welding is required.

3.3 INSTALLATION

- .1 Install items plumb and level, accurately fitted, free from distortion or defects.
- .2 Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- .3 Field weld components indicated on shop drawings.
- .4 Perform field welding in accordance with AWS D1.1.
- .5 Obtain approval prior to site cutting or making adjustments not scheduled.
- .6 After erection, prime welds, abrasions, and surfaces not shop primed.

3.4 ERECTION TOLERANCES

- .1 Maximum Variation From Plumb: 6 mm per story, non-cumulative.
- .2 Maximum Offset From True Alignment: 6 mm.
- .3 Maximum Out-of-Position: 6 mm.

3.5 SCHEDULE

- .1 The following Schedule is a list of principal items only. Refer to Drawing details for items not specifically scheduled.
- .2 Schedule each fabrication separately. Describe items, size, shape, materials, finish, and other relevant information.
- .3 Ledge, Shelf, and Support Angles, Channels and Plates Not Attached to Structural Framing: For support of mechanical units; prime paint finish.
- .4 Door Frames and Wall Openings: Angle sections; prime paint finish.

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 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.

1.5 QUALITY ASSURANCE

- .1 Perform Work in accordance with the following agencies:
 - .1 Lumber Grading Agency: Certified by NLGA.

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 Veneer 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 EPDM roofing cutting and patching.

1.2 RELATED SECTIONS

- .1 Section 06 10 53 – Rough Carpentry: Wood curbs.
- .2 Division 22, 23 - Mechanical roof openings.
- .3 Division 26 - Openings in roof system for electrical equipment.

1.3 REFERENCES

- .1 ASTM A653 – Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .2 CRCA (Canadian Roofing Contractors Association) "Roofing Specification"

1.4 SYSTEM DESCRIPTION

- .1 EPDM Roofing System: cutting and patching of roof system to accommodate new openings and infill abandoned openings.

1.5 QUALITY ASSURANCE

- .1 Perform Work in accordance with CRCA Roofing Manual.

1.6 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 three years documented experience and approved by manufacturer.

1.7 REGULATORY REQUIREMENTS

- .1 Conform to applicable code for roof assembly fire hazard requirements.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.
- .2 Store products in weather protected environment, clear of ground and moisture.

1.9 ENVIRONMENTAL REQUIREMENTS

- .1 Do not apply roofing membrane during unsuitable weather when ambient temperature is below -10 degrees C.

- .2 Do not apply roofing membrane to damp or frozen deck surface or when precipitation is occurring.
- .3 Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.10 COORDINATION

- .1 Coordinate the work with installation of associated roof penetrations.

PART 2 PRODUCTS

2.1 ROOFING MATERIALS

- .1 Roofing system materials shall match existing.
- .2 Provide materials of the same thickness as original roof.

2.2 FLASHINGS

- .1 Galvanized Steel: ASTM A653/A653M, G90 zinc coating; 24 ga. core steel.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Verify that surfaces and site conditions are ready to receive work.
- .2 Verify deck is supported and secure.
- .3 Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped to drains and suitable for installation of roof system.
- .4 Verify deck surfaces are dry and free of snow or ice.
- .5 Verify roof openings, curbs, and penetrations through roof are solidly set, and wood cant strips are in place.

3.2 PREPARATION

- .1 Cut back existing roof in stages exposing 300 mm of each successive roofing layer.

3.3 APPLICATION

- .1 Repair roofing at all locations damaged or demolished to accommodate new work.
- .2 Ensure that each layer repair is offset from the proceeding layer by 300 mm.
- .3 Match roofing thickness to match existing.

3.4 FLASHINGS AND ACCESSORIES

- .1 Apply galvanized steel base flashings over new curbs complete with 'S' lock vertical seams.

- .2 Mop in and seal flashings and flanges of items penetrating membrane with two plies of felt.
- .3 Counter-flash all mechanical and electrical items projecting through membrane roofing

3.5 CLEANING

- .1 Remove bituminous markings from finished surfaces.
- .2 In areas where finished surfaces are soiled by bitumen or any other source of soiling caused by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
- .3 Repair or replace defaced or disfigured finishes caused by work of this section.

3.6 PROTECTION OF FINISHED WORK

- .1 Where traffic must continue over finished roof membrane, protect surfaces.

END OF SECTION

PART 1 General

1.1 SECTION INCLUDES

- .1 Fireproof firestopping materials and accessories.

1.2 RELATED SECTIONS

- .1 Section 07 92 00 – Joint Sealants.
- .2 Section 09 21 16 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.3 REFERENCES

- .1 CAN /ULC-S115-1995, Fire Tests of Firestop Systems, Underwriter's Laboratories of Canada (ULC)
- .2 ULC - Fire Hazard Classifications.
- .3 WH (Warnock Hersey) - Certification Listings.
- .4 ULC-S115, Standard Method of Fire Tests of Firestop Systems.

1.4 SYSTEM DESCRIPTION

- .1 Firestopping Materials: ULC to achieve a fire rating as noted on Drawings.
- .2 Firestop all interruptions to fire rated assemblies, materials, and components.
- .3 Fire stopping and smoke seal systems: in accordance with CAN4-S115.

1.5 SUBMITTALS

- .1 Product Data: Provide data on product characteristics, performance and limitation criteria.
- .2 Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- .3 Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- .4 Provide cut sheets of each fire stop type with test No. and products installed.

1.6 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

- .1 Conform to applicable code for fire resistance ratings and surface burning characteristics.
- .2 All fire stopping products to be ULC listed for each system and penetration type.

- .3 Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material for recycling in accordance with Construction Waste Management Plan.
- .2 Dispose of unused sealant materials at official hazardous material collections site approved by Consultant.
- .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.

1.9 ENVIRONMENTAL REQUIREMENTS

- .1 Apply materials within the temperature range as recommended by the manufacturer.
- .2 Maintain this temperature before, during, and for 3 days after installation of materials.

1.10 SEQUENCING

- .1 Sequence work to permit firestopping materials to be installed after adjacent and surround work is complete.

PART 2 Products

2.1 MATERIALS

- .1 Fire stopping and smoke seal systems: asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of CAN4-S115 and not to exceed opening sizes for which they are intended in accordance with CAN4-S115.
- .2 Acceptable Manufactures:
 - .1 Tremco Inc.
 - .2 Bio Fireshield.
 - .3 Johns Manville.
 - .4 Hilti.
 - .5 A/D Fire Protection Systems Inc.

2.2 ACCESSORIES

- .1 Primer: Type recommended by firestopping manufacturer for specific substrate surfaces.
- .2 Dam Material: mineral fibreboard, permanent.
- .3 Installation Accessories: Clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

PART 3 Execution

3.1 EXAMINATION

- .1 Verify openings are ready to receive the work of this section.

3.2 PREPARATION

- .1 Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter which may affect bond of firestopping material.
- .2 Remove incompatible materials which may affect bond.
- .3 Install backing and damming materials to arrest liquid material leakage.

3.3 APPLICATION

- .1 Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.
- .2 Install firestop materials in accordance with published ULC systems.
- .3 Apply primer and materials in accordance with manufacturer's instructions.
- .4 Apply firestopping material in sufficient thickness to achieve rating.
- .5 Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
- .6 Dam material to remain.

3.4 CLEANING

- .1 Clean adjacent surfaces of firestopping materials.

3.5 PROTECTION OF FINISHED WORK

- .1 Protect adjacent surfaces from damage by material installation.

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 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 Capability 25 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 Non-rated, and fire rated steel frames.
- .2 Non-rated and fire rated steel doors.

1.2 RELATED SECTIONS

- .1 Section 08 71 00 - Door Hardware: Hardware, silencers, and weather-stripping.
- .2 Section 09 90 00 - Painting: Field painting of frames.

1.3 REFERENCES

- .1 ANSI A117.1 - Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
- .2 CSDFMA (Canadian Steel Door and Frame Manufacturers Association).
- .3 DHI - Door Hardware Institute: The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors in Wood Frames and Builder's Hardware.
- .4 NFPA 80 - Fire Doors and Windows.
- .5 NFPA 252 - Fire Tests for Door Assemblies.
- .6 SDI-100 - Standard Steel Doors and Frames.
- .7 UL 10B - Fire Tests of Door Assemblies.

1.4 SUBMITTALS

- .1 Product Data: Indicate frame configuration and finishes. Indicate door configurations, location of cut-outs for hardware reinforcement.
- .2 Shop Drawings: Indicate frame elevations, reinforcement, anchor types and spacings, location of cut-outs for hardware, and finish. Indicate door elevations, internal reinforcement, closure method, and finishes.

1.5 QUALITY ASSURANCE

- .1 Conform to requirements of CSDFMA SDI-100 and ANSI A117.1.
- .2 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- .1 Fire Rated Frame Construction: Conform to UL 10B.

- .2 Installed Door and Frame Assembly: Conform to NFPA 80 for fire rated class as scheduled.

1.7 PROJECT CONDITIONS

- .1 Coordinate the work with frame opening construction, door, and hardware installation.
- .2 Sequence installation to ensure wire connections are achieved in an orderly and expeditious manner.

Part 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- .1 Fleming
- .2 Shanahans
- .3 Allmar

2.2 FRAMES

- .1 Frames: 0.058-inch-thick material, base metal thickness with ZF75 Colourbond coating.
- .2 Removable Stops: Rolled steel shape, mitered corners; prepared for countersink style tamper proof screws.
- .3 Anchors: purpose made to rigidly secure frames, 3 per jamb.
- .4 Bituminous Coating: Fibered asphalt emulsion.
- .5 Primer: Zinc chromate type.
- .6 Silencers: Resilient rubber set in steel fitted into drilled hole.
- .7 Insulation: Fibreglass.

2.3 DOORS

- .1 Honeycomb Core Doors: minimum, 1.2 mm surface sheets and, top and bottom end channels; cores filled with honeycomb material laminated under pressure to surface sheets.
- .2 Fire Rated Doors: Minimum, 1.2 mm surface sheets and, top and bottom end channels, of ULC label requirements indicated on drawings.
- .3 Reinforcement for hardware:
 - .1 Locks: minimum 1.52 mm steel.
 - .2 Butts: minimum 3.42 mm steel.
 - .3 Flush Bolts: minimum 3.42 mm steel.
 - .4 Door Closures: minimum 1.9 mm steel.

2.4 FABRICATION FRAMES

- .1 Fabricate frames as welded unit.
- .2 Reinforce frames wider than 1 200 mm with roll formed steel channels fitted tightly into frame head, flush with top.
- .3 Prepare frames for silencers. Provide two single silencers on frame head at double doors without mullions.
- .4 Attach fire rated label to each fire rated door unit.
- .5 Provide drywall returns on all frames.
- .6 Attach channel spreaders at bottom of frames for shipping.

2.5 FABRICATION - DOORS

- .1 Fabricate hollow metal doors and panels in accordance with requirements of "Canadian Manufacturing Standards for Steel Doors and Frames" produced by the Canadian Steel Door and Frame Manufacturer's Association and as indicated on Drawings. Fabricate doors with hardware reinforcement welded in place.
- .2 Fabricate fire rated hollow metal doors in accordance with requirements of Underwriters Laboratories of Canada (ULC). Place ULC labels where visible when in installed position.
- .3 Longitudinal seams: Mechanically interlocked, continuously welded, filled and sanded with no visible edge seams. Top and bottom of doors closed with end channels recessed and spot welded in place.
- .4 Reinforce and prepare doors to receive hardware. Refer to Section 08 71 00 for hardware requirements.
- .5 Each exterior hollow metal door to be supplied complete with a full minimum 3.42 mm anti-intrusion plate welded to latch side of door.

Part 3 EXECUTION

3.1 EXAMINATION

- .1 Verify that opening sizes and tolerances are acceptable.

3.2 INSTALLATION

- .1 Install frames in accordance with CSDFMA.
- .2 Coordinate with masonry, gypsum board, concrete wall construction for anchor placement.
- .3 Install metal door frames in fire rated gypsum board walls in accordance with NFPA 80 and the Manitoba Building code.

- .4 Coordinate installation of glass and glazing.
- .5 Coordinate installation of doors and frames with installation of hardware specified in Section 08 71 00
- .6 Install roll formed steel reinforcement channels between two abutting frames. Anchor to structure and floor.
- .7 After installation, touch up all scratched or damaged surface and prime.
- .8 Insulate all frames exposed to the exterior.
- .9 Install door louvers, plumb and level.

3.3 ERECTION TOLERANCES

- .1 Maximum Diagonal Distortion: 1.5 mm measured with straight edges, crossed corner to corner.
- .2 Clearance on steel doors at head and jambs shall be: 3 mm maximum, and 3 mm maximum between pairs of doors

3.4 ADJUSTING

- .1 Adjust door for smooth and balanced door movement.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Hardware for hollow steel doors.
- .2 Thresholds.
- .3 Weatherstripping, seals, and door gaskets.

1.2 RELATED SECTIONS

- .1 Section 08 11 00 - Metal Doors and Frames.

1.3 REFERENCES

- .1 DHI (Door Hardware Institute) - A115 series.
- .2 DHI (Door Hardware Institute) - WDHS.3 - Hardware Locations for Wood Flush Doors.

1.4 SUBMITTALS FOR REVIEW

- .1 Shop Drawings:
 - .1 Indicate locations and mounting heights of each type of hardware, schedules, catalogue cuts, electrical characteristics and connection requirements.
 - .2 Submit manufacturer's parts lists, and templates.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- .2 Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 10 years documented experience.
- .2 Hardware Supplier Qualifications: Company specializing in supplying commercial institutional door hardware with years documented experience. approved by manufacturers.

1.7 DELIVERY, STORAGE, AND PROTECTION

- .1 Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

1.8 PROJECT CONDITIONS

- .1 Coordinate the work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware and recessed items.
- .2 Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
- .3 Coordinate Owner's keying requirements during the course of the Work.

1.9 MAINTENANCE PRODUCTS

- .1 Provide special wrenches and tools applicable to each different or special hardware component.
- .2 Provide maintenance tools and accessories supplied by hardware component manufacturer.

Part 2 Products

2.1 MANUFACTURERS

- .1 Refer to hardware schedule listed at the end of this specification section.

2.2 DOOR HARDWARE

- .1 Butts; Provide 1 - ½ pair for all doors, except doors over 900 mm wide or over 2200 mm high are to have 2 pair.

2.3 KEYING

- .1 Door Locks: Key to existing keying system.

2.4 FINISHES

- .1 Finishes: Identified in Schedule at end of section.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that doors and frames are ready to receive work and dimensions are as indicated on shop drawings.

3.2 INSTALLATION

- .1 Install hardware in accordance with manufacturer's instructions.
- .2 Use templates provided by hardware item manufacturer.
- .3 Mounting heights for hardware from finished floor to centre line of hardware item:

- .1 Locksets: 1024 mm.
- .2 Push/Pulls: 1067 mm.
- .3 Dead Locks: 1200 mm.
- .4 Levers and Exit devices - 950mm
- .5 All other door operating devices to be mounted as per DHI A115 Series, except maximum height to be limited to 1100mm.

3.3 ADJUSTING

- .1 Adjust hardware for smooth operation.

3.4 PROTECTION OF FINISHED WORK

- .1 Do not permit adjacent work to damage hardware or finish.

3.5 SCHEDULE

- .1 Hardware Set #1:

6 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Flush Bolt	2845	US26D	RO
1 Storeroom Lock (F07)	8204 LL	US26D	SA
1 Coordinator	2600 Series x Filler	Black	RO
2 Concealed Overhead Stop	6ADJ-X36	630	RF
2 Door Closer	1431 O	EN	SA
1 Threshold	171A		PE
1 Gasketing	2891AS		PE
2 Sweep	315CN		PE
1 Astragal	By Door Supplier		00

Notes: Confirm keying with owner prior to ordering locks.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Gypsum board and joint treatment.
- .2 Gypsum sheathing.
- .3 Light gauge metal stud wall framing.

1.2 RELATED SECTIONS

- .1 Section 06 10 53 - Rough Carpentry.
- .2 Section 07 92 00 - Joint Sealers
- .3 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 C1396/C1396M-13 - Standard Specification for Gypsum Board.
- .4 Gypsum Association GA-214-10 - Recommended Levels of Gypsum Board Finish.
- .5 Gypsum Association GA-216-10 - Application and Finishing of Gypsum Panel Products.

1.4 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.

1.5 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

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, 0.53 mm 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 Furring, Framing, and Accessories: GA-216 and GA-600.
- .4 Fasteners: ASTM C1002.
- .5 Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

2.3 GYPSUM BOARD MATERIALS

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

2.4 ACCESSORIES

- .1 Acoustical Sealant: non-hardening, non-skinning, for use in conjunction with gypsum board, specified in Section 079200.
- .2 Corner Beads: 0.45 mm. thick, galvanized sheet steel, paper faced; tapable
- .3 Edge Trim: GA-201 and GA-216; Galvanized steel with 'J' type bead, tapable.
- .4 Joint Materials: GA-201 and GA-216; reinforcing tape, joint compound, adhesive, and water.
- .5 Fasteners: ASTM C1002, Type S12.
- .6 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 Install 0.91 mm steels studs at locations where stud wall heights are greater than 3.5 m.

- .5 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.
- .6 Install slip joint head track where stud walls meet structure. Allow for 40 mm deflection.
- .7 Door Opening Framing: Install double studs at door frame jambs.
- .8 Coordinate installation of bucks, anchors, blocking, electrical and mechanical work placed in or behind partition framing.

3.2 GYPSUM BOARD INSTALLATION

- .1 Install gypsum board in accordance with GA-201, and GA-216.
- .2 Erect single layer standard gypsum board in most economical direction, with ends and edges occurring over firm bearing.
- .3 Use screws when fastening gypsum board to metal furring or framing.
- .4 Place control joints consistent with lines of building spaces as directed, but not more than 10 m o.c.
- .5 Place corner beads at external corners as indicated. Use longest practical length. Place edge trim where gypsum board abuts dissimilar materials.

3.3 JOINT TREATMENT

- .1 Finish in accordance with GA-214 Level 4.
- .2 Feather coats on to adjoining surfaces so that camber is maximum 0.8 mm.
- .3 Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile.
- .4 Feather coats on to adjoining surfaces so that camber is maximum 0.8 mm.

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 Resilient base.

1.2 RELATED SECTIONS

- .1 Section 09 21 16 – Gypsum Board Assemblies

1.3 REFERENCES

- .1 ASTM F1861 - Resilient Wall Base.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.
- .4 Dispose of unused finish and adhesive materials at official hazardous material collections site approved by Consultant.
- .5 Do not dispose of unused finish and adhesive materials into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MATERIALS - BASE

- .1 Base: ASTM F1861 rubber; premolded external corners:
 - .1 Height: 100 mm.
 - .2 Thickness: 3 mm thick
- .2 Base Accessories: Premolded end stops and external corners, of same material, size, and colour as base.

2.2 ACCESSORIES

- .1 Primers and Adhesives: Waterproof; types recommended by flooring manufacturer.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify lower wall surfaces are free of substances that may impair adhesion of new adhesive and finish materials.

3.2 PREPARATION

- .1 Apply primer to surfaces.

3.3 INSTALLATION - BASE

- .1 Fit joints tight and vertical. Maintain minimum measurement of 450 mm between joints.
- .2 Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
- .3 Install base on solid backing. Bond tight to wall and floor surfaces.
- .4 Scribe and fit to door frames and other interruptions.

3.4 CLEANING

- .1 Remove excess adhesive from floor, base, and wall surfaces without damage.
- .2 Clean, seal, and wax floor and base surfaces in accordance with manufacturer's instructions.

3.5 PROTECTION OF FINISHED WORK

- .1 Prohibit traffic on floor finish for 48 hours after installation.

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 05 50 00 – Metal Fabrications
- .2 Section 08 11 00 – Hollow Metal Doors and Frames
- .3 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 Allow for five (5) colours.
- .2 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 Uncoated Steel and Iron Surfaces: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by power tool, wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid

solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.

- .4 Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Prime metal items including shop primed items.
- .5 Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.
- .6 Metal Doors Scheduled for Painting: Seal top and bottom edges with primer.

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 metal 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 60°	Sheen at 85°
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	

- .1 Metal Doors:
 - .1 Touch-up with latex primer.
 - .2 Two coats of latex enamel, semi-gloss.
- .2 Gypsum Board:
 - .1 One coat of alkyd primer sealer.
 - .2 Two coats of alkyd enamel.
- .3 Steel - Unprimed:
 - .1 One coat of latex primer.
 - .2 Two coats of latex enamel, semi-gloss.
- .4 Steel - Primed:
 - .1 Touch-up with latex primer.
 - .2 Two coats of latex enamel, semi-gloss.

END OF SECTION

PART 1.0 GENERAL PROVISIONS

1.1 GENERAL

- .1 Refer to Section 23 00 00 for general conditions for the fire protection systems.
- .2 Refer to Divisions 21, 22, 23, and 25 for specific requirements of the fire protection systems.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

- .1 Sprinkler system.
- .2 Hydraulic design and calculations for the systems.

1.2 GENERAL REQUIREMENTS

- .1 Provide design calculation and installation of Sprinkler system, including piping sprinkler heads, valves, hangers and supports, sleeves, fire department connections and accessories.

1.3 REFERENCE STANDARDS

- .1 Conform to NFPA No. 13 - "Standard for the Installation of Sprinkler Systems" and the Saskatchewan Fire Code, Fire Prevention Act.

1.4 QUALITY ASSURANCE

- .1 Sprinkler equipment shall be installed by qualified Contractors licensed and regularly engaged in installation of automatic fire sprinkler equipment.
- .2 Submit shop drawings of the entire sprinkler system for approval.

1.5 SUBMITTALS

- .1 Shop drawings of entire sprinkler system after review of head locations, for approval by the Underwriters. Submit only Underwriter approved drawings to the Engineer.
- .2 Shop drawings shall clearly indicate:
 - .1 Name of building.
 - .2 Location.
 - .3 Point of compass.
 - .4 Ceiling construction.
 - .5 Full height cross section.
- .3 Submit calculations of hydraulically designed systems on form sheets, including summary sheet, detailed work sheets and graph sheet.

- .4 On summary sheet, clearly indicate:
 - .1 Date.
 - .2 Location.
 - .3 Building number or other identification.
 - .4 Description of hazard.
 - .5 Name and address of Contractor or designer.
 - .6 Name of approving agency.
 - .7 System design requirements, including design area of water application, minimum rate of water application (density) and area per sprinkler.
 - .8 Total water requirements as calculated including allowance for inside hose and outside hydrants.
 - .9 Water supply information.
- .5 On detailed work sheets or computer printout sheets, clearly indicate:
 - .1 Sheet number.
 - .2 Sprinkler description and discharge constant (K).
 - .3 Hydraulic reference points.
 - .4 Flow in L/s.
 - .5 Pipe size.
 - .6 Pipe lengths centre to centre of fittings.
 - .7 Equivalent pipe lengths for fitting and devices.
 - .8 Friction loss in kPa/m of pipe.
 - .9 Total friction loss between reference points.
 - .10 Elevation head in kPa between reference points.
 - .11 Required pressure in kPa at each reference point.

- .12 Velocity pressure and normal pressure if included in calculations.
- .13 Notes to indicate starting points, reference to other sheets or to clarify data shown.
- .6 Graph paper of semi-logarithmic type to contain water supply curves and systems requirements plus inside and outside hose requirements so as to present a graphic summary of complete hydraulic calculation.

1.6 MAINTENANCE DATA

- .1 Provide maintenance data for sprinkler equipment for incorporation into project maintenance manuals.

1.7 MAINTENANCE MATERIALS

- .1 If no sprinkler head cabinet is in the facility at present, provide a lockable metal cabinet containing a minimum of three spare sprinklers of each type and melting point temperature. Install cabinet in mechanical room. Include sprinkler wrenches and two keys, for emergency repair work.

PART 2.0 PRODUCTS

2.1 SPRINKLER HEADS

- .1 Temperature rating on fusible links shall suit specific hazard area with minimum margin of safety 10°C.
- .2 Provide sprinkler head types as shown on the drawing.
- .3 Sprinkler head finish is to be chrome plated in finished areas and brass in mechanical and electrical rooms, unless otherwise noted.

PART 3.0 EXECUTION

3.1 INSTALLATION

- .1 Install horizontal valves with stems upright where space allows.

3.2 PROTECTION

- .1 Provide red wire guards for new sprinkler heads:
 - .1 In mechanical and electrical rooms;
 - .2 Around ventilation equipment where required for protection against mechanical damage; and,
 - .3 Where lowest point of sprinkler head is less than 2,275 mm (7'-6") above finished floor level.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

- .1 Portable hand fire extinguishers.
- .2 Extinguisher cabinets and accessories.

1.2 REFERENCE STANDARDS

- .1 Do work in accordance with the recommendations and requirements of NFPA 10 for portable fire extinguishers and the National Fire Code.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 23 00 00.

1.4 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into Operation and Maintenance Manual.

PART 2.0 PRODUCTS

2.1 MULTI-PURPOSE DRY CHEMICAL EXTINGUISHERS

- .1 ULC labelled for A, B and C class protection. See drawings for specific requirements.

2.2 EXTINGUISHER BRACKETS

- .1 Type recommended by extinguisher manufacturer.

2.3 IDENTIFICATION

2.4 Identify extinguishers in accordance with recommendations of NFPA 10.

2.5 Attach tag or label to extinguishers, indicating month and year of installation. Provide space for service dates.

PART 3.0 EXECUTION

3.1 GENERAL

- .1 Install or mount extinguishers in cabinets or on brackets as indicated on the drawings.

- 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 Equipment drains.

1.2 General Requirements

- .1 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.
- .2 Provide piping connections to equipment furnished in other sections of this specification and by the Owner.

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 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.
 - .1 Where there is no sanitary sewer trapped connection in the floor that the unit is mounted on, run the drain to outdoors through exterior wall in copper piping. Hole in wall is to be only slightly larger than pipe exterior diameter. Insulate pipe from exterior wall back 1m into room. Seal pipe at exterior wall.
 - .2 Provide trap on drain from fan plenums.

PART 3.0 EXECUTION

3.1 Installation

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

- .2 Install all equipment and fitments to manufacturer's installation instructions.

- 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 WHIMS 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 The building will be fully occupied and operational during construction.
 - .1 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 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.
- .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 Air Handling Units
 - .2 Return Fans
 - .3 Heating Pumps
 - .4 Controls (except sequences)
- .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.
 - .1 Also to be included are completed profile property sheets for the equipment numbering and inventory.
 - .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
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	Aluminium	#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". Refer to Section 23 05 70.

.6 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.

.7 Ductwork:

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

Commodity	Identification
Return Air	RA
Supply Air	SA
Mixed Air	MA
Exhaust Air	EA

.8 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
Pumps and Similar Equip	White	Blue
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.

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 trial 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, IEEE 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
	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
	Automatic Flow Control Devices	Griswald Nexus
	Grooved Mechanical Piping	Victaulic Gruvlok
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 Terice Weiss
Pumps	In-Line Circulators with integral VFD	Bell & Gossett Taco Wilo Grundfoss
Expansion Compensation	Expansion Joints & Compensators	Flexonics Hyspan Twin City Hose, Flex Hose
	Metal Flexible Hose	United Flexible Metraflex Twin City Hose Flex Hose

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
	Flexible Connectors - Piping	Flexonics Tube-Turn Hyspan Hydroflex Metraflex Mason Twin City Hose Flex Hose
Vibration Isolation	Vibration Isolation	Fan unit manufacturer
Pipe and Equipment Insulation	Pipe and Equipment Insulation	Fiberglas Canada Manville Manson Knauf
	Valve Body Blankets	ThermoHelp Canada Thermaxx Unitherm Reflex GlassCell Isofab
	Equipment Jackets	ThermoHelp Canada Thermaxx Unitherm Reflex GlassCell Isofab
	Insulation Adhesives	Flintkote 3M
Silencers	Silencers	VAW Vibro-Acoustic Korfund Vibron
Duct Insulation	Acoustical Insulation	Fiberglas Johns-Manville Manson
	Ductwork Insulation	Fiberglas Canada Manville Manson Knauf

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
	Insulation Adhesives	Fiberglas Canada Manville Manson Knauf
Hand Held Fire Extinguishers	Fire Extinguishers	National Fire Equipment Wilson & Cousins Flag
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
Terminal Heat Transfer Units	Force Flows	Rittling Engineered Air Trane Sterling Sigma
Hydronic Specialties	Air Vents	Armstrong Bell & Gossett ITT Grinnell Sarco Taco
	Air Separators	Armstrong Bell & Gossett Caleffi
	Glycol Feeders	Axiom Hydronic System Sentry
	Sidestream Filters	Filterite Axiom

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
Heat Exchangers	Heat Exchangers (Plate)	Alfa Laval Taco Armstrong Bell & Gossett
Coils	Heating, Cooling, Glycol, Heat Recovery	McQuay Engineered Air Trane Scott Springfield York/JCI Bousquet Daikin Haakon
Air Handling Units	Air Handlers with Hot Water and DX Coils	McQuay Engineered Air Trane Scott Springfield York/JCI Bousquet Daikin Haakon
Fans	In-Line Centrifugal Fans	Penn-Barry Loren Cook Acme Northern Blower Twin City
Ductwork	Flexible Ductwork	Flexmaster Thermafex
Duct Accessories	Duct Access Doors	Krueger Milcor Titus J.R.Smith
	Fire Dampers	Canadian Advanced Air Controlled Air Ruskin Nailor

REFERENCE SECTION	ITEM	ACCEPTABLE MANUFACTURERS
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	TAMCO Johnson Controls Alumavent
Input/Output Devices	Temperature Sensor (AI)	Greystone
	Relative Humidity Sensor (AI)	Greystone Hy-Cal General Eastern
	Pressure Sensors (AI)	Greystone Modus Selva
	Damper Motors	Belimo Johnson Honeywell

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		
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		

TENDER PRICE BREAKDOWN - MECHANICAL			
ITEM	DESCRIPTION	MATERIAL	LABOUR
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 labelling and identification is completed.
- .2 Demonstrate the following systems, in the form of instruction seminars and contractor guided tour of the facility.
 - .1 Steam Systems.
- .3 Demonstrate the following pieces of equipment:
 - .1 Air Handling Units;
 - .2 Return Fans;

- .3 Heat Exchangers;
 - .4 Hydronic Pumps;
 - .5 Glycol Fill Tank;
 - .6 Air Separator;
 - .7 Expansion Tank;
 - .8 Unit Heaters;
 - .9 Air Door.
-
- .4 Demonstrate the control system. See Controls sections of this specification.
 - .5 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.
 - .6 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 braided 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 EXPANSION LOOPS

- .1 See details on drawings.

2.3 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.

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 aluminium case, aluminium 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
 - .3 Pressure Gauge Taps
 - .1 Both Sides of Two Way Control Valves
 - .2 All Lines to Three Way Control Valves
 - .3 Major Coils - Inlet and Outlet
 - .4 Heat Exchangers - Inlets and Outlets (minimum 4 per heat exchanger)

- .4 Stem Type Thermometers
 - .1 Supply and Return Headers to Central Equipment
 - .2 Heat Exchangers - Inlets and Outlets (minimum 4 per heat exchanger)
 - .3 Air Handling Unit Coils
- .5 Thermometer Wells
 - .1 All Lines to Three Way Control Valves
- .6 Static Pressure Gauges
 - .1 Air Handling Unit 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 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 1/2") : Adjustable wrought steel ring.
- .2 Hangers: Pipe sizes 50mm to 100mm (2" to 4") and cold pipe sizes to 150mm (6"): Adjustable wrought 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 Lead Flashing: 25 kg/m² (5 lb/ft²) sheet lead for waterproofing, 5kg/m² (1 lb/ft²) sheet lead for soundproofing.
- .3 Safes: 25 kg/m² (5 lb/ft²) sheet lead or neoprene.
- .4 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.

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"		
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 (1" x 14 ga)	3 m (10')
775 to 1200mm (31" to 48")	38mm x 1.6 mm (1 ½" x 14 ga)	
Over 1200mm (48")e		

- .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-	2.4 m (8')

	25 x 25 x 3mm (1" x 1" x 1/8")	
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 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 Provide housekeeping pads for:
 - .1 Hydronic pumps
 - .2 Heat exchangers
- .3 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- .4 Rigidly anchor ducts and pipes immediately after vibration connections to equipment.

3.5 FLASHING

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

3.6 SLEEVES

- .1 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.
- .2 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.
- .3 Piping passing through mechanical room floor, roof or wall, close off space between pipe and sleeve with synthetic rubber compound mechanical type seals.

- 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 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.

PART 2.0 PRODUCTS

2.1 SPRING HANGERS

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

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 Air Handling Units : Vibration isolation packaged with equipment.
 - .2 Return Fans : Vibration isolation packaged with equipment for field mounting.
 - .3 Hydronic pumps : Inline circulators per manufacturer's recommendations.

- .4 Unit Heaters : Not required.
- .5 Force Flows : Not Required.
- .3 Install 100mm long flex connection on all duct work connected to isolate equipment.

3.2 INSTALLATION

- .1 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.
- .2 Adjustable, horizontal stabilizers on close spring isolators shall be adjusted so that the side stabilizers are clear under normal operating conditions.
- .3 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
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.

- .4 Spring hangers shall be installed without binding.
- .5 Adjust isolators as required and ensure springs are not compressed.
- .6 Provide neoprene side snubbers or retaining springs where side torque or thrust may develop.

- .7 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.
- .8 Wiring connections to isolated equipment shall be flexible.

- 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				
Domestic Hot Water	DHW	White	-	Green	Green	Red	-	Green	Red	DHW	Red	Green
Domestic Hot Water Recirculation	DHWR	White	-	Green	Green	Yellow	-	Green	Yellow	DHWR	Yellow	Green
Glycol Supply	GS	Black	-	Blue	Yellow	Red	-	Blue	Red	GS	Red	Blue
Glycol Return	GR	Black	-	Blue	Yellow	Blue	-	Blue	Yellow	GR	Blue	Blue
Low Pressure Steam	LPS	Black	-	Purple	Yellow	-	xxx kPa	Purple	Yellow	LPS	Purple	Purple

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 Condensate	LPC	Red	-	Purple	Yellow	-	-		Purple		LPC		Purple
Refrigerant Suction	RS	White	-	Black	Yellow	Purple	-		Black	Purple	RS	Purple	Black
Refrigerant Hot Gas	RHG	White	-	Black	Yellow	Purple	-		Black	Purple	RHG	Purple	Black
Refrigerant Liquid	RL	White	-	Black	Yellow	Purple	-		Black	Purple	RL	Purple	Black
Fire Sprinkler	SPR	White	-	Red	Red	-	-		Red				Red
Fire Sprinkler - Dry Pipe	D-SPR	White	-	Red	White	-	-		Red	White	D-SPR	White	Red
Fire Sprinkler - Pre-Action	PA-SPR	White	-	Red	White	-	-		Red	White	PA-SPR	White	Red

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
Sanitary	SAN	White	-	-	Black	-	-			SAN		
Sanitary vent	V	White	-	-	Black	-	-			V		
Storm	ST	White	-	-	Black	-	-			ST		

- 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 steam 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.
- .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 Water Balance Element Test Sheet
 - .2 Air Moving Equipment Test Sheet
 - .3 Diffuser and Grille 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 $\pm 10\%$
 - .4 Hydronic-pumps and central equipment $\pm 5\%$

- .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 $\pm 10\%$ air flow.
 - .3 Balance branches, mains to $\pm 10\%$ air flow.
 - .4 Recheck central apparatus.

- .5 Balance all terminal air outlets to $\pm 10\%$
- .6 Rebalance central apparatus to $\pm 5\%$.
- .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.
 - .14 With two pumps operating.
 - .15 With one pump operating - repeat for each pump.

- .16 With controls demanding no heating or cooling.
- .17 For each pump, plot maximum and minimum flows on curve.
- .18 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, 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.
 - .1 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 domestic water piping.
- .3 Test sanitary sewer piping.
- .4 Test storm sewer piping.
- .5 Test sprinkler system piping.
- .6 Test refrigerant piping.
- .7 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 REFERENCES

- .1 SMACNA HVAC Air Duct Leakage Test Manual, latest edition.

1.4 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.

1.5 TESTING AGENCY

- .1 Installing Contractor.

1.6 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.

1.7 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 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 Domestic water piping: Test to 1000 kPa water pressure measured at system low point.
- .7 Drainage systems: Test by filling with water to produce water pressure of 30 kPa minimum and 75 kPa maximum.
- .8 Sprinkler System: Test as required by current edition of NFPA 13 and Authority Having Jurisdiction.
- .9 Refrigerant piping: Test with nitrogen to 2000 kPa on high pressure side and 1000 kPa on low side.
- .10 Low velocity ductwork: Test for tightness such that leakage is inaudible and not detectable by feel.

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 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.

- 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/m² 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/m³ minimum.
 - .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	25
Round cold and dual temperature supply air ducts	C-2	yes	25
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	50
Mixing plenums	C-1	yes	50
Exhaust duct between dampers and louvres	C-1	no	50
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

	TIAC Code	
	Rectangular	Round
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 Black Rubber Insulation for Cold or Hot Pipes: Flexible elastomeric unicellular pre-formed pipe sleeving to CAN2 51.40-M80, maximum thickness 13 mm. Maximum "k" value at 24°C to be 0.04 W/m.°C, with -4°C to 100°C service temperature.

- .6 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.
- .7 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.
- .8 Recovery:
 - .1 Aluminium 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 for interior use, off-white colour with one-piece pre-molded fitting covers.
- .9 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 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 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.

2.4 EQUIPMENT

- .1 Provide removable insulating blankets on the following equipment and devices:
 - .1 Heat Exchangers.
 - .2 Steam traps.
 - .3 Air Separators.

2.5 REMOVABLE INSULATING BLANKETS (REUSABLE FLEXIBLE INSULATION COVERS) : SERVICE TO 232°C.

- .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 fiber. 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 inside walls. Pack around pipes with fire proof self-supporting insulation materials, properly sealed.
 - .1 Insulation is not required at fire separations. Provide insulative fire rated caulking where pipes pass through assemblies that have a fire separation rating.

- .2 Insulate fittings and valves. 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 hangers 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.
- .10 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200mm centres or screws on 150mm centres. Lap joints 75mm minimum and seal with compatible waterproof lap cement.
- .11 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
Low Pressure Steam and Low Pressure Condensate	25mm	38mm		50mm		90mm
Glycol Heating Piping	25mm	38mm				

* Runouts 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 Insulate the following with Black Rubber Insulation for Hot Pipes:

Service	Pipe Size	Insulation Thickness (mm)
Refrigerant Hot Gas (inside building only)	All sizes	15
Refrigerant Liquid	All sizes	15
Refrigerant Suction (inside building only)	All sizes	15

- .3 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.

.4 Recover mineral fibre insulated piping as follows:

Commodity	Indoor Recovering	Outdoor Recovering
Steam and condensate	Pebble finish aluminium	Pebble finish aluminium
Heating Piping	PVC	Smooth finish aluminium
Domestic water	PVC	Smooth finish aluminium
Refrigerant	Coat exposed black rubber insulation with two coats of black rubber finish material.	

- .5 Seal black rubber insulated piping joints and seams with insulation adhesive.
- .6 Coat exposed ends of black rubber insulation with two coats of black rubber finish material.
- .7 Flare out staples may be used to secure jacket laps on hot systems. Staples are to be applied on 100mm centres.
- .8 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
Plumbing Vents	25mm	25mm	25mm	25mm	25mm	25mm

MINIMUM PIPE INSULATION (mm)						
COMMODITY	NOMINAL PIPE DIAMETER					
	Runouts* up to 50mm	25mm & smaller	30mm to 50mm	65mm to 100mm	150mm	200mm & larger
Air Conditioner Condensate Drain Lines - Exposed	Not required					

* Runouts 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 Seal black rubber insulated piping joints and seams with insulation adhesive.
- .4 Coat exposed black rubber insulation with two coats of black rubber finish material.
- .5 Insulate 2 metre portion of plumbing vents measured from roof outlet back, and through all cold spaces. Do not insulate remaining vent piping.
- .6 Insulate final 2 metre portion of storm sewer from outlet or roof drain back and through all cold spaces. Do not insulate remaining storm water piping.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

- .1 Provide material and labour 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 Return Fans
 - .3 Pumps
 - .4 Heat Exchanger
 - .5 Chemical cleaning and treatment
 - .6 Unit Heater
 - .7 Air Curtain
- .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 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.

- .3 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.
- .4 Confirm voltages and operating amperages at full load.
- .5 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 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.
- .6 Open steam traps and air vents: Remove operating elements and clean thoroughly, replace internal parts and put back into operation.
- .7 Remove rust, scale and foreign materials from equipment and renew defaced surfaces.
- .8 Set and calibrate draft gauges of air filters and other equipment.
- .9 Inspect fan wheels for clearance and balance. Provide factory-authorized personnel for adjustment when needed.
- .10 Check each control circuit to assure that operation complies with specifications and requirements to provide the desired performance.
- .11 Inspect each pressure gauge and thermometer for calibration. Replace items which are defaced, broken, or which read incorrectly.
- .12 Repair damaged insulation.
- .13 Vent gases trapped in any part of systems. Verify that liquids are drained from all parts of gas or air systems.
- .14 Check piping for leaks at every joint, and at every screwed, flanged, or welded connection, using "Leak-Tek" or other approved compound.
- .15 Tighten flanges after system has been placed in operation. Replace flange gaskets which show any sign of leakage after tightening.
- .16 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.

- .17 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.
- .18 Check specified and shop drawing data against installed data.
- .19 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 Sprinkler Piping

.2 Plumbing Water Supply Systems:

.1 Domestic Water Piping

.3 Plumbing Systems Inside Building:

.1 Sanitary Piping

.2 Plumbing Vent Piping

.4 Standard Heating and Cooling Systems:

.1 Glycol Supply and Return Piping

.5 Equipment Drains and Overflow Piping

.6 Low Pressure Steam Piping

.7 Low Pressure Condensate and Pumped Condensate Piping

1.2 SUBMITTALS

.1 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 Sprinkler system piping: NFPA No. 13, Standard for the Installation of Sprinkler Systems.

- .2 Domestic water, drainage and vent piping: Saskatchewan Plumbing Code.
- .3 Copper pipe, direct connections: ULC approval; brazing in accordance with Copper Development Association Copper Tube Handbook.
- .4 Refrigeration system piping and accessories: CSA B52, Mechanical Refrigeration Code.
- .5 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:	FIRE PROTECTION PIPING SPRINKLER PIPING PREACTION SPRINKLER PIPING DRY SPRINKLER PIPING
LOCATION :	ABOVE GROUND AND INSIDE BUILDING
DESIGN PRESSURE :	1200 kPa (175 psi)
MAXIMUM TEMPERATURE:	35°C (95°F)

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:	DOMESTIC WATER
LOCATION :	INSIDE BUILDING ABOVE GROUND
WORKING PRESSURE:	600 kPa (90 psi)
MAXIMUM TEMPERATURE:	60°C (140°F)

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) 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 may be used in mechanical rooms, and in other areas where couplings are fully accessible. 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 :	60°C (140°F)

ITEM	SIZES	GENERAL DESCRIPTION
Pipe	SAN, ST, V	200mm (8") & smaller
		<p>Above Ground : CSA B-70-M cast iron DWV solid pipe plain end or Copper Tube¹ DWV hard ASTM B306</p> <p>Above Ground : PVC XFR² 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.</p> <p>Below Ground: PVC DWV to CAN-3B-182</p>
Fittings	SAN, ST, V	200mm (8") & smaller
Joints	SAN, ST, V	All sizes
		<p>Cast Iron: CSA B70-M Cast iron DWV plain end (bituminous coated for buried)</p> <p>Copper: CSA B158.1 or ANSI B16.29</p> <p>PVC-DWV: Solvent Weld</p>
		<p>Cast Iron - mechanical joint coupling - neoprene sleeve with centre rib; stainless steel shield. 2 clamps per side (4 clamps total).</p> <p>PVC - Solvent Weld</p> <p>Copper: CSA B158.1 or ANSI B16.29</p>

- 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:	GLYCOL SUPPLY GLYCOL RETURN
LOCATION :	ALL
WORKING PRESSURE:	860 kPa (125 psi)
MAXIMUM TEMPERATURE:	105°C (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.
	copper	all sizes (above ground only)	Threaded Soldered with lead-free tin-nickel-silver-antimony-copper alloy "Bridgit". Plastic range 240°C to 330°C.
Flanges	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.
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.

ITEM	SIZES	GENERAL DESCRIPTION
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.
	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.

ITEM	SIZES	GENERAL DESCRIPTION
	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, and in other areas where couplings are fully accessible.

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 gasketed cap. Working pressure 1720 kPa (250 psi) A 120°C (250°F). Dahl 21.616.

COMMODITY CODE:	LPS LOW PRESSURE STEAM
LOCATION :	ABOVE GROUND AND INSIDE BUILDING
DESIGN PRESSURE :	Low Pressure - 105 kPa (15 psi)
MAXIMUM TEMPERATURE:	Low Pressure - 120°C (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.

All steam control valves are to have flanged connections. All steam valves 50mm and larger are to have flanged connections.

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 Use galvanized couplings with galvanized pipe.
- .4 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.
- .5 Use grooved mechanical couplings and mechanical fasteners only in mechanical rooms, and in other areas where couplings are fully accessible, and only where specifically noted as acceptable in this specification.
- .1 Use galvanised couplings with galvanised pipe, and copper couplings on copper pipe.
- .6 Make connections to equipment, specialty components, and branch mains with unions or flange sets.
- .7 Provide non-conducting type connections wherever jointing dissimilar metals.
- .8 Provide dielectric type connections wherever joining dissimilar metals in open systems. Brass adapters and valves are acceptable.
- .9 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.
 - .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.

3.5 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 Provide drain valves at main shut-off valves, low points of piping and apparatus and terminal units.

- .5 Size drain lines and drain valves equal to size of apparatus drain connection.
- .6 For pipe sizes 20mm (3/4") and over, minimum drain size to be 20mm (3/4").
- .7 Provide hose thread connection with cap and chain for 20mm (3/4") drain valves located in ceiling and public areas.
- .8 Provide male NPT nipples with threaded pipe cap for drain sizes over 20mm where not piped directly to floor drains.
- .9 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)	15	T							LEGEND T Forges tee or reducing tee S Socolet W Weldolet					
	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
		15	20	25	32	38	50	65	75	100	150	200	250	300
BRANCH SIZE (mm)														

- 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.
- .5 Radiation 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 [as indicated] [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°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°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 glycol fill tank.
- .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, transfer pump.
- .2 System expansion tanks.
- .3 Propylene glycol solution.
- .4 Comply with Provincial Regulations and have CSA approval.

1.2 SUBMITTALS

- .1 Submit shop drawings and schedules for review. Submit test results in neat typewritten copy.

1.3 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 GLYCOL FILL TANK

- .1 Provide glycol mixing / fill 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 SYSTEM EXPANSION TANK

- .1 Provide glycol system expansion tank of welded steel construction, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 860 kPa.

- .2 Diaphragm type expansion tank with adjustable air cushion.
- .3 Pre-charge to the minimum operating pressure.

2.3 GLYCOL SOLUTION

- .1 Provide 30% propylene glycol/water solution.
- .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:

	Ethylene Glycol	Propylene Glycol
Specific Gravity	1.02	0.99
Vapour Pressure	50 kPa	56 kPa
Viscosity	0.75 Centipoises	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 70/30 propylene glycol on site. 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 23 00 00.
- .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 23 00 00.

1.4 QUALITY ASSURANCE

- .1 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.
- .2 Pump logic controllers and variable frequency drives controlling pumps shall be programmed and supplied by the pump manufacturer.

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.

2.2 IN-LINE CIRCULATORS

- .1 Centrifugal, close coupled, in-line, single or multi-stage, stainless steel fitted, single suction, suitable for vertical or horizontal installation.
- .2 Single casing, stainless steel or cast iron, rated for the greater of 1225 kPa or 1-1/4 times the specified working pressure.
- .3 Stainless steel, bronze, or Noryl impeller held in place by self-locking cap-screw and nut.
- .4 Stainless steel shaft complete with integral thrust collar and lubricated sleeve bearings.
- .5 Mechanical seals.
- .6 Integral variable frequency drive capable of connection to the BMS over the BMS network.
- .7 Proportional pressure control option integral with drive.

PART 3.0 EXECUTION

3.1 INSTALLATION

- .1 Install pumps per Manufacturer's Instructions.
- .2 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.

- .3 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.
- .4 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.
- .5 Provide air cock and drain connection on horizontal pump casings.

3.2 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.

3.3 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 Run in pumps for 12 continuous hours.
 - .4 Verify operation of over temperature and other protective devices under low and no flow condition.
 - .5 Eliminate air from scroll casing.
 - .6 Eliminate cavitation, flashing and air entrainment.
 - .7 Measure pressure drop across strainer when clean and with flow rates as finally set.

- END OF SECTION -

PART 1.0 GENERAL

1.1 WORK INCLUDED

- .1 Steam Traps
- .2 Steam Air Vents
- .3 Steam Relief Valves
- .4 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 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.

2.5 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°C for 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 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.

3.5 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 glycol hydronic systems; and,
 - .2 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 labelled, 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 Provide chemical treatment and records of this chemical treatment from the time of commissioning to the time of acceptance by the Owner.
- .3 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 glycol and steam heating systems.
- .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 Steam and condensate systems : Boil-out and degrease.
 - .1 Standard of Acceptance : Maxim WT-725
- .4 Hydronic systems treatment : Contingent on water conditions.

- .1 Standard of Acceptance : Maxim WT-565
- .5 Glycol systems : Inhibited propylene 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.
- .6 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.

2.4 SIDE STREAM FILTERS

- .1 Provide one side-stream filter for each pump, or each pump set in the case of standby pumps, for each of the following systems:
 - .1 glycol hydronic system
- .2 At the completion of the project, turn over one complete with a case of 30, 20 micron filter cartridges to the Owner.
- .3 Standard of Acceptance : Maxim LM010-3/4" filter housing complete with 20 micron filter cartridge.
- .4 Provide on visual flow meter for each side-stream filter assembly.

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 Mount pressure gauges, valves, and controls furnished by manufacturer, in accordance with manufacturer's instructions.

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.
- .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 Make systems completely operational, filled, started and thoroughly vented.
 - .2 Use neutralising agents on recommendation of the treatment agency and to approval of the Consultant.
- .10 When cleaning is completed and system filled for glycol system, 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.

3.5 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.

- .2 Turn over test kits, conductivity meter, treatment chemicals, spare micron cartridges, and refractometer to Owner prior to substantial completion.

- 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 all 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 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."

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 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 Fabricate plenums to configurations shown on drawings and to SMACNA standards. Plenums to be constructed with double walled casing.
- .8 Install hinged access doors where shown, specified or where required for access to equipment for cleaning and inspection.
- .9 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/m³ 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 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

- .6 Install duct in accordance with SMACNA standards.
- .7 Protect galvanised ductwork exposed to outside elements by painting or coating with suitable weather resistant material.
- .8 Install balancing dampers at all branch ducts and as indicated and where indicated by Balancing Contractor.
- .9 Anchor all risers.
- .10 Install fire dampers to NFPA 90A and the National Building Code.
- .11 Install airtight access door and clean-outs on upstream side of all reheat coils and at all fire dampers.
- .12 Support flexible ducts at 1200 centers. Ensure bends are not tighter radius than standard 1.5 times duct width.
- .13 Co-ordinate the location of duct access doors. Refer to "Duct Accessories" Section.
- .14 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.
- .15 Shield ductwork from dust and construction material during construction. Clean any ductwork found to be dirty at no extra cost to the Contract.
- .16 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 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 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.
- .3 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application.
- .4 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.
- .5 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 Flexible connections.
- .6 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 use 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 72°C.

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 suitable for horizontal or vertical applications and shall be constructed to SMACNA standards.
 - .1 Standard of Acceptance : Everlock damper handle and ROSSI HVAC Hardware.

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 Flexible Connections

- .1 Provide where indicated, at fans and at air handling units, neoprene coated flame proof fabric, minimum density 1.22 kg/m², 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.

2.7 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 Splitter dampers shall only be used where indicated on the drawings.
- .7 Install flexible connections in ducts connected to fans and equipment subject to forced vibration, immediately adjacent to equipment and where indicated on the drawings.
- .8 Install all accessories in accordance with manufacturers' recommendations.

- END OF SECTION -

PART 1.0 GENERAL

1.1 Work Included

- .1 In-Line Centrifugal fans.
- .2 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 In-Line Centrifugal Fans

- .1 Belt driven centrifugal square Inline fan.
- .2 Units shall be equipped with removable access panels to access internal workings of fan.
- .3 Units shall be pre-wired to a junction box on the exterior casing and equipped with an electrical disconnect switch.
- .4 Two unit support angles shall be provided with spring isolators.
- .5 Statically and dynamically balanced backward inclined, centrifugal wheels shall be aluminium, spark-resistant, non-overloading, and matched to deeply spun venturis.
- .6 Motors shall be mounted out of the main air stream.
- .7 Heavy duty ball bearings are rated for a minimum L50 life exceeding 200,000 hours.
- .8 Each fan shall bear the AMCA Licensed Ratings Seal for Air and Sound Performance, and shall be UL and CSA listed.

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

1.1 WORK INCLUDED

- .1 Diffusers.
- .2 Grilles and Registers.
- .3 Outside Louvers.

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 25 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 minimum 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 – BRAZED PLATE

- .1 Plates shall be constructed with type 316 stainless steel with copper brazing material.
- .2 Design pressure 860 kPa or 12 times working pressure, whichever is the greater.
- .3 Maximum allowable pressure drop (either side) 10 kPa.
- .4 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 tapings 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.
- .4 Install to facilitate servicing.

3.2 OWNER'S INSTRUCTIONS

- .1 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 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 (where specified), filter section, and DX cooling coil 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.
 - .1 Access openings are required on both side of heating and cooling coils.
- .3 Drain pans shall be heavy gauge one piece galvanized steel with welded corners. Provide drain pans under coils.

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 Fans shall be direct drive, with variable frequency drive supplied with the air handling unit. Variable frequency drives shall be equipped with:
 - .1 Input and output line reactors.
 - .2 Bypass.

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 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.

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.

PART 3.0 EXECUTION

3.1 ASSEMBLY

- .1 Assemble low and medium pressure units by bolting sections together to make single unit.
 - .1 Units to be broken down so they can fit through the doorways. Remove door frames if necessary. Contractor to confirm units with fit through existing doorways prior to ordering units.
 - .2 Reassemble units by unit manufacturer's local representative.
- .2 Isolate Fan Section with flexible duct connections.

.3 Install unit on vibration isolators.

- 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, coils shall be rated for 2.5 m/s (500 ft/sec) maximum face velocity.
- .3 Cleanable tube coils shall have steel or cast iron headers and straight tubes.
- .4 Plate fin coils to have tubes mechanically bonded to fins. Spiral wound fin coils to be soldered to tubes.
- .5 Maximum tube length to be three metres unless specified otherwise.

- .6 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.
- .7 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 Protect coils so fins and flanges are not damaged. Replace loose and damaged fins. Comb out bent fins unless required to be replaced.

- 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.
- .2 Tie into the existing DDC control system in the building.

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 26. 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 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 23 00 00 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.

1.12 Existing Controls

- .1 Remove all existing redundant control devices, panels, tubing, wiring, hangers, fasteners, and appurtenances. This includes within ceiling spaces where there is a t-bar ceiling. Copper control tubing located within walls may remain in-situ.

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, gasketed 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.

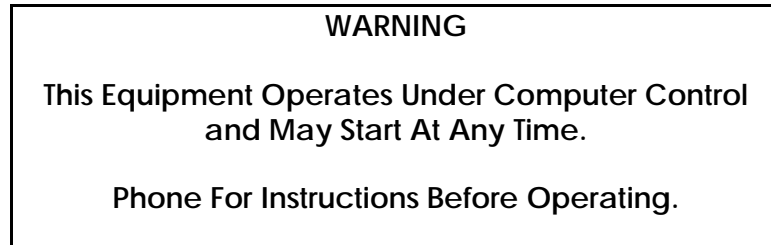
2.3 Conduits and Cables

- .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 jacketed 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:



- .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 $\pm 2^{\circ}\text{C}$
 - .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 or buttons
 - .2 Temperature indicator
 - .3 Override Switch
 - .4 The set-point adjustment shall allow for modification of the temperature by the occupant.
 - .5 An override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant.
 - .6 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 operator's terminal.
 - .7 Provide tamper proof thermostat guards for all areas. 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 $\pm 2\%$, 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 $^{\circ}\text{C}$
 - .5 Output Signal 4-20 mAdc, 0-100% linear, proportional
 - .6 Voltage Requirement 12 to 36 Vdc

2.10 Thermowells

- .1 Provide brass wells for chilled and heating water applications.
- .2 Provide stainless steel wells for domestic water, and all other liquid applications.

2.11 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.

2.12 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.

2.13 Control Valves

- .1 Two-way valves shall have equal percentage characteristics and three-way valves shall have linear characteristics.
 - .1 Ball valves as control valves are not acceptable unless in non-modulating service.
 - .2 All steam control valves are to have flanged connections.
- .2 Size control valves as per following criteria:
 - .1 Select steam control valves for 12 psi upstream and 2 psi downstream unless otherwise noted.
 - .2 Where two steam control valves are shown servicing a single piece of equipment, the valves shall be sized for 1/3 – 2/3 capacities.
- .3 Valves shall "fail-safe", spring return to normal position.
- .4 Provide valves complete with electronic operators.
- .5 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 2" 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.

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.
- .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 operator's 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 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, hysteresis, 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 Electrical

Application	Type	Operating Range	End to End Accuracy	Remarks
Current Transformers	IE	As Required	±0.25% Full Scale	Veris

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.
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
Current Sensing Relays	IR	As Required	Adjustable trip c/w LED Status Indication Standard of Acceptance: Veris H708/900
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
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.

Application	Type	Operating Range	Remarks
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 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 EXISTING UNIT HEATERS AND FORCE FLOWS - STEAM

- .1 Provide new wall mounted DDC thermostats to replace the existing line voltage thermostats. Provide new relays as required to control the fans in the existing unit heaters.
 - .1 Note : Existing unit heaters in the gymnasium (UH-21, UH-22, UH-23, and UH-24) are currently on the building management system, and therefore not changes are required to these units.
 - .2 The thermostat shall cycle the unit fan as required to provide heat.
 - .3 Points List : The following points, as a minimum, shall be provided associated with each unit heater or force flow. Each point shall also be shown on an individual system graphic.
 - .1 Room temperature sensor reading AI
 - .2 Setback override DI
 - .3 Room temperature set-point PP
 - .4 Fan on/off control DO

4.2 NEW UNIT HEATERS AND FORCE FLOWS - STEAM

- .1 Provide new wall mounted DDC thermostat.
- .2 The thermostat shall cycle the unit fan as required to provide heat.
- .3 Points List : The following points, as a minimum, shall be provided associated with each unit heater or force flow. Each point shall also be shown on an individual system graphic.
 - .1 Room temperature sensor reading AI
 - .2 Setback override DI
 - .3 Room temperature set-point PP
 - .4 Fan on/off control DO

4.3 UNIT HEATERS AND FORCE FLOWS - ELECTRIC

- .1 The existing electric force flows have integral thermostats, and are not to be tied into the existing BMS system.

4.4 SPLIT SYSTEM AIR CONDITIONER (AC-1)

- .1 The existing wall mounted electric thermostat complete shall remain.
- .2 No connections to the BMS are required from this unit.

4.5 BASEBOARD RADIATION

- .1 Provide a new steam control valve DDC motor to replace existing control valves. Provide a new DDC thermostat to replace existing thermostat.
- .2 Thermostat shall modulate the two-way normally open heating control valve. Valves shall be of the fail-last-position type.
- .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 Setback override DI
 - .3 Room temperature set-point PP
 - .4 Valve set-point AO

4.6 CONDENSATE RETURN UNITS CR-1, CR-2, and CR-3

- .1 The existing condensate return units have an integral control package and are already connected to the BMS System. No new sequences or points are required.

4.7 GLYCOL HEATING SYSTEM

- .1 All heating system controls are to be on the emergency power system.
- .2 De-energize the glycol heating system when the outdoor air temperature rises above 17°C (operator adjustable).

- .1 When the outdoor air temperature is below the de-energization temperature, energize the one of the heating pumps P-1 or P-2. Pumps P-1 and P-2 are to operate on a lead-lag basis, with one only being on at a time. Should the lead pump fail to run when required to run, de-energize the lead pump and energize the lag pump, and send an alarm to the BMS head-end.
- .3 Heat exchangers HX-1 and HX-2 shall be sequenced in a lead lag configuration using first-on first-off scenario.
 - .1 Control valve shall modulate lead heat exchanger control valve to maintain supply water temperature set-point. Once the lead heat exchanger control valve reaches 95% open, the lag heat exchanger shall be energized and both heat exchangers shall provide half the required load.
 - .2 Supply water temperature set-point shall be based on outdoor air temperature as follows:

Outdoor Temperature	Supply Temperature Set-Point
Below -25°C	85°C
-25°C to 10°C	Ramp from 85°C to 50°C
Above 10°C	50°C

- .4 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 HX-1 control valve signal AO
 - .4 HX-1 supply water temperature AI
 - .5 HX-2 control valve signal AO
 - .6 HX-2 supply water temperature AI

.7	System supply water temperature (between supply header and inlet to pumps).	AI
.8	Return water temperature	AI
.9	Pump P-1 start-stop	DO
.10	Pump P-1 status	DI
.11	Pump P-1 speed	AI from VFD
.12	Pump P-1 VFD alarm	DI
.13	Pump P-2 start-stop	DO
.14	Pump P-2 status	DI
.15	Pump P-2 speed	AI from VFD
.16	Pump P-2 VFD alarm	DI
.17	Pump supply water pressure	AI (just downstream of common pump discharge connection)
.18	Pump return water pressure	AI (just downstream of air separator)
.19	Glycol fill tank low level	DI

4.8 EXISTING AIR HANDLING UNITS AHU-1 SYSTEM

- .1 The existing air handling unit is already on the BMS. No new sequences or points are required.

4.9 AIR HANDLING UNITS AHU-2 AND RETURN FAN RF-2

- .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 System De-energized
 - .1 Supply and return fans off.
 - .2 Outdoor air and relief dampers closed. Recirculation damper open.
 - .3 Modulate heating coil to maintain a temperature of 10°C in the mixed air plenum.
- .3 Start-Up
 - .1 Close outdoor air and relief dampers, open recirculation damper.
 - .2 Energize heating valve control if outdoor air temperature is above heating start set-point (see Heating System sequence).
 - .3 After a 15 second delay, energize the supply fan.
 - .4 After a 5 second delay energize return fan.
 - .5 Energize the economizer cycle and either cooling mode or heating mode.
- .4 Shut-down:
 - .1 Close outdoor air and relief dampers, open recirculation damper.
 - .2 De-energize the supply fan.
 - .3 De-energize the return fan.
- .3 Freeze Stats
 - .1 Provide averaging type freeze stat. Upon sensing a low temperature, the supply fan shall stop, recirculation damper shall open, and outdoor and relief air dampers shall close. The return fan shall remain energized. The freeze stat must be reset manually.
- .4 Minimum Outdoor Damper Quantity
 - .1 Minimum outdoor air quantity is to be initially set to 20% of maximum AHU-1 supply air quantity (operator adjustable).

- .5 Mixed Air Economizer Control
 - .1 Cooling Mode: When the outdoor air enthalpy is lower than the return air enthalpy, the mixed air dampers shall modulate to maintain room temperature set-point with a minimum mixed air temperature of 13°C.
 - .2 Heating Mode: The mixed air dampers shall be set at minimum outdoor air.
- .6 Heating / Cooling Switchover
 - .1 When the heating system is energized, the cooling system shall not energize.
 - .2 The heating system shall be energized whenever the outdoor air temperature is below 17°C (see Glycol Heating System control sequence).
 - .3 The cooling system shall be energized whenever the outdoor air temperature is above 19°C.
 - .4 When the outdoor air temperature is between 17°C and 19°C, either the heating system or cooling system (or neither) shall be energized, dependant upon the weighted average difference of room temperature and thermostat set-points for all thermostats served by the air handling unit.
- .7 Heating
 - .1 Modulate the heating control valve to maintain a supply air temperature set-point of 22°C.
 - .2 If the BMS system calls for both cooling system energization and heating coil valve opening, an alarm shall sound at the BMS head end. The system shall revert to heating mode.
- .8 Cooling
 - .1 The cooling shall be energized to maintain a weighted average room temperature of 22°C (operator adjustable) for all room thermostats contained in the zone served by the air handling unit.
 - .2 When the cooling is energized, the unit heaters and force flows in rooms served by the air handling unit are to have their space temperature set-points overridden to 18°C.

.9 Air Handling Unit 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	Return fan Start/Stop	DO
.5	Return fan status	DI
.6	Heating coil control valve position	AO
.7	Cooling system energized	DO
.8	Heating coil condensate return water temperature	AI
.9	Supply air temperature	AI
.10	Supply air temperature set-point (heating)	PP
.11	Return air temperature	AI
.12	Mixed air temperature	AI
.13	Outdoor Air Damper / Relief Damper / Recirculation Damper	AO
.14	Minimum Outdoor Air Percentage	PP
.15	For each thermostat:	
.1	Room temperature sensor reading	AI
.2	Setback override	DI
.3	Room temperature set-point	PP

4.10 AIR HANDLING UNITS AHU-3 AND RETURN FAN RF-3

.1 The sequence is to be the same as AHU-2/RF-2.

4.11 AIR HANDLING UNITS AHU-4 AND RETURN FAN RF-4

- .1 The sequence is to be the same as AHU-2/RF-2.

4.12 AIR CURTAIN

- .1 Control air curtain off wall switch provided by Division 26.
- .2 Points List : The following points, as a minimum, shall be provided associated with each air curtain. Each point shall also be shown on an individual system graphic.

- .1 Unit status DI

4.13 EXISTING EXHAUST FANS EF-1 and EF-2

- .1 These existing two fans are already on the BMS. No new sequences or points are required.

4.14 EXHAUST FAN EF-6

- .1 Fan is to be controlled on when the air handling unit AHU-4 is energized.
- .2 Points List : The following points, as a minimum, shall be provided associated with each exhaust fan. Each point shall also be shown on an individual system graphic.

- .1 Fan Start/Stop DO

- .2 Fan Status DI

4.15 EXISTING EXHAUST FANS EF-12 AND EF-13

- .1 The two fans are to be controlled by a single wall mounted on/off switch or UH-9 room thermostat.

- .1 When the room temperature is 5°C (operator adjustable) above the room temperature set-point, energize the fans.

- .2 Points List : The following points, as a minimum, shall be provided associated with each exhaust fan. Each point shall also be shown on an individual system graphic.

- .1 Wall Switch Status DI

- .2 Fan Start/Stop DO x 2

.3 Fan Status DI x 2

4.16 EXISTING EXHAUST FAN EF-14

.1 The fan is to be controlled by a single wall mounted on/off switch or the UH-10 room thermostat.

.1 When the room temperature is 5°C (operator adjustable) above the room temperature set-point, energize the fans.

.2 Points List : The following points, as a minimum, shall be provided associated with each exhaust fan. Each point shall also be shown on an individual system graphic.

.1 Wall Switch Status DI

.2 Fan Start/Stop DO

.3 Fan Status DI

4.17 EXISTING EXHAUST FAN EF-15

.1 The fan is to be controlled by a new DDC thermostat that energizes the fan on a rise in temperature above set-point.

.2 Points List : The following points, as a minimum, shall be provided associated with each exhaust fan. Each point shall also be shown on an individual system graphic.

.1 Room temperature sensor reading AI

.2 Room temperature set-point PP

.3 Fan Start/Stop DO

.4 Fan Status DI

4.18 ALL OTHER EXISTING EXHAUST FANS

.1 This applies only to the existing exhaust fans noted in the schedule on drawing M-0.

.2 Fan are to be controlled on when the air handling unit associated with the area served by the exhaust fan is energized.

.3 Points List : The following points, as a minimum, shall be provided associated with each exhaust fan. Each point shall also be shown on an individual system graphic.

.1 Fan Start/Stop DO

.2 Fan Status DI

4.19 DOMESTIC HOT WATER SYSTEM

.1 The existing domestic hot water heating system is already on the BMS. No new sequences or points are required.

4.20 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 Coordination 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-galvanized 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.

END OF SECTION

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 90° 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 Breakers

- .1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.
- .2 Lock-on devices for fire alarm circuits.

2.3 Equipment Identification

- .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 Installation

- .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

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 Full Voltage Magnetic Starters

- .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

CONTRACTOR PROGRESS REPORT ES110



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Consulting Electrical Engineers

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Phone: (306) 569-1303 Fax: (306) 569-1307

ELECTRICAL PROGRESS CLAIM No. _____
DATE _____ 20____
PROJECT _____
ELECTRICAL CONTRACTOR _____
GENERAL CONTRACTOR _____
PRIME CONSULTANT _____
SUBMITTED BY _____

REVIEWED BY: _____

DATE: _____ 20____

RECOMMENDED PAYMENT AS SHOWN AS CORRECTED REJECTED

* Cross out if not applicable	TOTAL CONTRACT		COMPLETE TO DATE		THIS PROGRESS	
	MATERIAL	LABOR	MATERIAL	LABOR	MATERIAL	LABOR
A. MAIN SERVICE *HV, Duct Bank, Transformers, Switchboards						
B. DISTRIBUTION / PANELS *Distribution Centres, Dry Type Transformers, Fuses						
C. CONDUIT AND BOXES *Tray						
D. WIRE AND CABLE *Bus Duct						
E. MOTOR CONTROL						
F. WIRING DEVICES *Dimmers, Pac Poles, Low Voltage Switching, Cover-plates						
G. LIGHTING FIXTURES & LAMPS						
H. ALARM SYSTEMS *Fire, Security, Signal, Medical						
I. COMMUNICATIONS SYSTEMS *Intercom, Nurses' Call, Data/Telephones						
J. SPECIALS *Emergency Generator, Lightning Protection, CCTV, UPS, Trench Duct						
K. MISCELLANEOUS - 8% Maximum						
L. EXTRAS & CREDITS (List price changes separately, use separate sheet if necessary)						
TOTAL						

SUMMARY TOTAL

Contract \$	To Date \$	This Progress
Contract GST \$	To Date GST \$	This Prog GST \$
Total Amount	Less Holdback	Less Holdback
 	Net Amount	Net Amount

% COMPLETE _____