

# PROJECT MANUAL (SPECIFICATIONS)

SHSC C2 Decant (K3E) and GIM Decant (K2E)  
2075 Bayview Ave  
North York, ON

2025-11-20

Issued For: Tender

Volume 2 – Division 20-28

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Project No.: HS1024-0383

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END OF SECTION

The following professional seals and signatures are provided as required by the Building Code for the above Project and apply to documents prepared under the supervision of the following registered professionals as identified on the Project Manual table of contents.

ARCHITECTURAL (A)	STRUCTURAL (S)
ELECTRICAL (E)	MECHANICAL (M)

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**DESIGN DISCIPLINE AND ISSUING AUTHORITY (IA)**

DOCUMENTS HAVE BEEN PREPARED AND ISSUED BY EACH ISSUING AUTHORITY AS FOLLOWS:

ARCHITECT (A), PROFESSIONAL ENGINEER – STRUCTURAL (S), PROFESSIONAL ENGINEER – MECHANICAL (M), PROFESSIONAL ENGINEER – ELECTRICAL (E), DATA AND COMMUNICATIONS CONSULTANT (IT), VERTICAL TRANSPORTATION (VT), LANDSCAPE ARCHITECT (L), HARDWARE (H).

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Specifications**  
FOR  
**K Wing, 2<sup>nd</sup> Floor & 3<sup>rd</sup> Floor East  
Renovation**  
**Sunnybrook Health Sciences Centre**  
2075 Bayview Avenue  
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## **MECHANICAL GENERAL REQUIREMENTS 20 01 01**

### **1 GENERAL**

#### **1.1 General Contract Documents**

- .1 Comply with General Conditions of the Contract, Supplementary Conditions of the Contract, and Division 01 - General Requirements.
- .2 Where content in this Specification section duplicates requirements in various Division 01 Specification sections, this section and the applicable Division 01 sections are to be read together and the most stringent requirements apply.

#### **1.2 Work Included**

- .1 Work to be done under Divisions 20, 21, 22, 23 and 25 to include furnishing of labour, materials and equipment required for installation, testing and putting into proper operation complete mechanical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.
- .2 Read drawings and specifications together as a whole and in conjunction with other such documents included under the Construction Contract.

#### **1.3 Document Organization**

- .1 Applicable Divisions for Mechanical Work:
  - .1 Division 20 - Common Work for Mechanical
  - .2 Division 21 - Fire Protection
  - .3 Division 22 - Plumbing and Drainage
  - .4 Division 23 - Heating, Ventilation and Air Conditioning (HVAC)
  - .5 Division 25 - Building Automation System
- .2 For clarity, any reference in the Contract Documents to Division 20 includes Divisions 21, 22, 23 and 25.
- .3 The Specifications for these Divisions are arranged in sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.
- .4 Contractor is responsible for completion of work whether or not portions are sublet.

#### **1.4 Division 20, as it applies to Divisions 21, 22, 23 and 25**

- .1 Division 20 contains common work requirements that are applicable as necessary to the Work of Divisions 21 to 25 and apply as if written in full within those Divisions.

#### **1.5 Language**

- .1 The specification is written as a series of instructions addressed to the Contractor, and by implication to subcontractors and to suppliers. For clarity and brevity, use is made of numbered lists and bulleted lists. Where a list follows a semi-colon (;) the punctuation is for clarity. Where a list follows a colon (:) the punctuation is to be read as a short-hand form of the verb "to be" or "to have" as context requires.
- .2 It is not intended to debate with the Contractor the reasons for these instructions, and words associated with justification for an instruction or restatement of anticipated performance have been omitted to avoid possible ambiguities.



## **1.6 Definitions and Abbreviations**

- .1 Specification section 20 01 13 *Definitions and Abbreviations – Mechanical* contains general definitions and abbreviations that apply to one or more specification sections of this Division of the Work. Other specification sections of the mechanical Divisions of the Work may also include additional specific definitions and/or abbreviations that apply to that specification section.
- .2 The following general terms apply to Divisions 20 to 25 of the Work:
  - .1 The words "indicated", "shown", "noted", "listed" or similar words or phrases used in this Specification, mean that material or item referred to is "indicated", "shown", "listed" or "noted" on Drawings or in Specification.
  - .2 Wherever the word "listed" is used in conjunction with a product and a product certification standard (including but not limited to CSA, ULC, CGSB, BNQ, UL), it shall be understood to mean that the product is "listed" by an accredited 3<sup>rd</sup> party testing laboratory as being certified to the referenced product standard.
  - .3 Wherever the words "approved", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to shall be "approved by" the Owner.
  - .4 Wherever the words "satisfactory", "as directed", "submit", "permitted", "reviewed", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to shall be "satisfactory to", "as directed by", "submitted to", "permitted by", or "reviewed by" the Consultant.
  - .5 Instructions using any form of the word:
    - (a) "install" means to place in position and activate for service or use,
    - (b) "supply" means to procure and deliver materials to the place of the Work, or to make available labour or services for the stated purpose,
    - (c) "provide" means to supply material, labour and services to install the referenced item.
  - .6 The term "building code" means the edition of the applicable building code at the time of obtaining a building permit.
  - .7 Wherever manufacturers or manufacturer's products are identified in lists under the phrase "Standard of Acceptance", these are manufacturers and/or products which meet the project standards in regard to performance, quality of material and workmanship.

## **1.7 Examination**

- .1 Examine any existing buildings, local conditions, building site, the specifications and drawings, and report any condition, defect or interference that would prevent execution of the work.
- .2 No allowance will be made for any expense incurred through failure to make these examinations of the site and the documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender.
- .3 Before commencing work under this Division, examine the work of other Divisions of the Work and report any defect or interference.

## **1.8 Design Services**

- .1 Provide specialty design services for elements of the Work where specified in other sections of Division 20. Drawings and specifications prepared by such specialty design service providers shall be sealed by a professional engineer licensed in the jurisdiction of the Work.

## **1.9 Product Substitutions**

- .1 Comply with Division 01 for requests for substitution of products.

- .2 In the absence of requirements concerning product substitution requests in Division 01, Contractor may propose a substitute product to that which is specified in accordance with the following.
- .3 All proposed substitutions shall be submitted using the Consultant's product substitution form and include all information stated therein.
- .4 The use of a substitute article or material which the Contractor represents to be of at least equal quality and of the required characteristics for the purpose intended may be permitted, subject to the following provisions:
  - .1 a substitution will not be considered for reasons of meeting the construction schedule unless the contractor can demonstrate to the satisfaction of the Consultant they made all reasonable efforts to procure the specified product or material in a timely fashion,
  - .2 the manufacturer must advise the Consultant of this intention to use an alternative article or material before doing so,
  - .3 the burden of proof as to the quality and suitability of alternatives to be upon the manufacturer and they shall supply all information necessary as required by the Consultant at no additional costs to the contract,
  - .4 the Consultant shall be the sole judge as to the quality and suitability of alternative materials and their decision to be final,
  - .5 where use of an alternative material involves redesign or changes to other parts of the work, the costs and the time required to effect such redesign or changes will be considered in evaluating the suitability of the alternative materials,
  - .6 no test or action relating to the approval of substitute materials is to be made until the request for substitution has been made in writing by the manufacturer and has been accompanied by complete data as to the quality of the materials proposed. Such request to be made in ample time to permit appropriate review without delaying the work, taking into consideration that such a substitution request may be rejected and require providing the product or material as originally specified,
  - .7 whenever classification, listing, or other certification by a recognized standards body is a part of the specifications for any material, proposals for use of substitute materials is to be accompanied by reports from the equivalent body indicating compliance with the requirements of the specifications,
  - .8 the costs of all testing required to prove equality of the material proposed to be borne by the manufacturer.

## **2 SHIPPING, HANDLING AND STORAGE**

### **2.1 Shipping**

- .1 Provide adequate protection of equipment during shipping and handling so as to provide equipment at the Work site in ex-works condition when handled by commercial carrier systems.
- .2 Provide, as necessary, removable bracing of the internal components in each item of equipment so that the equipment can be moved on its side or back, without sustaining damage.
- .3 Where removeable internal bracing has been provided, the equipment to be provided with warning labels to call for the removal of the shipping bracing prior to energization.
- .4 Any component that is packaged or shipped separately is to be individually crated and tagged with unit number and the equipment number of the assembly to which it belongs.
- .5 Provide each "shipping section" with a permanently-attached, readily-visible identification tag bearing the equipment number of the assembly of which it is a part.

## **2.2 Storage**

- .1 Store equipment and materials at the worksite to protect them from any damage until placed into its final location. Maintain similar protection of installed equipment and materials to protect against damage until they are turned over to the Owner. Make good any damage to equipment or materials up to the time of ready for takeover.
- .2 Store equipment in accordance with the manufacturer's instructions and not less than:
  - .1 stored in a dry, clean location,
  - .2 cover with polyethylene plastic sheeting,
  - .3 include a desiccant material under the protective sheeting to absorb moisture, or provide heated ventilated air
- .3 Provide adequate ventilation and temporary heating to prevent condensation of moisture within the equipment.

## **2.3 Provisions for Handling and Field Erection**

- .1 For equipment that will require hoisting on site, provide removable side panels, lifting angles or lifting plates to accommodate the use of slings or crane hooks, for each shipping section.
- .2 For floor mounted equipment, provide on each shipping section removable steel channel base plates to permit use of pipe rollers or dollies without damaging the equipment.

## **3 OWNER'S SPECIAL REQUIREMENTS FOR EXISTING SITES**

- .1 The following special requirements are in addition to the requirements of Division 01 of the Work.
- .2 Provide a written list of names for employees and sub-trades entering the building, advising which areas they need access to at least 48 hours prior to expected time of arrival. This lead time is required to prearrange security passes.
- .3 Security passes must be visibly worn at all times by all employees.
- .4 Trades people to strictly adhere to owner's building security procedures otherwise entrance into the building will be denied.
- .5 Trades people are to enter the entrance identified by the Owner.
- .6 Park vehicles in designated areas. Do not block driveways.
- .7 Use only the freight elevator to transport tools and material. Freight elevator door must be shut immediately after exiting the cab.
- .8 Do not disable or activate any electrical or mechanical system without prior approval by the Owner's Project Manager. Also, prior to disabling or activation of any electrical or mechanical system, obtain approval from Building Operations and Building Security.
- .9 Submit prior notification to Building Security Staff before any construction activity commences which will result in heat, smoke, dust or fumes, such as welding, saw cutting, soldering, spray painting, which might affect sensitive fire detection and protection equipment.
- .10 Provide at least 48 hours prior notification to Building Operations for any fire system isolation requests.
- .11 Schedule work and meet with sub-trades daily on site, to show trades people the work areas and work to be done.
- .12 Trades-people are to supply and use their own tools. No tools, ladders or equipment, etc. will be loaned by the Owner.

- .13 Provide environmental cleaning of the job site daily during construction and upon completion. This includes both under raised floor and above ceilings. Do not store materials or garbage on the loading dock.
- .14 Provide special care, attention and protection when transporting equipment and materials to prevent accidental damage to fire protection equipment, finishes, furnishings and fixtures.
- .15 "No Smoking" – this is a smoke-free building. Violators will be asked to leave and may be denied reentry. Smoking is not allowed on the roof.
- .16 If Building Operations deems that work on a particular system requires security escort, allow 48 hours to make appropriate arrangements.
- .17 For any open flame work, provide fire extinguishers and security fire watch.
- .18 Obtain the approval of the Building Manager for the storage of materials on site.
- .19 Perform a daily cleanup prior to leaving the site.
- .20 Secure oxygen and acetylene cylinders at all times and capped nightly.
- .21 Restore operating and redundant systems to their normal condition at the end of each work day unless otherwise approved by the Owner
- .22 At the conclusion of each work day, the Contractor's superintendent/supervisor is to advise the Building Manager on the day's activities and plans for the next day's work.

## **4 PROGRESS PAYMENT PROCEDURE**

### **4.1 Schedule of Values**

- .1 Comply with Division 01 specifications.
- .2 Provide schedule(s) of values for progress payments in accordance with this part.
- .3 Prepare and submit a schedule of values ("SOV") for the Division 20 Work. Provide a separate SOV for each Phase of the project.
- .4 Each SOV is to be in the sample format shown in Article "Attachments", specifically that the SOV is to include four sections for:
  - .1 Contract price work element breakdown, which includes:
    - (a) detailed breakdown by work element as agreed with the Consultant,
    - (b) line items for coordination drawings, as-built documents and operating manuals,
    - (c) a summary line item for authorized Cash Allowance disbursements (if applicable),
    - (d) line items for each Itemized Price (if applicable),
    - (e) line items for each Separate Price (if applicable and included in the Contract Price)
    - (f) a line item for the total of the original contract work element values,
    - (g) a summary line item for approved change instructions,
  - .2 Cash Allowance disbursement authorization, with separate work elements for each cash allowance,
  - .3 Approved Change Instructions, with separate work elements for each change instruction,
  - .4 Outstanding Change Instructions which are either not quoted or not yet approved.
- .5 Each work element in the SOV sections (except Outstanding Change Instructions) is to include:
  - .1 the original contract value and the percent of original contract total value (Contract Price section only),
  - .2 the completed to date amount and percent of original work element contract value,

- .3 the previously billed amount and percent of original work element contract value,
  - .4 the current billing (payment request) amount and percent of original work element contract value, and
  - .5 the balance to complete amount and percentage of original work element contract value.
  - .6 The required Contract Price work element breakdown will be determined by the Consultant, with the level of breakdown appropriate to the project such as
    - .1 by trade,
    - .2 by specification section or portion thereof,
    - .3 by labour vs material,
    - .4 by location in the building,
    - .5 or any combination of the above.
  - .7 Submit a draft SOV for review and approval by the Consultant at least three weeks before the first request for progress payment. Do not submit requests for progress payments until the SOV has been reviewed and there are no outstanding comments from the Consultant.
  - .8 Make requests for progress payments using the values on the reviewed SOV.
  - .9 When a change in the Work has been approved by the Owner, include the approved changes on the SOV for the next payment application, whether or not payment is requested in full or in part for that change in that payment request period.
  - .10 For each SOV, include a line item "Interference & Coordination Drawings" and include a value that is the greater of:
    - .1 the value of the work or,
    - .2 1% of the Division 20 contract price.
- Payment of the indicated amount will not be made until satisfactory evidence of completion of this work element has been received by the Consultant. Where satisfactory documents are not received, a Change Directive and an associated Change Order will be issued to delete this work element and the amount from the Contract Price.
- .11 For each SOV, include a line item "As-Built & Operating Manuals" and includes a value that is the greater of:
    - .1 the value of the work or,
    - .2 1% of the Division 20 contract price.

Payment of the indicated amount will not be made until satisfactory documents have been received by the Consultant. Where satisfactory documents are not received, a Change Directive and an associated Change Order will be issued to delete this work element and the amount from the Contract Price.

## **5 CONSTRUCTION CHANGES**

### **5.1 General**

- .1 Comply with Division 01 Specifications.
- .2 The valuation method to be used for a change instruction to the Work is to be determined by the Consultant from the following methods:
  - .1 by labour and material when the change instruction is by a Change Directive;
  - .2 by unit prices set out in the Contract or subsequently agreed upon for other change instructions;

- .3 by a detailed quotation for other change instructions; or
- .4 by a Cash Allowance Disbursement instruction.

## 5.2 Definitions

- .1 The following definitions apply to this section
  - .1 **Allpricer** – the material pricing guide/service provided by Allpricer Limited.
  - .2 **MCAA manual** – the Mechanical Contractors Association of America publication *Labor Estimating Guide for Service* for labour units.
  - .3 **Base wage rate** – the hourly rate actually paid to the trades person, determined in accordance with applicable collective bargaining agreement, or in their absence the actual gross wages paid to the worker.
  - .4 **Job Site Impact Multiplier** – a multiplier expressed as a decimal number that is included in the Labour Rate to account for special job site conditions that affect labour availability, labour productivity, procurement of materials, and materials management, that are specific to the project and site conditions.
  - .5 **Indirect labour** – any labour that is neither journeyperson labour that directly performs the work nor labour that directly supervises journeyperson(s).
  - .6 **Labour Rate** – the actual fully burdened labour cost per hour of labour consumed by a trades person including statutory and regulatory burden, collective bargaining burden, and other project related burden. For greater clarity, the labour rate includes but is not limited to the following:
    - (a) base wage rate,
    - (b) vacation and statutory holiday pay,
    - (c) union deductions and additional union charges,
    - (d) Legislated burdens including EHT, WSIB, EI, CPP, RST on H/W
    - (e) wage-based taxes,
    - (f) job site impact multipliers,
    - (g) expendable small tools charge,
    - (h) project insurance,
    - (i) financing of payroll,
    - (j) estimating,
    - (k) rest breaks and idle time,
    - (l) safety including training, safety meetings, WHMIS, fall protection, personnel protection equipment, and safety committees,
    - (m) preparation and handling of shop drawings and other submittals,
    - (n) preparation of as-built documents, including operation and maintenance manuals,
    - (o) labour warranties,
    - (p) site facilities,
    - (q) clean-up,
    - (r) parking.
  - .7 **Foreperson** – a first level supervisory position having direct control over the work performed by journeypersons.
  - .8 **Journeyperson** – a person working in a skilled construction trade which may be prescribed by regulation, and includes apprentices.

- .9 **Labour Unit** – the number of journey person labour hours or part thereof, required to perform a specific construction task, and includes but is not limited to:
- (a) receiving, unloading, stockpiling, distribution and handling of materials and equipment,
  - (b) rigging or erecting of materials or equipment,
  - (c) fitting and joining of materials,
  - (d) pressure testing of piping and ductwork systems,
  - (e) testing of equipment and systems.
- .10 **Line materials** – components that make up a distribution network for fluid, power, or electronic/digital information, and includes:
- (a) piping, pipe fittings, valves (of all kinds), pipe strainers and other pipe mounted equipment,
  - (b) ducting, duct fittings, duct balancing dampers and other duct mounted equipment,
  - (c) conduit, cable tray, cable, conductors, and wiring,
  - (d) supports, hangers and restraints,
  - (e) vibration isolators and seismic restraints associated with line materials,
  - (f) instrumentation including gauges and sensors/transmitters,
  - (g) electrical, pneumatic, and hydraulic actuators for valves and dampers, and
  - (h) any coatings or other protective elements applied thereto including insulation and painting.
- .11 **Overhead** – administrative expenses of the Contractor's business and the project which are not included in a Labour Rate or Labour Unit. For greater clarity, overhead includes but is not limited to the following:
- (a) company office, storage, and fabrication spaces, and associated maintenance, utilities, and expenses,
  - (b) project site office, fabrication and storage spaces, washrooms, break rooms, and associated maintenance, utilities, and expenses,
  - (c) company office equipment, furniture and supplies,
  - (d) project site office equipment, furniture and supplies,
  - (e) labour time for project managers and project assistants,
  - (f) project site security,
  - (g) project site clean-up, recycling and waste disposal,
  - (h) materials management,
  - (i) property taxes, business licenses, and auto insurance,
  - (j) dues and subscriptions,
  - (k) postage and courier,
  - (l) advertising, telephone, IT services and equipment,
  - (m) legal and accounting fees and expenses,
  - (n) sales and marketing,
  - (o) salaries and benefits for company indirect labour including company management, sales force, dispatchers, estimators, clerical staff, and at-office general (non-trades) labour.
  - (p) all other indirect labour.
- .12 **Senior Foreperson** – the second (and subsequent) level supervisory position having direct control over one or more Forepersons, where the number of Forepersons supervised is in accordance with local regulatory requirements or collective bargaining agreements. ("Superintendent" or "Supervisor" has the same meaning.

### **5.3 Change Directive Method**

- .1 Except where otherwise determined in the Construction Contract or Division 01 specification, the valuation of changes by the Change Directive method shall comply with the following:
  - .1 the form of presentation of costs and methods of measurement shall be agreed to by Consultant and Contractor before proceeding with the change,
  - .2 the adjustment in the Contract Price for a change carried out by way of Change Directive shall be determined on the basis of the cost of the Contractor's actual expenditures and savings attributed to the Change Directive. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
  - .3 labour costs will be determined based on actual time spent and the agreed labour rate, the actual cost of installed line materials and equipment, and the agreed fee for overhead and profit,
  - .4 if the change results in a net decrease in Contract cost, the contract price will be decreased by the net decrease in the cost, without adjustment for the Contractor's percentage fee for overhead and profit,
  - .5 the Contractor shall keep accurate records, in an agreed upon form, of time, quantities and invoiced costs and present an account of the cost of the change in the Work, together with vouchers, material receipts and invoices,
  - .6 this time and material method shall be used until such time as a total cost estimate of the change is agreed between the Owner and the Contractor, at which time all payments made under this time and material method will be credited against the agreed total cost for the change.

### **5.4 Unit Price Method**

- .1 Costing of changes by the Unit Price method:
  - .1 Costs for work identified by agreed unit costs shall be charged at those rates, unless the Owner agrees to other rates.

### **5.5 Proposed Changes; Other Change Instructions Method**

- .1 For proposed changes to the Work or other similar instructions, submit a detailed quotation for approval.
- .2 The adjustment in the Contract Price for a change carried out by way of proposed change or other similar instruction shall be determined on the basis of the cost of the Contractor's actual expenditures and savings attributed to the Proposed Change. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
- .3 Costs are to be approved by the Owner before the proposed change to the Work proceeds. The quotation for the change to the Work is to include a summary of charges made up of three components: labour charges, material costs and fees.
- .4 Labour Charges:
  - .1 The labour unit hour estimates are to be based on the current MCAA estimating manual unless otherwise agreed by the Consultant;
  - .2 The labour cost is to be determined using the agreed labour rates.
  - .3 Labour rates for Foreperson and Senior Foreperson shall be as per agreement, or in absence of such agreement shall be 1.15 times the journeyperson labour rate. The maximum allowable labour hours for supervision are not to exceed:
    - (a) for a Foreperson, a maximum of 10% of the total calculated journeyperson hours on a change, and



(b) for a Senior Foreperson of all levels, a maximum combined amount of 3% of the total calculated journeyperson hours on a change.

(c) no other supervisory hours will be permitted.

**.5 Material Charges:**

.1 Material costs for line materials and installed equipment are to be net of trade discounts. The discount to be applied to list prices for items included in Allpricer manual shall not be less than:

(a) 20% for line materials, and

(b) 10% for equipment that is not line material.

**.6 Fees:**

.1 Refer to Division 01 regarding fees for overhead and profit on changes to the Work.

.2 If not specified in Division 01:

(a) The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 15% for work to be performed by their own forces,

(b) The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 5% for work performed by a sub-contractor (in the case of the Contractor) or a sub-sub-contractor (in the case of work performed for a sub-contractor),

(c) For clarity, the allowable fees on direct work and on sub-contracted work apply to a sub-sub-contractor of any tier.

**5.6 Cash Allowances; Contingency Allowances**

.1 Instructions for changes to the Work to be performed under a cash allowance or contingency allowance ("Allowance") included in the contract price shall be authorized by a Cash Allowance Disbursement instruction.

.2 Except as described below, the determination of costs for Work performed under an Allowance shall be in accordance with the procedure for proposed changes unless otherwise instructed to proceed with the work, in which case the cost of such work shall be valued in accordance with the procedures for Change Directive.

.3 The contract price, not the Allowance, includes the overhead and profit fee for the value of the Allowance.

.4 Except where otherwise specified in the Construction Contract, where the cost of the Work performed under a Cash Allowance Authorization;

.1 is less than the Allowance value, the contract price includes the overhead and profit for the contractor and any sub-contractors. A change order will be issued for a credit for the balance of the Allowance, but shall not include the associated overhead and profit fee.

.2 exceeds the Allowance value, a Change Order will be issued for the amount in excess of the Allowance, and the excess amount is to include the agreed fee for overhead and profit.

**6 SUBMITTALS**

**6.1 Shop Drawings and Product Data Sheets**

.1 Submit shop drawings, manufacturers product data and samples in accordance with the requirements of Specification sections of Division 01, this Part, and as further required in other Specification sections of Division 20.

.2 Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and U.S. customary units may be included.

- .3 Submit shop drawings by email to: [shopdrawings@hhangus.com](mailto:shopdrawings@hhangus.com), except where a project document management web-service is used.
- .4 Include a H.H. Angus shop drawing cover sheet form prepared for this project for each shop drawing submittal (refer to part "Attachments" for an example of this form) , or include the same information on the general or trade contractor's submittal cover sheet;
  - .1 Information required on each submission:
    - (a) Client/Architect name,
    - (b) Project Name,
    - (c) H.H. Angus project number,
    - (d) Date,
    - (e) Contractor name,
    - (f) Contractor reference No.,
    - (g) Manufacturer name,
    - (h) Product type,
    - (i) Specification section number,
    - (j) Contractor trade category: architectural, structural, conveying equipment, user equipment, mechanical, electrical, telecommunications, civil or other.
    - (k) If a re-submission, the Consultant's previous submittal reference number.
- .5 Submit shop drawings in PDF format except as follows;
  - .1 if the Consultant agrees to a shop drawing to be submitted in hardcopy format, submit in 8.5 x 11 or 11 x 17 size, black and white originals of graphic quality suitable for photocopying and digital scanning. Allow one additional week for processing of shop drawings submitted in hardcopy format.
- .6 Manufacturer's letter sized product data sheets for standard items are acceptable in place of shop drawings provided that physical characteristics are identified and are related to specification references.
- .7 Submit with manufacturers data sheets, typed schedules listing manufacturer's and supplier's name and catalogue model number.
- .8 For plumbing fixtures and other permeant fixtures, submit fixture sheets with catalogue numbers. Identify and arrange fixture sheets in the same sequence and using the same identification number as shown in specification fixture lists.
- .9 Shop drawings and/or product data sheets to show;
  - (a) dimensioned outlines of equipment and construction details,
  - (b) equipment weights and center of gravity,
  - (c) performance ratings,
  - (d) dimensioned details showing service connection points,
  - (e) elevations illustrating locations of visible equipment such as gauges, pilot lights, breakers and their trip settings, windows, meters, and access doors,
  - (f) description of operation,
  - (g) single line diagrams,
  - (h) general routing of bus ducts and connecting services,
  - (i) mounting and fixing arrangements,
  - (j) operating and maintenance clearances,
  - (k) access door swing spaces, and

- (l) where products are required to be certified to a published standard, the mark of the testing organization who certified the product and the standard reference number to which it is certified.
- .10 Shop drawings and product data to be accompanied by;
  - (a) detailed drawings of bases, supports and anchor bolts,
  - (b) sound power data, where applicable, and
  - (c) performance curve for each piece of equipment marked with point of operation.
- .11 Shop drawing and data sheet submission is taken as certification that the products are;
  - .1 from the manufacturer's current production, and
  - .2 in compliance with applicable codes, standards, and regulations.
- .12 For standard catalogued (non-custom) products, do not submit drawings showing internal construction details, component assemblies or interior piping and wiring diagrams. Such information may be necessary to understand correct functioning of equipment and are to be submitted with operating and maintenance data.
- .13 Check and stamp each shop drawing as being correct before submission. Shop drawings without such stamps will be rejected and returned.
- .14 Keep one copy of each reviewed shop drawing and product data sheet on site and have them available for reference purposes.
- .15 Where equipment is delivered without reviewed shop drawings, equipment will be condemned and is to be removed from site and replaced with new equipment after shop drawings have been submitted and reviewed.

## **6.2 Coordination, Fabrication, or Installation Drawings**

- .1 Contractor coordination, fabrication, installation and/or sleeving drawings are to be provided in accordance with specification Section 20 01 03 *Mechanical Coordination and Installation Design Services*.
- .2 Contractor's coordination, fabrication, installation, and/or sleeving drawings will not be reviewed as shop drawings. If submitted as a shop drawing, a transmittal only will be returned identifying the submitted drawings have not been reviewed as a shop drawing.
- .3 Maintain a copy on site of such drawings for reference by the Consultant.
- .4 The Consultant reserves the right to request selected Contractor's coordination, fabrication, or installation drawings for review.

## **6.3 Effect of Consultants Review of Submittals**

- .1 Consultant's review of shop drawings is performed on a sampling basis only, to confirm to Consultant's satisfaction that the Contractor understands the Work to be performed and is interpreting the design documents correctly, and such reviews are performed for the benefit of the Owner.
- .2 For greater certainty, the review of shop drawings by Consultant does not constitute a quality control function for the benefit of Contractor, nor does such a review relieve Contractor of their responsibility for complying with the Contract documents.

# **7 APPLICABLE CODES, STANDARDS AND REGULATIONS; PERMITS**

## **7.1 Codes, Standards and Regulations**

- .1 Where a published product standard or installation code is adopted by statute or regulation by an applicable AHJ, the applicable edition of the standard or code is the one that has been adopted

- .1 at the time of obtaining a permit for the applicable portion of the Work, or
- .2 in the absence of a requirement for a permit, the start date of construction.
- .2 Where a published product standard or installation code is not adopted by statute or regulation, then the most current edition of that standard or code at the start date of construction applies.
- .3 Install mechanical and electrical systems in accordance with the applicable requirements adopted by the AHJ in the jurisdiction of the Work.
- .4 Where requirements of the Specifications exceed those of applicable codes, standards, and regulations the requirements of the Specifications is to govern.
- .5 In the event of a conflict between codes, bulletins, regulations, or standards, or where work shown is in conflict with these documents, obtain interpretation before proceeding. Failure to clarify any ambiguity will result in an interpretation requiring application of the most demanding requirements.

## **7.2 Confined Spaces**

- .1 Unless otherwise prescribed by the Constructor's / Owner's workplace safety program, treat spaces not designed and constructed for continuous human occupancy as confined spaces in accordance with applicable health and safety legislation, including but not limited to:
  - .1 horizontal and vertical service spaces, shafts, and tunnels,
  - .2 inside of equipment which permits entry of the head and/or whole body, and
  - .3 ceiling spaces which are identified as containing a hazardous substance.

## **7.3 Permits, Tests and Certificates**

- .1 Arrange and pay for permits, tests, and Certificates of Inspection required by the AHJ applicable to the element of the Work.
- .2 Submit applications requiring Owner's signature before commencing work.
- .3 Obtain and submit applicable AHJ Inspection certificates or reports including but not limited to:
  - (a) Electrical inspection,
  - (b) Plumbing and drainage inspection,
  - (c) HVAC inspection,
  - (d) Pressure Vessel Inspection.
  - (e) Piping and Boiler Inspection.
  - (f) Fuel safety Inspection.
- .2 Renew certificates or reports so as to remain in force through the warranty period.
- .4 Co-ordinate and perform testing required by an AHJ in accordance with the Part on Testing in this Section.

# **8 COMMON PRODUCT REQUIREMENTS**

## **8.1 Standard of Material and Equipment**

- .1 Provide materials and equipment in accordance the requirements of Division 01 and as follows.
- .2 Materials and equipment:
  - .1 new and of uniform pattern throughout work,
  - .2 of Canadian manufacture where obtainable,
  - .3 standard products of approved manufacture,

- .4 labeled or listed (certified) to applicable standards in accordance with Specification sections of the Work and as required by authorities having jurisdiction,
  - .5 registered in accordance with the requirements of the applicable provincial pressure vessels regulation and registered in accordance with CSA B51 for Canadian Registration Numbers, as applicable,
  - .6 in compliance with Standards and Regulations including but not limited to;
    - (a) chemical and physical properties of materials,
    - (b) design,
    - (c) performance characteristics, and
    - (d) methods of construction and installation.
  - .7 identical units of equipment to be by the same manufacturer. ,
  - .8 identical component parts of same manufacturer in similar units of equipment, but various component parts of each unit need not be from one manufacturer.
- .3 Materials and equipment are described to establish standards of construction and workmanship. Where manufacturers and/or products are listed under "Standard of Acceptance", select manufacturers and or products from these lists. Use of manufacturers or products other than as listed are subject to specification requirements concerning requests for substitution.
- .4 Include items of material and equipment not specifically noted on Drawings or mentioned in Specifications but which are required to make a complete and operating system.
- .5 Confirm capacity or ratings of equipment being provided, when based on ratings of equipment being provided under other trade Sections, before such items are purchased.
- .6 Factory fabricated control panels and component assemblies are to be listed for electrical safety requirements.
- .7 Select materials and equipment in accordance with manufacturer's recommendations and these Specifications, and install same in accordance with manufacturer's instructions and these Specifications.
- .8 Materials and equipment not satisfying these selection criteria will be condemned. Remove condemned materials from job site and provide properly selected and approved materials.

## **8.2 Manufacturers Nameplates**

- .1 Provide manufactured equipment with metal nameplate with raised or recessed lettering, mounted on each piece of equipment. On insulated equipment, mechanically fasten plates on metal stand-off bracket arranged to clear insulation.
- .2 Manufacturer's nameplate to indicate equipment size, capacity, model designation, manufacturer's name, serial number, voltage, cycle, phase and power rating of motors, and approval listings.
- .3 Certified products are to clearly show the mark of the certification agency when in the final installed state.

## **8.3 Factory Applied Painting**

- .1 Protect factory finished equipment during construction, and clean at completion of work.
- .2 Touch-up factory painted prime and/or final coats damaged during construction, with colour matching paint recommended by the equipment manufacturer.
- .3 Use heat resistant paint where conditions require.

#### **8.4 Factory Applied Prime Painting**

- .1 Factory-prime paint other equipment fabricated from iron or steel, including equipment supports and hangers, access platforms, access doors, registers, grilles, diffusers, dampers, metal radiation enclosures and fire hose cabinets where separate product specifications do not require a factory applied final coat.

#### **8.5 Field Painting**

- .1 After equipment has been installed and piping and insulation is completed, clean rust and oil from exposed iron and steel work provided under this Division, whether or not it has been factory prime painted.
- .2 In "occupied" areas of building touch up any damage to prime coat resulting from shipping or installation and leave ready for final decorative painting under Finishes, Division 9.
- .3 In "un-occupied" areas of the building such as mechanical equipment rooms, boiler rooms, fan rooms, crawl spaces, pipe tunnels and penthouses, provide corrosion coatings and floor sealers in accordance with specification section 20 05 02 *Painting for Mechanical Services*.
- .4 In addition, apply prime and/or final paint coats to equipment and materials where specifically detailed in other Sections of these Divisions.

#### **8.6 Provision for Future**

- .1 Where space is indicated as reserved for future equipment or for future extension to building, leave such space clear and install piping, raceways and equipment so that connections can be made to future apparatus or building.
- .2 Identify provisions and service terminations for future on Record Drawings.

#### **8.7 Maintenance of Bearings**

- .1 Turn-over rotating equipment at least once a month from delivery to site until start-up.
- .2 Run-in sleeve type bearings in accordance with manufacturer's written recommendation. After "run-in", drain, flush out and refill with new charge of oil or grease.
- .3 Protect bearings, shafts and sheaves against damage, corrosion and dust accumulation during building construction.

#### **8.8 Pre-purchased Equipment; Damage and Ownership**

- .1 At time of receipt of pre-purchased or pre-tendered equipment at the job site by the installing mechanical contractor, provide the services of the manufacturer/distributor/supplier's technical representative to:
  - .1 inspect the equipment prior to unloading,
  - .2 witness the unloading and advise the contractor on the appropriate method for handling the equipment in order to avoid damage during the unloading, moving and setting in place phase of the equipment, and
  - .3 report any damage to the Consultant.
- .2 In the event the equipment has been found to be damaged before unloading, it is to be returned immediately to the factory for repairs and/or replacement by the manufacturer/supplier.
- .3 In the event of damage occurring at any time during unloading and until the equipment is accepted by the Owner, the installing contractor is responsible for repairs and/or replacement of the damaged equipment to the satisfaction of the Owner.

## **9 OFFICE AND STORAGE; TOOLS**

### **9.1 Office and Storage**

- .1 Provide temporary office, washroom and lunchroom facilities, workshop, and tools and material storage space in accordance with Division 01.

### **9.2 Tools, Temporary Equipment and Materials**

- .1 Provide tools, equipment, scaffolding, extension cords, lamps and miscellaneous consumable materials, required to carry out the Work.

## **10 COORDINATION; INSTALLATION DRAWINGS**

### **10.1 Coordination**

- .1 Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, etc. and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.
- .2 Lay out and coordinate Work to avoid conflict with work under other Divisions.
- .3 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.
- .4 When equipment provided under other Sections connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided.
- .5 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- .6 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.
- .7 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .8 Location of floor drains, hub drains, combination drains, plumbing fixtures, convectors, unit heaters, diffuser, registers grilles and other similar items may be altered without extra cost provided instruction is given prior to roughing in. No claim will be paid for extra labour and materials for relocating items up to 3 m (10 ft) from original location nor will credits be anticipated where relocation up to 3 m (10 ft) reduces material and labour.
- .9 Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the work as an operating installation.

### **10.2 Field, Fabrication, and Installation Drawings**

- .1 Prepare field, fabrication, and/or installation drawings to show location of equipment and relative position of services, and to demonstrate coordination with the work of other trades;
  - .1 drawing scale: minimum 1:50 (1/4"=1'-0")
  - .2 use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings,
  - .3 layout equipment and services to provide access for repair and maintenance,

- .2 Circulate drawings to other trades involved in each area, and conduct coordination meetings with those trades.

## **11 ANCHORS AND INSERTS**

- .1 Supply anchor bolts and locating templates for installation in advance of concrete pouring.

## **12 CUTTING, PATCHING AND REMEDIAL WORK**

### **12.1 General**

- .1 Assume responsibility for prompt installation of work in advance of concrete pouring, masonry, roofing, finishing trades and similar work. Should any cutting or repairing of either unfinished or finished work be required because such installation was not done, employ the particular trade whose work is involved to do such cutting and patching and pay for any resulting costs.
- .2 Neatly cut or drill holes required in existing building elements to accommodate building services including ductwork, piping, cable, raceways, bus duct or cable tray.
- .3 Arrange and pay for all cutting and patching as required for the Work. Before cutting, drilling, or sleeving structural load bearing elements, obtain the Consultant's approval of location and methods in writing. Employ original installer or expert in the finishing of material required to perform cutting or patching for weather-exposed, moisture-resistant elements or sight-exposed surfaces.

### **12.2 Structure Scanning and Cutting**

- .1 Layout cutting of structural elements, such as floors slabs, walls, columns or beams and obtain approval before starting work. Conduct an initial electromagnetic scan of reinforcing rods and electrical conduit, and review with structural engineering Consultant.

#### *Standard of Acceptance*

- Hilti - fig. PS 300 Ferrosan

- .1 Based on the preceding results, arrange and pay for supplemental radiographic examination where necessary to improve on locating concrete reinforcement, conduits and other embedment's.
  - .1 submit radiographic results to the structural engineer and obtain comments before starting work,
  - .2 the use of radiographic imaging methods is subject to approval by the Owner on a case by case basis.
- .2 As an alternative to radiographic examination for areas where the Owner does not permit radiographic examination, based on the preceding results, provide two-dimensional ground penetrating radar scans to locate concrete reinforcement, conduits and other embedment's. Scanners to be operated by personnel trained by the measurement device manufacturer.

#### *Standard of Acceptance*

- Hilti PS1000 X-SCAN

- .3 Relocate core drilling location if steel or conduit is found in the proposed location and repeat procedure. Reroute any circuits damaged by core drilling.
- .4 Scan for all shots and anchors in floors, walls, and ceilings.

## **13 PROTECTION OF PERSONNEL, WORK, AND PROPERTY**

### **13.1 Personnel Protection**

- .1 Without limiting the Contractor's responsibilities regarding occupational health and safety requirements at the construction site, provide specific personnel protection as follows:



- .1 protect exposed live equipment during construction for personnel safety,
- .2 shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage,
- .3 arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician,
- .4 do not leave conduit, wires, cables, tools, equipment or materials in such a way that they constitute a hazard,
- .5 provide toe guards around openings in the roof or floor to prevent materials or debris from dropping down to a lower level,
- .6 remove loose equipment and tools from overhead areas before leaving each day,
- .7 cut off bolts at floor level to eliminate a possible tripping hazard.

### **13.2 Protection During Construction**

- .1 Provide protection required to enable existing building and equipment to remain in continuous and normal operation.
- .2 Take the necessary precautions to protect equipment, existing building and service from damage during the Work. Accept responsibility for any damage and make good without cost to the Owner.
- .3 Protect existing surfaces and items so that they are not damaged in any way whatsoever by the work of all trades. Take precautions as necessary to prevent damage to walls, floors, ceilings, windows, doors, door frames, moldings, finishes, piping, ductwork, light fixtures, etc. Provide protection, hoarding, tarpaulins, dust sleeves etc., as required. Any damage caused because of lack of adequate protection to be made good at no cost to the Owner.
- .4 Take care when working above or around equipment that must remain in service.
- .5 Take care to eliminate dust in equipment areas.
- .6 Protect switchgear fronts from accidental breaker trips when working around or above them. Provide an extended shield constructed of 12 mm (½") fire retardant plywood a minimum of 450 mm (18") from board front to allow access to board.

### **13.3 Core Drilling**

- .1 Wherever core drilling is required, provide temporary dust proof screens.
- .2 In areas where core drilling through a slab in an operating facility is necessary, clearly mark out the areas to be drilled on the underside of slab. Owner's representative to be notified at least 1 week prior to core drilling operation. Provide tarping of equipment supervised by the Owner.
- .3 During core drilling operations, station at least one person directly below the area of drilling with a large plastic container pressed to underside of slab to capture and hold core and water upon completion of operations.
- .4 Continuously use a wet/dry commercial quality vacuum at location of drilling operation to remove all excess water from the area.

### **13.4 Temporary Dust Proof Screens**

- .1 Comply with Division 01 for temporary dust proof screens and infection control procedures.

- .2 Provide temporary dust proof screens where required to separate work areas from completed areas and/or existing areas, to prevent dust from settling on the Owner's plant and equipment.
- .3 Dust proof material to be neoprene coated nylon tarpaulin or other types of fabric.
- .4 Provide temporary framing as required.
- .5 Extend dust proof screens from floor to underside of ceiling, floor, or roof above. Lap sections of screen sheets 150 mm (6") minimum and tape joints.
- .6 Secure screen sheets at top, bottom and ends and tape perimeter.
- .7 Provide temporary doors and frames with weather seals to provide frequent access to the work zone. Other closure methods may be used where infrequent access or short term access (less than one week) only is required.
- .8 Co-operate with Owner in the erection of temporary dust proof screens.
- .9 Provide yellow-black warning tape along perimeter of the screen junction with the floor.
- .10 Remove screens when and as directed by Consultant.

### **13.5 Protection of Floors During Equipment Installation**

- .1 Provide protection of floor finishes during installation or removal of equipment, and at any other time when moving or installing heavy equipment.
- .2 Install 19mm (¾") plywood over 6 mil plastic over finished floor areas when moving heavy equipment that could damage floor finish, or when installing equipment or line materials overhead.
- .3 Repaint or re-tile any floors or walls damaged or scratched during construction.

### **13.6 Housekeeping**

- .1 Maintain a high level of cleanliness.
- .2 Remove scrap and refuse from the work area daily.
- .3 Whenever possible, clean up immediately following completion of work.
- .4 Deposit oily and waste solvent rags in approved containers to minimize the fire hazard.
- .5 Sweep and damp mop daily.

## **14 WORK IN EXISTING BUILDING**

### **14.1 General**

- .1 Comply with Division 01 requirements for restrictions on working in existing occupied buildings and as follows.
- .2 During the tender period, the Contractor shall perform a site inspection of the place of work and surroundings including the accessible ceiling spaces and other areas where access could be considered reasonable. Make a thorough investigation of as-built conditions to determine scope of renovation or demolition work required prior to submitting tender.

- .3 The Work includes changes to existing building and changes at junction of old and new construction. Route pipes, ducts, conduits and other services to avoid interference with existing installation.
- .4 Perform core drilling after hours and on weekends depending on the schedule of the impacted spaces. Coordinate with Owner for specific times.
- .5 Relocate existing pipes, ducts, conduits, bus ducts and any other equipment or services required for proper installation of new work, including as required for temporary removal and re-installation to suit new installation work.
- .6 Remove existing plumbing fixtures, lighting fixtures, piping, ductwork, wiring, and equipment to suit new construction. Cut back and cap drain, vent and water outlets, conduits and electrical outlets, not being used.
- .7 Unless noted otherwise removed materials and equipment become the property of the Contractor and are to be taken from the site and disposed of appropriately.
- .8 On completion of relocations, confirm relocated equipment are in proper working order.
- .9 Where Owner wishes to take over renovated areas ahead of project completion date and these areas are to be fed from new distribution systems, make temporary connections to existing services in these areas. Reconnect to permanent services, at later date, when new distribution systems are available.

#### **14.2 Continuity of Services**

- .1 Keep existing buildings in operation with minimum length of shutdown periods.
- .2 Make connections to existing systems at approved times.
- .3 Obtain written approval recording times when connections can be made.
- .4 Arrange work so that physical access to existing buildings is not unduly interrupted.
- .5 Be responsible for and make good any damages caused to existing systems when making connections.
- .6 Provide premium time labour to tie-in to services at night or on weekends.
- .7 For piping systems, make connections to existing piping by draining down the existing piping system. Use of hot-tapping or freezing of piping is only permitted where approved by the Owner and a specification section for such work has been included in the project specifications.
- .8 Provide temporary services to drain down existing piping systems which convey liquids or steam condensate, including provision of temporary hoses, etc., and provide services to perform the drain down of these systems, except where the Owner elects to perform such drain-downs.
- .9 For piping systems conveying liquids, after completion of new work to existing piping systems, refill the existing and new piping systems including provision of cleaning of new piping and addition of chemical treatments, as applicable, in accordance with the requirements of other sections of Division 20. Include for addition of replenishing chemical treatment for existing piping systems in accordance with the Owner's existing chemical treatment program, or in the absence of such, in accordance with the chemical water treatment requirements specified in other Sections of Division 20.

### **15 MOVING AND SETTING IN PLACE OF OWNER-SUPPLIED PRODUCTS**

#### **15.1 General**

- .1 The requirements of this Part applies to;
  - .1 Division 20 equipment that has been directly purchased by the Owner, and
  - .2 other Owner-supplied products or equipment (i.e. process equipment) that has building services requirements.
- .2 Comply with the requirements of Division 01 and as specified herein.

## **15.2 Owner-Supplied Products (Supplied by Owner Equipment – “SBO”)**

- .1 Items marked SBO on drawings are to be;
  - .1 purchased by the Owner,
  - .2 received, checked, and stored by the Contractor, and
  - .3 subsequently unpacked, uncrated, assembled and located in its final location by the Contractor, and installed in accordance with the manufacturer instructions,
  - .4 participate in the start-up and testing of the equipment and placing into service.
- .2 Provide mechanical and electrical services to SBO equipment in accordance with the SBO equipment manufacturer's instructions and as otherwise shown.

## **15.3 Existing Owners Equipment to be Relocated (E.R. or Ex. Rel.)**

- .1 Applies to owners existing equipment which has mechanical and electrical services, and marked on the drawings as E.R. Ex.Rel. or otherwise so identified.
- .2 Items so marked on drawings are to be moved from their present location and reinstalled by the Contractor.
- .3 Disconnect and reconnect mechanical and electrical services to accommodate this equipment relocation.

## **16 TEMPORARY HEATING**

### **16.1 During Construction**

- .1 Temporary heating required while building is under construction will be provided under Division 01.
- .2 Permanent heating system may be used for temporary heating, when this equipment is installed in its permanent location and the building is closed-in and Contractor under Division 1 provides staff for operation and maintenance whenever permanent heating system is being used for temporary heating.
- .3 Hot water boilers may not be used unless heating units, radiation, pumps and piping are complete, the piping system has been pressure tested, cleaned, and final chemical water treatment is in operation.
- .4 Permanent heating equipment used for temporary heating to be thoroughly cleaned and put in first class operating condition and appearance at completion of the Work, as approved by the Owner.

## **17 FINAL CLEANING AND ADJUSTMENTS**

### **17.1 Final Cleaning**

- .1 Conduct final cleaning in accordance with Division 01 requirements and as specified herein.
- .2 Perform final cleaning after construction activities that create dust have been completed.
- .3 Thoroughly clean exterior surface of exposed piping, and vacuum external surfaces of exposed ducts and interior surfaces of air handling units. Clean strainers in piping systems and install clean filters in air handling systems immediately prior to handover of the building to the Owner.
- .4 HEPA vacuum the top and interiors of motor controllers, VFDs, control panels, and control cabinets followed by a thorough HEPA vacuuming of the service room floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.
- .5 Remove tools and waste materials on completion of work and leave work in clean and perfect condition.

## **17.2 Final Adjustments**

- .1 Calibrate components and controls and check function and sequencing of systems under operating conditions.
- .2 Supply lubricating oils and greases for proper operation of equipment and systems until work has been accepted.

## **18 RECORD DRAWINGS**

### **18.1 Record Drawings**

- .1 Maintain record drawings in accordance with Division 01 during the course of the Work and as follows.
- .2 A set of design drawings in AutoCad or PDF format (as determined by the Consultant) will be provided by the Consultant. Record changes in actual installation as the Work progresses by the following method:
  - .1 make sets of white prints for each phase of Work and mark-up the print drawings, or
  - .2 revise the AutoCad file directly, and identify all changes made.
- .3 Mark-up these record drawings to provide dimensioned locations of drains, pipes, ductwork, conduit, manholes, foundations and similar buried items within the building, with respect to building column centres. Mark level with respect to an elevation which will be provided.
- .4 Retain on-site the survey information from excavation and backfill of site services, and after approval, transfer this information to the record documents.
- .5 Retain these drawings and make available to Consultant for periodic review.
- .6 At 75% project completion per phase, scan marked-up drawings to PDF format and submit copy to the Consultant, or to the project on-line document management service if one is used.

### **18.2 As-Built Drawings**

- .1 Prior to testing, balancing and adjusting, transfer site record drawing information to a copy of the computer aided drafting/design program ("CAD") files, in the same software format used for the Consultants design drawings, to record final as-built condition.
- .2 Obtain a current set of CAD files from the Consultant. The Consultant's CAD files may not reflect all or any construction changes.
- .3 Drawings are to remain set to and follow Consultants CAD Standards - do not alter drawing scales, reference files, colours, layers or text styles,
- .4 Where items have been deleted, moved, renumbered or otherwise changed from contract drawings, revise the CAD files to record these changes. "Bubble" these revisions, and place these annotations on a separate and easily identified drawing layer.
- .5 Show on mechanical as-built drawings final location of piping, ductwork, switches, starters, Motor Control Centres, thermostats, and equipment.
- .6 Show on site services as-built drawings survey information provided by an accredited land surveying service.
- .7 Identify each drawing in lower right hand corner in letters at least 12 mm (½ in) high with a note as follows:

AS-BUILT DRAWINGS.  
This drawing has been revised to  
show systems as installed  
(Signature of Contractor) (Date).

- .8 The site services drawings are to include the signature and stamp of the accredited surveyor adjacent to the note.
- .9 Submit one (1) set of white prints of the draft as-built CAD files for Consultant's review.
- .10 Once "AS BUILT DRAWINGS" white prints are reviewed, transfer Consultant's comments to the CAD files. Return CAD files modified to "As Built" condition to Consultants electronically by removable mass storage device or by electronic file transfer as designed by the Consultant.
- .11 Submit three (3) sets of white prints and one (1) electronic copy of CAD files with Operating and Maintenance Manuals to the Owner.

## **19 OPERATING AND MAINTENANCE INSTRUCTIONS**

### **19.1 Operating and Maintenance Manuals**

- .1 Provide operating and maintenance manuals in accordance with Division 01 and as follows.
- .2 Provide operation and maintenance data bound in vinyl covered, hard back, three-ring covers, nominally 50 mm (2 in) thick, suitable for paper size of 210 mm x 300 mm (8½ in x 11 in);
  - .1 organize material in volumes, generally grouped by Trade section;
    - (a) Table of Contents,
    - (b) General Information,
    - (c) Sub-contractors (list),
    - (d) Site services,
    - (e) Fire Protection,
    - (f) Plumbing,
    - (g) Heating and Cooling Plant and Distribution,
    - (h) Air Handling Equipment and Distribution,
    - (i) Building automation, Controls and Instrumentation,
    - (j) Testing Reports,
    - (k) As-Built Drawings,
    - (l) Warranties.
  - .2 Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear;
    - (a) Project Name,
    - (b) Project Number,
    - (c) Date,
    - (d) Trade Section,
    - (e) List of Contents.
  - .3 Provide three hard-copies to Owner.
- .3 In addition, provide PDF files for each document, produced from original direct-to-digital file creations;
  - .1 organize documents into separate PDF files for each Trade Section identified above, and apply PDF Bookmarks to create a Table of Contents for each file.
- .4 Operating data to include;

- .1 control schematics for each system,
- .2 description of each system and associated control elements,
- .3 control operating sequences at various load conditions, reset schedules and anticipated seasonal variances,
- .4 operating instructions for each system and each component,
- .5 description of actions to be taken in event of equipment failure,
- .6 valve schedules and flow diagrams,
- .7 service piping identification charts.
- .5 Maintenance data to include;
  - .1 manufacturer's literature covering servicing, maintenance, operating and trouble-shooting instructions for each item of equipment,
  - .2 fault locating guide,
  - .3 manufacturer's parts list,
  - .4 reviewed shop drawings,
  - .5 equipment manufacturer's performance sheets,
  - .6 equipment performance verification test results,
  - .7 voltage and ampere rating for each item of electrical equipment,
  - .8 spare parts list and an itemized cost,
  - .9 name and telephone numbers of service organization and technical staff that will provide warranty service on the various items of equipment.
- .6 Approval procedure;
  - .1 submit one set of first draft of Operating and Maintenance Manuals for approval at least one month prior to planned substantial performance date,
  - .2 make corrections and resubmit for a final review,
  - .3 review contents of Operating and Maintenance Manuals with Owner's operating staff or representative to ensure thorough understanding of each item of equipment and its operation.
  - .4 hand-over two (2) hard-copies and one (1) PDF copy on removable storage device of the Operating and Maintenance Manuals to the Owner's operating staff and obtain written confirmation of delivery. Provide a copy of the delivery record to the Consultant.

## **19.2 Operating and Maintenance Training**

- .1 Provide operating and maintenance training in accordance with Division 01 and as follows.
- .2 Provide training to Owners operations staff to thoroughly explain operation and maintenance of each system, incorporating specialized instruction by manufacturers as described under other Sections in these Divisions. Include classroom instruction and hands-on instruction, delivered by competent instructors.
- .3 Develop the proposed training plan, and submit an outline of the training program for review, adjustment and approval by the Owner.
- .4 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, utilizing the services of the manufacturers' representative as required.

- .5 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each training topic, separated by approximately one week each. Develop the proposed training plan and obtain approval from the Owner before commencing training.
- .6 All training to be scheduled and provided between the hours of 7 am to 5 pm, Monday to Friday. Where training is required to be performed outside of these hours due to availability of Owners operations personnel, if the trainers are paid for overtime outside of these hours, the overtime portion only is eligible to be paid by the Owner as an extra cost.
- .7 Complete the training as close to Substantial Performance as possible, so that the operations staff are prepared to operate the systems after Substantial Performance is certified.
- .8 Organize each training sessions as follows:
  - .1 Fire Protection - Division 21
  - .2 Plumbing – Division 22
  - .3 HVAC – Division 23
  - .4 Building Management System – Division 25
- .9 Keep records of date and duration of each instruction period together with names of persons attending. Submit signed records at completion of instruction.
- .10 For each training session, include the following topics;
  - .1 general purpose of system (design intent),
  - .2 use of O&M manuals,
  - .3 review of control drawings and schematics,
  - .4 start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, control set-up and programming troubleshooting, and alarms,
  - .5 interaction with other systems,
  - .6 adjustments and optimizing methods for energy conservation,
  - .7 health and safety issues,
  - .8 special maintenance and replacement sources,
  - .9 occupancy interaction issues, and
  - .10 system response to different operating conditions.
- .11 Develop and provide training material, including printed documents and electronic presentation aids (e.g. MS PowerPoint) for each session. Submit three (3) copies of materials in both hardcopy and PDF format, in accordance with article on Operating and Maintenance Manuals.
- .12 Sessions may be video recorded by the Owner as an aid to ongoing training of Owners staff.

## **20 CARE, OPERATION AND START-UP**

- .1 Provide all labour and materials as necessary to perform start-up and testing of equipment and systems.
- .2 Arrange and pay for services of manufacturer's factory service technician to supervise start-up of the installation, check, adjust, balance and calibrate components and equipment as specified in the specification sections of Division 20.
- .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 every aspect of the operation, care and maintenance thereof.



- .4 Arrange and pay for services of applicable manufacturer's factory service engineer or certified independent testing organization to supervise initial start-up of specialized portions of installation and to check, adjust, balance and calibrate components including related wiring and controls. Provide these services for such periods, and for as many visits as may be necessary to put applicable portion of the installation in complete working order. Provide a certificate indicating that the equipment is free and clear of deficiencies.

## **21 TESTING**

### **21.1 General**

- .1 The following describes the general requirements for testing of mechanical systems; refer to additional testing requirements in applicable sections of Division 20 of the Work.
- .2 Conduct tests during progress of Work and at its completion to verify equipment and systems meet the contract documents. Submit details of test methods in writing and obtain approval before commencing work.
- .3 Supply test equipment, apparatus, gauges, meters and data recorders, together with skilled personnel to perform tests and log results.
- .4 Submit written notice 24 hours in advance of each test series, setting out the time, place and nature of the tests, to the Inspection Authority and personnel witnessing tests.
- .5 The Owner reserves the right to witness any test; any such witnessing activity shall not be construed as acceptance of the system or equipment by the Owner.
- .6 Conduct tests before application of external insulation and before any portion of pipes, ducts or equipment is concealed.
- .7 Do not subject expansion joints, flexible pipe connections, meters, control valves, convertors, and fixtures, to test pressures greater than the stated working pressure of equipment. Isolate or remove equipment or devices during tests when prescribed test pressure is greater than working pressure of any piece of equipment or device.
- .8 Should section of pipe, duct, or electrical cable fail under test, replace faulty piping, duct, or cable with new fittings, pipe, duct or cable and then retest. Do not repair threaded pipe joints by caulking nor welded joints by peening. Repeat tests until results are satisfactory.
- .9 Where it is necessary to test portions of piping, ductwork or electrical cable system before system is complete, overlap successive tests so that no joint or section of duct or pipe is missed in testing.
- .10 Upon completion of work and testing of same, submit logs to demonstrate that tests have been carried out satisfactorily. Repeat any tests if requested.

### **21.2 Testing of Integrated Life Safety and Fire Protections Systems**

- .1 Conduct testing of integrated life safety and fire protection systems in accordance with specification Section 20 08 11 *Testing of Integrated Electrical Life Safety and Fire Protection Systems*.

### **21.3 Testing - Potable Water Piping**

- .1 Except where otherwise specified in other sections of Division 22, test potable water systems with water or air as required by the plumbing code in effect at the location of the Work.
- .2 For water service pipes 100 mm (4") and larger, disinfect the pipe with chlorine ("hyper-chlorinate") from the street valve to the first shut-off valve inside the building. At completion of disinfection, take water samples just before the utility meter and pay for the samples to be tested by an accredited testing laboratory. Test the water samples for contaminants and to measure the residual chlorine concentration and provide test certificate confirming water contaminates are below the threshold values proscribed by applicable legislation.

- .3 Where stainless steel piping is used in the domestic water system, between the entry point in the building and the utility water meter, after taking the water sample for laboratory testing, immediately drain down the incoming service piping up to the utility meter and then flush with clean city water until a site test of the drain water shows a residual chlorine level not greater than the incoming city water supply.
- .4 Where stainless steel piping is used in potable water piping inside the building (i.e. downstream of the utility meter), do not allow any hyper-chlorinated water used for disinfection of piping to come into contact with the stainless steel piping.

#### **21.4 Testing - Other Piping**

- .1 Except where otherwise specified in other sections of Divisions 21, 22 or 23, hydraulically pressure test other water piping systems at 1½ times system design pressure (relief valve setting) or 1000 kPa (150 psi), whichever is greater, for 10 minutes then reduce the test pressure and hold for 24 hours. Pressure must remain essentially constant throughout test period without pumping. Make allowance for correction of pressure readings for variations in ambient temperature between start and finish of test.
  - .1 Alternatively, hold the pressure at the design pressure and testing all joints with a soap test.
- .2 Test natural gas system in accordance with CSA B149.1 *Natural Gas and Propane Piping Code*.
- .3 Test fuel oil systems in accordance with CSA B139 *Installation Code for Oil Burning Equipment*.
- .4 Test drainage, waste and vent piping for tightness and grade as required by the plumbing code in effect at the location of the Work.
- .5 Test special service piping as detailed in other sections of Divisions 21, 22 and 23.

#### **21.5 Testing - Ventilation**

- .1 Pressure test ductwork in accordance with section 23 31 13 *Ductwork*, or other applicable sections of Division 23.

#### **21.6 Testing - Electrical**

- .1 Make tests of equipment and wiring. Test wiring systems in accordance with section 20 05 12 *Wiring Requirements for Mechanical*.
- .2 Replace defective equipment and wiring with new material.

### **22 COMMISSIONING**

- .1 Participate in commissioning of equipment and systems in accordance with Section 20 08 15 *Mechanical Commissioning*.
- .2 Equipment supplied on this project will be subject to detailed factory inspection and/or on-site testing and commissioning prior to being placed in service. The electrical contractor, their major system and equipment suppliers, and the Independent Testing Agent (ITA) will be required to participate in special commissioning meetings to review progress and status of the commissioning program.
- .3 Include in Bid amount for licensed electricians to participate in the commissioning program, to undertake temporary power connections, operation of equipment, opening and closing of panel boards and switchboards, testing of power and control wiring, and assisting the ITA and the equipment suppliers' field personnel in the startup and testing of the equipment.
- .4 The contractor and equipment suppliers to include in the Bid amount the costs to accommodate and undertake factory and site testing.

## **23 TEMPORARY AND TRIAL USAGE**

- .1 Temporary and trial usage by Owner of any mechanical or electrical device, machinery, apparatus, equipment or any other work or materials before final completion and written acceptance is not to be construed as evidence of acceptance by Owner.
- .2 Owner to have privilege of such temporary and trial usage, as soon as that said work is claimed to be completed and in accordance with Contract Documents, for such reasonable length of time as is sufficient for making complete and thorough test of same.
- .3 No claims will be considered for damage to or failure of any parts of such work so used which may be discovered during temporary and trial usage, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.
- .4 Defects in workmanship and materials identified during temporary and trial usage are to be rectified under warranty.

## **24 SPECIAL TOOLS AND SPARE PARTS**

### **24.1 Spare Parts**

- .1 Prior to application for Substantial Performance, furnish spare parts as follows;
  - .1 one set of mechanical seals for one pump of each model size,
  - .2 one pump casing joint gasket for each model size,
  - .3 one head gasket for each shell-and-tube heat exchanger with removable heads,
  - .4 one glass for each gauge glass,
  - .5 one set of V-belts for each drive of the same model size,
  - .6 one set of filter cartridges for each filter or filter bank installed.
- .2 Maintain an inventory record and delivery receipt record of spare parts delivered to the Owner, and include them in the Operating and Maintenance manuals.

## **25 CONSULTANT REVIEWS**

### **25.1 General**

- .1 Consultant's attendance at site including but not limited to site meetings, demonstrations, site reviews and any resulting reports are for the sole benefit of the Owner and as required by the local authority have jurisdiction. It is the Contractor's responsibility to ensure that the Work is complete and constructed in accordance with the design documents.

### **25.2 Site Reviews**

- .1 General reviews and progress reviews do not record deficiencies during the course of the Work until such time as a portion or all of the work is declared complete. In some instances, before the work is completed, readily noticeable deficiencies may be recorded by the Consultant where the deficient item is indicative of issues such as poor workmanship, incorrect materials or installation methods, or may be difficult to correct at a later date. Any such reported items, or lack thereof, shall not be relied on in any way as part of the Contractors quality assurance program nor relieve the Contractor in the performance of the Work, specifically in identification and rectification of deficiencies or incomplete Work.
- .2 Deficiency reviews conducted by the Consultant are performed on a sampling basis, and any deficiency item is to be interpreted as being indicative of similar locations elsewhere in the Work, unless otherwise shown.

### **25.3 Milestone Reviews**

- .1 Specific milestone reviews may be conducted at key stages by the Consultant, including;
  - .1 before backfilling of buried drainage,
  - .2 before closing of shafts,
  - .3 before closing of ceilings,
  - .4 before closing of walls,
  - .5 equipment demonstration,
  - .6 Substantial Performance deficiency review,
  - .7 Total Performance deficiency review.
- .2 Coordinate with the Consultant the type and quantity of milestone reviews required by the Consultant and incorporate these requirements in the construction schedule.
- .3 Notify the Consultant in writing seven (7) calendar days in advance of work to be concealed to arrange a site review prior to the Work being concealed where required by the Consultant. Any noted deficiencies are to be corrected before being concealed. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

### **25.4 Partial Occupancy Reviews**

- .1 Where the Work is planned to include occupancy by the Owner of a part of the Work but not the entire Work ("partial occupancy"), the procedures specified for Substantial Performance Review will apply to the portion of the Work being considered for partial occupancy.

### **25.5 Substantial Performance Review**

- .1 At the time of applying for project Substantial Performance, submit to Consultant a comprehensive list of items to be completed or corrected.

### **25.6 Final Review**

- .1 At project completion submit written request for final review of mechanical and electrical systems. Refer to section 20 08 19 *Project Close-Out*.
- .2 Include with the request a written certification that:
  - .1 reported deficiencies have been completed,
  - .2 systems have been balanced and tested and are ready for operation,
  - .3 completed maintenance and operating data have been submitted and approved,
  - .4 equipment/line material tags are in place and equipment identification is completed,
  - .5 cleaning is finished in every respect,
  - .6 all mechanical equipment surfaces have been touched up with matching paint, or re-finished as required,
  - .7 spare parts and replacement parts specified have been provided and receipt acknowledged,
  - .8 As-built and Record drawings are completed and approved,
  - .9 Owner's operating personnel have been instructed in operation and maintenance of systems,
  - .10 fire protection verification is 100% completed and Verification Certificates have been submitted and accepted.

## **26 CONTRACTOR INSPECTIONS**

### **26.1 General**

- .1 The Division 20 contractor shall assign one person responsible for ensuring that Work from all mechanical trades is complete prior to;
  - .1 closing in wall, ceilings or burying of services,
  - .2 partial-occupancy reviews, and
  - .3 substantial performance reviews.
- .2 In conjunction with the Contractor's Mechanical and Electrical sub-contractors, the Contractor shall walk the site and thoroughly inspect that the work is complete, in good workmanship and installed according to the contract documents and derived documents therefrom. The Contractor shall then submit a report attesting to the completed state of the Work (the "Statement of Completion" report, as detailed later in this part).
- .3 In the case of Contractor inspections for partial-occupancy or substantial performance, submit the Statement of Completion report at least 24 hours prior to the scheduled review by the Consultant.

### **26.2 Contractor Inspections for Partial Occupancy and Substantial Performance**

- .1 In preparation for the Consultants general review for partial-occupancy and/or substantial performance of the Work, the Contractor shall perform a comprehensive inspection of the Work to ensure that their contractual obligations are met before requesting a Consultant's review of the Work. In performing this inspection, the Contractor shall create a Statement of Completion report which is to include;
  - .1 date and time of the Contractor's inspection, signed by the person who conducted the inspection,
  - .2 names of the mechanical contractor's personnel who participated in the inspection,
  - .3 confirmation that previously noted deficiencies have been completed,
  - .4 confirmation that the work is 100% complete, tested, balanced and free of deficiencies, or include a list of outstanding deficiencies and incomplete Work with;
    - (a) a reason why the Work has not been completed (i.e. another trade has to complete their work)
    - (b) a plan of action to complete the Work, and
    - (c) a commitment date for completion of the Work including rectification of all deficiencies.
- .2 The format of the Statement of Completion shall be approved by the Consultant.
- .3 The Consultant shall review and sign-off the Statement of Completion Report and return a copy to the Contractor. The Contractor shall retain on-site a log of all signed off Statement of Completion reports.
- .4 If a required Statement of Completion report is not received, the Consultant reserves the right to withhold conducting a review for partial-occupancy or substantial performance.
- .5 After receipt of the Contractor's Statement of Completion report, if upon entering an area of the work covered by the Statement of Completion report the Consultant determines, in its sole opinion, that the applicable Work is not ready for review, the Consultant may elect to cancel the review of the Work or the affected portion of the Work, and shall assume no responsibility for any damages or losses as a result of cancellation of the review. The Contractor shall remedy the incomplete work and request another review with 72 hours prior written notice, and shall resubmit the revised Statement of Completion at least 24 hours prior to the new review.

## **27 CORRECTION AFTER COMPLETION**

- .1 At completion, submit a written warranty undertaking to remedy defects in work for a period of one year from date of substantial performance of the Work. This warranty is not to supplant other warranties of longer period called for on certain equipment or materials.
- .2 Warranties are to encompass replacement of defective parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation of the corrected Work.
- .3 Submit similar warranties for one year from date of acceptance for any part of work accepted by Owner, before completion of the whole Work.

## **28 ATTACHMENTS**

### **28.1 Schedule of Values Form**

- .1 Attached sample of the Schedule of Values form layout.

### **28.2 Shop Drawing Submittal Form**

- .1 Attached sample of shop drawings submittal form.

SCHEDULE OF VALUES

Project Name: <<name of project>>  
Owner Name: <<owner name>>  
Contractor Name: <<name of trade contractor: mechanical, electrical, etc>>  
Division(s) of the Work: <<i.e. 20, 21, 22...>>  
For the billing period ending: dd-mmm-yyy

This sheet is an example of a required schedule of values to be developed by the Contractor, to be submitted with each progress payment request.  
Specific level of detail for each work element to be approved by the Consultant.

Item	Base Contract Element	Contract Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
1.1	<<work element>>	1,000,000.00	65.9%	400,000.00	40.0%	225,000.00	22.5%	175,000.00	17.5%	600,000.00	60.0%
1.2	<<work element>>	250,000.00	16.5%	30,000.00	12.0%	5,000.00	2.0%	25,000.00	10.0%	220,000.00	88.0%
1.3	<<work element>>	125,000.00	8.2%	50,000.00	40.0%	22,000.00	17.6%	28,000.00	22.4%	75,000.00	60.0%
X.X	Itemized Price No. 1	25,000.00	1.6%	0.00	0.0%	0.00	0.0%	0.00	0.0%	25,000.00	100.0%
X.X	Separate Price No. 1	12,500.00	0.8%	5,000.00	40.0%	0.00	0.0%	5,000.00	40.0%	7,500.00	60.0%
CCA.1	Cash Allowance Disbursements Summary	75,000.00	4.9%	34,000.00	0.0%	8,000.00	0.0%	26,000.00	0.0%	41,000.00	0.0%
X.X	Coordination drawings	15,000.00	1.0%			0.00	0.0%		0.0%		0.0%
X.X	As-built documents and operating manuals	15,000.00	1.0%			0.00	0.0%		0.0%		0.0%
<b>Original Contract Values</b>		1,517,500.00	100.0%	519,000.00	34.2%	260,000.00	17.1%	259,000.00	17.1%	968,500.00	63.8%
CO.1	Approved Changes Summary	13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%
<b>Total Current Contract Values</b>		<b>1,530,900.00</b>		<b>524,200.00</b>	<b>34.2%</b>	<b>262,000.00</b>	<b>17.1%</b>	<b>262,200.00</b>	<b>17.1%</b>	<b>976,700.00</b>	<b>63.8%</b>

Reference	Cash Allowance Disbursement	CA Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$		\$	%	\$	%	\$	%	\$	%
CAA_1	<<description of cash allowance>>	20,000.00		20,000.00	100.0%	8,000.00	40.0%	12,000.00	60.0%	0.00	0.0%
CAA_2	<<description of cash allowance>>	55,000.00		14,000.00	25.5%	-	0.0%	14,000.00	25.5%	41,000.00	74.5%
					0.0%		0.0%	0.00	0.0%	0.00	0.0%
Total		75,000.00		34,000.00	45.3%	8,000.00	10.7%	26,000.00	34.7%	41,000.00	54.7%

Reference	Approved Changes	Change Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$		\$	%	\$	%	\$	%	\$	%
CO_01	<<description of change of work>>	5,800.00		-	0.0%	-	0.0%	0.00	0.0%	5,800.00	100.0%
CD-01	<<description of change of work>>	7,600.00		5,200.00	68.4%	2,000.00	26.3%	3,200.00	42.1%	2,400.00	31.6%
					0.0%		0.0%	0.00	0.0%	0.00	0.0%
Total		13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%

Reference	Unquoted/Unapproved Changes	Status	Quotation	
			\$	
CCN-01	<<description of change of work>>	Waiting for approval	12,000.00	
CCN-02	<<description of change of work>>	Unquoted		
Total			12,000.00	



Toronto Montreal Vancouver Dallas Chicago

## SHOP DRAWING SUBMITTAL

***Include this cover page with each shop drawing submission.  
Submissions without this form will be returned without review.  
Submit one submittal form per shop drawing; do not group under one submittal sheet***

Client/Architect: Click or tap here to enter text.

Project Name: Click or tap here to enter text.

HHA Project No: Click or tap here to enter text.

***Contractor to complete the following for each submission.***

Date: \_\_\_\_\_

Contractor Name: \_\_\_\_\_ Ref. No: \_\_\_\_\_

Manufacturer Name: \_\_\_\_\_

Product Type/Description: \_\_\_\_\_

Specification section number: \_\_\_\_\_

Contractor Trade Category:

- |  |                                     |  |   |
|--|-------------------------------------|--|---|
| <input type="checkbox"/> Architectural | <input type="checkbox"/> Structural | <input type="checkbox"/> Conveying Equipment | <input type="checkbox"/> User Equipment |
| <input type="checkbox"/> Mechanical    | <input type="checkbox"/> Electrical | <input type="checkbox"/> Telecommunications  | <input type="checkbox"/> Civil          |
| <input type="checkbox"/> Other         |                                     |  |   |

If this is a resubmission, check here: ☐

Previous submission HHA reference no.: \_\_\_\_\_

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**END OF SECTION**

Issued For Tender



## **QUALIFICATIONS AND AUTHORITIES - ONTARIO**

### **20 01 02**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 This specification section:
  - .1 describes the qualification requirements for tradesmen in the province of Ontario;
  - .2 defines the applicable authorities having jurisdiction related to construction in Ontario; and
  - .3 describes the responsibilities of the contractor and/or Owner for registration and inspection of systems and application for construction or installation permits.

##### **1.2 Definitions**

- .1 **TSSA:** Technical Standards and Safety Authority
- .2 **ESA:** Electrical Safety Authority

#### **2 QUALIFICATIONS**

##### **2.1 Trades Qualification and Apprenticeship**

- .1 Tradesmen to hold a a certificate of qualification or be an apprentice in accordance with the *Building Opportunities in the Skilled Trade Act, 2021*, S.O. 2021, c. 28, including but not limited to the following prescribed trades in accordance with the *Prescribed Trades and Related Matters* regulation O.Reg. 876/21:
  - .1 Construction Millwright,
  - .2 Electrician – construction and maintenance,
  - .3 Fuel and electrical systems technician,
  - .4 Heat and frost insulator,
  - .5 Information technology – hardware technician,
  - .6 Information technology – network technician,
  - .7 Network cabling specialist,
  - .8 Instrumentation and control technician,
  - .9 Plumber,
  - .10 Refrigeration and air-conditioning systems mechanic,
  - .11 Sheet metal worker,
  - .12 Sprinkler and fire protection installer,
  - .13 Steamfitter,

##### **2.2 Work-Specific Qualification Licenses**

- .1 Fabricators and installers of pressure piping and equipment which are subject to O.Reg. 220/01 *Boilers and Pressure Vessels* regulation shall hold the required license for performing such work, unless otherwise exempt by the regulation.
- .2 Contractors performing work on liquid or gaseous fuel piping systems and related equipment shall hold certificates of authorization made under O.Reg. 215/01 *Fuel Industry Certificates* to perform work within the scope of the following regulations;;

- .1 Gaseous Fuels, O.Reg. 212/01
- .2 Propane Storage and Handling, O.Reg. 211/01
- .3 Fuel Oil, O.Reg. 213/01
- .4 Compressed Natural Gas, O.Reg. 214/01

### **3 AUTHOURITIES**

#### **3.1 Authorities having Jurisdiction**

- .1 When referenced in specification sections in Division 20 to 25, the authority-having-jurisdiction ("AHJ") over regulated portions of the work are identified in the following table.

Work Element	Authority	AHJ Abbreviation
Fire Protection	Municipal Building Department or Fire Department	None
Plumbing	Municipal Building Department	None
HVAC	Municipal Building Department	None
Flammable and Combustible Liquids	Fire Department	None
Liquid fuels (for vehicle refueling)	Technical Standards and Safety Authority	TSSA
Heating Oil and Diesel Fuel	Technical Standards and Safety Authority	TSSA
Propane	Technical Standards and Safety Authority	TSSA
Pressure Piping	Technical Standards and Safety Authority	TSSA
Refrigeration	Technical Standards and Safety Authority	TSSA
Licensed Plant Operators	Technical Standards and Safety Authority	TSSA
Electrical	Electrical Safety Authority	ESA

### **4 PERMITS, REGISTRATION AND INSPECTION**

#### **4.1 Building Code Permits**

- .1 Application for Building Permit including plumbing and HVAC has been made by the Owner. Arrange and coordinate for municipal inspections as required under the Ontario Building Code.

#### **4.2 Other Work Permits, Registration and Inspection**

- .1 Arrange, provide documentation, and pay for permits, registration, and inspection of the following work elements:
  - .1 Boilers, pressure vessel and pressure piping,
  - .2 Buried liquid fuel tanks and underground piping,
  - .3 Electrical work performed under Division 20 to 25, and

- .4 Where described elsewhere in Division 20 to 25.
- .2 Arrange, provide documentation, and pay for variance approvals and field inspections where specified elsewhere in Division 20 to 25.

**END OF SECTION**

## **MECHANICAL COORDINATION AND INSTALLATION DESIGN SERVICES 20 01 03**

### **1 GENERAL**

#### **1.1 Scope**

- .1 Provide detailed coordination, fabrication, and installation design drawings for the services provided under Division 20. Integrate the coordination drawings provided under Division 26 into the design drawings provided under Division 20.
- .2 Provide the services of an experienced mechanical and electrical coordination supervisor to manage these contractors' design services. The supervisor is responsible for leading a multi-trade coordination effort including but not limited to: detailed inspection of existing conditions, layout and finalize routing of services, setting sleeves for structural openings and sequencing of service installation.

#### **1.2 Document Ownership**

- .1 Ownership and copyright of Contractors coordination, fabrication, and installation design drawings remains with the Contractor producing these documents, subject to the requirements of the project construction contract. In the absence of any requirements in the project construction contract, the Contractor will provide the Owner with a royalty-free, transferrable, and irrevocable license to copy and use the materials for the purpose of operating and maintaining the building and building systems.

#### **1.3 Consultant Drawings**

- .1 Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, bus duct, etc., and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.
- .2 The use of Consultant's drawings directly for construction, without preparation of Contractor detailed coordination, fabrication, and installation design drawings, is at the Contractors risk.

#### **1.4 Requests for Information**

- .1 Requests for Information (RFI's or similar type of document) concerning coordination are to be submitted with sketch drawings indicating proposed solution for review by the Consultant. RFI's submitted without such proposals may be returned by Consultant for re-submission to include proposed resolution.

### **2 WORK RESTRICTIONS**

- .1 Refer to Division 01 for a full list of work restrictions
- .2 The following commentary describes work restrictions that may affect the Contractors construction schedule and/or means and methods of construction, and are to be taken into consideration by the Contractor when estimating the cost and duration of the Work. This commentary does not limit the scope of work nor does it address all potential risk factors associated with the Work.
  - .1 restricted access to ceiling spaces for coordination with existing services
  - .2 restricted access to confined spaces
  - .3 hidden conduit in slabs and walls
  - .4 availability of existing documentation

### **3 INTERFERENCE COORDINATION DRAWINGS**

#### **3.1 General**

- .1 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- .2 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions. Provide necessary offsets in ducts, piping etc. to change elevation and direction as required to coordinate services in the ceiling space.
- .3 Location of equipment and associated service connections are diagrammatic and based on manufacturer information available at the time of design. Include suitable allowances for and make adjustments to installation of actual equipment, including but not limited to size of housekeeping pads, methods of support, routing of pipe, duct, conduit and other services around and to the equipment, and location of services connection points to the equipment, at no change to the Construction Price.
- .4 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .5 Location of floor drains, hub drains, combination drains, plumbing fixtures, convectors, unit heaters, diffuser, registers grilles and other similar items may be altered without extra cost provided instruction is given prior to roughing in. No claim will be paid for extra labour and materials for relocating items up to 3 m (10 ft) from original location nor will credits be anticipated where relocation up to 3 m (10 ft) reduces material and labour.
- .6 Include incidental material and equipment not specifically shown but which is needed to complete the work as an operating installation.
- .7 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.

#### **3.2 Interference Coordination Drawings**

- .1 Prepare interference coordination drawings to show location of equipment and relative position of services, and to demonstrate coordination with works of other trades. Drawings shall be prepared by a specialist firm experienced in CAD mechanical and electrical interference drawing production. Interference drawings are to include coordination with all mechanical and electrical services.
- .2 Mechanical contractor is to consult and co-operate with electrical contractor to identify electrical services which are to be incorporated into interference drawings.
- .3 Mechanical contractor shall make arrangements with Owner to access the site and ceiling spaces immediately after award of contract to start survey and preparation of co-ordination drawings so drawings are coordinated before services are installed. Reasonable time for survey and coordination drawings must be included in the schedule. Contractor shall perform site survey work to document all existing mechanical and electrical services that are to remain and are to be included in the interference drawings.
- .4 Conduct weekly meetings to discuss and resolve interference issues discovered during interference drawing production.
- .5 Submit drawings to other trades involved in each area and include a note in the drawing title block as follows;
  - .1 "This drawing was prepared and circulated for review and mark-up to related subcontractors as noted and initialed in the table below. Corrections and concerns identified through this coordination process have been addressed on this drawing. Areas that incorporate significant

changes from layouts shown on Contract Documents have been circled for Consultants' general review"

- .2 Drawing scale to be minimum 1:50 (1/4"=1'-0").
- .3 Produce coordination drawings, preferably in 3D AutoCad MEP or Revit format, and keep a set of drawings on site for Consultant's general review.
- .4 Obtain Consultant's drawing files for background information, pending completion and return of any electronic file waiver forms.

### **3.3 Coordination with Other Trades**

- .1 Superimpose all services (piping and conduits larger than 2" diameter) on one drawing to be installed in ceiling space or mechanical rooms from information gathered from all subcontractor on site. Lay out and coordinate Work to avoid conflict with work under other sections of this Division and other Divisions.
- .2 When equipment provided under other Sections or Divisions connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided.

### **3.4 Interconnecting Control and Power Wiring**

- .1 Provide wiring block diagrams and detailed termination drawings for controls wiring connections to equipment and instrumentation, for both Building Automation System control and hard-wired interlock wiring. Provide wiring terminal numbers specific for each equipment connection.
- .2 Maintain these interconnection drawings through the course of the Work and include a final updated version with the Operating and Maintenance instructions.

### **3.5 Fire Alarm and Building Automation System**

- .1 Provide a wiring coordination interface drawing for termination of fire alarm annunciation circuits to Building Automation System I/O equipment and/or motor starters, adjustable frequency drives, dampers, and motorized fire dampers.
- .2 Drawings to include wiring terminal numbers and description label for FAS annunciation zone.
- .3 Submit interface drawings as a shop drawing for Consultants review.
- .4 Maintain these interconnection drawings through the course of the Work and include a final updated version with the Operating and Maintenance instructions.

## **4 OWNERS EQUIPMENT AND RELOCATED EQUIPMENT**

- .1 The service provisions shown for Owner's supplied equipment and/or relocated equipment is based on the available information at the time of design. Examine the actual service requirements for this equipment and make adjustments as necessary to connection sizes of service drops to suit. A change (increase or decrease) in one trade size for piping, tubing, electrical conductors and conduit, and a change of up to 25% in duct cross-sectional area will be provided at no change to the construction cost.
- .2 Where actual service requirements (except as described above for size) are different between the Consultant's drawings and Owner's equipment requirements, submit proposal for new or deleted services or capacities to the Consultant for review.

## **5 FABRICATION AND INSTALLATION DRAWINGS**

- .1 On an as-needed basis, prepare fabrication, spooling, and/or installation drawings based on the completed interference coordination drawings. Such drawings are to be in accordance with Contractor's company standards.
- .2 Drawing scale: same as the interference coordination drawings or at larger scale as needed.

- .3 Use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings.
- .4 Layout equipment and services to provide access for repair and maintenance.

**END OF SECTION**

## **DEFINITIONS AND ABBREVIATIONS - MECHANICAL**

### **20 01 13**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 This specification provides definitions and abbreviations of terms which may apply to one or more specification sections under Division 20, 21, 22, 23 and 25.
- .2 Additional definitions and/or abbreviations may also be included in other specification sections where they apply only to one specification section.

##### **1.2 Definitions**

**Authourity having Jurisdiction ("AHJ"):** the designated government body or regulatory agency responsible for enforcement of applicable statute.

**Bronze:** a copper alloy with a minimum copper content of 84%.

**Building Automation System ("BAS"):** the building control systems as specified in Division 25.

**Class XXX:** a numerical pressure-temperature designation "XXX" in accordance with ANSI/ASME B16 series of standards.

**Canadian Registration Number ("CRN"):** as defined in accordance with CSA B51.

**Certificate of competency:** a license, certificate or other document which attests to the qualifications of a construction tradesperson and which is recognized and/or required under prevailing provincial, territorial or federal statutes in the location of the project as an authorization to perform such work.

**Cold Working Pressure ("CWP"):** the maximum non-shock cold working pressure at temperatures as stated in a MSS valve standard.

**Design Criteria:** criteria that states the requiree performance of equipment or a system, and is also the minimum design basis for equipment, systems and contractor's design responsibilities.

**Design Pressure:** (in reference to a pressure piping system) - the maximum allowable internal pressure in a piping system at the indicated coincident Design Temperature that the piping system may be subjected under normal operating conditions and is the basis for determining the piping system hydrostatic or pneumatic test pressure requirements.

**Design Temperature:** (in reference to a pressure piping system) – the maximum allowable in-service temperature of the piping system.

**Double Regulating Valve ("DRV"):** a calibrated manual flow balancing valves with pressure test ports (also referred to as circuit balancing valve),

**Dezincification Resistant ("DZR"):** a brass copper alloy which by means of its alloy and method of manufacture is certified as being resistant to the process of dezincification.

**Flow Limiting Regulating Valve ("FLRV"):** an automatic calibrated flow control device which limits the maximum flow to a branch piping network.

**Minimum Component Pressure Rating ("MCPR"):** the minimum pressure at the indicated coincident temperature at which the component must be capable of withstanding, remain functional and not exceed its maximum allowable stress in accordance with its referenced standard.



**National Pipe Taper (“NPT”):** a pipe thread in accordance with ANSI/ASME B1.21.1

**Operating Pressure:** the estimated maximum expected internal operating pressure of a fluid in a pipe or equipment for the purpose of establishing a piping system Design Pressure; actual in-service gauge pressures may be lower. The operating pressure may be specified as a single value, or it may vary by location in the system. “Working pressure” has the same meaning.

**Operating Temperature:** the estimated maximum normal temperature of the fluid in a piping system

**Potable water:** has the same meaning as defined in the applicable plumbing code or building code in the jurisdiction of the project. “Domestic water” has the same meaning.

**Steam Working Pressure (“SWP”):** the maximum steam pressure at the indicated maximum steam temperature or it is the saturated steam pressure if a coincident temperature is not specified.

**Service rooms:** means a room provided in a building to contain equipment associated with building services, and which includes but is not limited to: boiler rooms; furnace rooms; incinerator rooms; garbage handling rooms; rooms to accommodate HVAC appliances, pumps, compressors and other related equipment; rooms containing electrical distribution equipment; and rooms containing telecommunications and data equipment.

**Service space:** means space provided in a building to facilitate or conceal the installation of building service facilities such as chutes, ducts, pipes, shafts or wires.

### 1.3 Abbreviations

AMCA	Air Movement and Control Association International
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	ASTM International (formerly American Society for Testing and Materials)
CSA	Canadian Standards Association
FM	Factory Mutual Approvals
MCAA	Mechanical Contractors Association of America
MCAC	Mechanical Contractors Association of Canada
MSS	Manufacturers Standardization Society
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	NSF International (formerly National Sanitary Foundation)

SMACNA	Sheetmetal and Air Conditioning Contractors' National Association
UL	Underwriters Laboratory (USA)
ULC	Underwriters Laboratory Canada

**End of Section**

## **BASIC MATERIALS AND METHODS**

### **20 05 01**

## **1 GENERAL**

### **1.1 Scope**

- .1 Articles that are of a general nature, and applicable to each Section of Division 20 to 25.

## **2 ACCESSIBILITY FOR BUILDING CONTROL DEVICES**

- .1 Mount control devices, intended to be adjusted or to otherwise be operated by the occupant for the operation of building services or safety devices, as follows:
  - .1 room environmental controls, including thermostats/adjustable room temperature sensors: at 1200 (47 in) above the finished floor,
  - .2 all other controls: between 900 and 1100 mm (36 in. and 43 in.) above the finished floor.
  - .3 be positioned to have a clear space in front of and centered on the control device, of 810 x 375 mm (32 x 15 in).
  - .4 be operable using a closed fist and with a force not exceeding 22.2 N (5 lbf).
- .2 The above requirements do not apply to control devices that are solely located and used by the building operations staff.

## **3 ACCESS PANELS / DOORS**

### **3.1 General**

- .1 Provide access doors to be installed at locations where equipment requiring inspection, service, maintenance or adjustment is "built-in" to work of other trades.

#### *Standard of Acceptance*

- Williams Brothers – fig. GP
- Elmdor/Acorn - fig. DW
- Mifab - fig. UA

### **3.2 Applicable Product Standards**

- .1 CAN/ULC-S104 Standard Method for Fire Testing of Door Assemblies

### **3.3 Construction:**

- .1 Standard access door:
  - .1 1.6 mm (16 ga) carbon steel door and door-frame with white satin coat prime coat finish, with door edges turned back to frame for rigidity,
  - .2 flush mounted with 180° opening door, round safety corners, concealed hinges, plaster lock and anchor straps,
  - .3 latch: screw driver operated,
  - .4 access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive tile insert.
  - .5 size:
    - (a) 600 mm x 600 mm (24 in x 24 in) for personnel entry,
    - (b) 300 mm x 450 mm (12 in x 18 in) for hand entry,

.2 Variations:

- .1 stainless steel variant:
  - (a) Type 304 stainless steel with No. 4 brush satin finish.
- .2 waterproof variant:
  - (a) Type 304 stainless steel with No. 4 brush satin finish, with neoprene gasketed door.
- .3 security access variant:
  - (a) keyed cylinder, with all cylinders keyed alike,
- .4 fire rated variant:
  - (a) where access door is located in a horizontal or vertical fire separation that has a fire resistance rating of 2 hours or less,
  - (b) insulated door with 50 mm (2 in) fire retardant mineral wool insulation, and 0.95 mm (20 ga.) back liner,
  - (c) heavy duty spring for self-closing door action,
  - (d) rated for installation in masonry walls and fire rated shaft wall construction, or fire rated ceiling construction as applicable to the installation,
  - (e) listed to CAN/ULC-S104 for minimum 1.5 hour closure ratings.
- .5 Submit shop drawings showing access door size, type and location.

**3.4 Installation:**

- .1 Access doors are required at;
  - .1 expansion joints,
  - .2 dampers,
  - .3 fire dampers,
  - .4 air valves,
  - .5 air terminal units,
  - .6 isolation and control valves ,
  - .7 pressure reducing valves,
  - .8 heating or cooling coils,
  - .9 control wiring junction boxes.
- .2 Supply access doors and make arrangements and pay for installation by Division in whose work they occur.
- .3 Supply access doors with the required variations in accordance with the following table:

Space Type	Wall or Ceiling Finish	Variants		
		Stainless Steel	Water-proof	Key lock
Service rooms, Service corridors,	Drywall	---	---	---

Space Type	Wall or Ceiling Finish	Variants		
		Stainless Steel	Water-proof	Key lock
Public spaces and corridors - more than 2.4 m (8 ft) above the floor, Private spaces, washrooms	Tile or other hard finished surfaces	Yes	---	---
Public spaces and corridors - 2.4 m (8 ft) or less above the floor, Mental health patient areas, Public washrooms	Drywall	---	---	Yes
	Tile or other Hard Surfaces	Yes	---	Yes
Shower rooms, bathtub rooms, Pools, saunas, Kitchens, laundries, Other damp, washdown or high humidity spaces	All	Yes	Yes	Yes

- .4 Provide fire rated variant in addition to the above table variants, as applicable to the wall or ceiling construction.
- .5 Size and locate access doors in applied tile, block or in glazed or unglazed structural tile to suit joint patterns.
- .6 Access doors are not required in removable ceilings. Provide coloured marking devices after completion of ceilings, at four corners of each panel below point requiring access. Colour code markers to show service or device above.
- .7 At time of instruction of owners operating staff, hand-over and obtain signed receipt for 4 sets of each type of key used for access doors with key-lock cylinders.

## 4 DIELECTRIC FITTINGS

### 4.1 General

- .1 Provide dielectric fittings for connection between carbon/galvanized steel piping and either copper tube or stainless steel tube/piping in the following pipe systems:
  - .1 Non-Potable Water (NPW) piping systems which do not have any chemical treatment,
  - .2 Domestic hot water systems where galvanized steel pipe is used, including at connections to hot water heating equipment.

### 4.2 Products

- .1 Dielectric unions – NPS 2 and under:
  - .1 body and union nut material selected to suit connecting piping materials, including carbon steel/copper, carbon steel/stainless steel, and copper/stainless steel,
  - .2 flat-face union design,
  - .3 tail-piece with NFPT ends with thermobaked epoxy coating, and Teflon shoulder gasket,
  - .4 head-piece with integral O-ring, with threaded or sweat pipe ends.

- .5 union nut,
- .6 pressure rating: Class 3000.
- .7 dielectric coating resistance rating: minimum 500 V/mil thickness.

*Standard of Acceptance*

- Hart Industrial Unions - fig. D-3136 series

.2 Dielectric nipples – NPS 3 and smaller:

- .1 for connecting copper to carbon steel piping,
- .2 fitting body: Zinc-plated carbon steel tube to ASTM A513,
- .3 liner: polypropylene covering entire inner surface of fitting body,
- .4 fitting ends: threaded to ASME B1.20.1.
- .5 design pressure: 2000 kPa (300 psi) at design temperature,
- .6 design temperature: -40 to +110°C (-40 to +230°F)

*Standard of Acceptance*

- ASC - fig. 7090

.3 Dielectric insulating flanges – NPS 2-1/2 to NPS 4;

- .1 For connecting copper to carbon steel piping.
- .2 Ductile iron flanges, Class 125 to ANSI B16.42.
- .3 Copper tailpiece for soldered joint,
- .4 NFPT thread to AMSE B1.20.1 x copper solder joint,
- .5 BUNA-N gasket,
- .6 lead free materials to NSF 61+G.
- .7 maximum design pressure: 1200 kPa (175 psi)
- .8 maximum operating temperature: 82°C (180°F)

*Standard of Acceptance*

- Watts No. LF3100

.4 Dielectric insulated flange – single face with copper tube tailpiece – NPS 2-1/2 to NPS 4;

- .1 For connecting copper to carbon steel piping.
- .2 Van Stone style carbon steel flange with copper tailpiece with flared flaired end,
- .3 carbon steel flange, Class 150 to ANSI B16.5, with powder coated finish.
- .4 copper tailpiece with rolled flange face-end, and EPDM insulating gasket isolating the copper tube from the steel flange.

*Standard of Acceptance*

- CTS Flange Canada - fig. CTS Copper Flange Adaptor

.5 Dielectric Insulating gaskets for flanges NPS 6 and over:

- .1 for use with ASME Class 150 and 300 dimensional flanges.
- .2 suitable for connecting dissimilar piping materials, including carbon steel/copper, carbon steel/stainless steel, and copper/stainless steel,
- .3 compatible with pressure and temperature service,
- .4 BUNA-N or EPDM gasket seals compatible with potable water
- .5 flange bolts run in insulating sleeves with insulating washers under nuts.

*Standard of Acceptance*

- ° Advance Products and Systems

#### **4.3 Installation**

- .1 Provide dielectric isolation on specified piping systems between pipes of dissimilar metals with suitable insulating dielectric unions, dielectric nipples, insulating flanges, or insulating gaskets between flanges;
  - .1 place dielectric isolation between steel piping and bronze or brass valves,
- .2 Do not use bronze or brass valves as dielectric fittings.

### **5 DRAIN VALVES**

- .1 Provide drain points with drain valves at low points of piping systems and at section isolating valves.
- .2 Drain valves:
  - .1 NPS ¾ drain and valve for service pipes NPS 2-1/2 and smaller, complete with hose end male thread, cap and chain,
  - .2 NPS 2 drain and valve for services pipes NPS 3 and larger, complete with female Camlock coupling and dustcap.
- .3 Where mechanical-compression fittings are used in the piping system, use only threaded fittings for the construction of the drain piping.

### **6 V-BELT DRIVES**

#### **6.1 Products**

- .1 Provide V-belt drive for each motor driven device which is not directly connected to the motor. Keep overhung loads on prime mover shafts within manufacturer's design guidelines.
- .2 Sheaves for motors 7.5 kW (10 hp) and less, with not more than two belts:
  - .1 cast iron or steel secured to shafts with removable keys.
  - .2 adjustable pitch on motor, fixed pitch on driven device, giving plus or minus 10% speed range,
  - .3 selected to meet specified operating condition at mid position in pitch adjustment.
- .3 Sheaves for motors greater than 7.5 kW (10 hp) or drives with three or more belts:
  - .1 cast iron or steel with split tapered bushing and keyway.
  - .2 fixed pitch.
- .4 Belts:
  - .1 matched sets of 'B' section, selected for service factor of 2.0 times installed motor horsepower.
  - .2 capable of carrying load with one belt broken.
- .5 Motor slide rails:

- .1 adjustment plates for centre line alignment
- .2 belt tension adjusting screws.

## **6.2 Installation**

- .1 Tension belts to manufacturer's recommendations before start-up and after first 100 hr of operation using calibrated belt tensioning gauge.
- .2 Provide replacement pulleys and belts during start-up and balancing to suit field operating conditions.

## **7 DRIVE AND COUPLING GUARDS**

### **7.1 Products**

- .1 Provide guards to protect belt drives, flywheels, rotating couplings on equipment and fan inlet and outlets.
- .2 Guards:
  - .1 removable for servicing,
  - .2 arranged to permit lubrication with guards in place.
- .3 Guards for belt drives:
  - .1 expanded metal screen welded to steel bar stock or angle frame,
  - .2 minimum 1.2 mm (18 ga) thick galvanized sheet metal tops and bottoms,
  - .3 40 mm (1½") diameter holes at both shaft centres for insertion of tachometer.
- .4 Flexible coupling and flywheel guards:
  - .1 Removable "U" shaped, minimum 1.6 mm (16 ga) thick galvanized mild steel or expanded metal mesh on substantial welded angle iron or round barstock frame.
- .5 Guards on unprotected fan inlets and outlets:
  - .1 Minimum 20 mm (¾ in) galvanized wire mesh or expanded metal screen with net free area of guard not less than 80% of fan opening.

### **7.2 Installation**

- .1 Belt guards to accommodate movement of motors for belt tension adjustment.
- .2 Where equipment is installed on resiliently mounted base frame or pad, attach belt guard to this base
- .3 Belt guards and fan inlet guards may be omitted where fan and motor is installed in plenum less than 1.4 m (4 ft) high and disconnect for fan motor is mounted adjacent to and outside access door to plenum.
- .4 Fan inlet guards may be omitted where fan is fitted with inlet guide vanes.

## **8 SLEEVES**

### **8.1 General**

- .1 Provided sleeves for pipes, ducts and conduits passing through walls, floors and roofs.
- .2 Maintain fire-resistance integrity where pipes and ducts pass through walls, floors and partitions which are or form part of a fire separation.
- .3 Manufactured sleeves and integral sleeves with firestopping may be used provided they meet the same performance requirements as specified for fabricated sleeves.



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- Hilti
- 3M
- Marfab Metal Products

**8.2 Floor and Wall Sleeves – Dry Locations (“Standard Sleeves”)**

- .1 Sleeve dimensions in floor and wall fire separations having a fire-resistance rating:
  - .1 For piping, insulated piping, and conduit:
    - (a) opening sized to suit fire stopping methods employed but in no case having an inside dimension more than 50 mm (2 in.) larger than the outside dimension of the service.
    - (b) sleeves may be permanent or only provided as formwork in concrete and masonry construction,
  - .2 For ductwork:
    - (a) opening sized to suit duct fire damper and/or smoke damper with clearance required for thermal expansion between the wall/floor opening and the fire/smoke damper sleeve in accordance with the fire/smoke damper manufacturer installation instructions.
    - (b) opening sleeves may be permanent or only provided as formwork in concrete and masonry construction,
    - (c) in gypsum-board construction provide permanent opening sleeves or ensure that steel-stud framing is provided to line the opening in the construction.
  - .3 Sleeve length – permanent type:
    - (a) piping: extend 25 mm (1 in.) past each face of fire separation.
    - (b) ductwork fire damper sleeve: as required to allow for installation of retaining angles and installation of required access door.
- .2 Sleeve dimensions for all other wall and floor types (except waterproof floors):
  - .1 For all services:
    - (a) opening sized to suit the outside dimension of the service, but in no case having an inside dimension of not less than 12 mm (1/2 in.) and not more than 50 mm (2 in.) larger than the outside dimension of the service.
    - (b) for clarity, for insulated pipes and insulated ducts the outside dimension of the service includes the insulation thickness.
  - .2 Sleeve length:
    - (a) flush to wall/floor construction or not to extend more than 25 mm (1 in.) past each face of wall or floor construction.
  - .3 Sleeve construction for pipes and conduits:
    - .1 for all types of floor and wall construction:
      - (a) minimum schedule 10 steel pipe,
      - (b) fabricated carbon steel sheet of same thickness as schedule 10 pipe, rolled to dimension, lapped and spot welded, or
      - (c) as required by specific firestop system listing requirements.
  - .4 Sleeve construction for ducts smaller than 0.4 m<sup>2</sup> (4 sq ft) cross sectional area including insulation:
    - .1 for wall construction other than as fire separations having a fire-resistance rating:
      - (a) 1 mm (20 ga) minimum sheet metal, lapped and spot welded with 20 mm (3/4 in) lip flange at one, or

- (b) sleeves are not required where wall openings are coordinated wall construction trades which includes any duct insulation.
- .2 for floors and walls that are fire separations with required fire-resistance rating:
  - (a) as required by fire and/or smoke damper listing.
- .5 Sleeve construction for ducts of 0.4 m<sup>2</sup> (4 sq ft) and larger cross sectional area including insulation through walls and floors:
  - .1 for wall construction other than fire separations having a fire-resistance rating:
    - (a) 1.6 mm (16 ga) minimum sheet metal, lapped and spot welded with 20 mm (¾ in) lip flange at one end.
  - .2 for floors and walls that are fire separations with required fire-resistance rating:
    - (a) as required by fire and/or smoke damper listing.
- .6 Manufactured floor sleeves with integral fire stopping:
  - .1 floor sleeve with integrated firestopping, for insulated and non-insulated metal pipes, and plastic pipes,
  - .2 for installation in concrete floors and metal deck/concrete floors,
  - .3 adaptors for support or pipe riser clamps,
  - .4 listed to CAN/ULC-S115.

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- Hilti - fig. CP 680 series

### **8.3 Slot Sleeves**

- .1 Application:
  - .1 where multiple pipes or conduits are grouped together in a linear arrangement to pass through a concrete floor or wall, or masonry wall, a common slot sleeve may be used,
  - .2 where slot openings are not shown on structural drawings, Contractor may propose location and sizes of slot openings for approval by the structural engineer. Where such approval is denied, use individual sleeves for each pipe or conduit.
- .2 Formwork:
  - .1 provide removable formwork or instruct the contractor under Division 03 of the Work to set formwork for the required slot dimensions prior to pouring concrete or setting of masonry units.
- .3 Slot dimensions:
  - .1 slot sleeve dimensions, pipe and conduit sizes, and location of services within the slot are subject to firestopping listing requirements.

### **8.4 Roof Sleeves for Pipe and Conduit**

- .1 Manufactured roof sleeves:
  - .1 one-piece spun aluminium sleeve, minimum 1.6 mm (0.064 in) wall thickness, with integral continuous welded flashing,
  - .2 insulated with polyurethane insulation for hot and cold piping,
  - .3 with 135° gooseneck for flexible electrical conduit, with minimum clearance from gooseneck outlet to flashing flange of:
    - (a) minimum 300 mm (12 in) for installation on conventional roofs,

- (b) minimum 450 mm (18 in) for installation on inverted roofs.
- .4 with vented flashing insert and flashing cap for hot piping,
  - .5 with ventilation perforations at top of sleeve and a flashing cap for natural gas piping,
  - .6 stainless steel fasteners,
  - .7 EPDM base seal between conduit or pipe and bottom of sleeve,
  - .8 EPDM top seal, with triple pressure seal, either integral to the sleeve or as a two-piece sleeve and flashing cap,
  - .9 sleeve height: 300 mm (12 in),
  - .10 suitable for hot and cold piping, with or without pipe insulation, and rigid and flexible electrical conduit.

*Standard of Acceptance*

- ° Thaler – fig. MEF series

Application	Thaler Model
Hot piping	MEF-3A
Cold piping	MEF-3A
Natural gas piping	MEF-9
Rigid electrical conduit	MEF-1
Flexible electrical conduit	MEF-2A

## 8.5 Installation

- .1 Provide sleeves for the passage of services through walls, floors and roofs in accordance with the following table:

Construction Element	Fire Resistance Rating	Element Construction	Mechanical Service	Opening Sleeve Required
Roof	Any or none	All	All	Yes
Walls	>0 hrs	Concrete, Masonry Units	Pipe and Conduit	As required for formwork
			Ductwork	As required for formwork
		Gypsum Board	Pipe and Conduit	Yes
			Ductwork	As required by fire or smoke damper listing
Wall (smoke barrier)	0 hrs	All	All	Yes, or wall tightly finished to sides of service
Acoustic Isolation Walls	None [1]	All	All	Yes

All other walls	None [1]	All	All	None unless otherwise shown
Floors	>0 hrs	Concrete	Pipe and Conduit	As required for formwork
			Ductwork	As required by fire or smoke damper listing
Waterproof Floors	Any or none	Concrete	Pipe and Conduit	Yes
			Ductwork	Yes or Curb

**Notes:**

[1] Walls are not fire separations of any type.

- .2 Place and secure sleeves in concrete form work for floors, walls and roofs.
- .3 Supply sleeves to be set in masonry walls with installation detail drawings setting out locations of sleeves.
- .4 Standard sleeves:
  - .1 terminate flush with surfaces of concrete and masonry walls.
  - .2 standard sleeves may be omitted where the services pass through walls which are not fire-separations and are concealed above opaque ceilings.
- .5 Seal the void between sleeve and service:
  - .1 except for sleeves for fire dampers and smoke dampers, fill void between sleeve and pipe, conduit or duct in accordance with Article "Fire Stopping and Smoke Seals" in this Section for sleeves located in fire separations,
    - (a) for waterproof sleeves, use firestopping material which is also suitable for exposure to water under normal operating conditions.
  - .2 at other locations, pack the void between sleeve and pipe, conduit or duct for full depth of sleeve, with mineral wool insulation and seal both ends with silicone-free caulking compound.
- .6 Roof sleeves for pipe and conduit:
  - .1 install manufactured roof flashing sleeves in accordance with manufacturer instructions, specifically in accordance with requirements applicable to the type of roofing membrane requirements,
  - .2 where limestone ballast is used, apply asphalt or similar protective coating onto flashing sleeve to a height of 50 mm (2 in) above ballast layer.
- .7 Where shown, provide floor, wall or roof sleeves for future use. Coordinate with trade contractor under Division 03 of the Work to have such sleeves filled with light weight concrete.

## 9 FIRE STOPPING AND SMOKE SEALS

### 9.1 General

- .1 Provide fire stopping and smoke seals where ducts, pipes or conduits penetrate fire separations.
- .2 Fire stop materials to be impervious to water when installed in a horizontal separation, including waterproof service sleeves.
- .3 Firestop material manufacturer or their designated service representative to provide the following services:

- .1 selection of listed fire stopping assemblies for each applicable service penetration and fire separation assembly/rating,
- .2 provide training of contractor's staff for proper installation of fire stopping assembly; create and maintain a log of those personnel who obtain training,
- .3 inspect the completed installation of all penetrations and submit a written report to the Consultant, including photo record of randomly selected instances of each fire stopping method. Where deficiencies are discovered, note the deficiencies in the report and provide remedial instructions to the contractor to correct the deficiency. After deficiencies are corrected, re-inspect the deficiencies to conform their correction, update and resubmit the report to the Consultant.
- .4 Submit a complete fire stopping and smoke seal shop drawing schedule to the Consultant for review. Include details, cut sheets, system description and location for each proposed fire stopping and smoke sealing application.

## 9.2 Products

- .1 Materials and firestopping system to be listed for conformance with CAN/ULC-S115 "*Standard Method of Fire Tests of Firestop Systems*".
- .2 Firestop systems to have F duration rating equal to the fire resistance rating of the applicable fire separation. In addition, where required by the applicable building code for the specific service penetration, the fire stop assembly shall:
  - .1 have a F rating equal to the fire resistance rating of the applicable fire separation with a pressure differential of 50 Pa (0.2 in.w.c.) between exposed and unexposed side with the highest pressure on the exposed side, and
  - .2 have an FT rating equal to the fire resistance rating of the applicable fire separation,

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- Hilti Firestop Systems
  - 3M
  - Nelson Firestop Products
  - Eastern Wire + Conduit (Royal Quickstop)
- .3 Other manufacturers having products with explicitly similar characteristics, listings or classifications and approvals are acceptable.

## 9.3 Installation

- .1 Install firestopping and smoke seals in accordance with the manufacturer's recommendations and in accordance with its listing.
- .2 Firestopping and smoke seals to be installed only by personnel trained by the manufacturer on the installation of such systems.
- .3 Seal space between penetrating service and sleeve or opening in in fire rated floors and walls with a firestop and smoke sealing system.
- .4 Select thickness and arrangement of back-up materials to suit size of service, length of sleeve and anticipated movement.
- .5 At time of application of materials, surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint and foreign materials.
- .6 Select firestopping system to allow insulation and vapour barrier to pass un-broken through assembly.
- .7 Do not apply fire stopping materials to fire or smoke dampers.

## **10 WALL AND FLOOR PLATES**

### **10.1 General**

- .1 Provide finishing plates fitted to ducts, pipes, and electrical services provided under Division 20 of the Work which pass through walls, floors and ceilings in finished areas.

### **10.2 Products**

- .1 Escutcheons for small diameter piping and small diameter electrical conduit:
  - .1 manufactured chrome plated two-piece split type with hinge and set-screw.
- .2 Finishing plates for ducts, larger pipes, larger electrical conduits and electrical cables:
  - .1 finishing plate (ring) fabricated from minimum 0.9 mm (20 ga) thick T304 stainless steel with No. 4 brushed finish, with minimum 25 mm (1 in) high collar ring,
  - .2 mounting holes drilled at not less than three (3) symmetrically location positions around the ring to allow mechanical fastening,
  - .3 plate diameter to be sufficiently sized to overlap the wall, floor or ceiling opening by not less than 25 mm (1 in) all around the opening.

### **10.3 Installation**

- .1 Escutcheons:
  - .1 secure escutcheons to pipe and electrical conduit with mechanical fastener.
- .2 Finishing plates:
  - .1 set finishing plates flat against the finished surfaces, and secure to the surface with stainless steel pan-head mechanical fasteners. Provide insert anchor plugs in the finished surface as necessary to secure the fasteners.

## **11 PIPE SUPPORTS AND EQUIPMENT SUPPORTS**

### **11.1 General**

- .1 Design and fabricate supplementary supporting steel for piping, ductwork and equipment supports, and trench and pit covers, from steel plate and sections. For clarity, the contractor under these Division 20 to 25 of the Work is responsible for design, fabrication and installation of such materials.
- .2 Concrete housekeeping bases for mechanical and electrical equipment which are in direct contact with floor slab, are to be provided by this Division 20.
- .3 Concrete for equipment supported on vibration isolated inertia bases is to be provided by this Division 20.
- .4 Work to be done by firms specializing in these fields.
- .5 Submit shop drawings for steel and concrete work, prepared by Professional Engineers licensed in the jurisdiction of the Work

### **11.2 Applicable Codes and Standards**

- .1 Legislation:
  - .1 Ontario Building Code,
  - .2 R.R.O. 1990, Reg. 851 Industrial Establishments
- .2 Installation codes and standards:

- .1 CAN/CSA-S16.1 Limit States Design of Steel Structures.
- .2 CSA W59 Welded Steel Construction (Metal Arc Welding).
- .3 Product standards:
  - .1 ASTM A36 Standard Specification for Carbon Structural Steel
  - .2 ASTM A53/A53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
  - .3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - .4 ASTM A 307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .5 CAN/CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel.

### 11.3 Supplementary Supports and Support Brackets

- .1 Provide supplement supports and brackets for the support of equipment, piping and ductwork.
- .2 Fabricate supports from structural grade steel with anchor bolts and fastenings, so that horizontal supporting beam deflections do not exceed 1/360 for the span, and not exceed an absolute deflection of 5 mm (0.20 in), with a safety factor of 1:4 to the ultimate strength of the material
- .3 Design the supports in consultation with the building structural Consultant, to transfer live loads and dead loads to the building structural elements,
- .4 Construct the supports as frames bracketed from walls, and/or supported from building structure above, and/or floor below.

### 11.4 Slide Pads for Equipment Support

- .1 General:
  - .1 slide pads for equipment supports for equipment subject to thermal expansion,
  - .2 designed for continuous-weld and/or tack-welding of backing plate to the equipment support,
  - .3 assembled in pairs per load point.

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- ° Piping Technologies & Products Inc.
- .2 Composite 25% glass-filled PTFE bearing plate bonded to carbon steel backing plate:
  - .1 PTFE thickness: 0.1 mm (3/32 in.)
  - .2 backing plate: 3 mm (1/8 in.) thick carbon steel plate,
  - .3 compressive strength: 19.3 MPa (2800 psi)
  - .4 temperature rating: -45 to +260°C (-50 to +500°F)
  - .5 coefficient of friction: 0.15
- .3 Graphite bearing plate bonded to carbon steel backing plate:
  - .1 graphite thickness: 13mm & 6mm (1/2 in & 1/4 in.)
  - .2 backing plate: 6 mm (1/4 in.) thick carbon steel plate,
  - .3 compressive strength: 19.3 MPa (2800 psi)
  - .4 temperature rating: -45 to +537°C (-50 to +1000°F)

.5 coefficient of friction: 0.15.

### **11.5 Installation - General**

- .1 Locate supporting steel to permit removal of parts for service or repair, and to allow clear access to valves, fittings, and equipment,
- .2 Set equipment on supporting frames and brackets and install hangers, anchor bolts, vibration mountings and snubbers.
- .3 Set equipment base plates on housekeeping pads on minimum 13 mm (½ in) epoxy grout and fill hollow portion of base with concrete.
- .4 Install anchor bolts, vibration mountings and snubbers between equipment and housekeeping pad, or inertia pad and housekeeping pad.
- .5 Provide anchorage, dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .6 Make field connections with bolts to CAN/CSA-S16.1, or by welding.
- .7 Supply items for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .8 Touch-up field welds, bolts and burnt or scratched surfaces after completion of erection with primer.
- .9 Where trench covers are cut in field or damaged, touch up with zinc rich paint.

## **12 HOUSEKEEPING PADS AND CURBS**

### **12.1 General**

- .1 Provide housekeeping pads and containment curbs. Be responsible for laying out of these pads and curbs, location dimensions relative to the building structure, and setting pad/curb heights based on supported equipment type.
- .2 Provide equipment anchors for embedment in concrete floors, pads and curbs, and place and secure in required position.
- .3 Inspect the pads and curbs during construction and verify pads and curbs are level and true.

### **12.2 Housekeeping Pads for Seismically-Restrained Equipment**

- .1 Refer to Specification section 20 05 49 for additional requirements for housekeeping pads which support equipment requiring seismic restraint.

### **12.3 Products**

- .1 Concrete: 20 MPa (3000 psi),
- .2 Reinforcing bars: carbon steel Grade 400R to CSA G30.18 *Carbon Steel Bars for Concrete Reinforcement*,
- .3 Housekeeping pad manufactured anchors:
  - .1 for installation prior to pouring of the housekeeping pad and post-installation of the structural floor,
  - .2 tapered ductile iron body, with openings sized for two runs of 10M (#3) reinforcing bar, and body NC threaded receiver for connection to undercut or expanding wedge anchors,
  - .3 two pieces of Ø10mm (#3) reinforcing bar, of sufficient length to tie into housekeeping pad reinforcement,
  - .4 undercut or expanding wedge anchor for connection to the structural floor slab.



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- Mason Industries - fig. HPA

.4 Adhesive anchors for post-concrete installation:

- .1 seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC308.
- .2 to have an ICC-ES seismic evaluation report, and be suitable for installation in cracked and uncracked normal- and light-weight concrete.
- .3 anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.
- .4 injectable, two-component hybrid adhesive, matching threaded rod and accessories.

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- Hilti - fig. HIT-HY 200]

**12.4 Installation - Concrete Housekeeping Pads**

- .1 Construct housekeeping pads using plywood form-work and site-poured concrete with reinforcing bars and run pads continuously beneath the equipment.
- .2 Housekeeping pad reinforcement and floor anchors for seismically-restrained equipment: conform to Specification section 20 05 49.
- .3 Finish exposed concrete surfaces to make them flat, level, and smooth.
- .4 Finish exposed edges with a 20 mm (3/4 in.) chamfer.

**12.5 Housekeeping Pad Dimensions**

- .1 Housekeeping pad height for air handling equipment equipped with condensate drains: minimum 150 mm (6 in.) unless higher dimensions are shown.
- .2 Housekeeping pad height for all other equipment: in accordance with the following table based on equipment type, location and vibration isolation condition:

Equipment Type	Floor Type	Vibration Isolation	Thickness of Housekeeping Pad mm (in)
Stationary, not motorized	All	All	100 (4)
Fans	All	Yes	150 (6)
Motorized, up to 7.5kW (10 HP)	All	Yes or No	150 (6)
Motorized, 11 to 19kW (15 to 25 HP)	Slab on Grade	No	250 (10)
	Slab on Grade	Yes	150 (6)
	Suspended Slab	Yes	150 (6)
Motorized, 22kW (30 HP) and over	Slab on Grade	No	300 (12)
	Slab on Grade	Yes	150 (6)
	Suspended Slab	Yes	150 (6)

## **12.6 Installation - Concrete Containment Curbs**

- .1 Concrete containment curbs are not to be used for support of equipment except for equipment weighing less than 9 kg (20 lbs.).
- .2 Construct concrete housekeeping curbs to the same requirements as for housekeeping pads except/and as follows.
- .3 Containment curb reinforcement:
  - .1 reinforce the housekeeping curbs with two runs of size 10M reinforcement bar along the length of the curb with 10M on 300 mm (12 in.) on centres one way across the curb,
  - .2 locate the reinforcement bars parallel to the long dimension of the curb at 40 mm (1-1/2 in.) from the outside face of the curb,
  - .3 tie-wire reinforcing bars together at crossings,
  - .4 place reinforcing bars with bottom layer positioned at 50 mm (2 in.) up from structural floor.]
- .4 Curb anchors:
  - .1 as specified for housekeeping pads, with one anchor provide within 200 mm (8 in.) of the end of the curb and at intermediate spacing not exceeding 1500 mm (5 ft).

## **12.7 Concrete Curb Dimensions**

- .1 Dimensions for containment curbs: 150 mm wide x 150 mm high (6 in. x 6 in.) and length as shown, unless otherwise shown.

## **13 INSTALLATION OF EQUIPMENT SUBJECT TO THERMAL EXPANSION**

- .1 The following specific installation requirements apply to hot equipment which is not supported on spring vibration isolators, including but not limited to:
  - .1 boilers, hot water heaters,
  - .2 heat exchangers,
  - .3 expansion tanks,
  - .4 deaerators and condensate tanks,
  - .5 diesel exhaust SCR emission control units.
- .2 Fasten equipment to building structure to accommodate thermal expansion in accordance with manufacturer's instructions. In the absence of such instructions, fasten equipment support legs as follows unless otherwise shown;
  - .1 rigidly mechanically-fasten one fixed support point which is closest to the inlet exhaust piping connections,
  - .2 for supports located on the same transverse or longitudinal axis as the fixed support point, provide slide guides with lateral limit-stops (lateral to the direction of thermal movement) with a lateral clearance gap not exceeding:
    - (a) 6 mm (1/4 in.) lateral movement for outdoor equipment and/or equipment subject to seismic restraint,
    - (b) 12 mm (1/2 in.) total movement otherwise.
  - .3 for other support points, provide guides with two-axis horizontal limit-stops to allow free movement under thermal conditions,

- .4 when installed outdoors, or where subject to seismic restraint, or both, provide vertical movement limit stops to limit free movement due to wind loading or seismic forces to not more than 6 mm (1/4 in.).
- .3 Provide support slide pads beneath each support leg other than the fixed support;
  - .1 use PTFE slide pads for equipment with an operating temperature less than 260°C (500°F),
  - .2 use graphite slide pads for equipment with an operating temperature greater than 260°C (500°F).

**END OF SECTION**

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## **MECHANICAL RENOVATIONS IN EXISTING HEALTHCARE FACILITIES**

### **20 05 02**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Contractor is responsible to review all documents for all divisions to coordinate phasing and services required at end of each phase.
- .2 Work in existing areas where new construction connects to existing will be heavily phased. Rework of services will impact on the existing hospital. Notify the Owner and the Architect, in writing, at least one week in advance of the work where work requires shut-down or isolation of existing services.
  - .1 Note a portion of the renovation requires re-routing of existing piping. ***All new piping is to be in place prior to removal/disconnection of existing*** to minimize downtime.
- .3 Except as identified, shut downs of existing services will be restricted from 11PM to 5AM and on weekends.
- .4 All work outside area of renovation and/or outside of IPAC hoarding to be done after hours and/or on weekends. Work to be done in accordance with Owner's IPAC procedures.

##### **1.2 General**

- .1 When directed by the Engineer, where specific sizes are listed in sections below, components or services may be provided in sizes equal to or smaller than the sizes listed.
- .2 The contractor shall include all provisions below in the contract. The contractor shall not be required to credit or provide spare parts for any unused provisions.

##### **1.3 Access Doors**

- .1 Provide in contract, supply and installation of: 8 @ 24" x 24" keyed access doors and 4 @ 24" x 24" fire rated access doors. These spare access doors are for unexpected situations and in addition to access doors required in contract to provide access to installed devices in hard ceilings.

##### **1.4 Medical Gas Connections**

- .1 Make connections to the existing medical gas systems, on a gas by gas basis, within one overnight shut-down. Provide additional valves where new connections are to be made to limit shutdown to one night.
- .2 Complete, inspect and certify the medical gas installation, by hospital's designated inspection agency prior to connection to the existing hospital.
- .3 Arrange for the inspection of the connections to the existing hospital to be made immediately after the completion of the work.

### 1.5 Sleeving, Core Drilling and Scanning

- .1 All services penetrating concrete walls and floors to be sleeved prior to pouring. Submit sleeving drawings indicating service size and sleeve size, superimposed over structural drawings and submit for approval. Relocate sleeves as directed by Engineer.
- .2 Include in contract for additional cores and scanning for the following for missed sleeves and/or changes.
  - .1 4@ 2" cores
  - .2 4@ 4" cores

### 1.6 Spare Components

- .1 Provide the following components in addition to those required in contract.
- .2 Provide spare valves including installation on existing or new piping, modifications to insulation as required:
  - .1 Domestic Water service – 4@ 1/2", 4@ 3/4", 2@ 3", 4@ 4".
  - .2 Heating and Cooling service – 4@ 3/4", 4@ 1", 4@ 4".
  - .3 Medical Gas service – 4@ 1/2", 4@ 1", 3@ 4"
- .3 Provide the following spare fire dampers c/w duct access door and installation in new or existing ductwork
  - .1 4@ 12" x 12"
  - .2 2@ 24" x 36"
  - .3 4@ 44" x 48"
- .4 Provide **2** type spare **A1** diffusers complete with installation, 30 feet of 12"x12" duct and insulation on supply duct.
- .5 Provide **2** type spare **C1** grilles complete with installation, 30 feet of 12"x12" duct and insulation on supply duct.
- .6 Provide **3** spare **BAS control points** complete with device, wiring and conduit (assume 200 ft per point), programming, etc in contract to be used by discretion of Engineer.
- .7 Provide **4** additional **concealed pendant sprinkler heads** complete with installation, 10 feet of 2" sprinkler piping, and all associated fittings. Sprinkler heads shall be dry concealed heads where required in preaction systems.

### 1.7 Freezing of Live Water Services

- .1 Include in contract an allowance for the following connections where existing valves do not hold or do not exist:
  - .1 Freezing of four (4) 3" sprinkler lines
  - .2 Freezing of six (6) 1" water lines
  - .3 Freezing of six (6) 4" water lines

## **1.8 Phasing**

- .1 Comply with all Div. 01 specifications regarding Work Restrictions, Phasing, and Staging.
- .2 Carefully examine the phasing plan from the Architectural drawings and Div. 01 Specifications to develop a mechanical construction plan in conjunction with the General Contractor to ensure that areas can be constructed mechanically for each phase/stage with all active services. All services will be complete and available for occupancy of the phased spaces, unless noted otherwise.
- .3 The drawings show service configuration for final construction layout and do not include scope required for each individual phase of construction. Prior to construction, the mechanical contractor shall review each phase, review existing services and formulate a plan on how to construct the area with all services without interruption to other occupied areas.
- .4 The mechanical work necessary to maintain services will not be restricted to the architectural phased areas of work. This division will have to work in the existing occupied building during off hours; obtaining and modifying services for new phased areas.
- .5 The contractor shall maintain existing systems until the new services are ready for use. New equipment, ductwork, piping is to be installed prior to demolition of existing services, where possible to minimize shut down period.
- .6 Provide relevant reports at each phase of construction.

## **1.9 Air and Water Balancing**

- .1 Air and water balancing is to be carried by the mechanical contractor. Refer to relevant sections in Divisions 22 and 23.
- .2 Provide air/water balancing at the end of each phase.

## **1.10 Work in Occupied Areas**

- .1 Work in Owner occupied areas to be scheduled with the Owner.
- .2 Access to these areas will be at the discretion of the Owner and strictly after hours unless otherwise noted on the drawings.

## **1.11 Phased Occupancy, Equipment Maintenance, Equipment Operation and Warrantee.**

- .1 This is one project and substantial performance will be granted at the end of the project. There will be no phased substantial performance or phased release of holdback.
- .2 The Mechanical Contractor to ensure all mechanical equipment is complete and functioning before testing and commissioning is done.
- .3 The mechanical contractor will be responsible to maintain and operate new equipment (and systems) supplied under this project until the project is formally handed over to the Owner. Maintenance shall include all manufacturer recommended maintenance, filter changes, bearing lubrication, fan belt adjustment, chemical treatment, cleaning of coils. Maintenance and system downtime to be minimized and scheduled to suit the Owner.

- .4 The mechanical contractor shall operate the systems to the Owners benefit to ensure that the occupied phases are fully serviced to the Owners schedule. The mechanical contractor to provide a list of emergency contacts so they can respond 24/7 to issues with their system. Repairs to be made quickly to minimize disruption to the users and Owner.
- .5 Training of Owner's maintenance personnel to be done at end of project prior to formal turnover to Owner. Training will not be required at the end of each phase as the contractor will be maintaining and operating the equipment/systems installed under this project.
- .6 Equipment and system warranties to start after substantial performance even though equipment may be installed and operating early in the construction. Notify equipment supplier of this situation during bidding and include any additional costs related to operating the equipment during the construction period or include extended equipment warranty to cover contract duration plus the standard warranty period starting after substantial performance.

**END OF SECTION**

## **COMMON ELECTRICAL REQUIREMENTS FOR MECHANICAL SERVICES**

### **20 05 12**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide wiring, conduit, fittings, supports, disconnect switches, service lights, and related devices and equipment for mechanical trades work, at voltages of 600V and less and to the extent specified herein.
- .2 Pre-installation survey of SCCR values for equipment supplied under Divisions 20 to 25 which requires power wiring supply, to verify nameplate SCCR is equal to or greater than the minimum specified SCCR values.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 29 Hangers and Supports
  - .2 20 05 49 Seismic Restraint.
  - .3 20 05 14.13 Motor Controllers
  - .4 20 05 14.16 Variable- Frequency Drives
  - .5 25 55 13 Building Automation Smoke Damper Control Panels

##### **1.3 Definitions and Abbreviations**

- .1 The following definitions apply to this section and referenced sections:
  - .1 **Control panels** – an electrical device that controls or monitors mechanical equipment, or that interfaces with instrumentation devices.
  - .2 **Control wiring** - wiring for the purpose of communication or control of equipment and instrumentation.
  - .3 **Electrical safety code** - the edition with amendments of CSA C22.1 as adopted by applicable legislation at the location of the Work.
  - .4 **Mechanical breaker panel (MBP)** means a 120/208 V mechanical power panel with overcurrent protection circuit breakers provided as part of an MCC.
  - .5 **Mechanical service panel (MSP)** - panelboard with branch circuit overcurrent protection devices provided by Division 26, and dedicated to supply power for equipment provided by mechanical trades work.
  - .6 **Mechanical trades work** - equipment and systems provided under Divisions 20 to 25.
  - .7 **Motor controllers** - constant speed motor controllers of the manual, magnetic or solid-state type in accordance with specification section 20 05 14.13.
  - .8 **Motor Control Center** – has the meaning as specified in section 20 05 14.13.
  - .9 **Packaged equipment** - equipment containing some or all of: motor(s), controls and/or other electrically powered equipment, such as but not limited to: electric heating equipment, water treatment equipment, packaged HVAC equipment, electric boiler, electric domestic water heaters, etc.)
  - .10 **Power Panel (PP)**: 208 up to 600 V, 3 phase, panelboard with branch circuit overcurrent protection devices provided by Division 26, which serves general building loads and may also serve equipment provided by mechanical trades work.



- .11 **Power wiring** means wiring that provides electrical power to equipment including to control panels, including BAS panels, that are not integral to the controlled equipment.
- .12 **Receptacle panel (RP)** - a 120/208 V panelboard with branch circuit breakers, provided by Division 26.
- .13 **SCCR**: the RMS symmetrical short-circuit current rating of the equipment or motor controller, measured at the input to the motor or controlled equipment (short-circuit withstand rating has the same meaning).
- .14 **VFD**: variable frequency drives in accordance with specification section 20 05 14.16.
- .15 **Wiring** means conductors, cable, conduit, fittings, supports and accessories.
- .2 With respect to these definitions, for equipment provided by Division 26 the actual terminology used in the Division 26 drawings and specification may differ but the intent remains the same.
- .3 For clarity, any reference herein to Division 20 means Divisions 20 to 25 inclusive.

#### **1.4 Applicable Codes and Standards**

- .1 Legislation:
  - .1 Electrical safety legislation in the jurisdiction of the Work.
  - .2 For clarity, on Federal Government projects, comply with the provincial or territorial legislation at the place of the Work which adopts the applicable edition of CSA 22.1 with any amendments
- .2 Installation standards and codes:
  - .1 CSA C22.1 Canadian Electrical Code Part 1, as amended and adopted by the AHJ for electrical safety in the province or territory at the place of the Work.
- .3 Product standards:
  - .1 CSA C22.2 No. 4 Enclosed and Dead-Front Switches
  - .2 CSA C22.2 No. 38 Thermoset-Insulated Wires and Cables
  - .3 CSA C22.2 No. 39 Fuseholder Assemblies
  - .4 CSA C22.2 No.94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
  - .5 CSA C22.2 No. 106 HRC – Miscellaneous Fuses
  - .6 CSA C22.2 No. 124 Mineral Insulated Cable
  - .7 CSA C22.2 No. 131 Type TECK 90 Cable
  - .8 CSA C22.2 No. 208 Fire Alarm and Signal Cable
  - .9 CSA C22.2 No. 230 Tray Cable
  - .10 CSA C22.2 No. 239 Control and Instrumentation Cables

#### **1.5 Quality Control**

- .1 Electrical wiring for mechanical trades work to be performed by a specialist electrical contractor firm with an established reputation in the field of wiring of mechanical equipment and controls.

#### **1.6 Short Circuit Current Ratings (SCCR) and Markings**

- .1 Except where another Specification section requires a SCCR of a different value, equipment provided under Division 20 to 25 which is supplied electrical power in accordance with CSA C22.1 shall have a short circuit capacity rating (SCCR) of not less than 10 kAIC RMS symmetrical.

- .2 The SCCR value is to be marked on all equipment provide with power wiring in accordance with CSA C22.1. Where the SCCR nameplate rating references an instruction manual, provide a separate label that states the SCCR value.

### **1.7 Permits, Fees and Inspections**

- .1 Arrange and pay for electrical permits and any required inspections for electrical work for mechanical equipment and systems.
- .2 Submit to the electrical safety authority the required number of drawings and specifications for examination and approval prior to commencement of work.
- .3 Notify Consultant of changes required by the electrical safety authority prior to making changes.
- .4 On completion of the Work, furnish certificates of acceptance (or similar report) from the electrical safety authority to the Consultant.

### **1.8 Standard Details**

- .1 Device legend with list of abbreviations and schematic wiring diagrams are included at the end of this section that delineate the scope of work between Division 20 and Division 26 and as further specified herein.
- .2 This material is to be used in the interpretation of specification requirements for power wiring and control wiring of Division 20 to 25 equipment.

### **1.9 Submittals**

- .1 Submit manufacturer catalogue cut-sheets for the following materials;
  - .1 VFD Inverter Duty cable,
  - .2 service lights.

### **1.10 Storage of Materials**

- .1 Store wire and cable in a clean, dry, well-ventilated area.
- .2 Protect white insulated wire from exposure to NOx gas (e.g.: exhaust from propane fueled equipment) by wrapping with shrink wrap, by locating away from sources of NOx and by maintaining adequate ventilation to minimize NOx levels.
- .3 Where white insulated wire has discoloured:
  - .1 do not install,
  - .2 dispose of the wire,
  - .3 remove and replace wire that has been installed.

## **2 PRODUCTS**

### **2.1 Motor Feeder and Control Wiring ("Building Wires")**

- .1 Application:
  - .1 motor and equipment power feeders controlled by constant speed motor controllers;
    - (a) do not use for motors controlled by variable frequency drives,
  - .2 control wiring including control valves and damper actuators, panel control wiring, motor controller interlock wiring, BAS control wiring, and switch-type instrumentation,
  - .3 convenience power outlets and service lights.
- .2 Conductors:

- .1 solid copper for No. 12 and 14 AWG,
- .2 stranded conductors for 10 AWG and larger.
- .3 Minimum wire size:
  - .1 No. 12 AWG for equipment power,
  - .2 No. 14 AWG, for control wiring at 120 VAC or lower.
- .4 Insulation:
  - .1 chemically cross-linked thermosetting polyethylene (XLPE) material, RW90 or RWU90,
  - .2 1000 V insulation for 600 V systems,
  - .3 600 V insulation for 100 VAC to 480 VAC systems.
  - .4 300 V insulation for systems less than 100 VAC, and for systems 24 VDC and less.
- .5 Colour coded conductors:
  - .1 colour impregnated into insulation at time of manufacture,
  - .2 phase conductors No. 8 AWG and larger with black insulation, may be colour coded with adhesive colour coding tape.
- .6 Listed to CSA C22.2 No. 38.
  - Standard of Acceptance*
    - Aetna Insulated Wire
    - General Cable
    - Nexans Canada Inc.
    - Prysmian Cables & Systems Ltd.
    - Southwire

## **2.2 VFD Inverter Duty Cable**

- .1 Application:
  - .1 for motor power feeders between a VFD and its driven motor,
  - .2 specifically manufactured to reduce high frequency noise and grounding of common mode currents.
- .2 Cable:
  - .1 symmetrical conductor, low-capacitance design with three ground wires and shield,
  - .2 conductors: braided copper wire with RW90 XLPE insulation.
  - .3 voltage rating: 1000 VAC, with resistance to voltage spikes of not less than 2 kV.
  - .4 bonding conductors: three (3) bare copper conductors,
  - .5 shielding:
    - (a) designed for EMC/RFI reduction and as a low-impedance path for high-frequency common mode currents,
    - (b) 100% coverage by two-layers of copper-wrap tape shield, or
    - (c) shielding provided by continuous corrugated and welded aluminium armoured sheath.
  - .6 sheath:
    - (a) method 1: continuous corrugated and welded aluminum armour sheath (armour and shield),

- (b) method 2: interlocked aluminium sheath for armour, separate copper wrap shields as specified above,
- (c) method 3: no armour sheath required when cable has the specified copper tape shielding and is installed in conduit,
- .7 outer jacket: TPE or PVC liquid-tight with FT4 and AG14 rating, and UV resistant.
- .8 listed to CSA C22.2 No. 38, and CSA C22.2 No. 230.

*Standard of Acceptance*

- NEXANS - fig. DriveRx (armoured)
- ShawCor - fig. CSA Armoured AIA VFD (armoured)
- ShawCor - fig. CSA Unarmored Tray VFD (unarmoured)
- Belden - fig. Symmetrical 2kV (unarmoured)
- Belden - fig. Symmetrical 2kV (armoured)

.3 Cable shield termination fittings:

- .1 High-frequency/low impedance shield termination kit to provide 360° connection to the cable shield, with flexible tinned copper braid bonding strap with attached lug, and constant force spring collar.

*Standard of Acceptance*

- Southwire – fig. 85451

- .2 High-frequency/low impedance cable gland, with integral 360° copper alloy shield contact spring.

*Standard of Acceptance*

- Southwire - fig. 85452

**2.3 Extra-Low Voltage Power Wiring – 24 VAC, 24 VDC**

- .1 Application: power wiring to 24 VAC or 24 VDC electrically commutated motors.
- .2 Type: ACIC,
- .3 Cable:
  - .1 insulated solid or stranded copper conductors,
  - .2 insulation: XLPE, colour coded or numbered wires,
  - .3 minimum wire size: 16 AWG,
  - .4 voltage rating: 600 V.
- .4 Armour:
  - .1 aluminium interlocked armour.
- .5 Jacket:
  - .1 FT4 flame retardant,
  - .2 FT6 when installed in raised floors, or in ceiling spaces that are used as return air plenums.
- .6 Listed to CSA C22.2 N0. 239,

*Standard of Acceptance*

- General Cable (Carol)
- Belden
- Nexans Canada Inc.

## **2.4 Instrumentation Cabling**

- .1 Application: instrumentation and control wire suitable for analogue 4-20 mA and 0-10 VDC signaling.
- .2 Cable:
  - .1 insulated solid-copper twisted-multipair conductors, shielded cables with individually shielded pairs, 100% coverage overall shield, drain wires and overall rated jacket,
  - .2 insulation: XLPE, colour coded or numbered wires,
  - .3 minimum wire size: as specified by equipment manufacturer or controls vendor, but not less than 18 AWG,
- .3 Armour:
  - .1 corrugated steel, or
  - .2 none required if installed in conduit or approved wireway.
- .4 Jacket:
  - .1 FT4 flame retardant,
  - .2 FT6 when installed in open style cable trays in ceiling spaces that are used as return air plenums.
- .5 Listed to CSA C22.2 No. 239,

### *Standard of Acceptance*

- General Cable (Carol)
- Belden
- Nexans Canada Inc.

## **2.5 Conduits and Fittings**

- .1 Conduits:
  - .1 rigid hot dipped galvanized steel threaded conduit,
  - .2 electrical metallic tubing (EMT), hot dipped galvanized with couplings,
  - .3 PVC coated hot dipped galvanized rigid steel conduit: with 40 mil PVC exterior coating, 2 mil urethane interior and thread coating,
  - .4 flexible metal conduit and liquid-tight flexible metal conduit.
- .2 Conduit fastenings:
  - .1 single hole steel straps to secure surface conduits 50 mm (2") and smaller,
  - .2 two hole steel straps for conduits larger than 50 mm (2"),
  - .3 beam clamps to secure conduits to exposed steel work,
  - .4 channel type supports for two or more conduits,
  - .5 Ø6 mm threaded rods to support suspended channels.
- .3 Conduit fittings:
  - .1 manufactured for use with conduit specified including coatings,
  - .2 factory "ells" where 90° bends are required for 25 mm (1in.) and larger conduits,
  - .3 insulated throat steel set screw or raintight insulated throat steel compression connectors and couplings for EMT,

- .4 threaded or compression type raintight/concrete tight insulated throat zinc plated steel connectors and couplings for rigid steel conduit,
- .5 raintight insulated throat steel connectors at all surface equipment enclosures and other electrical equipment in sprinklered areas for all conduit terminations.

## **2.6 Outlet Boxes**

- .1 Construction:
  - .1 hot dipped galvanized steel single and multi-gang flush device boxes for flush installation,
- .2 Size:
  - .1 76 mm x 50 mm x 38 mm (3" x 2" x 1½") or as indicated,
  - .2 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

## **2.7 Disconnect Switches**

- .1 Construction:
  - .1 listed to CSA C22.2 No. 4,
  - .2 enclosure type:
    - (a) painted metal with hinged door,
    - (b) indoors: type 1, 3R, 4 or 12, unless otherwise specifically shown,
    - (c) outdoors: type 3R.
  - .3 fuseholder assemblies listed to CSA C22.2 No. 39,
  - .4 include fuses unless shown as unfused,
  - .5 fuseholders suitable for Class J fuses, sized to suit the fuse sizes without the use of adaptors,
  - .6 horsepower rated,
  - .7 one, two or three pole as required for single phase or polyphase circuits,
  - .8 two pole with solid neutral or three pole with solid neutral for three wire and four wire circuits with neutral,
  - .9 six pole for two speed motor applications,
  - .10 provision for padlocking in the Off switch position,
  - .11 mechanically interlocked door to prevent opening when handle is in the ON position,
  - .12 heavy duty, quick-make, quick-break action,
  - .13 ON-OFF switch position indication on switch enclosure cover.
- .2 Fuses:
  - .1 HRCI-J time delay up to 600A,
  - .2 HRCI-L for ratings above 600A,
  - .3 minimum interrupting capacity: 200 kAIC
  - .4 product of one manufacturer,
  - .5 ampere rating as indicated, where not indicated, the maximum rating permitted by the electrical code.
- .3 Special requirements for disconnect switch located upstream of harmonic filters:

- .1 double break contacts per pole, to isolate fuses on both the line and load side,
- .2 14 AWG power taps on both line and load sides for control power transformers.
- .4 Special requirements for disconnect switch located between a VFD and the controlled equipment:
  - .1 auxiliary switch position status switch;
    - (a) rating: 10 A at 120 VAC,
    - (b) switch contacts open when disconnect switch is Not-Closed.
- .5 Ratings:
  - .1 IEC 90 rotary switch for motors up to 18.6 kW (25 HP),
  - .2 NEMA flange mount switch-handle for all ratings.

*Standard of Acceptance*

- Square "D"/Schneider Electric Company (Canada) Ltd.
- Eaton
- Siemens Canada Ltd.
- Klockner Moeller/Eaton

## **2.8 Equipment Service Lights**

- .1 Protected globe light fixture ("Marine light"):
  - .1 die-cast aluminium housing and cage, frosted glass lens, stainless steel hardware, suitable for wall and ceiling mounting,
  - .2 enclosure rating: NEMA 4X or IP 65, vapourtight,
  - .3 listed and fixture marked for use in wet locations,
  - .4 bulb: LED with electronic driver, minimum life of 50,000 hours at L70 lumen level,
  - .5 optics: 3500 to 4000 K light, nominally 1400 lumens,
  - .6 operating temperature: -20 to +40°C (-4 to +104°F),
  - .7 operating humidity: up to 100% relative humidity at operating temperatures between 0 and +40°C (32 to 104°F),
  - .8 power: 120 VAC.

*Standard of Acceptance*

- Cooper - fig. LVL20UG

- .2 Area light fixture ("Area light"):
  - .1 reinforced-polyester fiberglass housing, stainless steel hardware, with lens gasket, suitable for wall and ceiling surface-mounting,
  - .2 fixture length: 600 mm (24 in),
  - .3 lens: low profile, high impact 50% DR acrylic lens, for wide distribution,
  - .4 enclosure rating: NEMA 4X or IP 65, vapourtight,
  - .5 listed and fixture marked for use in wet locations,
  - .6 bulb: LED with electronic driver, minimum life of 60,000 hours at L80 lumen level,
  - .7 optics: 3500 to 4000 K light, nominally 3000 lumens,

- .8 operating temperature: -20 to +40°C (-4 to +104°F),
- .9 operating humidity: up to 100% relative humidity at operating temperatures between 0 and +40°C (32 to 104°F),
- .10 power: 120 VAC.

*Standard of Acceptance*

- Cooper - fig. 2VT3
- Lithonia - fig. FEM LED

**2.9 Switches**

- .1 Toggle switch, with neon pilot light – light is On when switch is Off.
- .2 Rating: 20 A at 120 Vac.
- .3 Switch cover: weatherproof with silicone rubber gasket, and clear bubble over toggle.

*Standard of Acceptance*

- Hubbell - HBL1795

**2.10 Receptacles**

- .1 Class A GFCI type, 15 A at 120 VAC indoors, and 20 A T-slot for outdoors.
- .2 Receptacle outlet hood:
  - .1 in-use weatherproof, for both indoor and outdoor locations,
  - .2 die cast aluminum base and cover with gasket,
  - .3 vertical mount.
  - .4 self-closing lift cover.
  - .5 CSA 3R rated.

*Standard of Acceptance*

- Bryant Electric – WPB26EH

**2.11 Rooftop Maintenance Receptacle Pedestals**

- .1 Manufactured roof-mounted maintenance receptacle pedestal;
  - .1 formed galvanized steel with powder coat finish, or stainless steel square tube,
  - .2 roof deck mounting flange, for bolting from the top of flange to roof, or fastened using a two part deck flange assembly,
  - .3 minimum height above roof: as required for receptacle to be located at not less than 750 mm (30 in.) above the roof flange,
  - .4 receptacle: Class A GFCI type, 120 V, 20 A T-slot, with in-use weatherproof receptacle cover,
  - .5 factory-wired or field wired. For factory wiring, minimum no. 12 AWG RW90 conductors in liquid-tight flexible metallic conduit.
  - .6 CSA Type 3R rated.

*Standard of Acceptance*

- Valid Manufacturing fig. Rooftop Pedestal
- MAPA fig. MPX series



## 2.12 Conduit and Equipment Supports

### .1 General:

- .1 supports for conduit may conform to Specification section 20 05 29 except/and as specified herein.
- .2 Materials: carbon steel supports, hot dipped galvanized after fabrication.
- .3 manufacturer standard products suitable for support load rating of conduit and conductors:

#### *Standard of Acceptance*

- Burndy Canada Ltd.
- Canstrut
- Electrovert Ltd.
- E. Myatt & Co. Ltd
- Steel City Electric Ltd.
- Pilgrim Technical Products Ltd.

### .2 Upper attachment – concrete inserts

- .1 galvanized wedge inserts to MSS SP-58 type 18.
- .2 maximum tension load rating: 4.4 kN (1000 lbs),

#### *Standard of Acceptance*

- Anvil - fig. 281
- Unistrut - fig. P-3245

### .3 Upper attachment – existing concrete:

- .1 conform to Specification section 20 05 29.

### .4 Upper attachment – steel beams:

- .1 carbon steel beam clamp (top flange), hook rod with locking jaw, fasteners and lockwashers, to MSS SP-58, type 25,

#### *Standard of Acceptance*

- Anvil - fig. 227
- Myatt - fig. 504, 505

### .5 Upper attachment - steel joists:

- .1 for installation of support rod in the interstice space of double-ell steel joists and open-web steel joints for support on the lower chord,
- .2 carbon steel washer plate with double locking nuts on top-side of washer,
- .3 second steel washer plate on underside of joist with nut where supported equipment is subject to vibration.

#### *Standard of Acceptance*

- Anvil - fig. 60
- Myatt - fig. 545

### .6 Hanger rods:

- .1 continuous threaded rod, carbon steel, USS national course thread,

- .2 minimum rod size: Ø6 mm (1/4 in. dia.),
- .3 tension load ratings to MSS SP-58,

*Standard of Acceptance*

- Anvil - fig. 146
- Myatt - fig. 434

.7 Horizontal Pipe Support – Swivel Ring Hanger

- .1 swivel ring hangers, carbon steel ring strap, zinc plated, adjustable knurled swivel nut, to MSS SP-58 Type 10,
- .2 nominal conduit size: 12mmC to 100 mmC.

*Standard of Acceptance*

- Anvil - fig. 69, CT-69
- Myatt - fig. 41, 42, 43
- Unistrut

.8 Support channels:

- .1 U shape, minimum size 41 mm x 41 mm x 2.5 mm (1-1/2" x 1-1/2" x 1/10") thick, surface mounted, suspended or set in poured concrete walls and ceilings.
- .2 channel size selected for total supported loads,
- .3 conduit attachments: one-piece or two piece conduit clamps suitable for suspended loads and bottom supported conduit loads.

.9 J Hooks:

- .1 galvanized steel open-style J hooks with rolled edges for fastening direct to building structure or hanger rods.

.10 Rooftop conduit supports:

- .1 conform to specification section 20 05 29.

**2.13 Wire Markers**

- .1 Printed, self-laminating vinyl wire and cable labels and sleeve-labels.

*Standard of Acceptance*

- Brady BMP21 Plus series

**3 EXECUTION**

**3.1 Pre-Installation Survey for Short Circuit Current Ratings**

- .1 Prior to installation of power wiring to mechanical equipment provided under Division 20 to 25, conduct a survey of such mechanical equipment's' SCCR values. Verify that the equipment nameplate SCCR rating is equal to or greater than:
  - .1 the general value specified in this section, or
  - .2 the specific value specified in the relevant Specification section for the equipment.
- .2 Where the nameplate SCCR is less than the specified minimum SCCR required value, provide a fused disconnect switch as specified herein ahead of the equipment, even if the equipment already has an

integral disconnect switch. The cost for the provision of such disconnect switches shall be borne by the trade contractor supplying the mechanical equipment, at no cost to the Owner.

- .3 For clarity, this survey also applies to existing mechanical equipment where the Work includes replacement of the power wiring supplying the equipment.

### **3.2 General Installation Requirements**

- .1 Install electrical wiring work under this specification section in accordance with the applicable electrical safety code and regulations applicable at the location of the Work.
- .2 In other than service rooms, run conduit and cable concealed within walls or above ceilings.
  - .1 for open-cell concrete block walls, install conduit during wall construction with openings for outlet boxes,
  - .2 for solid concrete walls, rough-in conduit and outlet boxes supported from structural reinforcing bars prior to pouring of concrete,
  - .3 where walls or ceiling structures are exposed, such as steel or finished concrete, arrange conduit neatly on the supporting surface, avoid the use of elbows to the greatest extent possible, and locate conduit as close as possible to the building structure.
- .3 In service rooms, run conduit and cables exposed.

### **3.3 Conduit Support and Hanger Installation**

- .1 As an alternative to the materials specified herein, specification section 20 05 29 may also be used for support of conduits.
- .2 Support conduit from building structure in accordance with specification section 20 05 29.
- .3 Support conduit directly from or on structural building elements. Do not support conduit directly from other services.
- .4 Provide all miscellaneous materials including nuts, washers, and backing plates to make a complete support installation.
- .5 Where wall brackets are used, select brackets and size mounting bolts and backing plates to suit the supported load, allowing for a safety factor by not loading the bracket more than 80% of its published load rating.
- .6 In steel framed construction, support conduit from structural members. Where structural members are not suitably located for upper hanger attachment locations, and where inserts of adequate capacity cannot be installed in concrete slabs, provide supplementary steel framing members;
  - .1 fabricate supplementary steel from standard HSS sections, single EL section, double C "strongback" sections, or pipe rolls,
  - .2 size supporting steel to limit span deflection to 1/250 (0.4%) between support points,
- .7 Support horizontal conduit at intervals not exceeding 3 m (6 ft).
- .8 Support vertical conduit at intervals not exceeding 3 m (6 ft).
- .9 Where trapeze hangers are used, secure conduit to trapeze with U-bolts or conduit clamps.
- .10 Mechanically fasten supplementary steel to structural steel.

### **3.4 Armoured Cable Support**

- .1 Support armoured cable VFD cables on 300 mm (12 in.) centres on channel supports and secured with conduit clamps. Do not use nylon or wire lashing or perforated strap to support or secure cables.

- .2 Support instrumentation armoured cables horizontally in cable trays or with J-hooks on 300 mm (12 in.) centres.
- .3 Support instrumentation armoured cables vertically by securing to building structure or secondary framing with perforated straps with 3 mm (1/8 in.) thick EPDM protective strip between the strap and cable.

### **3.5 Plenum-Rated Control and Instrumentation Cables Support**

- .1 Support plenum-rated instrumentation and control cables in cable trays or with J-hooks on 300 mm (12 in.) centres. Support vertical cable drops to controls instrumentation, controlled devices or related equipment by use of vinyl tie-wraps fastened to building structure, supplementary steel, or equipment hanger rods. Do not support cables on piping or ductwork.

### **3.6 Installation of Power and Control Wiring – General Requirements**

- .1 Wiring methods and standards to conform with those specified in Electrical Division 26 for the area of building in which installation is to be made, except as otherwise specified in this section.
- .2 Except where fire rated cables or VFD Inverter duty cables are required, use building wire for:
  - .1 power wiring for motors and packaged equipment,
  - .2 power wiring to control panels, heat tracing and other non-motorized packaged equipment, and
  - .3 non-analog control wiring at 120 VAC or less, and 24 VDC or less.
- .3 Provided polyphase motor and equipment power conductors with the following colour coding:
  - .1 Phase A – Red,
  - .2 Phase B – Black,
  - .3 Phase C – Blue ,
  - .4 Neutral - White,
  - .5 Ground - Green,
  - .6 Control - Orange.
  - .7 Where colour coded tape is utilized, apply at least 50 mm (2") at terminations, junction boxes and pull boxes. Do not paint conductors.
- .4 Provide single-phase motor and control wiring conductors with the following colour coding:
  - .1 Line – Red,
  - .2 Neutral – White,
  - .3 Ground – Green.
- .5 Install all wiring in conduit or approved raceway.
- .6 Use conduit type as follows:
  - .1 EMT: use thin wall conduit up to and including 32 mm (1 ¼ in) size for wiring in ceilings, furred spaces, in hollow walls and partitions and where not exposed to mechanical injury, and as otherwise shown.
  - .2 Rigid : use rigid galvanized steel conduit for wiring in poured concrete, where exposed, and for conduit 40 mm (1½ in) size and larger.
  - .3 Liquid-tight flexible: use only for the last 1000 mm (3 ft) of motor feeder at connection to motor, and for instrumentation wiring to equipment subject to vibration.
  - .4 select conduit size to be of sufficient size to allow easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.

- .7 Provide separate conduit for power wiring for each motor or starter. Except for motor temperature transducer wiring, do not install control wiring in the same conduit as power wiring.
  - .1 exception: motor temperature transducer wiring between motor and associated motor controller may be run in the same conduit as the associated motor feeder provided the conduit is sized for the additional wire pair.

### **3.7 Installation of Power Wiring for VFDs and Associated Motors**

- .1 Use VFD inverter duty cables for motor feeders between VFDs and associated motor.
- .2 Run VFD inverter duty cables in rigid conduit or EMT between the VFD and the motor, with liquid-tight flexible conduit used at the motor connection;
  - .1 use only site-formed bent elbows for changes of direction; do not use ells,
  - .2 make an elbow radius so that the bend radius of the cable is not less than the minimum bending radius specified by the cable manufacturer,
  - .3 do not combine wiring from any other source or purpose within VFD feeder conduit.
- .3 VFD inverter duty cables may be run in free- air (without conduit) where all the following conditions are met;
  - .1 the VFD cable is of the armoured type,
  - .2 the armoured cable is located in the same room as the VFD and the motor,
  - .3 the armoured cable length does not exceed a total length of 10 m (33 ft);
    - (a) for longer cables, the 10 m (33 ft) free-air length is to be located at the motor end,
  - .4 where the cable passes through the wall of air handling units,
    - (a) provide a 100 mm (4 in) long section of rigid conduit (sleeve) through the wall,
    - (b) the sleeve is provided with escutcheons to seal the wall opening,
    - (c) the ends of the conduit are reamed and cleaned of burrs and sharp edges, and
    - (d) the cable/sleeve is sealed with a non-hardening mastic (i.e. firestop compound) at one end.
- .4 Terminate the shield on VFD inverter duty cables as follows:
  - .1 terminate at both ends of the cable at the motor enclosure box ground screw and at the VFD cabinet entrance potential bond screw,
  - .2 connect the shield to the ground screw of any intervening devices between the VFD and the motor where the cable is interrupted, including disconnect switches, output load-filters,
  - .3 connect the ends of the shield with a low-impedance 360° contact termination kit, either by use of a special-purpose gland or by a special-purpose bonding strap.
- .5 Terminate the three ground conductors at each end. A pigtail may be used for final termination to the motor ground lug or the VFD ground lug provided the pig-tail size is not less than the size of the individual cable ground wire.
- .6 Where the VFD cable must be interrupted at an equipment disconnect switch or otherwise spliced, terminate the ends of the shield using low-impedance termination kits at the common ground lug in the disconnect switch or junction box. Bond the six (6) ground conductors with a common pigtail to a ground lug.

### **3.8 Harmonic Filter Control Power**

- .1 Provide 120 VAC control power supply to operate contactors in the passive harmonic filters, of either:
  - .1 dedicated 120 VAC circuit with 15 A circuit breaker,

- .2 VFD auxiliary 120 VAC power supply (if available), or
- .3 control transformer power supply consisting of:
  - (a) primary side connection downstream of the harmonic filter disconnect switch,
  - (b) control transformer with primary voltage at VFD power supply voltage and 120 VAC secondary,
  - (c) fuse protection on primary and secondary side of transformer.
- .2 The control transformer may be located in the service disconnect switch upstream of the harmonic filter, inside the VFD enclosure (when permitted by VFD manufacturer), or in a custom electrical enclosure.
- .3 Provide control power wiring to the VFD and between the VFD and the passive harmonic filter. Provide an interposing dual-voltage relay (12 VAC/VDC coil, 120 VAC rated contacts) to operate the harmonic filter contactor.
- .4 Provide a CSA C22.2 No. 94.1 Type 1 or 3 electrical enclosure to house the transformer (if used) and dual-voltage relay and associated fuse protection and wiring, unless these materials can be included in the disconnect switch and/or the VFD enclosure.
- .5 Program the VFD to open the harmonic filter contactor (to disconnect the filter capacitors) when the VFD output is below 70% of motor rated speed.

### **3.9 Installation of Instrumentation, Communications and Control Cabling**

- .1 Install wiring in conduit.
- .2 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.
- .3 Run instrumentation, communication and control cabling point to point and terminate on terminal strips. Do not splice communication or control cabling. Where long runs make a continuous point to point installation impractical, make splices on labelled terminal blocks in an accessible labelled terminal cabinet, installed at 1200 mm (48") above floor, and indicate cabinet location, terminal and wire numbers on the As-built drawings.
- .4 Terminate control cables in equipment with suitable connectors.
- .5 Clearly identify cables/conductors at both ends, with permanent wire markers, indicating device/panel identification and terminal numbers on the device/panel (refer to standard detail 20 15 12-021 at the end of this specification section):
  - .1 Use applicable reference name or ID tag for the device or control panel.
  - .2 Print the labels such that the applicable panel/device identification is closest to the end of the cable.
  - .3 Where individual wires are run in conduit, collect wires associated to the same control panel/device and apply a label to the group of wires inside each control panel/device. Where there is insufficient space inside a device (such as a transmitter), the label may be applied to the conduit at the point of connection to the device.
  - .4 Where there are multiple conductors, individually identify each wire by its termination reference on the panel or device to which it connects.
  - .5 Where there are only two wires and it is readily understood where each wire is to be terminated (i.e. white neutral, green ground), individually marking of the wires is not required.

### **3.10 Grounding**

- .1 Ground electrical equipment and wiring in accordance with the applicable electrical safety code and regulations applicable at the location of the Work except where greater requirements are specified herein.

- .2 Provide insulated green bonding conductor in each power and control conduit sized per Table 16 of the Electrical Safety Code. Minimum bonding conductor size #12AWG copper.
- .3 Install grounding conductors, outside electrical rooms and electrical closets, in conduit.
- .4 Make connections to neutral and equipment with brass, copper or bronze bolts, star-washers, and connectors.
- .5 Except for VFD Inverter Duty cables, ground all motors with separate green insulated copper ground conductor installed in power feeder conduit, wired from ground terminal in the motor controller to a ground lug bolted directly to the motor frame, located inside the motor terminal box. Size the ground conductor per Table 16 of the electrical safety code except that the smallest conductor size to be #12 AWG.
- .6 Ground VFD inverter duty cables using all three integral ground conductors, from the ground terminal in the VFD enclosure to the ground lug bolted directly to motor frame inside the motor terminal box.
- .7 For VFDs, bond both ends of the VFD inverter duty cable as previously specified herein.

### **3.11 Disconnect Switches**

- .1 Provide a disconnect switch for each piece of mechanical equipment provided under Division 20 to 25 which requires a power supply. This requirement is to be met by the following methods as applicable to each piece of equipment:
  - .1 as an integral factory-installed component of the equipment, or
  - .2 as a field-installed switch where;
    - (a) the equipment does not have an integral disconnect switch, or
    - (b) the equipment includes a factory installed disconnect switch but the equipment as a whole does not have a SCCR rating which meets or exceeds the required minimum SCCR rating specified herein or as specified in the applicable equipment Specification section.
- .2 For clarity, provide a disconnect switch upstream of harmonic filters provided for VFDs.
- .3 Locate the disconnect switches as follows;
  - .1 within 9 m (29 ft) and in the line-of-site of motors serving non-refrigeration motorized equipment, and within 9 m (29 ft) of the motor controller or VFD controlling the equipment,
  - .2 within 3 m (9.5 ft) and in the line-of-site of equipment containing refrigeration compressors and related motorized equipment that forms part of a refrigerant circuit,
  - .3 at cooling towers and other outdoor equipment where the motor controller is located indoors, and
  - .4 within 1 m (3 ft) of non-motorized equipment,
  - .5 within 1 m (3 ft) of harmonic filters for VFDs.
- .4 Disconnect switch types for motorized equipment:
  - .1 fused type for motor controllers and VFD's, including harmonic filters.
  - .2 fused type for motorized packaged equipment,
  - .3 unfused for non-motorized equipment,
  - .4 unfused type at the controlled equipment for:
    - (a) cooling towers and other outdoor equipment where the motor controller is located indoors, or
    - (b) where the motor controller is in excess of the distance specified above or is not in line of site of the controlled equipment.
- .5 Disconnect switches on load side of VFD:

- .1 where a disconnect switch is required between a VFD and the driven motor due to excess distance or lack of line-of-site requirements, provide an unfused disconnect switch with integral disconnect status position switch, as close as possible to the motor,
- .2 wire the status switch back to the VFD input for drive output protection.
- .6 Disconnect switches for non-motorized equipment:
  - .1 provide unfused disconnect switch for non-motorized mechanical equipment.
- .7 Where the nameplate SCCR value of a mechanical equipment is less than the specified minimum SCCR value required, provide a fused disconnect switch to isolate the mechanical equipment, even if the equipment has an integral disconnect switch.
- .8 Where fuse protection is specified, install fuses of the correct overcurrent rating as specified by the mechanical equipment installation instructions.
- .9 Where fuse protection is specified, provide a set of six spare fuses of each size used in the disconnect switches. Turn spare fuses over to the Owner and submit a copy of the receipt signed by the Owner.
- .10 Provide power wiring between the field-installed disconnect switch and the associated equipment, with the conductors of the same wire gauge as the branch circuit conductors.

### 3.12 Outlet Boxes

- .1 Size boxes in accordance with CSA C22.1. Use 102 mm (4") square or larger outlet boxes as required for special devices.
- .2 Gang boxes where wiring devices are grouped. Use combination boxes with barriers where outlets for more than one system are grouped.
- .3 Provide blank cover plates for boxes without wiring devices.

### 3.13 Service Lights, Switches and Receptacle

- .1 Provide service light in the following locations, with the type and spacing as indicated.

Location	Condition	Fixture Type	Fixture Spacing
Inside air handling units with walk-in access	Unit height $\leq 2.0$ m (6.5 ft)	Marine	Each accessible section of the unit
	Unit height $> 2.0$ m (6.5 ft)	Area	
Inside air plenums	Plenum height Between 1.2 m and $\leq 2.0$ m (6.5 ft)	Marine	Each 3.0 m (10 ft) in length or width
	Plenum height $> 2.0$ m (6.5 ft)	Area	
Outside of cooling towers (if shown on drawings).	All	Marine	At lower access door, and at top of ladder accessing the top deck.
Under service catwalks in mechanical rooms (if shown on drawings)	All	Area	As shown.
Other location as shown on drawings	All	As shown	As shown.



- .2 Mount switches for service lights in accessible location on the outside of plenums and air handling units. Provide one switch for each AHU system.
- .3 Provide one receptacle wired ahead of each service light switch, located between 300 mm (12 in) and 1200 mm (4 ft) above the floor.

### **3.14 Rooftop Maintenance Receptacles**

- .1 Outdoor maintenance receptacles for rooftop equipment provided under Division 26.

### **3.15 Seismic Restraint**

- .1 Provide seismic restraints for electrical conduit in accordance with specification section 20 05 49.

### **3.16 Coordination and Division of Responsibility – Division 20 and Division 26**

- .1 Schedule A at the end of this Specification section specifies the division of responsibility between Division 20 and Division 26 for provision of electrical work for mechanical equipment, including termination of conductors.
- .2 For clarity;
  - .1 the Division 20 electrical Work may be performed by the Division 26 contractor, but the work is managed and paid for by the Division 20 contractor.
  - .2 related work performed under Division 26 is listed in Schedule A for reference.
- .3 Coordinate power requirements for mechanical trades equipment with the contractor under Division 26 of the work, including;
  - .1 provide a list of all planned and ordered mechanical trades equipment with motor horsepower ratings and electrical power requirements, prior to the Division 26 contractor procuring their power distribution equipment,
  - .2 periodically update this power requirements list as mechanical trades equipment is ordered, and review with the Division 26 contractor to allow them to revise breaker ratings in a timely manner,
- .4 Where the branch circuit breaker rating requirements change as a result of the actual ordered mechanical trades equipment, coordinate and pay for any breaker and feeder changes required whether the affected work is in Division 20 or Division 26 scope of work.

### **3.17 Wiring Diagrams**

- .1 The following wiring diagrams are included at the end of this section:
  - .1 20 05 12 - 001 Mechanical – Electrical Coordination (Sheet 1 of 3)
  - .2 20 05 12 - 002 Mechanical – Electrical Coordination (Sheet 2 of 3)
  - .3 20 05 12 - 003 Mechanical – Electrical Coordination (Sheet 3 of 3)
  - .4 20 05 12 - 005 Rooftop Custom A.H.U. – Maintenance Receptacles
  - .5 20 05 12 - 006 Rooftop HVAC Equipment – Maintenance Receptacles

<b>Schedule A – Coordination of Division 20 and 26 Scope of Work</b>			
<b>Reference</b>	<b>Work Element</b>	<b>Div. 20</b>	<b>Div. 26</b>
All	Motor Control Centers, motor controller racks, motor controllers, VFDs, Mechanical Breaker Panels (MBP), and disconnect switches	●	
Mechanical Equipment at voltage > 600 VAC	Power wiring from Division 26 switchgear to: <ul style="list-style-type: none"> <li>- motor controller,</li> <li>- between motor controller and the mechanical equipment (where motor controller is free-standing separate from the mechanical equipment)</li> <li>- field-installed disconnect switches, and wiring between the disconnect switch and the mechanical equipment</li> </ul>		●
	Field-installed disconnect switches.		●
General Mechanical Equipment fed from Dedicated Power Panels for Mechanical Equipment (Note 1)	Mechanical Service Panels (MSP), including branch overcurrent protection devices.		●
	Power wiring from MSPs and/or MCCs to: <ul style="list-style-type: none"> <li>- motors, including between motors and motor controllers, VFDs and/or disconnect switches as applicable,</li> <li>- packaged equipment, including disconnect switches as applicable,</li> <li>- equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)</li> </ul>	●	
	Power wiring from RP and/or MBP to: <ul style="list-style-type: none"> <li>- motors, including between motors and motor controllers,</li> <li>- packaged equipment, including disconnect switches as applicable,</li> <li>- equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)</li> </ul>	●	
General Mechanical Equipment fed from Non-dedicated Power Panels (Note 2)	Non-dedicated Power Panels (PP) and receptacle panels (RP), including branch overcurrent protection devices.		●
	Distribution splitters		●
	Power wiring from PPs and/or distribution splitters to: <ul style="list-style-type: none"> <li>- motor controller,</li> <li>- disconnect switch ahead of VFD,</li> <li>- disconnect switch for package equipment,</li> <li>- packaged equipment (with integral disconnect switch)</li> <li>- equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)</li> </ul>		●
	Power wiring from RP to: <ul style="list-style-type: none"> <li>- motor controller or disconnect switch,</li> <li>- disconnect switch for package equipment,</li> <li>- packaged equipment (with integral disconnect switch),</li> <li>- equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)</li> </ul>		●

<b>Schedule A – Coordination of Division 20 and 26 Scope of Work</b>			
<b>Reference</b>	<b>Work Element</b>	<b>Div. 20</b>	<b>Div. 26</b>
	Power wiring from: <ul style="list-style-type: none"> <li>- disconnect switch to a VFD,</li> <li>- motor controller or VFD to the motor,</li> <li>- disconnect switch to packaged equipment</li> </ul>	●	
Terminal Units BAS Controllers	Power wiring for controllers at 120 V, single phase terminating in a junction box for each group of terminal boxes.		●
	Power wiring for controllers at 120 or 24 VAC, from junction box provided by Division 26 to each terminal unit controller.	●	
	Power wiring for controllers at 24 VAC/DC, from building automation system control panels to terminal unit box controller.	●	
	3 phase, 208 V and higher voltage wiring direct to terminal unit box.		●
BAS Controls and OEM Controls	In service rooms: provision of 120/208 VAC mechanical service panels (MSP) complete with 15 A breakers in service rooms for use by Division 20 to 25.		●
	In service rooms: where MCC's are used, dedicated 120 VAC mechanical breaker panels (BP) complete with 15 A breakers for use by Division 20 to 25.	●	
	Power wiring for controls in service rooms: wiring from MSP or BP to the BAS and OEM control equipment.	●	
	Other than service rooms: Dedicated 120V 15A normal and emergency branch circuit breakers as indicated on the receptacle panel schedules.		●
	Power wiring for controls other than in service rooms: wiring from dedicated circuits in receptacle panels to control equipment.	●	
	120 V, single phase power supply with a junction box at specific control devices as shown.		●
	Breaker tamper-protection locks.	●	
	Instrumentation and actuator power and control wiring, for both BAS controls and OEM controls.	●	
	Control wiring to interlock motor controllers and to connect safety and operating controls.	●	
Plumbing Fixtures	120 V, single phase power supply with a junction box with sufficient wiring to terminate at plumbing fixtures requiring control power		●
	Conduit from adjacent junction box or pull box to plumbing fixtures requiring control power, pulling of wiring to the plumbing fixture and termination of wiring to the fixture or primary side of control transformer.	●	
	Control transformers and extra-low voltage wiring	●	























<b>Schedule A – Coordination of Division 20 and 26 Scope of Work</b>			
<b>Reference</b>	<b>Work Element</b>	<b>Div. 20</b>	<b>Div. 26</b>
Medical Gas Equipment	Dedicated emergency power circuits 120 VAC, single phase for central and distributed medical gas alarm panels, terminated in the control panels.		●
	Control wiring between field installed instrumentation and medical gas alarm panels.	●	
Equipment Service Lights	120 VAC, 15A power circuits for equipment service lights, terminated in the equipment service light.		●
	120 VAC, 15A power circuits for equipment convenience receptacles, terminated in the receptacle.		●
	Power wiring from adjacent junction boxes to light switches/service convenience receptacles and fixtures	●	
	Equipment service lights, switches and convenience receptacles.	●	
Fire and Smoke Dampers	Power wiring to damper interlock control panels for smoke dampers, motorized fire dampers, and combination smoke/fire dampers.		●
	Wiring between damper interlock control panels (for smoke dampers, motorized fire dampers, and combination smoke/fire dampers), to their associated dampers.	●	
Life Safety Interface	[Fire Alarm System ("FAS") control and monitoring modules located at BAS control interface panel.][Fire Alarm System ("FAS") control and monitoring modules located at/near fan starter or damper actuator, and wiring between control module and damper motor and fan starter.]		●
	FAS control and monitoring modules located at/near sprinkler and standpipe supervised valves and flow switches including wiring between each module and the respective valve/flow switch.		●
	Wiring between FAS control and monitoring modules, and smoke control and smoke venting fans and dampers.		●
	Termination of FAS control and monitoring wiring in BAS panels	●	
Rooftop Maintenance Receptacles	Rooftop maintenance receptacle pedestals.	●	
	Power wiring from breaker panel (BP) to and terminating in the rooftop maintenance receptacles.		●

**Notes:**

[1] MPP and MBP will be located in mechanical services rooms.


[2] PP and RP are not dedicated for mechanical equipment and may be located in any type of service room or space.

## LEGEND

	CONSTANT SPEED MOTOR CONTROLLER		SCOPE OF WORK: DIVISION "A" / DIVISION "B" BOUNDARY
	VARIABLE FREQUENCY DRIVE		
	UNFUSED SERVICE DISCONNECT SWITCH		WIRING AND/OR EQUIPMENT BY DIVISIONS 20-25
	FUSED SERVICE DISCONNECT SWITCH		WIRING AND/OR EQUIPMENT BY DIVISION 26
	TRANSFORMER		
	120 VAC/ XX VDC POWER SUPPLY, CLASS AS SHOWN		
	120/208 VAC MECHANICAL BREAKER PANEL		
	MECHANICAL SERVICE PANEL (DIV 26)		
	POWER PANEL (DIV 26)		
	JUNCTION BOX		
	MOTOR		
	ELECTRIC HEAT TRACING		
	PACKAGED EQUIPEMENT WITH MOTORS AND INTEGRAL MOTOR CONTROLLERS		
	CONTROL PANELS, TERMINAL UNIT CONTROLLERS, AND OTHER NON- MOTORIZED EQUIPMENT		
	FUSE		
	LIGHT SWITCH (FOR SERVICE LIGHTS) - FLOOR PLAN		
	POWER SWITCH (SINGLE-LINE)		
	SERVICE LIGHT		
	ALARM BEACON		

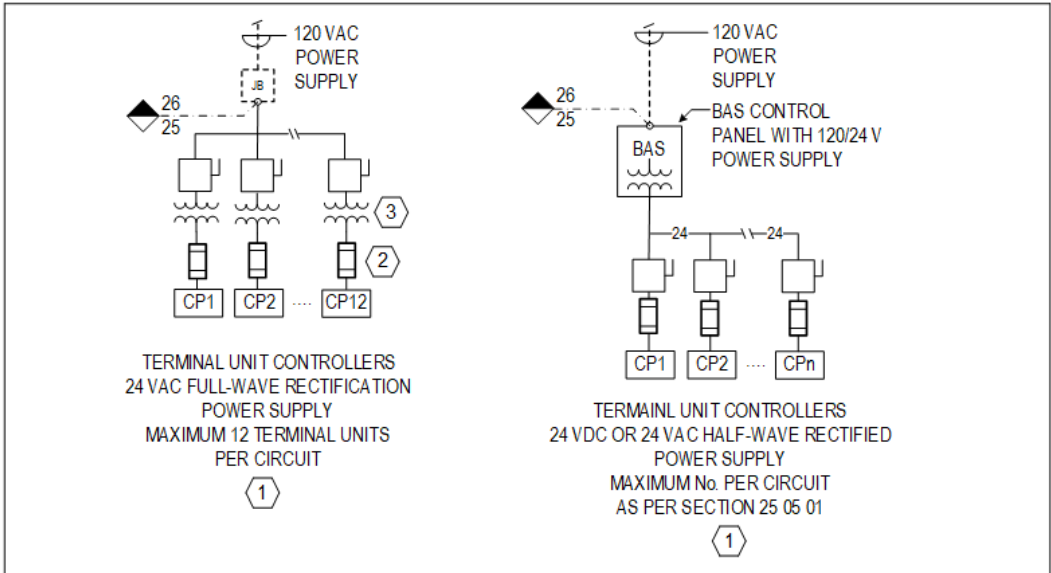
### General Notes

1. This drawing indicates general coordination of mechanical and electrical work. Refer to plan and riser drawings and specifications for project specific requirements, which take precedence over this drawing.

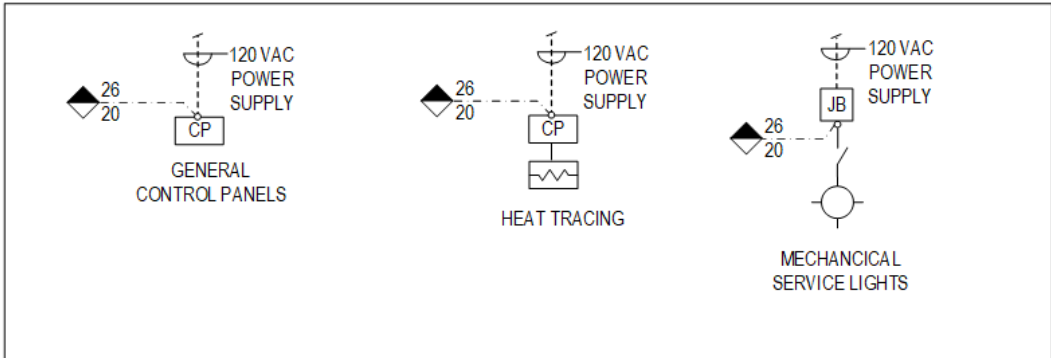
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Sheet Title:  
**MECHANICAL – ELECTRICAL  
COORDINATION BLOCK DIAGRAM  
(SHEET 1 OF 3)**

Date: 21 JUNE 2023	Rev. No.: 03	Checked: PS
Standard Detail No. <b>20 05 12 - 001</b>		



TERMINAL UNITS



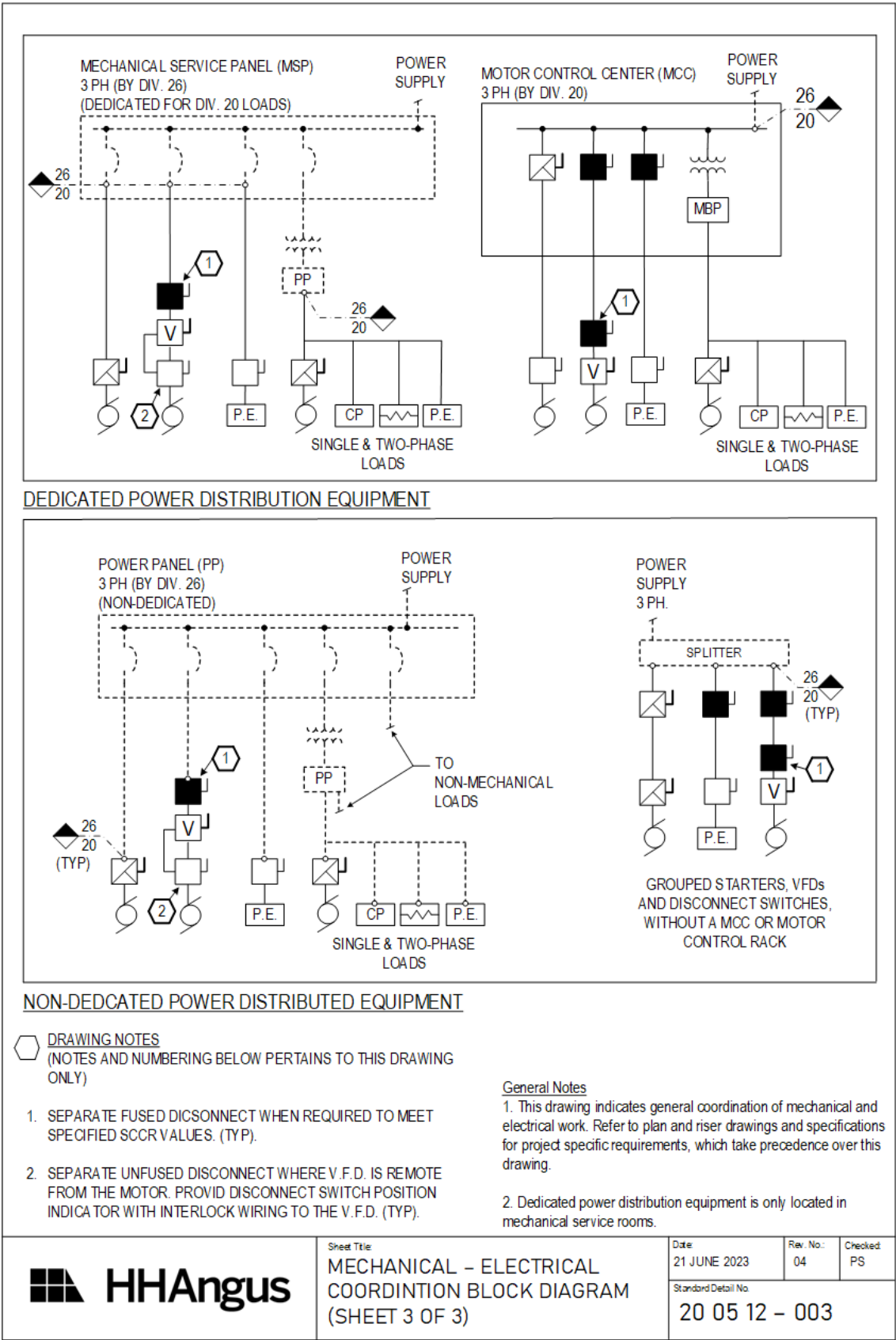
MISCELLANEOUS EQUIPMENT

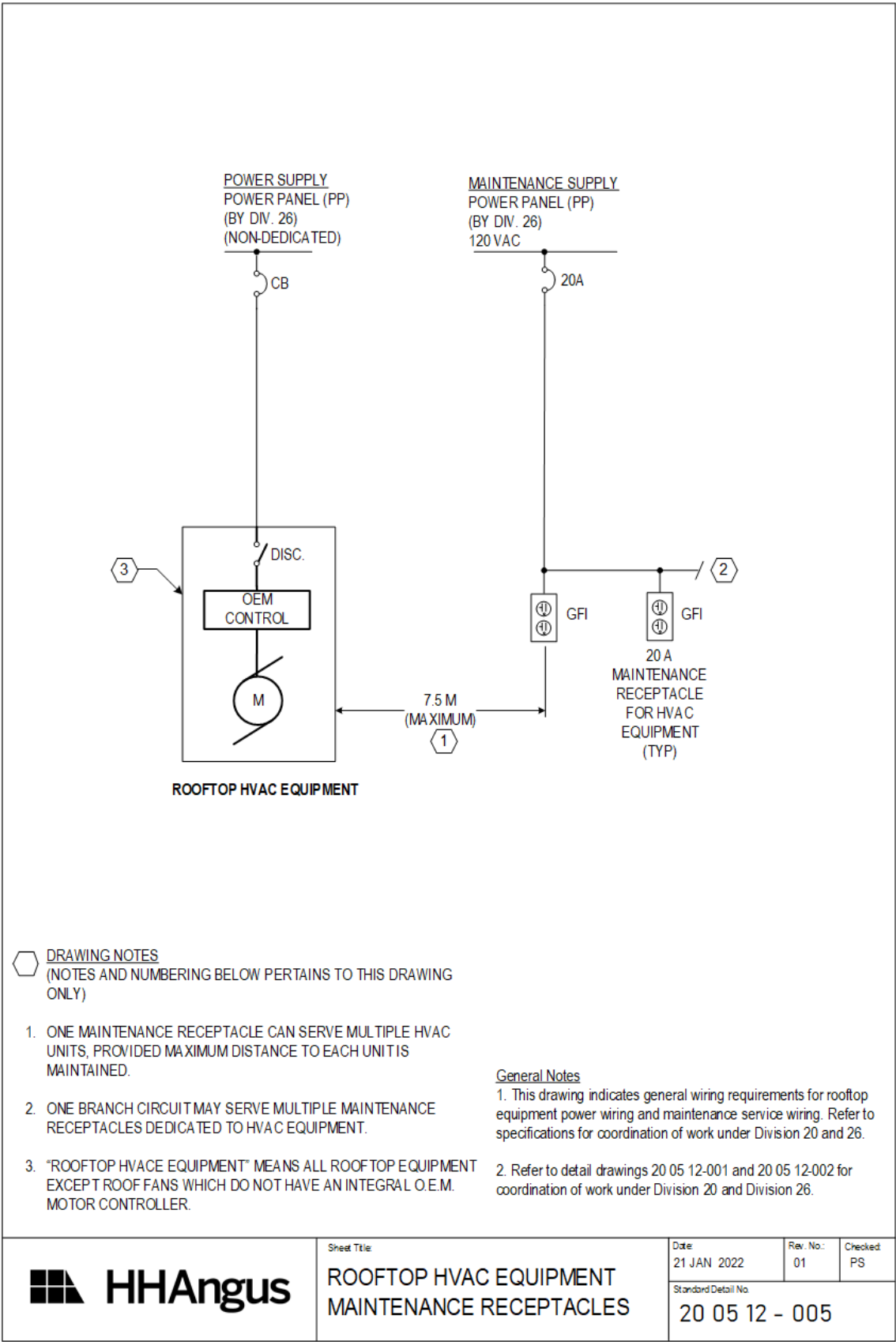
- DRAWING NOTES  
(NOTES AND NUMBERING BELOW PERTAINS TO THIS DRAWING ONLY)
1. REFET TO SPECIFICATION SECTION 25 05 01 FOR APPLICABLE WIRING METHODS.
  2. PROVIDE FUSE PROTECTION IF TRANSFORMER DOES NOT HAVE INTEGRAL CIRCUIT BREAKER.
  3. PROVIDE DEDICATED TRANSFORMER FOR FULL-WAVE RECTIFIED 24 VAC CONTROL DEVICES.



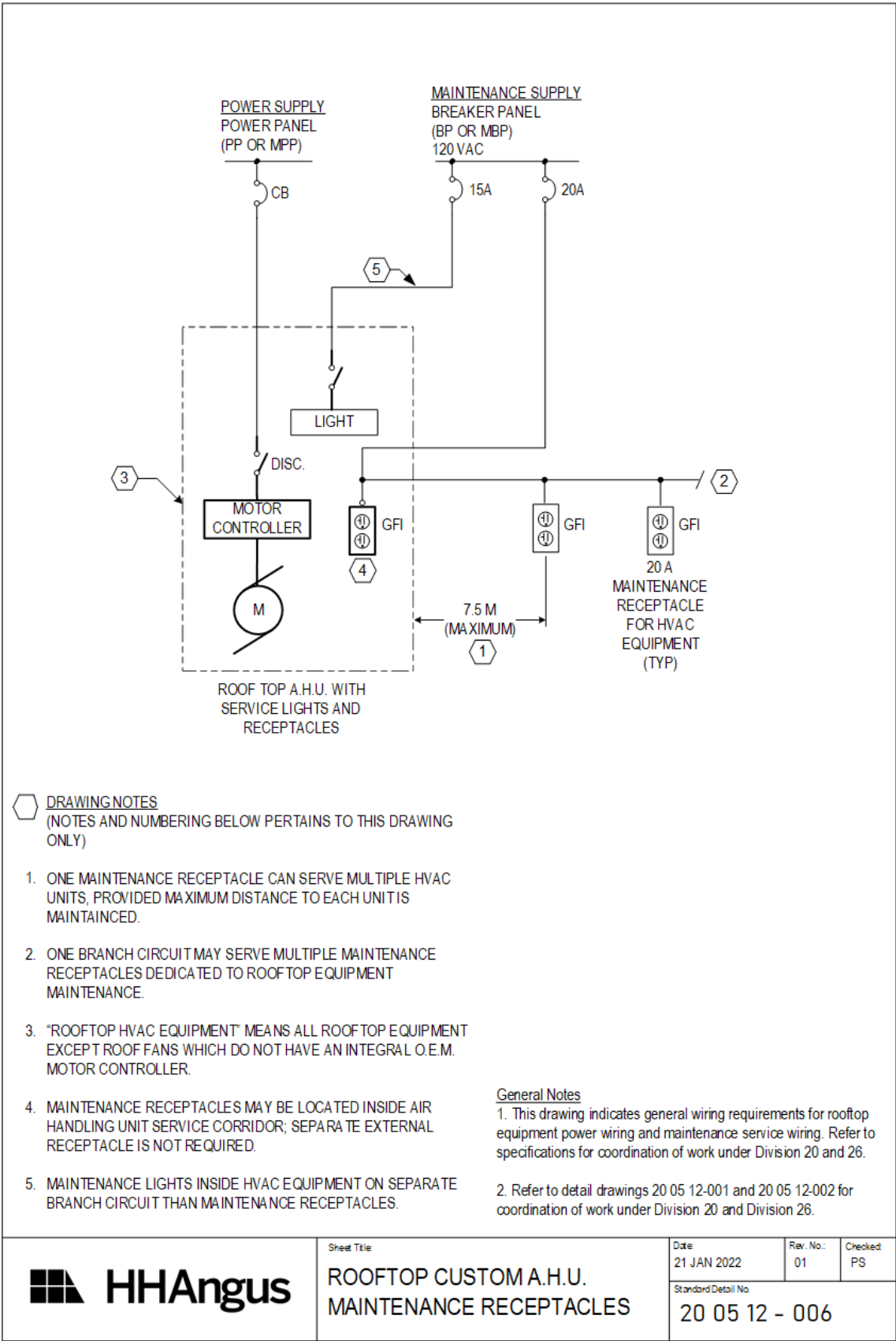
Sheet Title:  
**MECHANICAL – ELECTRICAL  
COORDINATION BLOCK DIAGRAM  
(SHEET 2 OF 3)**

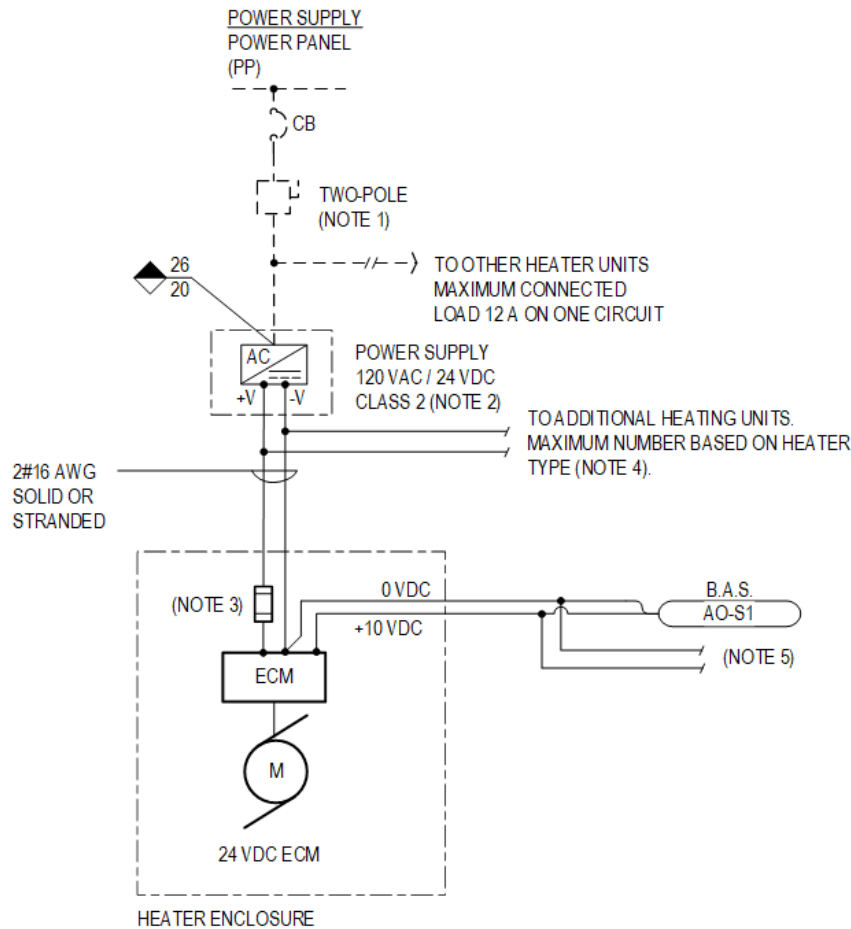
Date: 21 JUNE 2023	Rev. No.: 03	Checked: PS
Standard Detail No. <b>20 05 12-002</b>		











#### REFERENCE NOTES

1. DISCONNECT BOTH LINE AND NEUTRAL
2. POWER SUPPLY MOUNTED IN TYPE 1 ELECTRICAL ENCLOSURE AND MOUNTED WITHIN 10 M (30 FT) OF FIRST HEATER SERVED AS SHOWN..
3. PROVIDE FUSE OF AMPERE RATING AS SPECIFIED BY HEATING EQUIPMENT MANUFACTURER
4. REFER TO PLAN DRAWINGS FOR NUMBER OF INDIVIDUAL HEATER UNITS SERVED BY THE SAME 24 VDC POWER SUPPLY.
5. THE SAME B.A.S. OUTPUT MAY CONTROL MULTIPLE HEATER UNITS IN THE SAME ZONE.

#### GENERAL NOTES

1. THIS DRAWING INDICATES GENERAL WIRING REQUIREMENTS FOR 24 VDC FAN-COIL HEATING UNITS. REFER TO EQUIPMENT MANUFACTURER INSTALLATION INSTRUCTIONS FOR SPECIFIC WIRING REQUIREMENTS.
2. REFER TO DETAIL DRAWINGS 20 05 12-001 AND 20 05 12-002 FOR GENERAL COORDINATION OF WORK UNDER DIVISIONS 20 AND 26.



Sheet Title

**FORCED-AIR CONVECTORS  
24 VDC & CONTROL WIRING**

Date  
08 DEC 2022

Rev. No.:  
00

Checked:  
PS

Standard Detail No.

**20 05 12 - 007**

**END OF SECTION**

## **COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT 20 05 13**

### **1 GENERAL**

#### **1.1 Scope**

- .1 Provide single phase and three-phase low-voltage AC induction motors from fractional horsepower to 200 horsepower, and brushless DC ECM motors.
- .2 This specification section applies to general purpose motors and inverter duty motors, except where otherwise specified by other specification sections of Divisions 20 to 25.

#### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 14.13 Motor Controllers
  - .2 20 05 14.16 Variable- Frequency Drives

#### **1.3 Definitions**

- .1 The following definitions apply to this section and referenced sections:
  - .1 **ECM**: electrically commutated motor (AC supply, brushless DC motor).
  - .2 **ODP**: open drip proof (motor enclosure).
  - .3 **Soft-start motor controller**: a solid-state electronic motor controller that regulates output current and voltage during motor starting.
  - .4 **FEFC**: totally enclosed non-ventilated (motor enclosure without motor driven cooling fan).
  - .5 **TEFC**: totally enclosed fan cooled (motor enclosure with motor driven cooling fan).

#### **1.4 Applicable Codes and Standards**

- .1 Legislation:
  - .1 O.Reg. 509/18 Energy and Water Efficiency – Appliances and Products
  - .2 U.S. DOE 10 CFR 431 Code of Federal Regulations Part 431 (to the extent adopted in O.Reg. 509/18)
- .3 Product standards:
  - .4 CSA C22.2 No. 100 Motors and Generators
  - .5 CSA C390-10 Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-phase Induction Motors
  - .6 CSA C747-09 Energy Efficiency Test Method for Small Motors
  - .7 IEEE 85-1973 Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery
  - .8 IEEE 112-2004 Standard Test Procedure for Polyphase Induction Motors and Generators
  - .9 IEEE 114-2010 Standard Test Procedure for Single-Phase Induction Motors
  - .10 NEMA MG1-2016 Motors and Generators

**1.5 Submittals**

- .1 Submit manufacturer data sheets with the following information for motors 50 HP and smaller:
  - .1 motor model/catalogue numbers,
  - .2 motor full load ratings: current, speed, voltage, horsepower, efficiency, and KVAR.
- .2 Submit manufacturer data sheets with the following information for motors greater than 50 HP:
  - .1 associated driven equipment identification tag,
  - .2 motor model/catalogue numbers,
  - .3 motor full load ratings: current, speed, voltage, horsepower, efficiency, and KVAR,
  - .4 bearing data,
  - .5 acceleration time at maximum inertia,
  - .6 guaranteed efficiency and power factor at full load, 75% load, 50% load, and 25% load,
  - .7 dBA scale sound power levels.
- .3 For inverter duty motors 5 HP and larger, submit manufacturer data sheets or similar documentation for the following information:
  - .1 confirmation of compliance to NEMA MG-1 for inverter duty,
  - .2 protection method for grounding of stray motor currents,
  - .3 motor frequency operating range (minimum to maximum),
  - .4 insulation winding class,
  - .5 details of motor bearing construction.

**1.6 Shipping and Storage**

- .1 Ship motors from factory;
  - .1 packed in impact-absorbing material, or fastened to hardwood skid or pallet for fork truck handling. Do not use Styrofoam or similar plastic-based materials,
  - .2 protected against dirt and moisture during transit and outdoor storage,
  - .3 clearly identified with permanent ink marking on packing,
- .2 Protect motors attached to equipment against dirt and moisture during transit and outdoor storage.

**1.7 Operating and Maintenance Manuals**

- .1 Include in the operating and maintenance manuals the following data for all motors supplied to the project:
  - .1 shop drawing data as specified herein,
  - .2 motor weight,
  - .3 sliding base dimensioned drawings,
  - .4 internal winding connection diagram,
  - .5 speed torque performance data for across line start, from stand-still to synchronous speed,
  - .6 installation and maintenance instructions.

## **2 PRODUCTS**

### **2.1 Motors - General Requirements**

- .1 Listed to CSA C22.2 No.100.
- .2 Listed to CSA C390 for NEMA MG-1 Premium efficiency ratings (three phase, 1 – 200 HP)
- .3 Motors selected and marked with a power rating that is the greater of:
  - .1 not less than the input brake horsepower of driven equipment at both the specified operating condition and at maximum run-out conditions at design driven equipment operating speed, without operation in the motor service factor, and
  - .2 not less than the minimum horsepower rating as shown.
- .4 Common motor characteristics:
  - .1 frequency: 60 Hz.
  - .2 voltage:
    - (a) 115 and 220 volt, for single phase motors as shown,
    - (b) 575 and 208 volt, for three phase motors, as shown.
  - .3 nominal rated-load speed: 1750 RPM unless otherwise shown,
  - .4 minimum ambient operating temperature at nameplate power rating: 40°C (104°F),
  - .5 vibration velocity: not to exceed 2.0 mm/s (0.08 inches/second) measured at bearing housing,
  - .6 motor generated noise, 10 HP and larger: not to exceed 85 dBA, measured at 3 m (10 ft) in accordance with IEEE 85.
- .5 Permanently lubricated ball bearing rotor supports.
- .6 Motor enclosure:
  - .1 cast iron, aluminum, or rolled steel construction,
  - .2 drain openings,
  - .3 shouldered lifting eye bolts (three phase TEFC motors),
  - .4 bi-directional, spark-proof, abrasion and corrosive resistant cooling fan keyed to shaft (three phase TEFC motors),
  - .5 compression type grounding lug or double ended cap screw of silicon bronze, mounted in conduit box by drilling and tapping into motor frame.
- .7 Motor nameplate:
  - .1 stainless steel plate mounted on enclosure with stainless steel fastening pins,
  - .2 information as described in NEMA MG-1 including motor efficiency rating,
  - .3 motor bearing part numbers and motor wiring diagram instructions,
- .8 Protective coating, TEFC motors:
  - .1 primer and 4 to 5 mils epoxy overcoat on external surfaces, and corrosion resistant coating of epoxy paint on internal surfaces, shaft, rotor, stator iron, and end bells,
  - .2 shaft extension protected with rust preventive strippable coating capable of being peeled off or unwrapped.
- .9 Motor termination junction boxes and motor leads:
  - .1 cast iron or sheet steel diagonally split, tapped for conduit, and attached to motor frame with cadmium plated hex head cap screws,

- .2 arranged for conduit entry from either side or bottom,
- .3 gaskets between box and motor frame and between halves of box, with cover secured with cadmium plated hex head cap screws,
- .4 motor leads in conduit box;
  - (a) identified in accordance with ANSI C6.1,
  - (b) with the same insulation class as windings,
  - (c) sized in accordance with EASA recommended minimum ampacity values,
- .5 motor leads between motor frame and termination box to pass through tight fitting neoprene rubber seals.

## **2.2 Motor Efficiency**

- .1 Motor efficiency test method:
  - .1 CSA C747 or IEEE 114 for single phase ECM and AC motors,
  - .2 CSA C747 or IEEE 112 for polyphaser motors up to 3 HP, and.
  - .3 CSA C390 or IEEE 112 for three-phase motors 1 to 200 HP.
- .2 Motor efficiency ratings:
  - .1 Minimum motor efficiency to be not less than the greater of the following:
    - (a) applicable legislation for energy efficiency,
    - (b) NEMA Premium® for three-phase integral horsepower motors, and
    - (c) as specified in the Schedules appended at the end of this specification section.
- .3 These motor efficiency ratings do not apply to electric motor-driven fire pumps.

## **2.3 Single Phase Motors**

- .1 Single phase motor rating less than 375 W (1/2 hp):
- .2 Types:
  - .1 PSC motor:
    - (a) permanent split capacitor type for AC power supply,
    - (b) suitable for variable speed applications.
- .3 ECM motor:
  - .1 brushless DC electrically commutated motor with integral microprocessor based inverter and controller, for AC power supply,
  - .2 factory programmed or field programmable for specific application,
  - .3 capable of accepting an external 0-20 mA or 0-10 V signal for remote variable speed operation including fan On/Off control.
- .4 Winding insulation: Class B.
- .5 Suitable for mounting in the horizontal or vertical orientation.
- .6 Continuous duty rating with 1.35 service factor.
- .7 ODP or TEFC enclosure, resilient mounts.
- .8 Built-in overload protection.
- .9 Motor over-temperature protection as specified herein.

## **2.4 Three Phase Motors, Fractional Horsepower**

- .1 Motors of 375 W ( $\frac{1}{2}$  HP) and 560 W ( $\frac{3}{4}$  HP).
- .2 For use with magnetic motor controllers.
- .3 Three phase squirrel cage induction type, NEMA T frame, general purpose type, to NEMA MG-1.
- .4 NEMA B design.
- .5 Winding insulation: Class F, with a rated motor winding temperature rise of not more than 90°C above an ambient temperature of 40°C at full motor load,
- .6 Continuous duty rating with minimum 1.15 service factor.
- .7 ODP or TENV enclosure.
- .8 Motor over-temperature protection as specified herein.

## **2.5 Three Phase Motors, Integral Horsepower**

- .1 Motors 745 W (1 hp) to 150 kW (200 hp).
- .2 For use with constant speed magnetic motor controllers.
- .3 Three phase squirrel cage induction type, NEMA T frame, general purpose type.
- .4 NEMA design:
  - .1 Type B for centrifugal fans and pumps,
  - .2 Type C for positive displacement pumps and compressors.
- .5 Winding insulation: Class F, with a rated motor winding temperature rise of not more than 90°C above an ambient temperature of 40°C at full motor load,
- .6 Continuous duty rating with minimum 1.15 service factor.
- .7 TEFC enclosure.
- .8 Suitable for horizontal, vertical or belt-driven mounting.
- .9 Motor over-temperature protection as specified herein.
- .10 Motor winding leads:
  - .1 three (3) leads for single speed operation,
  - .2 six (6) leads for two-speed operation (five lead two-speed motors are not acceptable).

## **2.6 Three Phase Motors – Inverter Duty**

- .1 Application: motors 745 W (1 hp) to 150 kW (200 hp) operating on power supply controlled by a variable frequency drive (inverter) motor controllers and soft-start constant speed motor controllers.
- .2 General requirements:
  - .1 three phase squirrel cage induction type, NEMA T frame, general purpose type, suitable for pulse width modulated wave form,
  - .2 winding insulation: Class F insulation, with a rated motor winding temperature rise of not more than 90°C above an ambient temperature of 40°C at full motor load (i.e. Class B temperature rise),
  - .3 continuous duty rating and rated for 200% of full load starting torque,
  - .4 service factor: 1.15 on Sine Wave and 1.0 on pulse-width modulated power supply,
  - .5 TEFC enclosure,
  - .6 suitable for horizontal, vertical or belt-driven mounting,



- .7 motor over-temperature protection as specified herein,
- .8 motor winding leads: three (3) leads,
- .9 motor over-temperature protection as specified herein except where the protection function is provided by the variable frequency drive.
- .3 Special requirements:
  - .1 motors rated for inverter duty in accordance with NEMA MG-1 Part 31,
    - (a) stator winding insulation ratings:
      - i) peak voltage and partial discharge-free voltages:

Rated Voltage V RMS	Withstand Voltage Zero-to-Peak (Line-to-Line) V	Partial Discharge-Free Zero-to-Peak (Line-to-Line) V
208, 3 phase	645	513
575, 3 phase	1782	1281

- ii) for operation on a VFD with a carrier frequency of between 2 and 12 kHz.
    - iii) with a VFD switching voltage rise time of 0.1  $\mu$ s and higher.
- .2 speed range: minimum 10:1 (6 to 60 Hz) for variable torque applications,
- .3 provided with stray rotor current grounding system consisting of;
  - (a) 3 HP and smaller: electrically conductive bearing grease for motors,
  - (b) all HP ratings: rotor shaft grounding system at the drive-end bearing, either integral to the bearing construction or externally mounted to the motor frame.

*Standard of Acceptance*

- ° AEGIS - fig. SGR series
- .4 for motors 100 HP and larger, provide insulated bearings on the non-drive end.
- .5 motor to be compatible with type of soft-start motor controller or variable frequency drive supplied under other specification sections, and that the starter/motor system will be capable of providing rated torque over a frequency range from 15 to 60 hz while operating within motor temperature rise specification,
- .6 motor to be capable of operating between 60 Hz and 90 Hz with torque reducing at drive frequency above 60 Hz,
- .7 ball bearing rotor supports suitable for continuous low speed operation at minimum motor speed.
- .8 drive end face drilled and tapped (4 places) for mounting of auxiliary devices.
- .4 Motor stator winding:
  - .1 made up with copper magnet wire coated with moisture resistant triple-build Class F insulation, non-hygroscopic varnish, phase paper insulation, and with thermal rating of not less than 150°C for 30,000 hours life when tested in accordance with IEEE No. 57,
  - .2 insulation resistance greater than 100 megohms when measured at 25°C with 1000-volt direct current mega-ohm bridge,
  - .3 slot-wound installation, held in stator slots that have had sharp edges and burs removed prior to winding insertion,

- .4 connection leads mechanically secured and silver soldered,
- .5 designed for operation in either direction of rotation.
- .5 Motor bearings:
  - .1 anti-friction single shield, vacuum-degassed steel ball bearings,
  - .2 lubricated bearings; extended pipe zerk fitting, and ½-lb relief fitting for external lubrication while machine is in operation, bearing seal, lubricated at factory after assembly,
  - .3 bearing shield on motor winding side of bearing,
  - .4 rated fatigue life of L'-10 (B-10) 150,000 hours for direct coupled applications and 50,000 hours for belted applications,
  - .5 belt drive-set rating based on radial loads and pulley sizes from NEMA MG1-14.43.
- .6 Motor junction box sized and provided with at least two (2) conduit connection points, one for motor feeder cable and one for motor thermal sensor control wiring.

## **2.7 Motor Over-Temperature Protection**

- .1 Motor thermal protection for single phase motors mounted in air ducts, plenum chambers or in air stream inside air handling equipment:
  - .1 motor winding thermostats, normally closed contact, phenolic snap-acting disc thermal switch, temperature calibrated,
  - .2 automatic reset type.

### *Standard of Acceptance*

- Texas Instruments - Klixon Phenolic Motor Protectors

- .2 Motor thermal protection for three phase motors less than 37 kW (50 HP) that are mounted in air ducts, plenum chambers or in air stream inside air handling equipment:
  - .1 Winding sensors;
    - (a) three (3) Positive Temperature Coefficient (PTC) temperature sensors, one in each motor winding, wired in series, and compatible with Texas Instruments - Klixon model 42AA100E control unit,
    - (b) control unit provided under section 20 05 14.13 or 20 05 14.16.
- .3 Motor thermal protection for three phase motors 37 kW (50 HP) and larger:
  - .1 Winding sensors;
    - (a) three (3) Positive Temperature Coefficient (PTC) temperature sensors, one in each motor winding, wired in series, and compatible with Siemens model 3RN10 12 control unit,
    - (b) control unit provided under section 20 05 14.13 or 20 05 14.16.

## **2.8 Field Applied Rotor Grounding System for Operation with Variable Frequency Drives**

- .1 Shaft-grounding ring system with contact brushes providing 360 degree coverage of drive shaft, to provide grounding of rotor to motor frame.

### *Standard of Acceptance*

- AEGIS - fig. SGR series

## **2.9 Sliding Base for Motors with V-belt Drives**

- .1 Construction:
  - .1 fabricated from steel as a single unit with double supported slide and two adjusting bolts,
  - .2 finished with coating as specified above for motor exterior.

## **3 EXECUTION**

### **3.1 Application**

- .1 Refer to other specification sections for motor style requirements for single phase motors and fractional horsepower polyphase phase motors (ODP, TENV or TEFC).
- .2 Where motors are provided with internal thermistors for motor overtemperature protection, run thermistor control wiring:
  - .1 in the same conduit as the motor power conductors for constant speed motor controllers,
  - .2 in a separate conduit from the motor power conductors for variable frequency drive motor controllers.

### **3.2 Field Applied Rotor Grounding System**

- .1 Install shaft-grounding system on motors operating on variable speed drives and not provided with OEM rotor grounding systems.

### **3.3 Maintenance During Construction**

- .1 Rotate motors by hand at one month intervals while at the project site.

### **3.4 Schedules**

- .1 The following schedules of motor minimum electrical efficiency ratings apply:
  - .1 Schedule A – Single Phase Electric Motor Efficiency, 0.25 to 0.5 HP,
  - .2 Schedule B – Two-phase Electric Motor Efficiency 0.25 to 3 HP, and Three-phase Electric motor Efficiency 0.25 to 0.75 HP,
  - .3 Schedule C – Three Phase Electric Motor Efficiency, 1 to 200 HP.

**Schedule A - Single Phase Electric Motor Efficiency, 0.25 to 0.5 HP**

Motor HP (kW)	Single Phase, Permanent-Split Capacitor 0.25 to 0.5 HP Nominal Full-Load Efficiency (%) [Note 1]		
	Open Motors		
	6 Pole 1200 RPM	4 Pole 1800 RPM	2 Pole 3600 RPM
0.25 (0.18)	62.2	68.5	66.6
0.33 (0.25)	66.6	72.4	70.5
0.5 (0.37)	76.2	76.2	72.4

**Notes:**

[1] From U.S. DOE 10 CFR Part 431, SubPart X, §431.446(a)

**Schedule B – Polyphase Electric Motor Efficiency, 0.25 to 3 HP**

Motor HP (kW)	Polyphase Induction Motors 0.25 to 3 HP Nominal Full-Load Efficiency (%) [Note 2]			Remarks
	Open Motors			
	6 Pole	4 Pole	2 Pole	
0.25 (0.18)	67.5	69.5	65.6	2 Phase & 3 Phase
0.33 (0.25)	71.4	73.4	69.5	2 Phase & 3 Phase
0.5 (0.37)	75.3	78.2	73.4	2 Phase & 3 Phase
0.75 (0.55)	81.7	81.1	76.8	2 Phase & 3 Phase
1 (0.75)	82.5	83.5	77.0	2 Phase only
1.5 (1.1)	83.8	86.5	84.0	2 Phase only
2 (1.5)	---	86.5	85.5	2 Phase only
3(2.2)	---	86.9	85.5	2 Phase only

**Notes:**

[2] From U.S. DOE 10 CFR Part 431, SubPart X, §431.446(a)

**Schedule C – Three-Phase Electric Motor Efficiency, NEMA Premium, 1 to 200 HP**

Motor HP (kW)	Three-Phase Induction Motors 1 to 200 HP Nominal Full-Load NEMA Premium Efficiency (%) [Note 3]							
	2 Pole 3600 RPM		4 Pole 1800 RPM		6 Pole 1200 RPM		8 Pole 900 RPM	
	Encl.	Open	Encl.	Open	Encl.	Open	Encl.	Open
1 (0.75)	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5 (1.1)	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2 (1.5)	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3 (2.2)	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5 (3.7)	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5 (5.5)	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10 (7.5)	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15 (11)	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20 (15)	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25 (18.5)	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30 (22)	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40 (30)	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50 (37)	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60 (45)	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75 (55)	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100 (75)	94.1	93.6	95.4	95.4	95.0	95.0	93.6	94.1
125 (90)	95.0	94.1	95.4	95.4	95.0	95.0	94.1	94.1
150 (110)	95.0	94.1	95.8	95.8	95.8	95.4	94.1	94.1
200 (150)	95.4	95.0	96.2	95.8	95.8	95.4	94.5	94.1

**Notes:**

[3] From U.S. DOE 10 CFR Part 431, SubPart B, §431.25(h), Table 5, and NEMA MG-1 Table 12-12.

**END OF SECTION**

## **VARIABLE FREQUENCY DRIVE MOTOR CONTROLLERS**

### **20 05 14.16**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide variable frequency drive ("VFD") motor controllers, harmonic filtration equipment, and load-side power conditioning equipment, for electric motor-driven equipment provided under mechanical trades work.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections;
  - .1 20 05 12 Common Electrical Requirements for Mechanical Services
  - .2 20 05 49.23 Seismic Qualification for Mechanical Equipment

##### **1.3 Definitions and Abbreviations**

- .1 The following definitions apply to this section.
  - .1 **Harmonic filter**: an electronic device which reduces the current harmonic distortion created by the VFD.
  - .2 **SCCR**: the RMS symmetrical short-circuit current rating of the VFD, measured at the load-side terminals of the VFD (short-circuit withstand rating has the same meaning).
  - .3 **THID**: current total harmonic distortion.
- .2 For other definitions, conform to definitions in specification section 20 05 12.

##### **1.4 Applicable Codes and Standards**

- .1 Product standards:
  - .1 CSA C22.2 No. 5 Molded-case Circuit Breakers, Molded-case switches and Circuit-breaker Enclosures
  - .2 CSA C22.2 No. 14 Industrial Control Equipment
  - .3 CSA C22.2 No. 39 Fuseholder Assemblies
  - .4 CSA C22.2 No. 94.2 Enclosures for Electrical Equipment, Environmental Considerations
  - .5 CSA C22.2 No. 106 HRC – Miscellaneous Fuses
  - .6 CSA C22.2 No. 274 Adjustable Speed Drives
  - .7 ICC ES ACC-156 Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
  - .8 IEC 61800-3 Adjustable Speed Electrical Power Drive Systems – Part 3: EMC Requirements and Specific Test Methods

##### **1.5 Seismic Qualification**

- .1 Seismically qualify (certify) the following equipment specified herein:
  - .1 variable frequency drives,
  - .2 harmonic filters.
- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 20 05 49.23 for the following seismic qualification level and certification method:

- .1 Functional seismic qualification (Level III) for motor control equipment and non-vibration isolated equipment: by shake table testing,
- .3 The following equipment specific seismic force parameters are to be used:

$C_p$	$A_r$	$R_p$	$h_x/h_n$
1.00	1.00	1.25	1.0

## 1.6 Submittals

- .1 Submit shop drawing material in accordance with the requirements of Division 01.
- .2 Submit shop drawings for VFD motor controller and include the following minimum information:
  - .1 outline dimensions, conduit entry locations and weight,
  - .2 power efficiency rating,
  - .3 input THID,
  - .4 device SCCR value that will be marked on each drive unit,
  - .5 protection method used to meet the required short-circuit current rating,
  - .6 the interrupting rating of the required integral or external overcurrent protection device,
  - .7 included AC line reactor capacity to suit the available short-circuit (fault) current (ASCC),
  - .8 control and power wiring diagrams,
  - .9 complete technical product description including a list of options provided,
  - .10 termination diagrams for electrical contacts, relays, thermostats, timers and components in control circuits shown.
- .3 Include SCCR data for each size of VFD supplied to the project, including:
  - .1 VFD model reference and HP rating,
  - .2 site-specific available short-circuit current value (ASCC) as specified herein,
  - .3 disconnecting means by type,
  - .4 overcurrent protection device by type,
  - .5 overcurrent protection rating, SCCR kA RMS symmetrical (at the input side of the drive),
  - .6 AC line reactor, size to suit the site-specific ASCC.
- .4 Where an external disconnecting means with overcurrent protection equipment is being supplied (due to the VFD not being available with such integral devices), submit shop drawings of the overcurrent protection equipment with confirmation from the VFD manufacturer that it meets their protection requirements.
- .5 Submit shop drawings for harmonic filters and include:
  - .1 certified factory test results for harmonic mitigation performance and energy efficiency under actual VFD drive loading, including product serial numbers.
- .6 Submit certification test certificate for seismic qualification in accordance with Specification section 20 05 49.

## 1.7 Product Support

- .1 Manufacturer to have factory trained application engineering and service personnel locally available at the installation locations and/or available through a toll free 24/365 technical support line.



## **1.8 Warranty**

- .1 Provide an extended warranty covering parts, labour, travel time and expenses, for VFDs for a period of not less than twenty-four (24) months from the date when the equipment is handed over to the Owner.

## **2 PRODUCTS**

### **2.1 General – Short Circuit Current Rating**

- .1 Required short circuit protection rating (SCCR) for VFD motor controllers:
  - .1 packaged VFD minimum SCCR value: 10 kAIC RMS symmetrical.
  - .2 SCCR rating may be met by;
    - (a) design and testing of VFD package and provided with internal overcurrent protection device, or
    - (b) field-installed external overcurrent protection device field-installed on the line side of drive.
  - .3 SCCR value to be marked on the VFD nameplate. Where the SCCR nameplate rating references an instruction manual, provide a separate label on the VFD that states the SCCR value.
  - .4 Where the VFD requires field-installed external overcurrent protection to meet the required SCCR rating, the drive manufacturer is responsible to provide information to the installation contractor for the required circuit breaker or fuse type and rating that they require to be included in the external protection device.

### **2.2 Variable Frequency Drives (VFD) – General Requirements**

- .1 Type:
  - .1 electronic pulse-width-modulating type for speed control of NEMA Design B inverter-duty induction motors, using constant voltage/frequency control,
  - .2 designed for control of HVAC fans and pumps, with internal PID control loops,
  - .3 six-pulse drive:
    - (a) input stage AC-DC rectifier: diode or IGBT power switches,
    - (b) DC bus link capacitors,
    - (c) output stage DC-AC inverter: IGBT power switches.
  - .4 motor-horsepower rated,
  - .5 listed to CSA C22.2 No. 274 and conform to CSA C22.2 No. 14.
- .2 VFDs to include the following equipment either as an integral part of the drive, or as a separate field-installed device:
  - .1 main power disconnecting means with overcurrent protection to meet the SCCR rating,
  - .2 input harmonic filtration where specified based on motor HP rating,
  - .3 output load voltage spike suppression and reflected wave reduction devices where specified based on motor feeder length,
- .3 Principle operating features:
  - .1 operating speed range: minimum 10:1, except where specified in other specification sections for mechanical trades work.
  - .2 ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip.
- .4 Operating voltage:
  - .1 +10%, -10% of nominal supply voltage range to drive,

- .2 input frequency: 60 Hz,
- .3 protection circuitry to lock-in drive or bypass over this voltage tolerance.
- .5 Output voltage frequency range: 0 – 320 Hz.
- .6 Output switching frequency:
  - .1 2 kHz to 12 kHz, adjustable/selectable,
  - .2 automatic switching frequency de-rating in case of overheating.
- .7 VFD efficiency:
  - .1 output current not less than 97% of input current at 100% full load.
- .8 Power factor:
  - .1 not less than 0.98 lagging in operating range from 75% to 100% full load.
- .9 Drive overload rating:
  - .1 110% of normal duty current rating for 1 minute every 10 minutes,
  - .2 130% of normal duty current for 2 seconds.
- .10 Environmental operating conditions without derating:
  - .1 temperature: -10 to +50°C (14 to 122°F) continuous,
  - .2 altitude: 0 - 1000 m (0 - 3300 ft) above sea level,
  - .3 humidity: 5 to 95% relative humidity non-condensing.
- .11 Seismic rating:
  - .1 designed to withstand the seismic loads in accordance with specification section 20 05 49,
  - .2 product-type seismically rated for structural and functional integrity based upon shake table test to ICC ES ACC-156.
- .12 Supply VFDs from one manufacturer.

*Standard of Acceptance*

- ABB - fig. ACH580
- Danfoss - fig. VLT
- Eaton - fig. H-Max
- Benshaw - fig. H2
- Siemens - fig. BT300
- Yaskawa - fig. H600
- Schneider Electric - fig. Altivar 212W, 61W

## **2.3 VFD - Enclosure and Electrical Protection**

- .1 Electrical enclosure:
  - .1 enclosures to be of the following types in accordance CSA C22.2 No. 94.1/UL50:
    - (a) indoor installations: Type 1
    - (b) outdoor installation: Type 3, 3R or 4.
  - .2 fuse: HRC type "J" time delay type, 200 kAIC interrupting rating.
- .2 Equipment and motor protection:
  - .1 under- and over-voltage protection, phase loss protection and phase unbalance protection,
  - .2 current limiting device adjustable from 70% to 100% of rated motor current,

- .3 ground fault protection,
- .4 motor and motor cable short-circuit protection for line-to-line and line-to-ground faults,
- .5 instantaneous electronic overcurrent-protection,
- .6 motor overtemperature protection (calculated, or measured where otherwise specified),
- .7 motor overload protection,
- .8 phase-loss detection (both line and load side),
- .9 underload supervision (belt loss detection),
- .10 overload supervision,
- .11 loss of control signal input reference,
- .12 motor stall protection.
- .3 AC Mains surge protection device:
  - .1 transient surge protection consisting of 4 MOVs (phase-to-phase and phase-to-ground), or
  - .2 transient voltage surge suppressor/surge protection device (TVCSS/SPD).
- .4 Panel heater:
  - .1 internal panel heater for Type 3R enclosures, with integral circulating fan,
  - .2 heater capacity: as required to maintain panel interior temperature at manufacturer minimum temperature requirements, with an outdoor ambient temperature of -25°C (-13°F) when in service.
  - .3 integral heater and fan controller, with temperature sensor,
    - (a) operates at same voltage as VFD,

## **2.4 VFD - Auxiliary Power Supply**

- .1 24 VAC/DC input power supply for maintain logic controller during interruption of mains power.

## **2.5 VFD - Control Inputs/Outputs**

- .1 Internal 24 VDC power supply for process transducer inputs.
- .2 Analog inputs;
  - .1 two (2) configurable inputs for current or voltage signals, 0-10 V or 0-20 mA;
    - (a) frequency/speed setpoint value command,
    - (b) actual feedback input.
- .3 Analog output:
  - .1 two (2) configurable outputs for 0-20mA and/or 0-10VDC;
    - (a) current actual value,
    - (b) voltage actual value
- .4 Digital inputs:
  - .1 six (6) inputs, 12 to 24 VDC, 10 to 24 VAC,
  - .2 Stop/Start command,
  - .3 constant frequency/speed selection bypass command,
  - .4 start permissive interlock,
  - .5 3 other programmable inputs.
- .5 Digital outputs:

- .1 four (4) programmable Form-C relay outputs, 250 VAC/30 VDC, 2A RMS continuous;
  - (a) auxiliary output control (e.g., damper or valve command),
  - (b) motor run status,
  - (c) drive fault status,
  - (d) passive harmonic filter capacitor contactor control.

## **2.6 VFD - Programming and Functions**

### **.1 General:**

- .1 built-in time clock in the VFD keypad with battery backup of 10 years minimum life span,
- .2 time clock date-and-time stamp for faults and records operating parameters at the time of fault. On battery failure, the VFD automatically reverts to hours of operation since initial power up,
- .3 time clock programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays,
- .4 self-tuning function to automatically match VFD to the motor impedance,
- .5 motor flux optimization circuit to automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise;
  - (a) selectable software for optimization of motor noise, energy consumption, and motor speed control.
- .6 programmable number of restart attempts, trial time, and time between attempts.
- .7 utilize pre-programmed application macros specifically designed to facilitate start-up,
- .8 application macros provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time, and
- .9 two (2) user macros to allow the end-user to create and save custom settings.
- .10 password protection against parameter changes.

### **.2 General control functions:**

- .1 three (3) programmable critical frequency lockout ranges to prevent VFD from operating the load continuously at an unstable speed, fully adjustable, from 0 to full speed.
- .2 two (2) PID Set point controllers allowing pressure or flow signals to be connected directly to the VFD;
  - (a) microprocessor for the closed-loop control,
  - (b) 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others,
  - (c) PID set-point adjustment from the VFD keypad, or via the communications bus,
  - (d) two (2) independent parameter sets for the PID controller and the capability to switch between the parameter sets via a discrete input, serial communications or from the keypad.
- .3 the independent second PID loop able to utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (i.e., valves, dampers, etc.),
- .4 all set points, process variables, etc. to be accessible from the serial communication network,
- .5 programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal,
- .6 "bumpless transfer" of speed reference and output when switching between "Hand" and "Auto" modes – speed changes by controlled ramp rate,

- .7 programmable loss-of-load (broken belt / broken coupling) with programmable time delay for motor start-up, via the serial communications bus,
- .8 programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure / jam condition causing motor overload,
- .9 loss of input reference (4-20mA or 2-10V): User option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued as selected by the user, with alarm output via the serial communication bus,
- .3 Programmable time-delay functions:
  - .1 VFD start delay and a keypad indication that this time delay is active,
  - .2 four (4) separate, independent timer functions that have both weekday and weekend settings,
  - .3 output relay provides a contact closure to signal a valve/terminal boxes to open prior to the motor starting,
  - .4 field programmable from 0 - 120 seconds,
  - .5 start-delay active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications), and when switching from drive to bypass (where bypass is specified).
- .4 Speed control functions:
  - .1 minimum five (5) programmable preset speeds,
  - .2 two (2) independently adjustable acceleration and deceleration ramps with 1 - 1800 seconds adjustable time ramps.
  - .3 minimum speed setting adjustable from 0 to 70%,
  - .4 maximum speed setting adjustable from 50 to 150%,
- .5 Upset condition recovery functions:
  - .1 flying start into a rotating load, to match output drive frequency to motor frequency before taking load,
  - .2 control-board kinetic energization protection: control deceleration of motor to use motor-load inertia to keep drive controller energized as long as possible during loss of mains AC failure,
  - .3 carrier frequency control circuit to reduce the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
- .6 Passive harmonic filter low-load function:
  - .1 digital output relay opens capacitor-bank contactor in passive harmonic filters when motor control speed is  $\leq 70\%$  of rated motor speed, and when the VFD is Off.
  - .2 adjustable control setpoint.
- .7 Fireman's override control function (constant frequency/speed selection bypass command):
  - .1 on receipt of a contact closure from the Fire Alarm System or Building Automation System, the VFD operates in one of two selectable modes:
    - (a) operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward), or
    - (b) operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback; setpoint adjusted over the serial communications bus.
  - .2 operating mode overrides all other inputs (analog/digital, serial communication, and all keypad commands), except safety run interlocks, and force the motor to run in one of the two modes.
  - .3 "Override Mode" displayed on the keypad.

- .4 upon removal of the override signal, the VFD resumes normal operation, without the need to cycle the normal discrete input run command.

## **2.7 VFD - Operator Interface**

- .1 Digital display panel:
  - .1 removable back-lit LCD display operator interface unit, with navigation keys and minimum of two (2) soft keys to operation and programming,
  - .2 Bluetooth or WiFi accessibility, with free down-loadable app which replicates control panel functions on a mobile device or tablet,
  - .3 Hand-Off-Auto section and manual speed control without having to navigate to a parameter,
  - .4 Fault reset and Help keys,
  - .5 Digital display with keypad, including quick-access for “Hand-Off-Auto” selection, fault reset, and “Help” functions,
- .2 Loss-of-load alarm,
- .3 Display unit:
  - .1 LCD display, text or graphic display,
  - .2 user selectable language: English or French.
  - .3 complete descriptive words for programming and fault diagnostics,
  - .4 faults displayed in complete descriptive words.
- .4 “Help” button access to on-line assistance for programming and troubleshooting, including a minimum of 14 programming assistants:
  - .1 start-up
  - .2 parameter
  - .3 PID
  - .4 reference
  - .5 I/O
  - .6 serial communications
  - .7 option module
  - .8 panel display
  - .9 low noise set-up
  - .10 maintenance
  - .11 troubleshooting
  - .12 drive optimizer
- .5 Operating values displayed in engineering units, including the following:
  - .1 output frequency,
  - .2 motor speed (RPM, %, or Engineering units),
  - .3 motor current,
  - .4 motor torque,
  - .5 motor power (kW),
  - .6 DC bus voltage,

.7 output voltage.

## **2.8 VFD - Building Automation System ("BAS") Integration**

- .1 Two communication ports: EIA-485 and RJ45,
- .2 BAS network interface: BACnet MS/TP
- .3 BACnet device protocols certified by BTL listing to ASHRAE Standard 135 BACnet as an Application Specific Controller,
- .4 If additional hardware is required to obtain the BACnet interface, the VFD manufacturer to provide one BACnet gateway per drive; multiple VFDs sharing one gateway is not acceptable.
- .5 BAS digital communication functions include:
  - .1 write command:
    - (a) run-stop control,
    - (b) speed set adjustment,
    - (c) proportional/integral/derivative PID control adjustments,
    - (d) current limit,
    - (e) accel/decel time adjustments,
    - (f) remote VFD fault reset,
    - (g) lock and unlock the keypad.
  - .2 read command:
    - (a) monitor current values including process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature.
    - (b) monitor the VFD relay output status, discrete input status, and all analog input and analog output values.
    - (c) Monitor all diagnostic warning and fault information,
- .6 BAS may force digital and analog outputs via the serial interface; this control is independent of any VFD function except the local Emergency Shut-Down function.

## **2.9 VFD - Input RFI Filters**

- .1 VFD integral RFI/EMC filter, Category C2 to IEC/EN 61800-3.

## **2.10 VFD – Internal Harmonic Filters**

- .1 VFD internal harmonic filters:
  - .1 dual (positive and negative) DC bus chokes equivalent to 5% impedance,
  - .2 and 3% impedance AC line reactor where required as specified in Part 3 – EXECUTION.

## **2.11 Line Reactor Harmonic Filter**

- .1 3% impedance AC line reactor, copper windings on iron core, for installation inside of VFD enclosure or as a separate device.
- .2 Enclosure: to CSA C22.2 No. 94.1/94.2, Type 1 or 3R (for filters not forming part of the VFD).
- .3 Refer to article in Part 3 – EXECUTION for when this harmonic filter type is required based on motor HP rating.

*Standard of Acceptance*

- MTE - fig. RL Line Reactors

## **2.12 Passive Harmonic Filters**

### **.1 General:**

- .1 passive inductor/resistor/capacitor network to treat low frequency harmonics generated by 6-pulse VFD drives, for treatment of at least the 5<sup>th</sup>, 7<sup>th</sup>, 11<sup>th</sup> and 13<sup>th</sup> harmonic.
- .2 input voltage: same as associated VFD, 60 Hz, 3 ph., 3 W.
- .3 listed to CSA C22.2 No. 14 and/or CSA C22.2 No. 107.1, but need not be classified as a motor controller,
- .4 may be provided as an integral part of the VFD unit where offered by the VFD manufacturer.

#### *Standard of Acceptance*

- Mirius - fig. Lineator AUHF
- MTE - fig. Matrix AP
- TCI LLC - fig. HGP
- VFD manufacturer product

### **.2 Performance:**

- .1 limit THID to less than 8% total harmonic distortion between 30% and 100% full load. Filter must be capable of operating in voltage distortion up to 8% without derating,
- .2 have no resonance between harmonic filter with system impedances or attract harmonic currents from other harmonic sources,
- .3 power factor: 0.98 lagging to 0.95 leading in operating range from 30% to 100% full load,
- .4 maximum voltage injection at no load: < 3% of nominal line voltage.
- .5 maximum capacitive reactive power KVAR generated: 20% of kVA rating,
- .6 full load efficiency: not less than 99% at full load.
- .7 short circuit capacity rating: 100 kAIC symmetrical.

### **.3 Construction:**

- .1 enclosure: to CSA C22.2 No. 94.1/94.2, Type 3R (for filters not forming part of the VFD),
  - .2 copper conductors,
  - .3 wiring insulation class: 220°C (428 F),
  - .4 temperature rise: 130°C (266 F).
  - .5 contactor-control for capacitors:
    - (a) contactors wired in series to the filter capacitors, to disconnect the capacitors and resistors under motor low or no- load conditions based on control signal from the associated VFD,
    - (b) contactor coil control power: 120 VAC based on VFD control output relay rating,
  - .6 anti-vibration pad mounts between the reactor or transformer core and the enclosure.
- .4 Refer to article in Part 3 – EXECUTION for when this harmonic filter type is required based on motor HP rating.

## **2.13 Active Harmonic Filter**

### **.1 General:**

- .1 active inductor/capacitor network to inject non-fundamental counter-current to cancel out current harmonics, synchronizes the current and voltage waveform,



- .2 designed to control harmonics from one or more VFDs when installed at the common power distribution point,
- .3 input voltage: same as associated VFD, 60 Hz, 3 ph., 3 W.
- .4 listed to CSA C22.2 No. 14 and/or CSA C22.2 No. 107.1, but need not be classified as a motor controller.

*Standard of Acceptance*

- ° TCI LLC - fig. HGA

.2 Performance:

- .1 limit THID to less than 5% total harmonic distortion between 30% and 100% full load, for the 2<sup>nd</sup> through 50<sup>th</sup> order harmonic current.
- .2 voltage distortion: filter injected THDV not to exceed 5% at the line side of the filter.
- .3 responds time:
  - (a) at steady state - not greater than 1 line cycle.
  - (b) at load change – not greater than 3 line cycles.
- .4 having no resonance between harmonic filter with system impedances or attract harmonic currents from other harmonic sources,
- .5 power factor: improve reactive current to be between 0.90 and 0.99 lagging over the load operation range,
- .6 maximum capacitive reactive power KVAR generated: 20% of kVA rating,
- .7 full load efficiency: not less than 99% at full load.
- .8 short circuit capacity rating: 100 kAIC symmetrical.

.3 Construction:

- .1 enclosure: to CSA C22.2 No. 94.1/94.2, Type 3R (for filters not forming part of the VFD),
- .2 two current transformers for two-phases of the load side of the filter for control of the equipment,
  - (a) current rating: no less the full load current of the conductor being measured,
  - (b) rated for 400 Hz.
- .3 copper conductors,
- .4 wiring insulation class: 220°C (428 F),
- .5 temperature rise: 130°C (266 F).
- .6 digital LCD operator interface, door mounted, for programming and monitoring of the filter,
  - (a) three operating modes: harmonic correction, power factor correction, and combination harmonic and power factor correction,
  - (b) Modbus RTU communications over RS-485 network interface,
  - (c) store and display trend log historical data for line voltage, line current, filter current, current THD, filter bus voltage, and filter heatsink temperature.
- .7 anti-vibration pad mounts between the reactor or transformer core and the enclosure.

- .4 Refer to article in Part 3 – EXECUTION for when this harmonic filter type is required based on motor HP rating.

**2.14 Load-Side Load Reactor**

- .1 3% impedance AC load reactor, copper windings on iron core, for installation inside of VFD enclosure or as a separate device.

- .2 Enclosure: to CSA C22.2 No. 94.1/94.2, Type 3R (for filters not forming part of the VFD),
- .3 Refer to article in Part 3 – EXECUTION for when this load-side filter type is required.

*Standard of Acceptance*

- MTE - fig. RL Line Reactors

## **2.15 Load-Side dV/dT Filter for Motor Protection**

### **.1 General:**

- .1 Low pass RLC circuit filter device to:
  - (a) limit voltage spikes due to drive output and reflected wave voltage,
  - (b) reduce the rate of change of current / increase voltage rise time,
  - (c) reduce common mode current.
- .2 operating environment: 4 to 40°C (40 to 104°F), 5 to 95% RH non-condensing,
- .3 input voltage: same as associated VFD, with an output fundamental frequency of 60 Hz,
- .4 listed to CSA C22.2 No. 14 and/or CSA C22.2 No. 107.1, but need not be classified as a motor controller.

*Standard of Acceptance*

- MTE - fig. dV E-Series
- TCI LLC - fig. V1K

### **.2 Performance:**

- .1 matched to VFD carrier frequency range between 2 to 4 kHz,
- .2 limit peak voltage at motor to not exceed 150% of VFD DC bus voltage for motor feeder lengths of up to 300 m (1000 ft),
- .3 reduce common mode current by not less than 30%,
- .4 overload rating:
  - (a) 200% rated current for 10 seconds per hour
  - (b) 150% rated current for 1 minute per hour
- .5 full load efficiency: not less than 98% at full load.

### **.3 Construction:**

- .1 enclosure: to CSA C22.2 No. 94.1/94.2, Type 3R, with ventilation openings,
- .2 RLC circuit construction:
  - (a) three-phase iron core, air-gapped inductors, copper wire wound with insulation temperature rise of not less than 115°C, impregnated with 100% solids epoxy resin,
  - (b) metallized polypropylene film capacitors, wye-connected with ungrounded neutral, rated at not less than 700 VAC,
  - (c) wire-wound cement resistors.
- .3 wire insulation rating: 1000 V class
- .4 wire insulation class: minimum Class H 180°C (356°F).

- .4 Refer to article in Part 3 – EXECUTION for when this load-side filter type is required.

## 2.16 Load-Side Sine Wave Filter for Motor Protection

### .1 General:

- .1 For operation with VFD's with pulse-width modulation, operated in scalar (constant V/Hz) mode only.
- .2 Low pass RLC sinewave filter device:
  - (a) tuned to shunt frequencies at and above the target carrier frequency,
  - (b) eliminate voltage spikes due to drive output and reflected wave voltage,
  - (c) reduce rate of change of current / increase the voltage switching rise time,
  - (d) produce an output voltage sinewave to the motor.
- .3 operating environment: 4 to 40°C (40 to 104°F), 5 to 95% RH non-condensing,
- .4 input voltage: same as associated VFD, with an output fundamental frequency of 60 Hz,
- .5 listed to CSA C22.2 No. 14 and/or CSA C22.2 No. 107.1, but need not be classified as a motor controller.

#### *Standard of Acceptance*

- MTE - fig. dV E-Series
- TCI LLC - fig. MSD Motor Shield

### .2 Performance:

- .1 matched to VFD carrier frequency range between 2 to 16 kHz,
- .2 produce a sinusoidal voltage signal with not more than 5% THVD,
- .3 filter output voltage @ 600 VAC system voltages: not to exceed 1020 V,
- .4 output dV/dt waveform: at least 6 V/μs @ 600 VAC system power,
- .5 voltage drop at filter output terminals: not to exceed 5% of rated voltage,
- .6 overload rating:
  - (a) 200% rated current for 3 minutes per hour
- .7 full load efficiency: not less than 98% at full load.

### .3 Construction:

- .1 enclosure: to CSA C22.2 No. 94.1/94.2, Type 3R, with ventilation openings,
- .2 tuned RLC circuit construction:
  - (a) three-phase iron core, air-gapped inductors, copper wire wound with insulation temperature rise of not less than 135°C (275°F), impregnated with 100% solids epoxy resin,
  - (b) metallized polypropylene film capacitors, bio-degradable impregnate, wye-connected with ungrounded neutral, rated at not less than 700 VAC, with pressure-sensitive circuit interrupters to disconnect the three phases simultaneously,
  - (c) wire-wound cement resistors.
- .3 wire insulation rating: 1000 V class
- .4 wire insulation class: Class H 180°C (356°F) or better.

#### *Standard of Acceptance*

- Mirius - fig. Inversine
- MTE - fig. SineWave Guardian
- TCI - fig. MSD

- .4 Refer to article in Part 3 – EXECUTION for when this load-side filter type is required.

## **2.17 Field-Installed Disconnect Switches**

- .1 Field-installed disconnect switches to conform to Specification section 20 05 12, except/and as specified herein.
- .2 Disconnects with overcurrent protection device:
  - .1 include fuses or circuit breakers which have a short-circuit interrupting capacity equal to or greater than the SCCR specified for VFDs.
  - .2 select fuse or circuit breaker type and rating in accordance with VFD manufacturer installation instructions for the purpose of achieving the required SCCR value.

## **3 EXECUTION**

### **3.1 General**

- .1 Provide each controlled motor with a dedicated VFD, unless otherwise shown to group motors on a common VFD on a special case basis.

### **3.2 VFD Installation**

- .1 Except where the VFD is provided with a Type 12 enclosure, provide temporary dust protection around installed VFDs until the drives are energized.
- .2 Install variable speed drives in accordance with manufacturer's requirements. Provide field wiring in accordance with Specification section 23 05 12.
- .3 Install VFD as closed as possible to controlled equipment unless otherwise shown. Position the motor controller so that:
  - .1 the door front is readily visible and accessible from the workspace,
  - .2 for wall-hung motor controllers, install with the top of the motor controls located between 1700 and 1800 mm above the local work surface and all adjacent motor controllers aligned to the same height,
  - .3 there is a minimum clear space of 1000 mm (40 in.) in front of the motor controller.
- .4 Mount motor controllers to building walls or structure, on Unistrut or similar rails;
  - .1 do not weld miscellaneous support steel to building structure,
  - .2 secure VFDs with seismic-rated fasteners where seismic restraint is required in accordance with specification section 20 05 49.
- .5 Where there is no adjacent or insufficient wall space or building structure upon which to mount the motor controller, provide a floor-mounted fabricated support assembly to mount the motor controller. Design the support assembly to:
  - .1 support the dead-weight of the motor controller,
  - .2 withstand a 220 N (50 lbf) horizontal force from any direction applied to the VFD enclosure, with a maximum deflection of 3 mm (1/8 in).
  - .3 resist seismic movement where seismic restraint is required in accordance with specification section 20 05 49.
- .6 Provide control wiring between the VFD and associated harmonic filter to disable the filter when the drive is at low-speed or is Off.

### 3.3 Motor Feeder Installation

- .1 Provide inverter-duty motor feeder cable in accordance with Specification section 20 05 12, between VFD and the controlled motor, including connections to specified load-side filters.

### 3.4 Disconnect Switch Installation

- .1 Provide disconnect switches with overcurrent protection for:
  - .1 VFDs not provided with integral disconnect switches,
  - .2 VFDs with integral bypass motor controllers, and
  - .3 VFDs which have an internal SCCR rating that is less than the minimum SCCR value specified herein.
- .2 Locate the disconnect switch immediately upstream of the VFD;
  - .1 install the disconnect switch within 9 m (29 ft) and in line-of-site of the VFD and the motor served by the VFD,
  - .2 where a VFD has an associated harmonic filter installed immediately adjacent to the VFD, the disconnect switch may be mounted ahead of the harmonic filter.
- .3 Where a disconnect switch is required between the drive and the motor, provide an un-fused disconnect switch that has an auxiliary contact switch to indicate when the disconnect switch is not closed.

### 3.5 Harmonic Filters Installation

- .1 Provide harmonic filters for VFDs based on drive HP rating in accordance with the following table 1, to not exceed the maximum current total harmonic distortion when measured at the line side of the filter/drive assembly.

Table 1: Harmonic Filter Requirements					
Individual Motor Rating HP	Harmonic Filter Method				Maximum THID Rating
	Dual DC Choke 5%	AC Line Reactor 3%	Passive Filter	Active Filter	
≤ 5	Included	---	---	---	45%
>5 and ≤ 40	Included	Yes	---	---	35%
>40 and ≤ 100	Included	---	Yes	---	8%
>100	Included	---	---	Yes	5%

- .2 Install harmonic filters in accordance with the manufacturer's instructions.
- .3 Where a 3% impedance AC line reactor is required, if it is not provided integral to the VFD, provide a field-installed reactor in its own electrical enclosure as specified herein, located immediately ahead of the VFD.
- .4 For passive harmonic filters;
  - .1 provide interlock control wiring between the VFD and the harmonic filter to control the contactor isolating the filter capacitor bank. Control interlock to consist of:
    - (a) 600 V/120 VAC control transformer with fuse protection on primary and secondary legs,
    - (b) interposing double-voltage relays at VFD output, for 24 VAC coil and 120 VAC contacts,
    - (c) interlock wiring: minimum 14AWG-15mmC,
    - (d) wiring logic arranged to open contactor when VFD is off or at part load.

- .2 set the filter contactor-control trip setting in the VFD to open the contactors when the load drops below a value that causes the drive/filter combination to create a leading power factor, and when the drive is Off. Default value = 70% of maximum rated motor speed.

### 3.6 Load-Side Filters Installation

- .1 Provide load-side motor protection filters based on motor feeder developed length from the VFD to the motor in accordance with the following table(s) 2:

- .1 Table 2A: for new inverter duty motors provided with new VFD inverter duty feeder cable.
- .2 Table 2B: for existing motors of any type provided with new VFD inverter duty feeder cables.
- .3 Table 2C: for existing motors of any type provided with standard motor feeder conductors.

Table 2A: New Inverter-Duty Motors and VFD Inverter-Duty Feeder Cable	
Motor Feeder Length	Output Load-Filter
0 to ≤18 m (0 to 60 ft)	None required
>18 m and ≤ 30 m (>60 ft and ≤ 100 ft)	3% Line Reactor
>30 m and ≤ 50 m (>100 ft and ≤ 160 ft)	dV/dT filter
>50 m (>160 ft)	Sine wave filter

Table 2B: Existing Motor with VFD Inverter-Duty Feeder Cable	
Motor Feeder Length	Output Load Power Conditioner
0 to ≤12 m (0 to 40 ft)	None required
>12 m and ≤ 20 m (>40 ft and ≤ 65 ft)	3% Line Reactor
>20 m and ≤ 46 m (>65 ft and ≤ 150 ft)	dV/dT filter
>46 m (>150 ft)	Sine wave filter

Table 2C: Existing Motor with Standard Motor Feeder Conductors	
Motor Feeder Length	Output Load Power Conditioner
0 to ≤ 6 m (0 to 20 ft)	None required
>6 m and ≤ 12 m (>20 ft and ≤ 40 ft)	3% Line Reactor
>12 m and ≤ 43 m (>40 ft and ≤ 140 ft)	dV/dT filter
>43 m (>140 ft)	Sine wave filter

- .2 Install the load-side filter in accordance with manufacturer's instructions, and as close as possible to the load-side connect of the VFD;
  - .1 load-side filters may be installed above, to the side, or beneath the associated VFD.

### **3.7 Control Wiring for Remote Disconnect Switch at Motor**

- .1 Where a separate disconnect is installed between the drive and the controlled motor, provide interlock control wiring between disconnect switch auxiliary-contact switch and the VFD, to prevent drive from operating if the motor disconnect switch is open.

### **3.8 Cleaning**

- .1 Vacuum clean the inside of VFD panels to remove construction dirt and debris before energizing the VFD.
- .2 Do not start-up VFDs until the local area has been brought to final clean, floors are sealed, and any drywall in the same space is sanded and painted.

### **3.9 Temporary Use of VFDs During Construction**

- .1 Except where a VFD is provided with a Type 12 enclosure, VFDs are not specified for operation in a construction dust-laden environment. Except for VFDs in Type 12 enclosures, do not operate VFDs for the purpose of temporary construction heat or ventilation prior to final construction cleaning of the space in which the drives are located.
- .2 If such heating equipment is to be used prior to final construction clean, provide temporary dust protection enclosures around the VFDs and provide ventilation to the temporary enclosure with a source of filtered supply air.

### **3.10 Start-Up and Testing**

- .1 Provide the services of a certified factory authorized representative for the start-up of each drive, including any configuration and programming required. Complete and submit a VFD manufacturer's start-up inspection and test form for each drive.
- .2 Set the carrier frequency to 4 kHz as the default value. Where noise is found to be objectionable, increase carrier frequency to the lowest possible value until noise level is acceptable or cannot be discerned from the background noise.
  - .1 where a load-side dV/dT filter is installed, do not use a carrier frequency greater than 4 kHz.
- .3 Commission harmonic mitigation devices on-site. Test the performance of these devices at 0%, 30% and 100% motor load;
  - .1 for the purpose of this test "100% motor load" means the motor current draw when the equipment driven by the motor is operating at its full design load,
  - .2 measure voltage, current, power factor, harmonic distortion (by frequency) and total harmonic distortion at the line-side terminals to the drive/harmonic mitigation device assembly,
  - .3 obtain measurements with a recording type Fluke 41 or equivalent harmonics analyzer for individual and total harmonic currents and voltages,
  - .4 submit written test records to Consultant for review, and include the test records in the operation and maintenance manuals.
- .4 Commission load-side motor protection filters onsite. Test the performance of these devices at 30% and 100% motor load;
  - .1 for the purpose of this test "100% motor load" means the motor current draw when the equipment driven by the motor is operating at its full design load,
  - .2 measure peak-overshoot and peak-normal voltage at VFD load terminals, at load-filter output terminals, and at motor terminals,
  - .3 voltage rise time at the same locations,
  - .4 obtain measurements with a recording type voltage meter capable of recording and graphically displaying peak voltage and voltage rise-time,

- .5 submit written test records to Consultant for review, and include the test records in the operation and maintenance manuals.

### **3.11 Setting Skip-Speed for Driven Equipment Natural Frequency**

- .1 Conduct a vibration field test on the following driven equipment to determine its first natural frequency:
  - .1 all cooling towers,
  - .2 each style of pump and HP rating,
- .2 Based on the vibration field tests, program the VFD skip-speed function to prevent operation of the motor at the speed corresponding to the driven-equipment's first natural frequency;
  - .1 set the skip speed range setpoint to be equal to  $\pm 5\%$  of measured equipment first natural frequency, unless a wider or narrower range is determined by field testing.
- .3 Provide a machine printed, self-adhesive label and place below the drive nameplate, identifying the skip-speed frequency programmed in the drive.

This drive has been programmed to skip  
over the following speed range:  
Hz to      Hz

### **3.12 Demonstration and Training**

- .1 Provide the services of a factory trained manufacturer's representative to provide training to Owner's operations staff. Include in training;
  - .1 installation instructions,
  - .2 programming of VFD,
  - .3 operation of VFD,
  - .4 at-site servicing of VFD,
  - .5 replacement of VFD keypad controller,
  - .6 manual and automatic operation of bypass, if applicable,
  - .7 serial communications,
  - .8 fireman's smoke control override,
  - .9 method of isolating VFD and bypass (if provided) for servicing the equipment,
  - .10 purpose and function of harmonic filters,
  - .11 purpose and function of load-side motor protection filters.

### **3.13 Hand-Over**

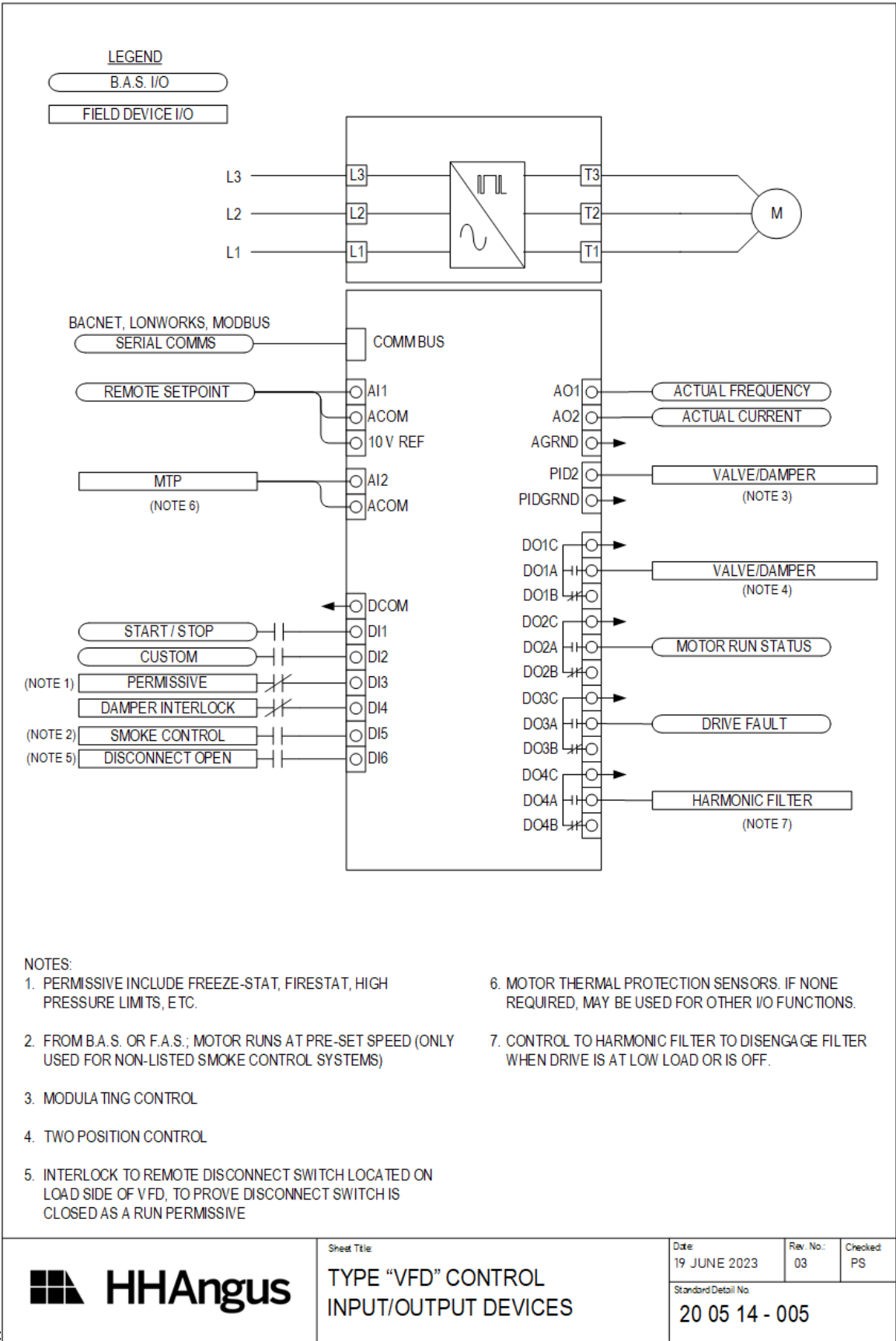
- .1 Provide to the Owner the service and maintenance manuals, wiring and interconnection diagrams and the start-up reports.

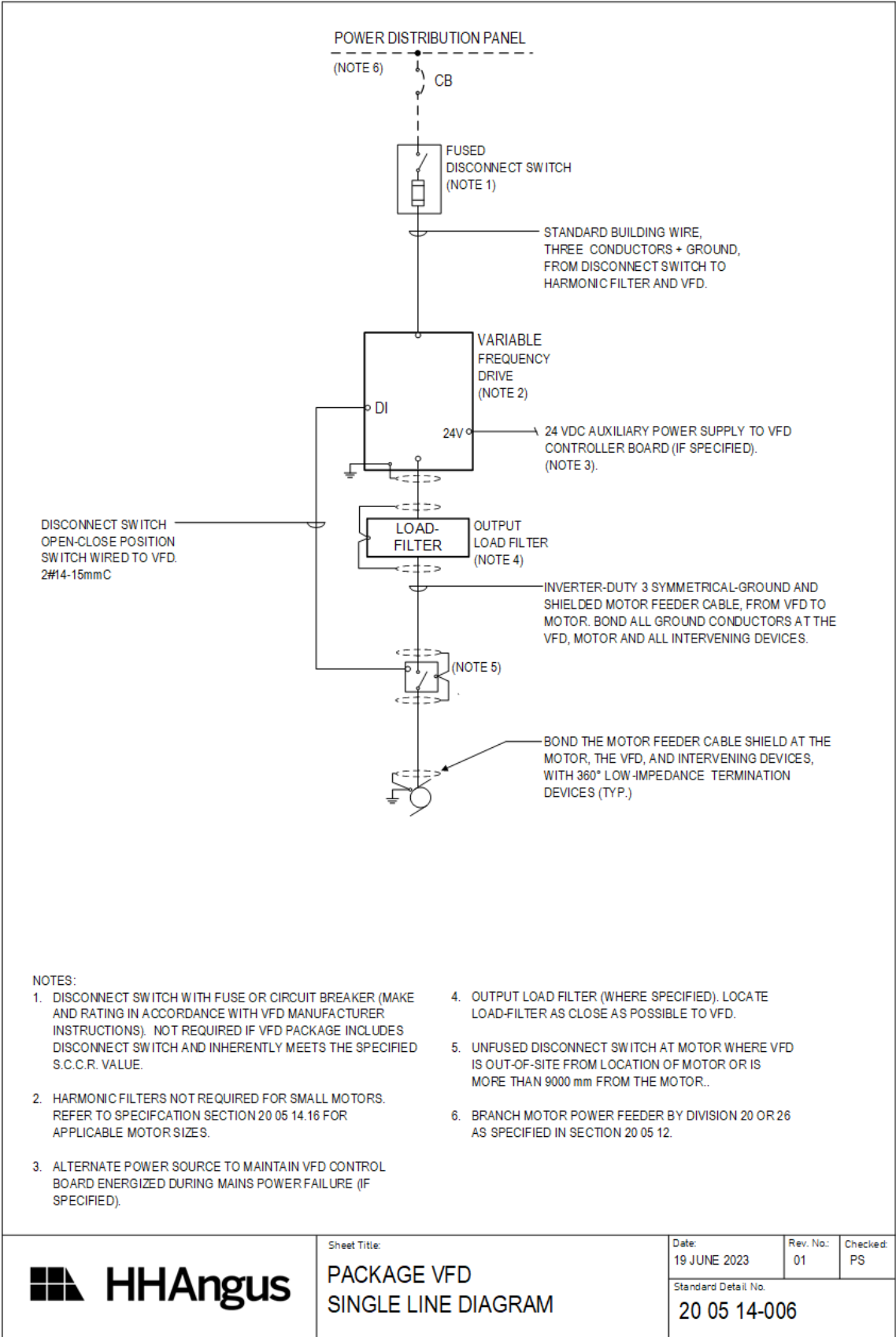
### **3.14 Wiring Diagrams**

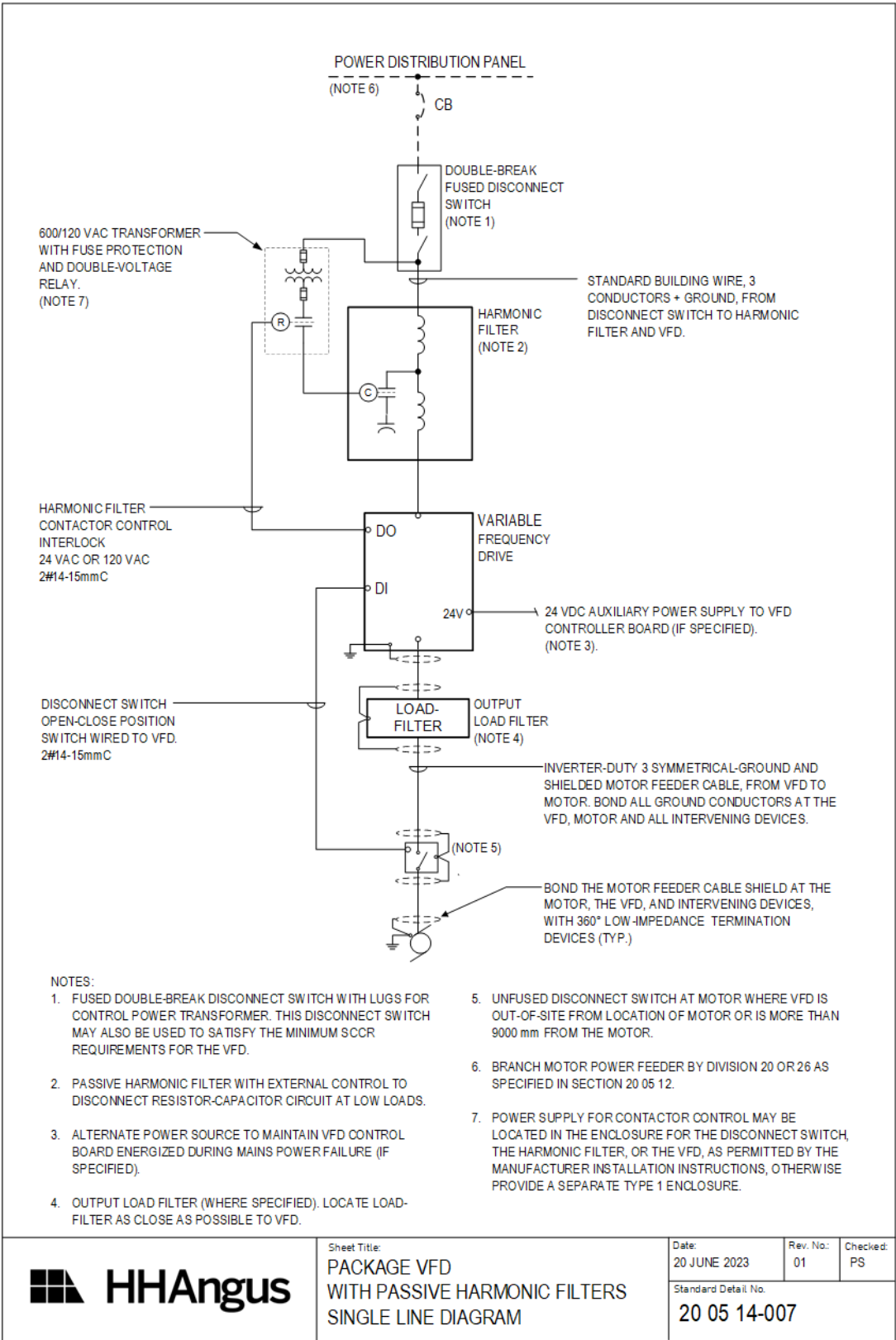
- .1 The included VFD motor controller wiring diagrams are to be read in conjunction with equipment specifications, control sequences, and motor/starter schedules for implementation of control sequences and identification of components required in each in each motor controller.
- .2 The following standard details provide indicative wiring requirements for VFD motor controllers.
  - .1 20 05 14-005 Type "VFD" – Control Input/Output Devices
  - .2 20 05 14-006 Packaged VFD - Single Line Drawing



.3 20 05 14-007 Packaged VFD with Passive Harmonic Filter - Single Line Drawing







END OF SECTION



## **FLEX CONNECTIONS, EXPANSION JOINTS, ANCHORS & GUIDES**

### **20 05 16**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide flexible connections, expansion joints, pipe anchors, and pipe guides as shown.
- .2 Provide services of expansion joint manufacturer service representative to inspection selected expansion joint installation.

##### **1.2 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 Refer to each piping specification section for applicable piping installation codes.
  - .2 CAN/CSA-S16.1 Limit States Design of Steel Structures.
  - .3 CSA W59 Welded Steel Construction (Metal Arc Welding).
- .2 Product standards:
  - .1 ASME B1.20.1 Pipe Thread, General Purpose, Inch
  - .2 ASME B16.5 Pipe Flanges and Flange Fittings
  - .3 ASTM A53 Standard Specification for Pipe, Steel, Black and hot dipped, zinc-coated, welded and Seamless
  - .4 ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
  - .5 ASTM F1120 Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications.
  - .6 CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code,
  - .7 CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel.

##### **1.3 Design Requirements**

- .1 Provide engineering services by a professional engineer licensed in the province of the Work, for the design of pipe anchors including pipe stress design and resulting forces and moments at point of building attachment for the following pipe sizes and/or systems.
  - .1 piping system using expansion joints regardless of pipe size or fluid service,
  - .2 hot water heating, max 93°C (200 F): NPS 6 and larger

##### **1.4 Submittals**

- .1 Submit manufacturers product data sheets for expansion joint equipment including:
  - .1 Manufacturer name, model number, piping service, pressure and temperature rating.
  - .2 design allowances for axial, lateral and angular movement.
  - .3 nominal size and overall dimensions.
- .2 Submit design drawings sealed by a professional engineer licensed in the province of the Work, for pipe anchors and include;

- .1 plan drawings showing location of anchors and guides,
- .2 fabrication details,
- .3 pipe expansion forces,
- .4 resulting reaction force and bending moments at building connection,
- .5 building fastening details.

## **2 PRODUCTS**

### **2.1 Slip Type Expansion Joints**

- .1 Application:
  - .1 for axial pipe movement,
  - .2 travel: 100 mm (4 in) to 300 mm (12 in) single unit, 200 mm (8 in) to 600 mm (24 in) for double units.
  - .3 size: NPS 1-1/2 to NPS 24
- .2 Construction:
  - .1 body and packing housings: [Class 150][Class 300] carbon steel pipe to ASTM A 53, Grade B,
  - .2 wall thickness to match service pipe with flanges or weld ends to match service pipe jointing specification.,
  - .3 adjustable packing gland or fixed packing gland arrangement with a packing injection assembly, arranged for repacking under full line pressure.,
  - .4 slip pipe of carbon steel pipe to ASTM A 53, Grade B, hard chrome plated,
  - .5 anchor base constructed of steel welded to body on double units,
  - .6 internal and external guides in packing housing with concentric alignment of slip pipe,
  - .7 extension limit stop of stainless steel, with accessible and removable pins,
  - .8 not less than six packing rings of teflon or graphite impregnated material,
  - .9 lubricating fittings with grease nipple, pet cocks, and lubricant gun with hose assembly or plunger body of heavy wall carbon steel and plunger of carbon steel with hex head for use with socket wrench.
  - .10 lubricant: to manufacturer's recommendations. .
  - .11 drip connection coupling with drain plug.
  - .12 working pressure: [1030 kPa (150 psig)][2070 kPa (300 psig)] saturated steam.
  - .13 factory tested to 1½ times maximum working pressure; furnish test certificate.
  - .14 CRN to CSA B51.

#### *Standard of Acceptance*

- Senior Flexonics – fig. Slip Pak
- Adasco – fig. Ram Pak
- Hyspan - fig. 6500
- Advanced Thermal System – fig. Thermal Pak

### **2.2 Controlled Ring Expansion Joints**

- .1 Application:

- .1 for axial and lateral movements,
- .2 travel: up to 190 mm (7.5 in) axial and 38 mm (1.5 in) lateral depending on size.
- .3 size: NPS 3 to NPS 18
- .2 Construction:
  - .1 bellows: hydraulically formed to ASTM F1120, minimum three ply laminated, stainless steel T304 or T321 to ASTM A240,
  - .2 stabilizing control rings: two piece nickel iron reinforcing/control rings,
  - .3 pipe connections: ASME/ANSI B16.5 flanges, weld ends to ASME/ANSI B16.9, or grooved ends as applicable.
  - .4 carbon steel tie rods,
  - .5 flow liner: ASTM A240 T304 stainless steel.
  - .6 carbon steel painted shroud,
  - .7 working pressure: [1030 kPa (150 psig)][2070 kPa (300 psig)] at up to 425°C (800°F)
  - .8 factory tested to 1½ times maximum working pressure; furnish test certificate.
  - .9 CRN to CSA B51.

*Standard of Acceptance*

- Senior Flexonics – fig. CSF/CSW
- Adsco - fig. Corruflex
- Metraflex - fig. MC

**2.3 Externally Pressurized Expansion Joints**

- .1 Application:
  - .1 for axial movements.
  - .2 travel:
    - (a) single unit: 100 mm (4 in) to 200 mm (8 in)
    - (b) double unit: 200 mm (8 in) to 400 mm (16 in) double unit.
  - .3 size: NPS 2 to NPS 24
- .2 Construction:
  - .1 external pressurized design,
  - .2 bellows: hydraulically formed to ASTM F1120,, minimum three ply laminated, stainless steel T304 or T321 to ASTM A240,
  - .3 housing: ASME A53 Gr B carbon steel,
  - .4 pipe connections: ASME/ANSI B16.5 flanges, weld ends to ASME/ANSI B16.9, or grooved ends as applicable.
  - .5 flow liner: ASTM A240 T304 stainless steel,
  - .6 internal and external guides,
  - .7 working pressure: 1030 kPa (150 psig) and 2070 kPa (300 psig) at up to 260°C (500°F)
  - .8 factory tested to 1½ times maximum working pressure; furnish test certificate.
  - .9 CRN to CSA B51.



*Standard of Acceptance*

- Senior Flexonics – fig. SX, DX
- Adscot - fig. Pressure Master II
- Hyspan - fig. 3500 series
- Metraflex - fig. Metragator
- Flex-Hose Co fig. Flexpress

**2.4 Expansion Compensators****.1 Application:**

- .1 for axial movements,
- .2 travel:
  - (a) carbon steel: 50 mm (2 in) to 75 mm (3 in)
  - (b) copper tube: 50 mm (2 in)
- .3 size: NPS ¾ to 3.

**.2 Construction:**

- .1 externally pressurized design,
- .2 bellows: hydraulically formed to ASTM F1120, minimum three ply laminated, stainless steel T304 or T321 to ASTM A240,
- .3 pipe ends: schedule 40 ASME A53 Gr B carbon steel,
- .4 pipe connections:
  - (a) steel pipe: NPT to ASME B1.20.1, or grooved end
  - (b) copper tube: female soldered fitting.
- .5 flow liner: ASTM A240 T304 stainless steel.
- .6 NPS ¾ NPT condensate drain connection on outer shell.
- .7 working pressure: 2070 kPa (300 psig) at up to 400°C (700°F)
- .8 factory tested to 1½ times maximum working pressure; furnish test certificate,
- .9 CRN to CSA B51.
  - Senior Flexonics - fig. H2, H3, COPPER
  - Hyspan - fig. 8500
  - Flex-Hose Co fig. FlexComp

**2.5 Flexible Metal Hose****.1 Application:**

- .1 for connections to duct mounted reheat coils, and fan coil units.
- .2 travel limitations;
  - (a) parallel offset equal to the diameter of the hose,
  - (b) single 90 degree bend in one plane.
- .3 size: NPS 1/2 to NPS 2.
- .4 hose length:
  - (a) minimum: 300 mm (12 in).

- (b) maximum for straight or parallel offset: 300 mm (12 in)
- (c) maximum for one 90 degree bend in one plane: minimum bend radius plus 200 mm (8 in), not including end fittings, or the specified minimum length whichever is greater.

.2 Construction:

- .1 inner hose: corrugated T316 or T321 stainless steel,
- .2 outer jacket: braided T300 series stainless steel wire mesh, to restrain hose from elongation and to limit hose movement,
- .3 end connections:
  - (a) schedule 40 stainless steel pipe, threaded to ASME B1.20.1,
  - (b) with union at one end connection.
- .4 working pressure: 2070 kPa (300 psig) at up to 121°C (250°F),
- .5 field pressure test: capable of being hydrostatically pressure tested at not less than 120% of unit MAWP, when installed at smallest 90° radii or at maximum parallel offset, at a test temperature of 21°C (70°F),
- .6 factory tested to 1 ½ times maximum working pressure,
- .7 CRN to CSA B51.

*Standard of Acceptance*

- Senior Flexonics - fig. 101 series
- Metraflex - fig. SuperFlex
- Flex-Hose - fig. Pumpsaver
- Flexpression - fig. Series I

## 2.6 Guides

.1 Spider guides:

- .1 pipe size: NPS ¾ to NPS 20
- .2 axial movement: minimum 200 mm (8 in),
- .3 carbon steel spider guides, with guide spider clamped to pipe, and guide body with split bolted housing and angle bracket base.

*Standard of Acceptance*

- Senior Flexonics - fig. PGT
- Hyspan - fig. 9500
- Metraflex - fig. Style IV
- Advanced Thermal System Type GA
- Flex-Hose Co - fig. Guideline

.2 Horizontal Pipe Support and Slide Guide:

- .1 Tee or H shaped pipe support for welding to pipe, to allow axial and lateral movements,
- .2 axial movement: minimum 200 mm (8 in),
- .3 carbon steel, structural shape or fabricated, to ANSI/MSS SP-58 Type 35,
- .4 PTFE bonded to underside of slide,
- .5 matching lower steel plate with bonded PTFE element (for fastening to structural support beam), with lug restraints to limit:

- (a) lateral movement to 1.6 mm (1/6 in) or 25 mm (1 in),
- (b) uplift movement to 1.6 mm (1/6 in),
- .6 operating temperature range: -28 to 200°C (-20 to 400°F),
- .7 nominal pipe size: NPS ½ to NPS 30.

*Standard of Acceptance*

- Anvil - figs. 257, 436, 439
- Myatt - figs. 705, 706
- Metraflex - fig. PTFE Slide Guide

.3 Vertical Pipe Riser Slide Guide:

- .1 pipe size: NPS 1 to NPS 12,
- .2 axial movement: minimum 200 mm (8 in),
- .3 for welded or clamp attachment to pipe, and bolt attachment to structure floor (top or underside),
- .4 PTFE slide pads,

*Standard of Acceptance*

- Metraflex - fig. PGQ

.4 Custom guides:

- .1 designed by a professional engineer licensed in the jurisdiction of the Work,
- .2 carbon steel, standard structural shapes conforming to CSA G40.20/G40.21, and hot-dipped galvanized to ASTM A123,
- .3 designed to limit pipe movement to not more than 6 mm (1/4 in) in any lateral direction,
- .4 for insulated piping, provide structural Tee shape with web welded to pipe, and of sufficient height to clear the insulation by not less than 12 mm (1/2 in) at each location.

## **2.7 Anchors**

.1 Custom designed pipe anchors and combination pipe support anchors.

.2 Fabrication:

- .1 designed by a professional engineer licensed in the jurisdiction of the Work,
- .2 carbon steel, standard structural shapes conforming to CSA G40.20/G40.21, and hot-dipped galvanized to ASTM A123,
- .3 designed to withstand applied dead loads and live loads including thermal expansion forces and moments including those caused by expansion joint pressure thrust, seismic restraint forces and moments, and wind forces and moments where piping is located outdoors.
- .4 building structure connection point: specifically designed to suit the structure at the point of attachment, and coordinated with the building structural engineer.
- .5 for insulated piping, pipe attachments to be of sufficient height to clear the insulation by not less than 12 mm (1/2 in.) at each anchor connection location.

### 3 EXECUTION

#### 3.1 General

- .1 Provide expansion loops in preference to expansion joints, where space permits.

#### 3.2 Expansion Joints Selection and Installation

- .1 Select expansion joints to compensate for thermal expansion in pipe between anchors with not less than 25% safety margin, calculating expansion based on the following operating temperatures;
- .1 heating systems: from -18°C (0°F) ambient up to maximum possible operating fluid temperature, but not less than 93°C (200°F) for water and design saturation temperature for steam,
  - .2 cooling systems: from 15°C (60°F) ambient down to 5°C (40°F).
- .2 Provide expansion joint types as follows:

Service	Limits	Type
Steam piping Boiler Feedwater piping	Over 1030 kPa (150 psig)	Slip
	501 - 1030 kPa (76 - 150 psig)	Slip, Ring Controlled, or Externally Pressurized
	500 kPa (75 psig) and less	Ring Controlled or Externally Pressurized
Heating water piping Condensate piping Glycol heating piping Chilled water piping Glycol cooling piping Condenser water piping	NPS 20 and larger	Slip
	NPS 3 to NPS 18	Ring Controlled
	NPS 2 to NPS 24	Externally Pressurized
	NPS ¾ to NPS 3	Expansion Compensator
Domestic Hot Water piping Domestic Recirculation Water piping	NPS 2 to NPS 24	Externally Pressurized
	NPS ¾ to NPS 3	Expansion Compensator
Domestic Cold Water piping	NPS 2 to NPS 24	Externally Pressurized

- .3 Provide pressure balanced expansion joints where shown, or they may be provided in lieu of externally pressurized expansion joints, slip joints, or ring controlled ring joints where the design of the anchors would be simplified with their use.
- .4 Support piping immediately adjacent to and on each side of expansion joints and expansion loops. Do not use pipe guides to support the expansion joint or loop.

#### 3.3 Pipe Guides Installation

- .1 Provide pipe guides at each expansion joint and expansion loop:
- .1 provide two guides on each side of and adjacent to the joint or loop;
    - (a) locate the first guide within 4 x pipe diameters from joint or loop,
    - (b) locate the second guide within 10 to 12 x pipe diameter from the first guide, and
    - (c) any additional guides as required to suite anchor design,
  - .2 and otherwise as shown.
- .2 Guide installation:

- .1 secure guides to the building structure and arranged to restrict lateral displacement and bowing of pipe adjacent to expansion joint or loop,
- .2 supported from building structure with structural steel angles, channels or plates,
- .3 guides may be omitted between an expansion joint and an adjacent anchor where an anchor is located within minimum distance in accordance with expansion joint manufacturer installation instructions, but not greater than four pipe diameters from the expansion joint.

### 3.4 Pump Connector Selection and Installation

- .1 Provide pump connectors as follows:

Service	Pump Type	Limits	Connector Type
Heating pumps Glycol Heating pumps Condensate pumps	Base Mount	Flange NPS 6 to NPS 14	Bellows
		Flange NPS 4 and smaller	Corrugated
	Vertical In-Line	All	Corrugated
	Circulator	All	None required
Steam Feedwater pumps	Base Mount or Multi-stage	NPS 3 and larger	Bellows
		NPS 2 ½ and smaller	None required
Chilled water pumps Glycol cooling pumps	Base Mount	Flange NPS 10 to NPS 14	Bellows
		Flange NPS 8 and smaller	Corrugated
	Vertical In-Line	All	Corrugated
	Circulator	All	None required
Condenser water pumps	Base Mount	All	Flexible Rubber, Corrugated
	Vertical In-Line	All	Flexible Rubber, Corrugated
Domestic Booster pumps	All	All	Corrugated
Sump pumps (sanitary and storm)	All	All	None required
Fire pumps	All	All	None required

- .2 Provide pump connectors on inlet and discharge side of each pump.
- .3 For vertical-in-line pumps, install connector in vertical portion of piping with pump isolation valves on top of connector; do not install connectors in the horizontal position. Provide pump supports at pipe elbows.
- .4 For base mount pumps, install connectors at pump inlet and outlet flanges.
- .5 Support and guide piping adjacent to pump connector to eliminate lateral misalignment; support piping independently from the connector.

- .6 For bellows type connectors, provide a pipe anchor on the piping as close as practical to the pump connector.

### 3.5 Equipment Connector Selection and Installation

- .1 Provide pump connectors as follows:

Service	Limits	Connector Type
Refrigeration equipment	Chilled Water Piping	Corrugated
	Condenser Water Piping	Corrugated or Flexible Rubber
	Refrigerant Relief Piping	Corrugated
Cooling Towers	Condenser Water Piping	Flexible Rubber (indoors) Corrugated (outdoors)
	Domestic Water Piping	Corrugated
Air compressors (except medical air compressors)	Inlet piping	None required
	Outlet piping	Corrugated
Medical Air Compressor Medical Vacuum Pumps	All	None required
Domestic Hot Water Tanks	Inlet and Discharge piping NPS 3 and larger	Corrugated
	Inlet and Discharge piping NPS 2 ½ and smaller	None required
Steam, heating and cooling coils, and humidifiers	Air handling units supported on spring vibration isolators	Flexible Metal Hose
	Other air handling units	None required
Hot water reheat coils, Fan Coil units	Optional : All sizes	Flexible Metal Hose, Flexible Non-Metallic Hose
Duct mounted humidifiers	Optional: All sizes	Flexible Non-Metallic Hose

- .2 Connector and hose sizing:
- .1 nominal diameter: same size as piping serving the equipment, not the equipment fitting size.
- .3 Support or guide piping firmly adjacent to equipment connectors and prevent pipes from swaying.
- .4 Where equipment connectors are to be installed at steam coils, locate connectors;
- .1 between control valve and coil on steam supply side, and
- .2 after steam trap on condensate line.
- .5 Where equipment connectors are to be installed at chilled and/or hot water coils, locate connectors;
- .1 between strainer and coil on the supply side, and
- .2 between coil and control valve on return side
- .6 At reheat coils installed in terminal boxes or in ductwork, arrange equipment connectors so there are no bends, and no axial offsets greater than the OD of the connector measured from the centerline of the connector.

### 3.6 Piping Anchor Installation

- .1 Design anchors suitable for locations shown;
- .1 submit shop drawings sealed by a professional engineer licensed in the jurisdiction of the project,

- .2 include connection loads to the building structure to be reviewed by the Structural Engineering Consultant
- .2 Fabricate piping anchors from structural steel angles, channels, or plates secured directly to piping and the building structure unless otherwise shown:
  - .1 single leg design, for piping NPS 4 and smaller and where distance between side of pipe and building attachment point is 600 mm (24 in) and less,
  - .2 minimum four-contact point design for all other distances.

### **3.7 Manufacturer's Inspection of Anchor and Guide Installation**

- .1 Make arrangements and pay for expansion joint manufacturer's field representative to review anchors and guides around expansion joints on;
  - .1 steam piping
  - .2 domestic hot water and recirculating water piping NPS 6 size and larger
  - .3 heating system and chilled water piping NPS 8 size and larger
- .2 Submit written report, prepared by field representative, confirming that expansion joints, anchors, and guides are installed in accordance with joint manufacturer's recommendations.

### **3.8 Start-Up and Testing**

- .1 Prior to placing expansion joint in service, apply match-marks to joint flanges/connectors to record axial, lateral, rotation and angular movement of joint connections. After system is at operating temperature, inspect match-marks and record displacement of joint connections compared to pre-start conditions. Submit report including photos of displaced match-marks.

**END OF SECTION**

## INDICATING GAUGES 20 05 19

### 1 GENERAL

#### 1.1 Scope

- .1 Provide temperature and pressure measuring devices and flow indicators as shown.

#### 1.2 Submittals

- .1 Submit manufacturer's catalogue literature for;
  - .1 flow indicators,
  - .2 thermometers,
  - .3 pressure gauges.
- .2 Product data sheets to include:
  - .1 measurement range,
  - .2 maximum operating pressure,
  - .3 installation accessories
- .3 Where there are multiple piping system design pressures based on building elevation, submit separate shop drawings for measuring and indication devices based on applicable piping system design pressure.

#### 1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
  - .1 CSA B51                      Boiler and Pressure Vessel Code
- .2 Product standards:
  - .1 ASME B40.100              Pressure Gauges and Gauge Attachments
  - .2 ASME B40.200              Thermometers, Direct Reading and Remote Reading
  - .3 ASME PTC 19.3 TW      Thermowells

#### 1.4 Quality Control

- .1 All products that are connected to or installed in a piping system are to have Canadian Registration Numbers in accordance with CSA B51.

### 2 PRODUCTS

#### 2.1 Thermometers and Pressure Gauges - Selection Criteria

- .1 General:
  - .1 normal operating reading to be between one-half and two-thirds of full scale range,
  - .2 expected maximum and minimum readings to be within scale range.
  - .3 thermometers to have both Celsius and Fahrenheit scales,
  - .4 pressure gauges to have both kPa and psi scales.
  - .5 select pressure gauges and thermometers from manufacturer's standard product line.



*Standard of Acceptance*

- Terice
- Ashcroft
- Dwyer
- Weksler
- Winter
- Weiss
- WIKA

**2.2 Direct Reading Thermometers – Liquid and Gases**

- .1 For liquid and compressed gas service only.
- .2 Electronic solar cell light-powered:
  - .1 length: 178 mm (7 in.)
  - .2 temperature indicator: electronic, light-powered solar cell, glass passivated thermistor, and 11 mm 14 mm (9/16 in.) LCD display
  - .3 measurement units: switchable °C/ °F units scale,
  - .4 case: NEMA-4X cast aluminium with epoxy finish,
  - .5 process connection: NPT threaded mount, and constructed of:
    - (a) for carbon steel pipe: brass,
    - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
    - (c) for copper tube: brass
  - .6 resolution: 1/10<sup>th</sup> of measurement degree,
  - .7 accuracy: 1% or 0.5°C (1 °F),
  - .8 refresh rate: 10 seconds,
  - .9 conforms to ASME B40.200,
  - .10 with matching thermowell.

*Standard of Acceptance*

- Terice - fig. SX9

- .3 Industrial, adjustable angle type;
  - .1 indicator: 225 mm (9 in.) long, coloured organic spirit fill, magnifying lens type,
  - .2 measurement units: dual scale °C/ °F,
  - .3 case: cast aluminum with epoxy finish,
  - .4 window: UV stabilized acrylic for temperature range up to 150°C (300°F), and glass for higher temperatures,
  - .5 process connection: NPT threaded mount, and constructed of:
    - (a) for carbon steel pipe: brass,
    - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
    - (c) for copper tube: brass
  - .6 accuracy: ± 1 unit minor scale division,
  - .7 conforms to ASME B40.200,

- .8 with matching thermowell.

*Standard of Acceptance*

- ° Terice – fig. BX9

- .4 Bi-metal dial, adjustable angle:

- .1 scale length: Ø125 mm (5 in. dia.)
- .2 temperature indicator: bi-metal type dial display, silicon damped for temperature range up to 149°C (300°F) and undamped at higher temperatures, with calibration screw,
- .3 measurement units: dual scale °C/ °F,
- .4 case: 300 series stainless steel, hermetically sealed,
- .5 window: glass,
- .6 process connection: NPT threaded mount, and constructed of:
  - (a) for carbon steel pipe: brass,
  - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
  - (c) for copper tube: brass
- .7 accuracy: ± 1 full scale
- .8 conforms to ASME B40.200.
- .9 conforms to ASME B40.200,
- .10 with matching thermowell.

*Standard of Acceptance*

- ° Terice - fig. B856

### **2.3 Remote Reading Thermometers**

- .1 Surface-mounted remote reading thermometer:

- .1 115 mm (4½ in) liquid filled or gas activated type,
- .2 capillary sensing tube: armoured stainless steel capillary tube with union fitting connection, of length required to suit installation requirements,
- .3 measurement units: dual scale °C/ °F,
- .4 case: cast aluminum with epoxy finish, with mounting ring,
- .5 window: clear glass with retaining ring or hinged bezel,
- .6 process connection: NPT threaded mount, and constructed of:
  - (a) for carbon steel pipe: brass,
  - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
  - (c) for copper tube: brass
- .7 accuracy: ± 1 unit minor scale division,
- .8 conforms to ASME B40.200,
- .9 with matching thermowell.

*Standard of Acceptance*

- ° Terice - fig. V/L80341 (gas/liquid activated)

- Weksler - fig. 413B (gas activated)
- Ashcroft - fig. 600A Series (gas activated)

## **2.4 Thermometer Wells (Thermowells)**

- .1 Manufactured from bar stock or forged brass,
  - .1 compatible with temperature sensors used,
  - .2 external NPT mounting threads,
  - .3 pressure rating: 2000 kPa (300 psig) at 121°C (250°F)
  - .4 C.R.N. registered.
- .2 Body material:
  - .1 for carbon steel piping: brass,
  - .2 for copper and brass tubing: brass.
  - .3 for stainless steel piping: 304 stainless steel.
- .3 C.R.N. to CSA B51.

### *Standard of Acceptance*

- Terice - fig. 4350

## **2.5 Temperature Well Conversion Kits**

- .1 Retrofit kit to convert straight liquid filled thermometer wells to accept bi-metal dial thermometers.

## **2.6 Pressure Gauges – Liquid and Steam Process**

- .1 For measurement of pressure piping for liquid and steam systems.
- .2 Direct pressure measurement:
  - .1 display: Ø115 mm (4½ in. dia.) dial type, dry type, adjustable stainless steel pointer movement
  - .2 measurement units: dual scale kPa/ psi,
  - .3 case: fiberglass reinforced polypropylene, solid-front and blow-out back,
  - .4 window: acrylic,
  - .5 wetted parts:
    - (a) for carbon steel pipe: brass,
    - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
    - (c) for copper tube: brass
  - .6 accuracy: 0.5% full scale reading,
  - .7 maximum service temperature: 121°C (250°F)
  - .8 conforms to ASME B40.100 Grade 2A.
  - .9 C.R.N. to CSA B51.

### *Standard of Acceptance*

- Terice – 450B, 450SS

## 2.7 Pressure Gauges – Ventilation

- .1 For measurement in HVAC ventilation systems.
- .2 Direct or differential pressure measurement:
  - .1 process service: ventilation air,
  - .2 display: Ø115 mm (4½ in. dia.) dial type, adjustable stainless steel pointer movement, pressure relief plug, and NPT 1/8 low- and high-pressure inlet ports, and tubing adaptors,
  - .3 measurement units: dual scale Pa / in. w.c.
  - .4 case: cast aluminium with bezel with epoxy finish coat,
  - .5 window: acrylic,
  - .6 accuracy: ±2% full scale reading,
  - .7 service pressure range: -500 mm Hg to 103 kPa (- 20 in.Hg. to 15 psig)
  - .8 maximum service temperature: -6.5°C to 60°C (20 to 140°F),
  - .9 accessories:
    - (a) attached surface mounting plate,
    - (b) adjustable signal flag for measurement across air filter banks.

### *Standard of Acceptance*

- ° Dwyer - fig. 2000, 2000-ASF series

## 2.8 Pressure Gauge Accessories

- .1 Pressure snubbers:
  - .1 brass or T303 stainless steel construction,
  - .2 C.R.N. to CSA B51.
- .2 Gauge isolation ball valves:
  - .1 for water, compressed gases, and fuel oil services,
  - .2 NPS 1/4, brass body, quarter-turn ball valves with Teflon seats,
  - .3 minimum pressure rating: 2000 kPa (300 psig) at 121°C (250°F),
  - .4 C.R.N. to CSA B51.

### *Standard of Acceptance*

- ° Terice - fig. 866

- .5 alternate product: NPS 1/4 or 1/2 size as specified for associated liquid or gas piping system.
- .3 Gauge isolation valves for steam service:
  - .1 isolation valves as specified for associated steam piping system.
- .4 Coil syphons:
  - .1 1/4" NPT x 180° coil, seamless 304SS, schedule 40 body,
  - .2 minimum pressure rating: 3500 kPa (500 psig) at 343°C (650°F),

- .3 C.R.N. to CSA B51.

*Standard of Acceptance*

- Trerice – 885-4

## **2.9 Test Port Plugs**

- .1 Piping test port plugs with gauge adaptors for pressure tests or insertion of pocket thermometer probes.
  - .1 Wetted parts: lead-free brass, with BUNA-diaphragm core,
  - .2 size: 1/2" NPT with MNPT threaded connection, with probe guard
  - .3 pressure rating: 7000 kPa (1000 psi) from -40 to 150°C (-40 to 300°F)

*Standard of Acceptance*

- Winters – fig. STP-LF

## **3 EXECUTION**

### **3.1 Installation - General**

- .1 Install thermometers and gauges not more than 3 m (10 ft) from floor or platform, or install remote reading thermometers and gauges, with dial mounted at eye level, mounted on backplate and fastened to building structure.
- .2 Provide nameplates for each gauge and thermometer as specified in Section 20 19 00 Identification.

### **3.2 Thermometer Installation**

- .1 Install thermometers on inlet and outlet of;
  - .1 heat exchangers,
  - .2 water heating and cooling coils,
  - .3 water boilers,
  - .4 chillers,
  - .5 open-circuit cooling towers and closed-circuit water coolers,
  - .6 domestic hot water tanks, and
  - .7 as shown.
- .2 Install thermometers in thermowells.
- .3 Install thermowells with extension necks where piping and equipment is to be insulated.

### **3.3 Pressure Gauge Installation**

- .1 Install pressure gauges on inlet and outlet of;
  - .1 heat exchangers,
  - .2 water heating and cooling coils,
  - .3 steam piping to heating coils (inlet only),
  - .4 water boilers,
  - .5 chillers,
  - .6 closed-circuit water coolers,

- .7 domestic hot water tanks,
  - .8 steam boilers,
  - .9 condensate receivers,
  - .10 deaerators,
  - .11 air-compressors (discharge only),
  - .12 compress-air dryers,
  - .13 compressed-air receivers, and
  - .14 as shown.
- .2 Provide an isolation valve for each pressure gauge. For differential pressure gauges, provide an isolation valve on each high and low pressure sensing lines.
- .3 Provide pressure snubbers on pressure gauges at the following locations:
- .1 suction and discharge sides of positive-displacement pumps including oil pumps,
  - .2 air-compressor discharge, and inlet and discharge of compressed-air dryers, and at outlet of compressed-air receivers,
- .4 Install coil syphons on steam and condensate pressure gauges.

### **3.4 Test Port Plugs**

- .1 Install test port plugs in locations as shown. Test port plugs shall not be used in lieu of temperature or pressure gauges specifically shown.

**END OF SECTION**

## **GENERAL REQUIREMENTS FOR VALVES**

### **20 05 23**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide valves in piping systems for shut-off service, manual flow balancing, check-stops and valve bodies for automatic flow control.
- .2 This specification section provides general requirements for valves.

##### **1.2 Related Sections**

- .1 Refer to the following valve specification sections for requirements for general-duty valves in addition to the general requirements specified herein.

21 05 23	General-Duty Valves for Water-Based Fire-Suppression Piping
22 05 23.13	General-Duty Valves for Plumbing Piping
22 05 23.16	Valves for Underground Water Service Piping
22 05 23.19	General-Duty Valves for Sewage Systems
22 15 16	General Service Compressed-Air Valves
23 05 23.13	General-Duty Valves for HVAC Water Piping
23 05 23.19	Stainless Steel Valves for HVAC Water Piping
23 05 23.23	General-Duty Valves for Steam System Piping
23 05 23.26	Valves for Steam Boiler Plant Piping
23 05 23.29	Stainless Steel Valves for Clean Steam System Piping
- .2 Refer to the following specifications sections for requirements for specific-duty valves in addition to the general requirements specified herein.

22 31 16	Commercial Water Softeners
22 53 13	Irrigation System
22 60 13.54	Laboratory Gas Piping – Copper
22 60 13.55	Laboratory Gas Piping – Stainless Steel
22 60 13.70	Medical Gas Piping
22 67 13	Process Water Piping for Laboratories and Healthcare Facilities
23 11 13	Facility Fuel Oil Piping and Accessories
23 11 23	Facility Natural Gas Piping and Accessories
23 24 17.16	Services for Selective Catalytic Reduction System
23 24 19	Diesel Exhaust Fluid Systems
23 27 13	Vacuum Insulated Piping – Cryogenic Service
23 26 13	Instrumentation Piping and Accessories
23 26 16	Process Tubing and Accessories – Stainless Steel
23 26 19	Vacuum Insulated Piping – Cryogenic Service
23 61 05	Refrigeration - Field Constructed

23 61 07	Refrigeration Piping – HVAC
25 35 01	Building Automation Compressed Air Supply

### 1.3 Submittals

- .1 Submit manufacturer product data-sheets for valves, including pressure-temperature ratings with confirmation that the valve meets the required MCPR rating specified for each valve.
- .2 Where valves are specified to be listed (certified) to a standard, include the following information for each affected product:
  - .1 applicable standard by name and reference number,
  - .2 name of accredited testing organization or their mark who certified the product, and
  - .3 the testing organization file reference number.
- .3 Where valves are required to have a CRN, include the CRN and its expiry date on each valve submittal.
- .4 Where manufacturer pre-printed data-sheets do not include this information, a schedule may be submitted which includes the manufacturers name, model number and the required listing and/or CRN information described above. Where the product is name-branded for a manufacturer, include the name of the source manufacturer.

### 1.4 Applicable codes and standards

- .1 Legislation:
  - .1 Valves installed in piping systems which are subject to provincial or federal pressure piping legislation shall have current Canadian Registration Numbers ("CRN") in accordance with CSA B51.
- .2 Installation standards, codes and guidelines:
  - .1 CSA B51 Boiler and Pressure Vessel Code.
  - .2 Refer to applicable piping specification sections for any other specific requirements.
- .3 Product standards:
  - .1 ANSI/ASME B1.20.1 Pipe Threads, General Purpose, Inch
  - .2 ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings
  - .3 ASME B16.5 Pipe Flanges and Flanged Fittings
  - .4 ASME B16.10 Face-to-Face and End-to-End Dimensions of Valves
  - .5 ASME B156.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings
  - .6 ASME B16.34 Valves Flanged, Threaded and Welding Ends
  - .7 ASME B16.47 Large Diameter Steel Flanges: NPS 26 Through NPS 60
  - .8 ISO 5211 Industrial Valves – Part-turn Actuator Attachments
  - .9 MSS SP-25 Standard Marking System for Valves, Fittings, Flanges, and Unions
  - .10 MSS SP-42 Corrosion-Resistant Gate, Globe, Angle, and Check Valves with Flanged and Butt Weld Ends (Classes 150, 300, & 600)
  - .11 MSS SP-67 Butterfly Valves
  - .12 MSS SP-68 High Pressure Butterfly Valves with Offset Design
  - .13 MSS SP-70 Cast Iron Gate Valves, Flanged and Threaded Ends
  - .14 MSS SP-71 Cast Iron Swing Check Valves, Flanged and Threaded Ends



- |                  |  |
|------------------|--|
| .15 MSS SP-72    | Ball valves with Flanged or Butt-Welding ends for General Service  |
| .16 MSS SP-78    | Cast Iron Plug Valves  |
| .17 MSS SP-80    | Bronze Gate, Globe Angle and Check Valves  |
| .18 MSS SP-85    | Cast Iron Globe and Angle Valves, Flanged and Threaded Ends  |
| .19 MSS SP-110   | Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends                                  |
| .20 MSS SP-125   | Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves                                |
| .21 MSS SP-126   | In-Line, Spring-Assisted, Center-Guided Check Valves (Carbon, Alloy Steel, Stainless Steel, & Nickel Alloys) |
| .22 MSS SP-136   | Ductile Iron Swing Check Valves  |
| .23 MSS SP-139   | Copper Alloy Gate, Globe, Angle, and Check Valves for Low Pressure/Low Temperature Plumbing Applications     |
| .24 NSF/ANSI 61  | Drinking Water System Components – Health Effects  |
| .25 NSF/ANSI 372 | Drinking Water System Components – Lead Content (formerly NSF/ANSI 61- Annex G).                             |

## 1.5 Quality and Equivalence

- .1 Valve selections are in general identified by model designations taken from manufacturers catalogues to indicate physical properties and quality requirements not otherwise described.

## 2 PRODUCTS

### 2.1 General

- .1 Refer to related specification sections.
- .2 Manufactures and/or trade names listed in Table 1 are acceptable for various indicated valve types, where products offered are essentially similar to those identified by manufacturer or model number under "Standard of Acceptance" designation in the related specification sections.
- .1 Refer to the General-duty valve specification sections and specific-duty valve requirements contained in the related piping system specification sections.
- .2 Additional specification requirements and/or certification requirements may be required by those sections.

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
A-Chem Valves & Controls	•			•		•
American Valve						•
APCO		•				
Apollo				•		•
Bonney Forge	•					
Beric	•					
Bray				•		•

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
Canadian Worcester Controls						•
Challenger				•		
Couplox				•		
Crane	•			•		•
Crane Centreline				•		
Crane Flowseal				•		
Dahl Bros	•					•
Demco				•		
DeZurik				!		
Durabla		•				
Grinnell				•		
Gruvlok				•		•
Hattersley Milliken (Crane)					•	
Jenkins	•			•		•
Keystone				•		
Kitz	•			•		•
MA Stewart (MAS)	•					•
Milwaukee Valve				•		•
Mueller		•		•	•	
Neo Valves	•					•
Nibco	•	•		•		•
Nordstrom					•	
Powell	•					
Preso			•			
S.A. Armstrong	•		•			
Shurjoint				•		•
Sure Seal				•		
Tour & Anderson			•			
Toyo Valve (Red & White)	•					•
Triad				•		
Trueline	•					•
Valmatic		•				
Velan	•			•		•
Victaulic				•		•
Watts	•			•		•
WKM				•		

### 3 EXECUTION

#### 3.1 Valve Selection Criteria

- .1 Select valves in accordance with function criteria as shown in Table 2.

Table 2: Valve Function Selection						
Function	Gate	Butterfly	Ball	Globe	Plug	DRV
Shut-Off	•	•	•		•	
Flow Balancing only (excluding pumps)				•		•
Pump Balancing		• [1] [3]		•		•

**Notes:**

- [1] Gear operator with position limit memory stops.  
[2] Not used.  
[3] Sized one (1) NPS line size smaller than pipe line size (not pump discharge size).

#### 3.2 Piping System Drain Valves

- .1 Provide drain valves on piping and at equipment as follows unless otherwise shown on drawings:
- .1 On pipe mains and branches NPS 3 and under, and for equipment with pipe connections NPS 4 and smaller:
    - (a) NPS ¾ ball valve in accordance with pipe system specification with integral NPSH ¾ hose end with cap and chain.
  - .2 On pipe mains NPS 4 to NPS 6, and for equipment with pipe connections NPS 6 and larger:
    - (a) NPS 1 ball valve, with a NPT threaded brass Cam and Groove female coupler fitting with dust-plug
  - .3 On pipe mains NPS 8 and larger:
    - (a) NPS 2 ball valve, with a NPT threaded brass Cam and Groove female coupler fitting with dust-plug.

#### 3.3 Valve Installation - General

- .1 Install shut off valves at:
- .1 branch take-offs,
  - .2 to isolate piping to each piece of equipment, and
  - .3 in locations shown.
- .2 Remove internal parts of valves before soldering, welding or brazing pipe to valve body.
- .1 Exception: where valve is provided with tube end extensions to allow soldering or brazing without removal of internal parts.
  - .2 For valves which do not permit disassembly including ball valves and inline check valves, comply with valve manufacturer instructions to protect valve internal components during soldering, brazing or welding.
- .3 Install triple duty or throttling valves where shown in pump discharge piping with ten pipe diameters of straight pipe on the inlet side and two pipe diameters on outlet side.

- .4 Install butterfly valves between weldneck or slip-on flanges.

### 3.4 Valve Orientation and Accessibility

- .1 Arrange valve hand-wheels and operating levers to be accessible.
- .2 In equipment rooms and service spaces provide chain operators for valves mounted more than 2m (6 ft) above floor or access platform. Provide sufficient chain length to extend to 1.5m (4 ft-6 in) above floor or platform and to be hooked on clips secured to building structure, clear of walking aisles.
- .3 In horizontal piping (see figure 1);
- .1 For OS&R valves, install the valve with stem vertical where the valve centerline is not more than 1200 mm above the adjacent floor or access platform. For greater heights, install the valve with stem horizontal. Where space is restricted, the valve may be installed with the valve spindle at a 45° angle from the vertical where the valve centerline is not more than 1500 mm above the floor or access platform.
- .2 For gear operated valves, install with gear-box on top of the valve and hand-wheel shaft in the horizontal position.
- .3 For lever operated valves, install with handle on top of valves where the valve centerline is not more than 1500 mm above the floor or access platform. Where spaces is restricted, the valve may be positioned with the lever handle shaft in the horizontal position. For greater heights, install valves with handle shaft in the horizontal position.

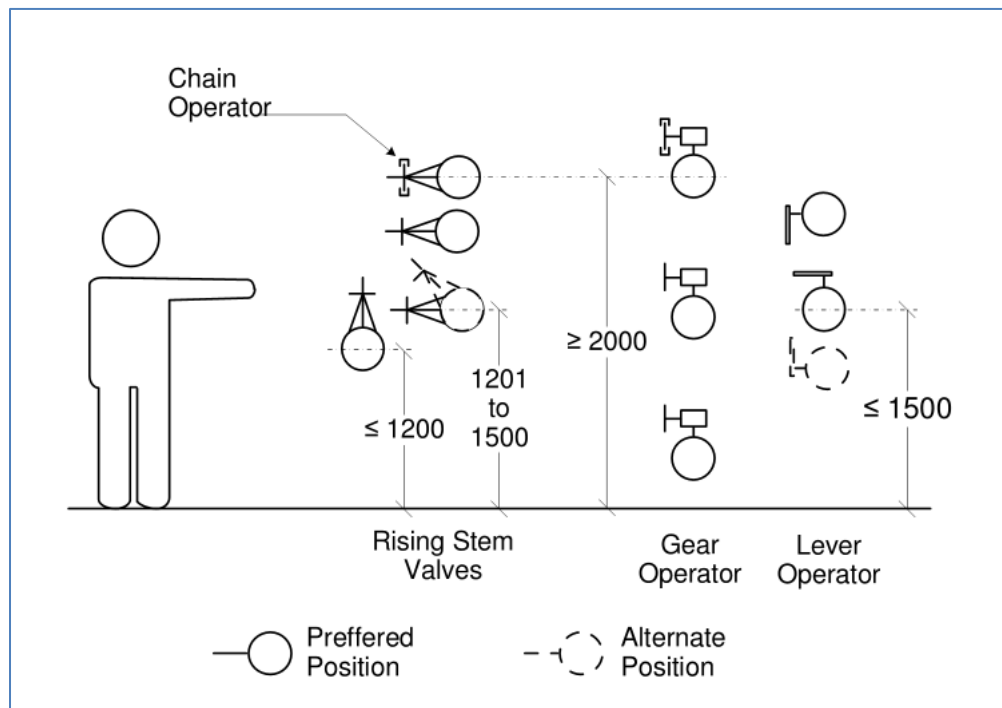


Figure 1: Valve Spindle Arrangement

- .4 In vertical piping, install with valve stem facing directly towards the means of access. Where access space in front of the valve is less than 900 mm (36 in), rotate the valve 45° from the straight forward position.

**END OF SECTION**

## **WELDING AND BRAZING**

### **20 05 24**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Weld or braze pipe and fittings for work of Division 20.

##### **1.2 Definitions**

- .1 The following definitions apply to this specification section:

**AHJ (BPV):** *the authority having jurisdiction which is responsible for boiler, pressure vessel and pressure piping safety in the province of the project.*

- .2 In this specification,
  - .1 the word “piping” also includes tubing as the case applies.
  - .2 the words “welding” or “welder” shall be read as to also refer to “brazing” or “brazer” unless the context otherwise dictates one or the other.

##### **1.3 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 ASME B31.1                      Pressure Piping
  - .2 ASME B31.3                      Process Piping
  - .3 ASME B31.9                      Building Services Piping
  - .4 ASME BPVC Section V Nondestructive Examination
  - .5 ASME BPVC Section IX              Welding and Brazing Qualifications
  - .6 CSA B51.                      Boiler, Pressure Vessel, and Pressure Piping Code

##### **1.4 Quality Control**

- .1 Welding of piping systems which have specified design pressures greater than 100 kPa (15 psi) to be carried out using approved welding procedures by welders certified for pressure piping by the AHJ (BPV), whether or not the piping system is subject to registration as pressure piping.
- .2 Welding procedures shall be registered with the AHJ (BPV), in accordance with CSA B51 and as qualified in accordance with ASME BPVC Section IX.
- .3 Welders shall be certified for welding of pressure piping in accordance with the requirements of the AHJ (BPV). Welders shall be qualified by their employer on the employers welding procedures.
- .4 For piping systems which have specified design pressure of 100 kPa (15 psi) or less, welding procedures and welders shall be qualified by the Contractor in accordance with the requirements of ASME B31.9.

## **2 PRODUCTS**

### **2.1 Not used**

## **3 EXECUTION**

### **3.1 Welding Method and Quality**

- .1 Welding, both shop and field, to be electric arc in accordance with recommendations of Canadian Welding Bureau unless other welding methods are specified in the piping specification sections.
- .2 Welds to be solid homogeneous part of metals joined and free from pits, slag-inclusions, and scale.
- .3 Weld surfaces to be smooth and regular and weld metal deposition to achieve full penetration groove weld fused to the base metal throughout joint thickness. Fillet welds, where permitted or required by applicable piping codes, shall achieve adequate depth of fusion of the base metal as required by those codes.
- .4 Brazed joints to use brazing filler and fluxes as specified for each applicable piping system. For socket joints, the tube and joint are to overlapped not less than four times the thickness of the thinner base material, with filter material penetrating to this full depth and finished with well-developed fillet.

### **3.2 Welded Connections to Existing Pressure Piping Systems**

- .1 At the commencement of the Work, where registration and/or inspection of the piping system is required in accordance with provincial boiler and pressure vessel regulations, review with the AHJ (BPV) inspector to determine their weld testing requirements to validate the proposed welding procedures for connecting to existing piping, including but not limited to:
  - .1 acceptable dimensional misalignment between old and new pipe;
  - .2 requirements, if any, for metallurgical analysis of exiting piping;
  - .3 sample butt weld guided-bend test; and
  - .4 sample fillet weld test.
- .2 After testing requirements are determined, provide a proposed schedule for tie-in connections and required existing service shut-down periods, for approval prior to commencing work.
- .3 Prior to shut-down of existing piping systems for tie-ins, inspect the existing pipe O.D. dimensions to confirm their suitability for pipe attachment. Specifically, where the work requires a complete transection of an existing pipe, check the existing pipe for excessive out-of-roundness which would otherwise exceed the allowable misalignment as defined in the applicable ASME piping code. Where necessary, trim the pipe ends in accordance with the referenced piping code.

### **3.3 Welding Examination**

- .1 For piping systems which are specified to be constructed to ASME B31.1 or ASME B31.3, examination of pipe welds, including both visual and other nondestructive examination performed in accordance with those piping codes shall be arranged and paid for by the Contractor, and are to be performed by a specialist testing company whose personnel are qualified to perform such examinations in accordance with ASME BPVC Section V.
- .2 For piping systems which are specified to be constructed to ASME B31.9, examination of pipe welds in accordance with that piping code shall be performed by the Contractor using personnel who are suitably experienced for such examinations.
- .3 Acceptance criteria for weld examination shall be in accordance with the specified ASME piping code applicable to each piping system and as may be specified in other Specification sections of Division 21 to 23.

- .1 for clarity, where ASME B31.9 code applies to a piping system, the weld examinations and weld defect acceptance criteria are summarized in the following table.
  - (a) Notwithstanding the listed weld defect criteria, the overall quality of the weld shall also be able to meet the requirements for incomplete weld penetration and weld root concavity. However, examination of the interior surface of the weld is not required.

<b>Table 1: Weld Defect Acceptance Criteria – ASME B31.9</b>		
Type of Weld	Weld Defect	Acceptance Criteria
Girth (butt) weld, Groove weld, Fillet weld, Socket weld, Seal weld	Cracks	None
	Lack of fusion	Length of unfused areas ≤ 20% of pipe circumference or total length of weld, and not more than 25% in any 150 mm (6 in.) of weld
	Undercut	Not exceed the lessor of 1 mm (1/32 in.) or 12.5% of wall thickness.
	Weld surface	Weld reinforcement not to exceed 4.8 mm (3/16 in.)

### 3.4 Welding Inspection

- .1 Arrange and pay for any required inspection of welds by the AHJ (BPV).
- .2 Welders certificates and welding procedures used for the Work to be made available for inspection by the AHJ (BPV) on demand. Provide traceability of welders work by either stamping each weld with the welder's identifying number, or maintain a record log to record and identify each welders work.

### 3.5 Radiography

- .1 Notwithstanding that a referenced ASME piping code may not require radiographic or other non-visual non-destructive examination methods based on the service conditions of a piping system, provide radiographic examination of piping systems as specified herein.
- .2 Arrange and pay for services of an inspection company specializing in making and interpreting radiographic imaging of pipe welds.
- .3 For piping systems where ASME B31.3 is the specified piping code, the following rules apply:
  - .1 The designated lots of piping for radiographic examination ("Lots") are defined as follows:
    - (a) Lot 1: the aggregate of all piping within a boiler plant room or other mechanical service room.
    - (b) Lot 2: the aggregate of all piping located in a vertical service space (total of all such piping).
    - (c) Lot 3: the aggregate of all piping located in areas not defined in Lot 1 and Lot 2.
- .4 Submit a copy of the radiograph results and analysis for every weld so examined.
- .5 Radiography to be in accordance with ASME BPVC Section V, article 2. Weld acceptance criteria shall be in accordance with the specified ASME piping code.
- .6 Where a weld is found to be defective in a Lot, conduct two additional tests in the same Lot. If one of those additional tested welds is found defective, conduct an additional second set of two additional tests in the same Lot. If one of those welds fail, then conduct 100% radiographic examination of all butt welds in the Lot.
- .7 Repairs to defective welds shall be performed in accordance to the requirements of the specified ASME piping code.

**END OF SECTION**





## **PIPELINE HOT-TAPPING AND LINE STOPPING**

### **20 05 26**

#### **1 GENERAL.**

##### **1.1 Scope**

- .1 Make branch connections to existing piping systems by means of hot-tapping while maintaining main pipeline in service.
- .2 Installation of temperature thermowells to existing piping systems by means of hot-tapping while maintaining main pipeline in service.
- .3 Temporarily isolate portions of existing piping systems by means of pipe line-stopping.

##### **1.2 Limitations on Use**

- .1 Hot-tapping and/or line-stopping are not to be used where isolation and/or draining of the pipeline is permitted by the Owner.
- .2 Hot-tapping and/or line-stopping are only to be used where;
  - .1 permitted by the Owner,
  - .2 specified for particular branch connections and for temperature thermowells,
  - .3 the existing piping design pressure at the location of a welded-on hot-tap does not exceed 2100 kPa (300 psig),
  - .4 the existing piping design pressure at the location of a mechanical-bolted tapping-saddle does not exceed 1050 kPa (150 psig); and
  - .5 permitted by the AHJ responsible for boiler and pressure vessel safety.
- .3 The application of this specification is limited to the following piping systems:
  - .1 potable water systems,
  - .2 liquids no more hazardous than water, including building heating and cooling piping systems which contain industry-standard corrosion inhibitors and other related chemical treatment additives, including anti-freeze additives,
  - .3 saturated steam at design pressures not exceeding 1100 kPa (160 psig), or
  - .4 steam-condensate systems not exceeding a design temperature of 185°C (365°F),

##### **1.3 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 24 Welding and Brazing
  - .2 22 05 01 Plumbing Piping Systems – General Requirements
  - .3 22 05 23.13 General-Duty Valves for Plumbing Piping
  - .4 22 11 16.13 Domestic Water Piping – Copper
  - .5 23 05 01 HVAC Piping Systems - General Requirements
  - .6 23 05 23.13 General-Duty Valves for HVAC Water Piping

- .7 23 21 13.23 Hydronic Piping – Carbon Steel
- .8 23 21 13.33 Hydronic Piping – Copper

#### 1.4 Definitions and Abbreviations

- .1 The following definitions apply to this section.
  - .1 **Hot-tapping** – the method by which a new branch connection is made to an existing mains pipe while the mains pipe is under pressure and continues operating.
  - .2 **Line-Stopping** – the method for temporarily blocking flow in an existing pipe by use of line-plugging or line-freezing.
  - .3 **Line-Freezing** – line-stopping by freezing the mains pipe fluid by application of cryogenic fluids to the exterior of the pipe.
  - .4 **Line-plugging** – line-stopping by insertion of a plug through a branch connection, and which may require the use of hot-tapping to make suitable branch connections.

#### 1.5 Applicable Codes and Standards

- .1 Legislation;
  - .1 TSSA SB-05-02(R2) Safety Information Bulletin: Hot Tap and Line Stopping for Pressure Equipment.
- .2 Installation codes and standards (as adopted and amended by the AHJ for pressure vessels):
  - .1 CSA B51 Boiler, pressure vessels, and pressure piping code
  - .2 ASME B31.1 Power Piping
  - .3 ASME B31.3 Process Piping
  - .4 ASME Section IX Boiler and Pressure Vessel Code: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators – Welding, Brazing and Fusing Qualifications.
  - .5 ASME PCC-2 Repair of Pressure Equipment and Piping

#### 1.6 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency (license) issued by the AHJ responsible for pressure piping system safety. The license shall include an endorsement for performance of hot-tapping operations, when required by the AHJ.

#### 1.7 Registration and Inspection

- .1 Before commencing work, make arrangements and pay for registration and inspection by the AHJ responsible for boiler and pressure vessel safety as applicable to the piping system being modified. Include specific information required for hot-tapping and/or line stopping.
- .2 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.

#### 1.8 Design Criteria

- .1 Specialist hot-tapping contractor to prepare hot-tapping procedures in accordance with, at a minimum, the requirements of the applicable piping code, ASME Section IX and ASME PCC-2.

- .1 for hot-tapping by welding to steel pipe, develop welding procedures to provide for a resulting maximum allowable working pressure of the new branch fitting attachment that is not less than 2.0 times the piping system design pressure listed in the schedule at the end of this section, assuming the following wall thickness deductions:
  - (a) 12.5% mill tolerance of new nominal wall thickness,
  - (b) 0.75 mm (0.030) corrosion allowance,
- .2 allowable pressure to be based on the measured actual wall thickness of the existing mains pipe.
- .2 Piping design and installation code:
  - .1 Refer to the applicable specification section for the piping system.
- .3 System design criteria.
  - .1 Refer to the applicable specification section for the piping system.

## **1.9 Submittals**

- .1 Shop drawings:
  - .1 submit product data sheets for materials specified herein.
  - .2 submit shop drawings for fabricated components and equipment.
- .2 Submit written procedures for hot-tapping and/or line-plugging as applicable to the method used.
- .3 Submit calculations sealed by a professional engineer licensed in the province of the project, for the resulting maximum allowable working pressure of the resulting branch-to-main pipe fitting at the design temperature of the applicable piping system.

## **1.10 Quality Control**

- .1 Welding of piping to conform to specification section 20 05 24 and as specified herein.
- .2 Produce and implement hot-tapping procedures, which includes but is not limited to:
  - .1 pre-installation inspections, preparation, welding, pressure testing, weld examination, and safety precautions,
  - .2 specific welding procedure specifications (WPS) suitable for hot tapping, which include
    - (a) requirements for groove welds for direct attachment of integrally reinforced welding branch fittings, with requirements (if any) for supplemental reinforcing pads,
    - (b) the use of fillet-weld attachments for split-tee welding fittings.
- .3 Hot-tap welding procedures are to be registered with the AHJ responsible for pressure piping safety, and as a minimum shall conform to ASME Section IX and ASME PCC-2.
- .4 Hot-tap branch fitting or fabricated split-tee assembly to have current Canadian Registration Number (CRN) in accordance with CSA B51.

## **2 PRODUCTS**

### **2.1 Hot-Tapping – Steel Piping**

- .1 Reinforced outlet fittings: as specified in the applicable piping specification section,
- .2 Flanges and gaskets: as specified in the applicable piping specification section.
- .3 Manufactured split-tees:
  - .1 fabricated split-tees with integral reinforced outlets branch fitting and branch end fitting,

- .2 inside surface of split tee to be equal to the outside diameter of the mains pipe,
- .3 designed for fillet welds of the split-tee to the mains pipe, and with flange-edge weld joint of mating flanges,
- .4 Branch pipe run end fitting:
  - .1 branch size NPS 2 and smaller: threaded.
  - .2 branch size NPS 2-1/2 and larger: flanged.
  - .3 for thermowells: threaded.

## **2.2 Hot-Tapping - Copper Tube**

- .1 For potable water applications only.
- .2 Two-piece mechanical tapping saddle:
  - .1 body: two-piece body, T304 stainless steel to ASTM A240, providing 360° coverage of mains pipe,
  - .2 hardware: fastening hardware including threaded studs, washer bar to be T304 stainless steel to ASTM A240, and welded to the body.
  - .3 branch outlet fitting: T304 stainless steel to ASTM A240, with MNPT threaded end fitting to ASME AB1.20.1.
  - .4 gasket: gridded, multiple O-ring, NBR gasket providing complete coverage of mains pipe, bonded to the body,
  - .5 listed for low lead and contamination to NSF 61 and NSF 61+G
- .3 Pipe sizes:
  - .1 mains pipe size: NPS 2 to 8
  - .2 branch pipe size: at least one NPS size smaller than the mains pipe.
- .4 Performance:
  - .1 working pressure rating: 1000 kPa (148 psi),
  - .2 test pressure: 1.5 times working pressure.
  - .3 working temperature rating: -40 to 120°C (-40 to 248°F)

### *Standard of Acceptance*

- PowerSeal Corp. - fig. 3425 PowerStop
- Pacific Flow Control Inc.

## **2.3 Hot Tapping for Thermowells (Carbon Steel Piping)**

- .1 Carbon steel branch-welding fitting, with internal threads to accept thermowell,
- .2 Suitable for Ø15mm (1/2 in. dia.) and Ø20mm (3/4 in. dia.) thermowells.
- .3 Designed to allow removal of the temporary hot-tap isolation branch valve after installation of the thermowell.
- .4 Select hot tap size (outlet fitting and isolation valve) to allow installation of the thermowell to pass through the temporary hot-tap valve.

### *Standard of Acceptance*

- ° PipeMan Products Inc. - fig. ThermSetter 5075/Thermfit

## **2.4 Valves**

- .1 As specified in the applicable piping specification valve sections,
  - .1 branch size NPS 2 and under: full ported ball valve,
  - .2 branch size NPS 2-1/2 and larger: gate valves.

## **3 EXECUTION**

### **3.1 Site Safety**

- .1 At all times manage the site safety protocols described in the hot-tapping or line-stopping procedure(s). Exclude all personnel not necessary for the actual hot-tap or line-stopping operation from the work area.

### **3.2 Site Investigation**

- .1 Prior to performing any hot-tapping operation for weld-on branch connections, verify existing pipe wall thickness at the location of the hot-tap with an ultrasonic thickness gauge. Actual wall thickness to be used in verifying suitability of welding procedures and to determine if reinforcing pads are required.

### **3.3 Hot-Tapping**

- .1 Pre-installation inspection and cleaning;
  - .1 Prior to hot-tapping the pipe, check mains pipe or tube that the work surface area is clear of pitting, damage or excessive surface corrosion.
  - .2 For steel piping, select a location which will be free of existing main pipe butt welds. For split-tee welding fittings, if the existing main pipe has a longitudinal manufacturer seam weld, grind any excess weld smooth to the main pipe surface as required to permit full contact between the split-tee welding fitting and the mains pipe.
  - .3 Clean the pipe surface at the area of the work, removing all dirt, oil, grease and debris from the external surface of the main pipe or tube. For copper tubing, clean the exterior surface of the copper tube with emery cloth.
- .2 Hot tapping machine;
  - .1 Select tapping machine and cutters as required to suit the product operating pressure and temperature, and mains pipe material.
  - .2 Bore cutter to be the maximum size possible to pass through the isolation valve. Check that the coupon retention system is not damaged prior to use.
  - .3 Support the tapping machine so as not to impose an overhung load on the isolation valve.
- .3 Hot-tapping for thermowells;
  - .1 Make hot-taps for installation of thermowells. Size the branch temporary isolation valve to suit the hot-tap thermowell fitting.
  - .2 After completion of the hot-tap thermowell and pressure testing, remove the temporary hot-tap branch valve. Check that the thermowell is firmly seated in the hot-tap branch thermowell fitting. If the thermowell is leaking, remove and reinstall the thermowell following the hot-tap thermowell manufacturer instructions.
- .4 Weld-on branch connection installation on steel pipe:

- .1 Use an integrally reinforced outlet fitting directly welded to the pipe, or a split-tee fitting welded to the main pipe.
- .2 Where an integrally reinforced outlet fitting is directly welded to the main pipe, provide additional reinforcing pads where the welding procedure requires such additional reinforcement to attain the required maximum allowable working pressure.
- .5 Mechanical fitting installation on copper tube;
  - .1 Confirm existing mains tube OD is within the acceptable range of the mechanical fitting manufacturers installation instructions.
  - .2 Install the mechanical saddle fitting, including cleaning of the gasket and application of any required lubricant, in accordance with the fitting manufacturer's installation instructions.
  - .3 Tighten fitting bolts to the required torque specified by the manufacturer, and check that the gasket has compressed to the required thickness.
  - .4 Retighten the fitting bolts at other times as required by the manufacturer instructions.
  - .5 Where the operating fluid temperature is greater than 20°C, retighten the fitting bolts 48 hours after the completion of the hot tap. If there are small leaks observed at this time, retighten the fitting bolts following another 48 hour period. At all times, do not exceed the maximum torque value specified by the fitting manufacturer.
  - .6 If leaks continue to occur after two x 48 hour retightening periods, arrange with the Owner to shut-down the system, and replace the mechanical saddle fitting with new pipe-tee fitting.
  - .7 Record the torque values (required and measured) for the initial tightening and all subsequent re-tightening of the bolts, and measured compressed gasket thickness.

### **3.4 Hot-Tap Pressure Testing**

- .1 Initial pressure testing:
  - .1 conduct an initial pressure test of the branch fitting after the branch connection fitting and isolation valve has been attached to the mains pipe/tube, but prior to drilling the branch opening,
  - .2 where the test pressure is 820 kPa (120 psig) or less, a pneumatic pressure test using CO<sub>2</sub> or nitrogen may be used with a soap leak test.
  - .3 where the test pressure is greater than 820 kPa (120 psig), use a hydrostatic pressure test.
- .2 Secondary pressure test:
  - .1 Conduct a secondary pressure test after the hot tap machine has been installed but prior to drilling. Conduct the pressure test with the same method as described for the initial pressure test.
- .3 Final pressure test:
  - .1 After completion of the hot tap and removal of the hot-tapping machine, conduct an in-service soap pressure test to check for any final leaks. If leaks are discovered, modify the installation to make it leak-tight.

### **3.5 Line-Freezing**

- .1 Temporarily freeze the piping by use of freezing assembly jackets with cryogenic fluids (preferably liquid nitrogen). Freeze a sufficient length of pipe to achieve an ice plug which would have a nominal compression strength of at least 17 MPa (2500 psig). Allow greater ice plug length where welding on the pipe mains is required.

- .2 Once the line-stopping is achieved, in addition to the work required on the mains pipe that necessitated the line-stopping, add a drain connection consisting of:
  - .1 a branch pipe of not less than NPS 1 in size, of the same material as the mains pipe,
  - .2 a ball valve as specified for the applicable piping section, and
  - .3 a 100 mm long nipple with a hose-end fitting with cap.
- .3 After completion of the work on the main pipeline, partially open the new drain valve and leave open during melting of the plug. Provide temporary hoses to discharge fluid to a safe location until such time as both plugs are partially melted and operating fluid discharges from the drain.

### **3.6 Inspections**

- .1 Coordinate with the AHJ inspector to allow them to witness the hot-tapping work.

### **3.7 Cleaning**

- .1 After completion of the hot tap and removal of the hot tap machine, flush the branch assembly to remove any residual metal filings:
  - .1 for water systems, provide a temporary hose to drain water to a safe location.
  - .2 for steam systems, provide temporary piping to allow free-blowing of steam to a safe location.

### **3.8 Test and installation records**

- .1 Submit a test record recording all pressure test results, including test method and test pressures, and in the case of a mechanical fitting include all bolt torque values and manufacturer torque requirements. Include time and date of each measurement and the name of the person conducting the test.
- .2 Submit a copy of the above test to the Owner and the Consultant.
- .3 Submit a copy of any AHJ inspection reports to the Owner and the Consultant.

**End of Section**

## **COMMON HANGER AND SUPPORT REQUIREMENTS FOR PIPING**

### **20 05 29**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide hangers and supports for piping, including insulation protection devices.
- .2 The requirements of this specification section apply to all piping systems, except where required otherwise by specific piping specification sections including:
  - .1 20 05 16 Rooftop Supports for Building Services and Equipment
  - .2 20 05 16 Flex Connections, Expansion Joints, Anchors and Guides
  - .3 21 05 01 Common Work Results for Fire Suppression
  - .4 22 60 13.70 Medical Gas Piping
  - .5 Applicable sections of Division 22 sections for plumbing and drainage piping,
- .3 Provide engineering services associated with the design, analysis, and selection of custom piping supports, including pipe riser supports.

##### **1.2 Related Work**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 06 Rooftop Supports for Building Services and Equipment
  - .2 20 05 16 Flex Connections, Expansion Joints, Anchors and Guides
  - .3 20 05 48 Vibration Isolation
  - .4 20 05 49 Seismic Restraints for Mechanical Services
  - .5 20 07 19 Piping Insulation

##### **1.3 Definitions and Abbreviations**

- .1 The following definitions apply to this section:
  - .1 **Ambient piping:** piping with a fluid temperature greater than 16°C (61°F) and up to and including 40°C (104°F).
  - .2 **Cold piping:** piping with a fluid temperature greater than 4°C (39°C) and up to and including 16°C (61°F).
  - .3 **Dual temperature piping:** piping which operates non-simultaneously as both cold piping and hot piping depending on the season.
  - .4 **Hot piping:** piping with a fluid temperature greater than 60°C (140°F).
  - .5 **Low temperature piping:** piping with a fluid temperature greater than 40°C (104°F) and up to and including 60°C (140°F)

##### **1.4 Applicable Codes and Standards**

- .1 Product and installation codes and standards:
  - .1 ANSI/MSS SP-58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
  - .2 CAN/UL 203 Standard for Pipe Hanger Equipment for Fire Protection Service



- .2 Refer to each applicable piping specification section for supplemental requirements for pipe supports.

### **1.5 Analysis, Design, and Inspection Services**

- .1 Where custom fabricated pipe and equipment supports are proposed to be used, provide the services of a professional engineer, licensed in the province or territory of the Work and who specializes in the design of piping and equipment supports (the "Specialty Engineer"), for the design of piping and equipment support systems and to provide inspection services of the completed installation.
- .2 Provide services of a Specialty Engineer for the design and selection of constant-load and variable-load hanger supports. Where a manufacturer of such equipment provides this design service, this is deemed to meet this requirement.
- .3 Specialty Engineer design services to include;
  - .1 provide the design of the piping support system, including anchors, guides, expansion joints, and shall include seismic restraints where applicable,
  - .2 analysis of dead loads, thermal expansion loads, wind load, static seismic loads (where applicable) and capacity of materials utilized for connections to equipment and structure.
  - .3 provide design drawings showing locations of supports, restraints and details of construction and attachment of supports and restraints,
  - .4 seismic design to conform to Specification section 20 05 49 where applicable.
- .4 Specialty Engineer inspection services to include:
  - .1 at periods during installation and at completion of the installation of the piping supports and anchor devices, the Specialty Engineer shall inspect the installation, identify and report deficiencies (if any) which are observed, and re-inspect the installation after deficiencies have been corrected,
  - .2 Specialty Engineer to submit periodic inspection reports and a final inspection report after all work is completed and deficiencies have been corrected, confirming the installation conforms to the design requirements. Prepare and submit any required declarations or similar document to this effect where required by local legislation. Include in the final report site photographs of the complete installation prior to covering with insulation, with specific photos at pipe anchors, guides, and expansion joints.
- .5 Provide shop drawings of custom supports, which shall be sealed by the Specialty Engineer.
- .6 Provide signed declarations for commitment for general review and final review letters of conformity as required by applicable legislation at the place of the Work.

### **1.6 Design Criteria**

- .1 The support spacing and hanger rod size specified herein is based on supporting a single pipe directly from the structure in accordance with MSS SP-58. If multiple pipes are supported from trapeze hangers (or similar), or from common hanger rods supporting a tier of multiple piping, then;
  - .1 the total load on the support rods or similar elements shall not exceed published tension load rating data in accordance with Table 2 of MSS SP-58.
  - .2 design of custom trapeze hangers shall meet the design criteria as specified in Part 2 of this section.
- .2 Provide complete custom engineered design services in accordance with the requirements of MSS SP-58 for support of vertical piping for the following portions of the Work:
  - .1 vertical piping located in vertical services spaces (shafts) where any of the following criteria apply;
    - (a) piping is NPS 8 and larger,
    - (b) the vertical pipe length exceeds 25 m (82 ft),

- (c) pipe expansion joints are shown, or
  - (d) vibration isolated supports, variable spring supports or constant load supports are shown.
- .2 where horizontal piping is supported on;
  - (a) trapeze hangers or supported on/suspended from horizontal structural elements, or
  - (b) pipe racks.
- .3 Where the mechanical system are required to have seismic restraints, this section is to be read in conjunction with the requirements of Specification section 20 05 49.

## **1.7 Submittals**

- .1 Submit manufacturer product data sheets for hanger components, and include:
  - .1 load ratings,
  - .2 typical composite detail drawings for complete hanger assembly, including upper attachment, hanger rods, hanger rod swivels, pipe attachments, shields and saddles, and load ratings, for each pipe condition and size.
- .2 Submit support details for glass, fibre-reinforced plastic, and other plastic piping systems which are coordinated with the piping material manufacturer installation instructions.
- .3 Where variable spring supports or constant load supports are shown, provide completely engineered design and fabrication drawings, including any supplementary steel requirements, and loads transferred to the building structure.
- .4 Submit engineered design drawings for fabricated trapeze hangers and completely engineered support systems, including
  - .1 construction detail drawings for each loading condition,
  - .2 span deflection calculations,
  - .3 building attachment load calculations and type.
  - .4 shop drawings to be sealed by a professional engineer licensed in the project location jurisdiction.
- .5 Where custom designed supports are proposed, shop drawings are to be sealed by a professional engineer licensed in the place of the Work.

## **1.8 Quality Control**

- .1 Where custom engineered supports are used, provide the services of a specialist professional engineer licensed in the location of the Work, to design the support systems and to conduct an inspection of the completed installation that it is in general conformance with the sealed shop drawing requirements, and submit an inspection report to the Owner and the Consultant.

# **2 PRODUCTS**

## **2.1 General**

- .1 Fabricate pipe hangers, supports, sway braces and associated components from stock or production parts, manufactured and fabricated in conformance with MSS SP-58, and the requirements of the piping code specified for each piping system.
- .2 Pipe hangers and supports for fire protection systems to be listed to CAN/UL 203, except where such listing requirement is excluded under applicable NFPA standards.
- .3 Select elements of pipe support systems to provide adequate factors of safety under loads applied by gravity, by temperature induced expansion and contraction, by internal pressure in mechanically jointed plain end pipe, and by fluid flow pressure thrust.

- .4 Where specified products define the applicable pipe size NPS range (notwithstanding that the product may be available for larger pipe sizes), the maximum specified pipe size is limited to not exceed the load rating of the specified product under maximum allowable pipe spans as defined in MSS SP-58 for insulated pipe filled with water.
- .5 Product finishes (unless otherwise specified for each product):
  - .1 outdoors: hot dipped galvanized,
  - .2 in mechanical service rooms, pipe tunnels and pipe trenches: zinc-plated or hot-dipped galvanized,
  - .3 within data server and switch equipment rooms: plain carbon or hot-dipped galvanized,
  - .4 all other indoor locations: plain carbon steel or zinc-plated steel.
- .6 Select pipe support products from manufacturers standard product line.

*Standard of Acceptance*

- Anvil
- Unistrut
- Taylor
- Acrow Richmond
- Portable Pipe Hangers
- Hilti
- nVent Caddy
- Pipe Shields
- Buckaroos

## 2.2 Upper Attachments – Anchors for Existing Concrete

- .1 General:
  - .1 upper hanger attachment for anchoring into existing concrete decks, for piping or equipment supports,
  - .2 designed to receive USS coarse thread hanger rods.
- .2 Drop-in anchors:
  - .1 zinc-plated carbon steel drop-in friction anchor design, with matched drill bit and setting tool,
  - .2 not to be used for seismic restraints or hanger rods at pipe hangers having seismic restraint,
  - .3 rated for uncracked concrete,
  - .4 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8,
  - .5 capacity rating with 4:1 safety factor to ultimate load,
  - .6 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	2.82 (635)	2
Ø1/2	4.2 (945)	3
Ø5/8	8.34 (1875)	4
Ø3/4	11.1 (2500)	8

*Standard of Acceptance*

- Hilti - fig. HDI, HDI+, HDI-L+

.3 Wedge anchors:

- .1 anchor-end wedging action on concrete, and not relying on friction between side of bolt and concrete hole wall,
- .2 zinc-plated carbon steel wedge anchor design with load washer and nut,
- .3 wedge anchor capacity as specified herein to be rated for cracked concrete having not less than 20 MPa (2900 psi) strength.
- .4 rated for cracked and uncracked concrete,
- .5 listed for seismic tension and shear loads in accordance with ACI 355.2 and ICC-ES AC193.
- .6 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8,
- .7 extra-long bolt length to allow attachment of hanger rod coupling with full thread engagement in the coupling, while providing required load engagement length,
- .8 standard rating: minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	4.85 (1090)	2
Ø1/2	7.52 (1690)	3
Ø5/8	12.1 (2715)	4
Ø3/4	15.5 (3495)	8

*Standard of Acceptance*

- Hilti - fig. Kwick Bolt series

- .9 high-capacity rating: minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)
Ø3/8	14.0 (3150)
Ø1/2	20.8 (4675)
Ø5/8	29.1 (6535)
Ø3/4	40.6 (9135)
Ø7/8	53.4 (12,000)

*Standard of Acceptance*

- Hilti - fig. HSL-3 series

## 2.3 Upper Attachment – Mounting Plates

- .1 Surface mounting plates to underside of concrete decks:
  - .1 for installation post concrete pour with either concrete inserts or drilled anchors,

- .2 surface mount carbon steel plate, with either clevis hanger with pin (for use with hanging rod-eye) or for attachment of hanger rod and load nut,
- .3 mounting holes in four corners of plate, sized for fastening bolts to achieve rated capacity,
- .4 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	3.25 (730)	2
Ø1/2	6.0 (1350)	3
Ø5/8	9.6 (2160)	4
Ø3/4	14.4 (3230)	8
Ø7/8	19.9 (4480)	12
Ø1	26.2 (5900)	18
Ø1-1/4	42.3 (9500)	20
Ø1-1/2	61.4 (13,800)	30

*Standard of Acceptance*

- Anvil - fig. 49 clevis plate,
- Anvil - fig. 52 load nut,
- Taylor - fig. 166 clevis plate,
- Taylor - fig. 167 load nut

## 2.4 Upper Attachments – Steel Structure

- .1 Steel beam clamp (bottom flange), pipe size NPS 8 and smaller:
  - .1 hanger clamp attachment to beam or joist bottom flange, applying concentric loading to the beam/joist web,
  - .2 for hanger rod sizes Ø3/8 to Ø7/8 in.,
  - .3 malleable iron or carbon steel, symmetrically loading beam clamp to MSS SP-58, type 30,
  - .4 listed to CAN/UL 203 for fire protection piping,
  - .5 minimum load rating in tension: 6.1 kN (1365 lbf)
  - .6 with extension piece swivel attachment to receive hanger rod.

*Standard of Acceptance*

- Anvil - fig. 218 with fig. 157 extension swivel.
- Taylor - fig. 410 with fig. 411 extension swivel.

- .2 Steel beam clamp (bottom flange), pipe size NPS 2½ to 24:
  - .1 hanger clamp attachment to beam or joist bottom flange, applying concentric loading to the beam/joist web,
  - .2 for hanger rod sizes Ø5/8 to Ø1-1/2 in.,
  - .3 forged steel, symmetrically loading heavy duty beam clamp, to MSS SP-58, type 28 or 29.
  - .4 load rating based on standard hanger rod load capacities in accordance with MSS SP-58,

.5 with weldless eye nut.

- Anvil - fig. 228
- Taylor - fig. 450

.3 Steel beam (top flange) - for conduit, piping NPS 6 and smaller, and ductwork:

- .1 hanger clamp attachment to the top flange of beam or joist, applying an eccentric loading to the beam/joist,
- .2 carbon steel, hook rod with locking jaw, fasteners and lock washers, to MSS SP-58, type 25,
- .3 for hanger rod sizes Ø3/8 to Ø3/4 in.,
- .4 minimum load rating in tension:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	3.2 (730)	2
Ø1/2 to Ø3/4	4.2 (940)	6

.5 listed to CAN/UL 203 for fire protection piping (rod size Ø3/8 and Ø1/2 in.)

*Standard of Acceptance*

- Anvil - fig. 227

.4 Steel joists (joist bottom chord) – for piping NPS 2 and smaller:

- .1 steel washer plates for installation of support rod within the interstice space of double-channel steel joists and open-web steel joints, installed on top and bottom surface of the joist and secured with load nut (top washer plate) and locking nut (bottom washer plate).
- .2 load rating based on standard hanger rod load capacities in accordance with MSS SP-58,
- .3 carbon steel washer plates with locking nuts,

*Standard of Acceptance*

- Anvil - fig. 60
- Taylor - fig. 80

## 2.5 Upper Attachments – Wall Brackets

.1 Medium and heavy-duty wall mounting brackets:

- .1 welded carbon steel plate or channel assembly, designed to allow at least 75 mm (3 in.) of horizontal adjustment of hanger rod position, to MSS SP-58, Types 32 and 33,
- .2 carbon steel backplates for through bolting of concrete walls where required by supported load and wall material,
- .3 for bolting into concrete wall, concrete block, or welding to building structure (where permitted by structural engineer),
- .4 minimum load rating:
  - (a) medium duty: 6.7 kN (1500 lbs).
  - (b) heavy duty: 13.4 kN (3000 lbs).

*Standard of Acceptance*

- Anvil - fig. 195 and 199
- Taylor - fig. 801 and 802.

.2 Light-duty wall mounting brackets:

- .1 welded carbon steel plate or channel assembly, single point rod support, to MSS SP-58, Types 31,
- .2 with carbon steel backplates for through bolting of concrete walls where required by supported load,
- .3 FM approved,
- .4 for bolting into concrete wall, concrete block, or welding to building structure,
- .5 minimum load rating: 3.35 kN (750 lbs).

*Standard of Acceptance*

- Anvil - fig. 194

**2.6 Upper Attachment - Swivels**

.1 Clevis swivel:

- .1 to allow rotation movement of suspended clevis hangers,
- .2 forged steel clevis with hanger pin, threaded rod socket, to MSS SP-58 type 14,
- .3 tension load capacity not less than the connected rod load capacity,
- .4 threaded end connected to concrete insert, with clevis end connected to weldless eye nut or welded eye rod.

*Standard of Acceptance*

- Anvil - fig. 299
- Taylor - fig. 63

.2 Weldless eye nut swivel:

- .1 to allow rotation movement of suspended clevis hangers,
- .2 forged steel eye nut, threaded rod socket, to MSS SP-58 type 17,
- .3 tension load capacity not less than the connected rod load capacity.
- .4 for connection to top of rod hanger, suspended from a clevis.

*Standard of Acceptance*

- Anvil - fig. 290
- Taylor – fig. 64

**2.7 Hanger Rod**

.1 Continuous threaded rod:

- .1 carbon steel, USS coarse thread,
- .2 tension load ratings to meet or exceed MSS SP-58.

*Standard of Acceptance*

- Anvil - fig. 146

- Taylor – fig. 54

.2 Welded eye rod:

- .1 carbon steel, USS course thread,
- .2 tension load ratings to MSS SP-58,
- .3 tension load ratings to meet or exceed MSS SP-58 for hanger rod.

*Standard of Acceptance*

- Anvil - fig. 278
- Taylor - fig. 53

.3 Rod connectors:

- .1 carbon steel, USS course thread,
- .2 with mid-point site hole,
- .3 tension load ratings to meet or exceed MSS SP-58.

*Standard of Acceptance*

- Anvil - fig. 135i
- Taylor - fig. 62S

## **2.8 Horizontal Pipe Support - Clevis**

.1 Clevis support:

- .1 applicable piping materials:
  - (a) carbon steel and stainless steel pipe, schedule 10 to 80,
  - (b) cast iron DWV piping,
- .2 carbon steel, adjustable clevis, with clevis bolt reinforcing tube, to MSS SP-58 Type 1,
- .3 adjustable hanger height while under load,
- .4 listed to CAN/UL 203 for fire protection piping,
- .5 applicable pipe size:
  - (a) steel pipe: NPS ½ to NPS 16
  - (b) ductile or cast iron drainage pipe: NPS 3 to 24

*Standard of Acceptance*

- Anvil - fig. 260
- Anvil - fig. 590 (for ductile or cast iron drainage pipe)
- Taylor – fig. 24
- Taylor – fig. 27AC (for ductile or cast iron pipe)

.2 Clevis support with extended yoke for where yoke is located inside of pipe insulation:

- .1 applicable piping materials:
  - (a) carbon steel and stainless steel pipe, schedule 10 to 80,
  - (b) cast iron DWV piping,
- .2 carbon steel, adjustable clevis, with clevis bolt reinforcing tube, to MSS SP-58 Type 1,
- .3 adjustable hanger height while under load,



- .4 yoke sized for outside dimension of pipe only, with extended yoke to clear pipe insulation,
- .5 applicable pipe size:
  - (a) steel pipe: NPS  $\frac{3}{4}$  to NPS 12

*Standard of Acceptance*

- Anvil - fig. 300
- Taylor – fig. 24L

- .3 Clevis support with integral non-metallic insulation saddle:
  - .1 alternate to using standard clevis hanger specified above with separate high density insulation inserts or pipe insulation saddles,
  - .2 applicable piping materials:
    - (a) insulated carbon steel and stainless steel pipe, schedule 10 to 80,
    - (b) insulated cast iron drainage piping.
  - .3 carbon steel, adjustable clevis, with clevis bolt reinforcing tube, to MSS SP-58 Type 1,
  - .4 adjustable hanger height while under load,
  - .5 listed to CAN/UL 203 for fire protection piping,
  - .6 with glass-reinforced polypropylene saddle, sized to allow up to 50 mm (2 in.) insulation thickness,
  - .7 yoke and clevis sized for outside dimension of pipe and insulation,
  - .8 applicable pipe size:
    - (a) steel pipe: NPS  $\frac{1}{2}$  to NPS 8,
    - (b) copper tube: NPS  $\frac{1}{2}$  to NPS 8.
  - .9 piping system design temperature limits: 4.4 to 100°C (40 to 212°F).

*Standard of Acceptance*

- Anvil - fig. 260 ISS

- .4 Clevis support for copper pipe and tube:
  - .1 for copper tube, NPS  $\frac{1}{2}$  to 4,
  - .2 zinc-plated carbon steel yoke and clevis, adjustable clevis to MSS SP-58, type 1, copper plated or felt lined finish,
  - .3 applicable tube size: NPS  $\frac{1}{2}$  to NPS 4,
  - .4 sized for outside dimension of pipe/tube, or outside diameter of pipe and insulation as applicable.

*Standard of Acceptance*

- Anvil - fig. CT-65 or 260F
- Taylor – fig. 52

## **2.9 Horizontal Pipe Support – Clevis for Fire Protection**

- .1 Pipe size range: NPS 2 to NPS 8.
- .2 Light-duty, side-opening clevis support:
  - .1 for fire protection service only,

- .2 pipe size range: NPS 2 to 8,
- .3 galvanized carbon steel, adjustable clevis with fixed yoke,
- .4 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
- .5 sized for outside dimension of pipe (and insulation if applicable).
- .6 sized for outside dimension of pipe (and insulation where applicable),
- .7 nominal pipe size: NPS 2 to NPS 8.

*Standard of Acceptance*

- Hilti - fig. MH-SLC Speed Lock

**2.10 Horizontal Pipe Support – Swivel Ring Hanger**

- .1 For non-insulated drain-waste-vent piping, gas piping, and chemical piping.
- .2 Pipe swivel ring hangers:
  - .1 carbon steel ring strap, zinc plated, adjustable knurled swivel nut, to MSS SP-58 Type 10,
  - .2 copper plated or epoxy-coated for use on copper tubing,
  - .3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
  - .4 nominal pipe size: NPS ½ to NPS 4.

*Standard of Acceptance*

- Anvil - fig. 69, CT-69
- Taylor – fig. 41, 43

**2.11 Pipe Straps**

- .1 General:
  - .1 for non-insulated drain-waste-vent piping, gas piping, and chemical piping.
  - .2 pipe size: NPS 4 and smaller.
- .2 Zinc plated carbon steel U-loop straps for mechanical fastening to structure.

*Standard of Acceptance*

- Anvil - fig. 262

- .3 Hot-dipped galvanized carbon steel U-loop with clip-in or bolt-on attachment to modular channel supports.

*Standard of Acceptance*

- Unistrut

**2.12 Horizontal Pipe Support – Pipe Roller (Type 41, 43, 44)**

- .1 Suspended support pipe roller – trapeze hanger style:
  - .1 adjustable height, pipe roller support for overhead support, to MSS SP-58 type 41,
  - .2 dual-hanger rod trapeze style,
  - .3 pipe size range: NPS ½ to NPS 16, with or without insulation.

*Standard of Acceptance*

- Anvil - fig. 171
- Taylor – fig. 95

.2 Suspended support pipe roller – clevis hanger style:

- .1 adjustable height, pipe roller support for overhead support, to MSS SP-58 type 43,
- .2 single rod clevis style,
- .3 pipe size range: NPS ½ to NPS 8, with or without insulation.

*Standard of Acceptance*

- Anvil - fig. 181
- Taylor – fig. 93

.3 Bottom support pipe roller:

- .1 adjustable height, pipe roller with bottom support rods, to MSS SP-58 type 41,
- .2 for bottom support of piping,
- .3 with mounting rods and upper/lower retention nuts at both ends,
- .4 pipe size range: NPS ½ to NPS 16, with or without insulation.

*Standard of Acceptance*

- Anvil - fig. 177
- Taylor – fig. 95S

.4 Bottom support pipe roller with stand:

- .1 pipe roller with cast iron support stand, to MSS SP-58 type 44,
- .2 for bottom support of piping,
- .3 fixed height and adjustable height variants,
- .4 base drilled for fastening to supporting element,
- .5 pipe size range: NPS ½ to NPS 18, with or without insulation.

*Standard of Acceptance*

- Anvil - fig. 271 (fixed), fig. 274 (adjustable)
- Taylor – fig. 279S (fixed), fig. 280S (adjustable)

## 2.13 Horizontal Pipe Support – Slides

.1 Structural slide bases – welded attachment:

- .1 Tee or H shaped pipe support for welding to pipe, to allow axial and lateral movements,
- .2 carbon steel, structural shape or fabricated, to ANSI/MSS SP-58 Type 35,
- .3 operating temperature range: -28 to 200°C (-20 to 400°F),
- .4 pipe insulation thickness clearance: up to 75 mm (3 in.),
- .5 pipe size and load rating in accordance with the following table:

Slide Base Type	Vertical Support Load Rating	Lateral Restraint Load Rating	Uplift Restraint Load Rating	Pipe Size Range NPS
-----------------	------------------------------	-------------------------------	------------------------------	---------------------

	kN (lbf)	kN (lbf)	kN (lbf)	Water	Steam, Gas
T	35.0 (8000)	9.0 (2000)	3.6 (800)	½ to 18	½ to 30
H	53.0 (12,000)	13.0 (3000)	5.3 (1200)	6 to 8	½ to 30
	53.0 (12,000)	18.8 (4000)	7.1 (1600)	10 to 20	
	107 (24,000)	26.0 (6000)	10.7 (2400)	24 to 30	

*Standard of Acceptance*

- Anvil - figs. 257A, 436A, 439A
- Taylor – figs. 257A

.2 Structural slide base assemblies with PTFE pads – welded attachment:

- .1 for piping with design temperatures greater than 121°C (250°F), including steam at pressures greater than 103 kPa (15 psig),
  - (a) may also be used for lower temperatures,
- .2 as specified above for slide bases and as follows,
- .3 PTFE bonded to underside of slide,
- .4 matching lower steel plates with bonded PTFE element (for fastening to structural support beam),

*Standard of Acceptance*

- Anvil - figs. 257, 436, 439
- Taylor – figs. 257

.3 Restraint variants for slides:

- .1 lug restraints to limit lateral movement due to thermal expansion of between 6 mm to 25 mm (1/4 to 1 in.),
- .2 where seismic restraint is required, lug restraints designed to limit lateral and vertical uplift movement to not more than 6 mm (1/4 in.),
  - (a) exception: if lateral movement of greater than 6 mm (1/4 in.) is shown, then the seismic design load is to be two (2) times the seismic load as shown in Specification section 20 05 49.

.4 Clamp for T and H slides supporting cold piping:

- .1 galvanized steel clamp for insulated cold piping, sized for outside dimension of insulated pipe,
- .2 rolled from structural plate steel with bolting flanges,
- .3 continuous single clamp for length of slide, or two (2) individual clamps at each end of the slide,
- .4 bottom half of clamp welded to T or H slides,
- .5 top half of clamp mechanically fastened to bottom half.

*Standard of Acceptance*

- Anvil - fig. 212 (2 clamp) 432 (continuous clamp)

## 2.14 Horizontal Pipe Support – Trapeze

.1 Manufactured trapeze support:

Issued For Tender

- .1 load ratings as per manufacturers data sheets,
- .2 carbon steel, double-C channel (strong-backs), HSS shape and equal-leg angles.

*Standard of Acceptance*

- Anvil - fig. 45, 46, and 50
- Taylor – fig. 170

.2 Fabricated trapeze support:

- .1 custom designed trapeze hangers of either hollow structural sections, double C channels (strongbacks), single C channel or unequal lengths angle channels, to support one or more pipes, conduits or ducts,
- .2 design of custom trapeze supports to conform to the requirements of MSS SP-58,
- .3 designed and sealed by a professional engineer licensed in the jurisdiction of the work.
- .4 design criteria:
  - (a) static design load: deadweight of supported services plus 1.5 kN (250 lbf) point load at the mid-span,
  - (b) dynamic loads: include for seismic loads where system is subject to seismic restraint, and for wind and snow loads where located outdoors, superimposed on static design load,
  - (c) maximum trapeze deflection at any point: 1/250 (0.4%) of trapeze span,
  - (d) design load for carbon steel materials: not to exceed 28% of minimum tensile strength nor exceed 50% of minimum yield strength in tension/compression and bending,
  - (e) design load for stainless steel and low alloy steel materials: not to exceed 20% of minimum tensile strength and 45% of minimum yield strength in tension/compression and bending.
- .5 for concurrent tension/compression loads and bending loads, the sum of the ratio of the stresses to allowable stress shall not exceed 1.0.

$$\frac{\text{Stress in Tension or Compression}}{\text{Allowable Tension or Compression Stress}} + \frac{\text{Stress in Bending}}{\text{Allowable Bending Stress}} \leq 1.0$$

.3 Hanger rods:

- .1 minimum of two support rods per trapeze,
- .2 rod size selected not to exceed 80% of the allowable maximum rod tensile load rating in accordance with MSS SP-58,

.4 Pipe restraint:

- .1 restrain pipes from lateral movement with:
  - (a) bolt-on angle brackets or pipe U-bolts for manufactured hangers, or
  - (b) welded-on angles for fabricated hangers,
- .2 restraints to permit axial linear movement and axial-rotation, except where otherwise shown to be an anchor.

**2.15 Horizontal Pipe Support – Drainage MJ**

- .1 For support of horizontal cast iron drainage piping, as an alternative to clevis hangers.
- .2 Designed to support each end of the pipe on both sides of a drainage MJ joint, and at intermediate supports, elbows and tees.
- .3 Carbon steel, plain finish.

- .4 Pipe size: NPS 2 to NPS 6

*Standard of Acceptance*

- Anvil - fig. 250
- Taylor – fig. 25

**2.16 Vertical Pipe Stanchions**

- .1 Pipe support stanchion, with welded attachment:

- .1 fixed height, or telescoping two-piece design with height adjustment, field-welded to pipe elbow or horizontal pipe,
- .2 carbon steel, structural cylinder shape,
- .3 designed for static loads of pipe and contents, as well as dynamic loads and anchor loads as shown,
- .4 nominal pipe size: NPS 2 to NPS 18.

*Standard of Acceptance*

- Anvil - fig. 62

**2.17 Vertical Pipe Riser Clamps**

- .1 Steel pipe, cast iron pipe:

- .1 carbon steel clamps for carbon steel piping and cast iron piping,
- .2 stainless steel clamps for stainless steel piping,
- .3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
- .4 supplied with field-welded pipe support lugs of same material as supported steel pipe (not including cast iron pipe).
- .5 floor supported pipe riser clamps, to ANSI/MSS SP-58, type 8,

*Standard of Acceptance*

- Anvil - fig. 261
- Taylor – fig. 82

- .6 suspended pipe riser clamps, 4 or 6 bolt patterns, to ANSI/MSS SP-58, type 42,

*Standard of Acceptance*

- Anvil - fig. 40, 40SS
- Taylor – fig. 82HCopper pipe and tube:

- .7 floor supported pipe riser clamps, carbon steel with copper plated finish, to ANSI/MSS SP-58, type 8,

*Standard of Acceptance*

- Anvil - fig. CT-121
- Taylor – fig. 85

**2.18 Vibration Isolation Supports**

- .1 Refer to specification section 20 05 48.

**2.19 Cast Iron Pipe Joint Restraint**

- .1 Joint restraint rodding assembly for cast iron and asbestos cement drain waste and vent pipe, for each branch, tee, wye and clean-out fittings on drainage piping NPS 5 and over.
- .2 Clamp and rod joint restraint:
  - .1 carbon steel pipe clamps with four bolt fasteners and rod washers, plain finish, to MSS SP-58, Type 8,
  - .2 carbon steel threaded rods and load nuts,
  - .3 two pipe clamps and two restraint rods required for each joint.

*Standard of Acceptance*

- Taylor – fig. 35

**2.20 Insulation Shields**

- .1 Insulation shields:
  - .1 galvanized steel protection shield, thickness and length as applicable to pipe size, to MSS SP-58 type 40
  - .2 designed to meet MSS SP-58 maximum support spans with insulation inserts having a compressive strength of 620 kPa (90 psi).
  - .3 pipe size: NPS ½ to 24,
  - .4 insulation thickness: 12 mm to 50 mm (1/2 in. to 2 in.).
  - .5 gauge: minimum 18 ga.
  - .6 sleeve width: minimum 180 degree arc of insulation exterior surface
  - .7 minimum sleeve length:
    - (a) pipe NPS ½ to 4: 300 mm (12 in.)
    - (b) pipe NPS 6: 450 mm (18 in.)
    - (c) pipe NPS 8 to 24: 600 mm (24 in.)

*Standard of Acceptance*

- Anvil - fig. 167 (up to NPS 24)
- Anvil - fig. 168 (up to NPS 8)
- Taylor – fig. 69H

- .8 sleeve length exemption: sleeve lengths may be reduced where shield is supplied as an integrated part of a high density insulation insert system. – refer to Specification section 20 07 19.
- .2 Heavy-duty insulation shield:
  - .1 for piping NPS 18 and larger installed on roller hangers and trapeze hangers,
  - .2 insulation shield as specified above plus a heavy duty support plate as follows,
  - .3 support plate fabrication: 6 mm (1/4 in.) thick ASTM A36 galvanized steel rolled plate, inside diameter to fit outer radius of insulation shield,
  - .4 size:
    - (a) width: minimum 120 degrees arc of mating insulation shield,
    - (b) length: not more than 100 mm (4 in.) shorter than the primary shield.

- .5 Support plate tack welded to the insulation shield.

## **2.21 Insulation Pipe Saddles**

- .1 Carbon steel or stainless steel (to match pipe material) saddle welded to pipe with insulation inserted between saddle and pipe, to MSS SP-58 type 39.
- .2 For pipe sizes NPS ¾ to 36.
- .3 Insulation thickness range: 25 to 140 mm (1 to 5.5 in.)

### *Standard of Acceptance*

- Anvil - fig. 160 to 166
- Taylor – fig. 70 to 77

## **3 EXECUTION**

### **3.1 General**

- .1 Where the specific requirements for pipe supports are specified in other sections of Division 20 to 23, the requirements of those sections take precedence over the requirements of this specification section.

### **3.2 Coordination with Concrete Work**

- .1 Supply, deliver and install concrete inserts in ample time to be built into the work of Division 03.
- .2 Correctly position and set concrete inserts onto concrete formwork for pipes and equipment hangers. Secure inserts firmly to formwork before concrete is poured.
- .3 Do not use explosive drive pins in any section of the Work without obtaining prior approval from the Consultant.

### **3.3 Support and Hanger Installation – General Requirements**

- .1 Support piping directly on or from structural building elements. Do not support pipe directly from other services. Multiple piping services may be supported on a common trapeze support.
- .2 Provide all miscellaneous materials including nuts, washers, and backing plates to make a complete installation.
- .3 Where wall brackets are used, select brackets and size mounting bolts and backing plates to suit the supported load, allowing for a safety factor by not loading the bracket more than 80% of its published load rating.
- .4 Do not support piping or tubing in direct contact with hangers or supports of dissimilar metallic material. Select hangers to include an electrical insulating material between the hanger and the pipe, or provide electrical insulating material.
- .5 Coordinate location of pipe supports with pipe flexible connectors, pipe guides and pipe anchors provided under specification section 20 05 16.
- .6 In steel framed construction, support piping from structural members. Where structural members are not suitably located for upper hanger attachment locations, and where inserts of adequate capacity cannot be installed in concrete slabs, provide supplementary steel framing members;
  - .1 fabricate supplementary steel from standard HSS sections, single EL section, double C “strongback” sections, or pipe lengths,
  - .2 size supporting steel to limit horizontal span deflection to 1/250 (0.4%) between connecting points to the structure,
  - .3 mechanically fasten supplementary steel to structural steel to prevent axial and transverse displacement, and rotation.



- .7 It is permissible to offset hangers and displace the hanging rod so that in the final operating position, the hanging rods are within 4° of vertical.
- .8 Provide a pipe support within 300 mm (12 in.) of;
  - .1 an elbow or tee,
  - .2 a concentrated load, including but not limited to valves, strainers and flanges,
  - .3 a connection to equipment.
- .9 Where hanger rods are used, provide load nuts on top and load nuts on the underside of attachment to the pipe support, including clevis hangers, roll supports, roll yoke hangers, and trapeze hangers.

### **3.4 Horizontal Pipe Support Spacing and Hanger Rod Size**

- .1 Provide horizontal pipe supports at the spacing as detailed in the Schedule "A" included at the end of this Specification section, unless specified otherwise in other sections of Division 20 to 23.
  - .1 Schedule "A" includes alternate hanger rod size and support spans for reduced rod sizes.
- .2 Use threaded rod of the size based on pipe type and horizontal pipe hanger spacing as stated in the Schedule "A" for single rod hangers. Where the pipe hanger type requires two rods, the rod size may be reduced by one trade size but shall not be less than Ø3/8 in.
- .3 For piping using flexible roll-groove joints, there shall be not less than one hanger between pairs of joints.
- .4 Support plastic and other special piping, including anchors and guides, in accordance with the pipe manufacturer's requirements.

### **3.5 Horizontal Pipe Hanger and Support Selection**

- .1 Select horizontal pipe hanger and support type based on pipe size and fluid service temperature in accordance with Schedules "B(1)" and "B(2)" at the end of this section.
- .2 For fire protection piping;
  - .1 use clevis hangers for all pipe sizes,
  - .2 swivel ring pipe hangers may be used for fire protection piping NPS 4 and smaller.
- .3 Swivel ring pipe hangers may only be used for;
  - .1 drain waste and vent (DWV) piping and tubing, NPS 4 and smaller,
  - .2 medical gas piping and laboratory gas piping, NPS 4 and smaller,
  - .3 compressed air piping and tubing located downstream of a refrigerated dryer, NPS 2 and smaller,
  - .4 chemical treatment piping NPS 2 and smaller.
- .4 For cast iron drainage and vent piping;
  - .1 use clevis hangers for suspended supports,
  - .2 drainage MJ type hangers may be used on hub-less cast iron piping,
  - .3 use roller or slide type supports for bottom supported piping. For slide supports, use a variant incorporating pipe band clamps in lieu of welded attachment.
- .5 For other piping, select pipe support types in accordance with Schedule B at the end of this section.
- .6 For pipe size NPS 16 to 24, a clevis hanger may be used to support a concentrated load, provided it is used only to locally support the concentrated load and there is a separate pipe run support within one-third of the maximum allowable span on each side of the concentrated load.

- .7 The use of a half-section of a suspended pipe clamp to support a horizontal pipe using two threaded rods is prohibited unless the manufacturer has written installation instructions permitting such use. The use of a pipe riser clamp for this purpose is prohibited.

### **3.6 Clevis Hangers**

- .1 Where clevis hangers are used for cold piping, select clevis to fit the outside dimension of pipe and associated insulation.
- .2 Where clevis hangers are used for heating piping;
  - .1 select clevis to fit the pipe diameter only (clevis located inside of insulation) for small diameter piping in accordance with Schedule "C" at the end of this section,
  - .2 for larger diameter piping, select clevis to fit the outside dimensions of pipe and insulation – refer to Schedule "C" at the end of this section,
  - .3 where the distance from the building support element to the clevis pin is less than the value shown in the standard details at the end of this section, use an alternative method of support;
    - (a) exception: where the pipe is installed tight to the structure, the exposed length between the structural attachment and the top of the clevis shall not exceed 25 mm (1 in.).
- .3 Where clevis hangers are used for stainless steel pipe or tube and for copper tube;
  - .1 use copper or epoxy finished carbon steel clevis hangers for copper pipe/tube,
  - .2 use stainless steel or alloyed steel clevis hangers (for stainless steel pipe/tube), or
  - .3 use a standard clevis hanger with integral non-metallic insulation saddles, and select hanger size for outside of the pipe and insulation.
- .4 Adjust clevis hangers to provide the required drainage slope and direction for each pipe.
- .5 Where the project requires seismic bracing of piping systems, add a Schedule 40 pipe over the clevis bolt, sized to provide at least 6 mm (1/4 in.) inside diameter clearance to the clevis bolt. This applies only where a transverse or longitudinal brace is attached to the clevis hanger.

### **3.7 Roll Hangers and Supports**

- .1 For roll hangers, provide load and lock nuts to allow final adjustment of roll hanger to allow pipe drainage.
- .2 For roll supports supported above the structure element, the length of exposed threaded pipe between the roll support and the structural element shall not exceed 10 times the outside diameter of the rod.

### **3.8 Trapeze Hangers**

- .1 Provide U-bolts or fabricated angles to restrict lateral pipe movement, while allowing pipe thermal axial motion and rotation;
  - .1 fasten U-bolts or angles to the trapeze hanger with top and bottom nuts,
  - .2 fabricated retention angles to extend vertically at least one-quarter the outside pipe/insulation diameter, and mechanically fasten to the trapeze,
  - .3 where seismic restraint is required, only use U-bolts.
- .2 Adjust trapeze hangers to provide the required drainage slope and direction for each pipe. If the trapeze serves multiple pipes having different drainage slopes or directions, provide shims under each pipe as necessary to provide required slope. Mechanically fasten or tack-weld the shim plates to the trapeze.

### **3.9 Slide Supports**

- .1 For hot piping, weld the T or H slide directly to the pipe.

- .2 For cold piping, weld the T or H slide to the bottom half of a carbon steel clamp assembly.
- .3 Use slides with integral lateral movement limit lugs at pipe supports required to function as a guide. Movement clearance to be between 6 mm and 25 mm (1/4 to 1 in.).
- .4 Where seismic restraint is required, use slides with integral lateral and vertical-up movement limit lugs so that the maximum allowable movement does not exceed 6 mm (1/4 in.).
- .5 For fluid service temperatures of 121°C (250°F) and less, apply grease with a service temperature of not less than 200°C (392°F) over the entire bottom of the T or H slide.
- .6 For fluid service temperatures greater than 121°C (250°F) use a PTFE slide pad bonded to the underside of the slide and a matching PTFE slide pad bonded to the top of the structural steel support.

### **3.10 Vertical Pipe Supports**

- .1 Pipe riser clamps:
  - .1 provide pipe riser clamps for non-insulated pipes NPS 4 and smaller at every second floor level for vertical pipe risers passing through two or more floors, unless other vertical pipe support types are shown,
  - .2 for steel pipe, provide support lugs welded to steel piping so that pipe lugs bear on the top-surface of the riser clamp,
  - .3 for copper tube and pipe, arrange vertical piping so that a pipe joint bears on the top-surface of the riser clamp.
- .2 Fabricated pipe riser supports:
  - .1 support piping NPS 6 and larger, using fabricated riser support brackets complete with reinforcing gusset plates welded or clamped to piping, designed not to exceed the maximum allowable local pipe stress at a load of not less than 200% of the supported load of:
    - (a) for the lowest support point of the riser, the supported pipe plus insulation weight for the lowest support interval plus the total water weight of the entire riser.
    - (b) except at the lowest support point of the riser, the pipe plus insulation weight for each support interval (except at the bottom of the riser).
- .3 Support vertical cold piping and hot piping for riser heights that are 25 m (82 ft) or less in height as follows:
  - .1 provide spring vibration isolators in accordance with specification section 20 05 48, attached to pipe riser supports at intervals of every 2<sup>nd</sup> storey or 10 m (32 ft), whichever is less,
  - .2 provide a pipe anchor at the base of the riser or the mid-height of the riser.
- .4 Support vertical cold piping and hot piping for riser heights that are greater than 25 m (82 ft) but do not exceed 50 m (165 ft) in height as follows:
  - .1 provide a custom engineered support system utilizing variable spring isolators,
  - .2 provide pipe anchors at the mid-point of the riser, and
  - .3 provide at least one spring support per riser section above and below the anchor point.
- .5 Support vertical cold piping and hot piping for riser heights greater than 50 m (165 ft) as follows:
  - .1 provide a custom engineered support system utilizing constant load supports for each pipe section located between expansion joints,
  - .2 variable spring supports may be used at intermediate locations between main constant load supports,

- .3 provide pipe anchor supports at the base of the riser, and at intermediate locations along riser length at locations as shown,
- .4 provide in-line expansion joints between each pair of pipe anchors on the same riser in accordance with Specification section 20 05 16,
- .5 design pipe anchors to withstand pressure thrust created by the expansion joints, unless pressure-balanced expansion joints are used,
- .6 Design riser anchors to support the deadweight of the riser pipe, fluid contents and insulation. Where seismic restraint is required, the anchors may also be designed to resist the seismic horizontal and vertical loads.
- .7 Where custom engineering riser supports are required, they are to be designed to meet the following criteria:
  - .1 the maximum vertical movement of a horizontal branch pipe is not to exceed 20 mm (0.75 in) from its installation temperature to its in-service temperature,
  - .2 the maximum vertical movement of the horizontal mains pipe at the base or top of the riser is not to exceed 40 mm (1.5 in.) from its installation temperature to its in-service temperature, provided that the horizontal piping adjacent to the riser are also supported on variable spring supports for the first three horizontal support points.

### **3.11 Pipe Saddles and Shields**

- .1 Provide pipe saddles and shields for insulated piping in accordance with Schedule "C" at the end of this section.
- .2 Provide pipe shields for uninsulated glass and plastic piping NPS 1-1/2 and larger.
- .3 Where piping is insulated and requires pipe shields, install the shields between pipe insulation and pipe support. Provide high-density insulation insert between pipe and insulation shields of the designation type as shown in Schedule "C" and as specified in accordance with specification section 20 07 19.
- .4 Where piping is not insulated and requires a pipe shield, install the shields between the pipe and the pipe support.
- .5 Where clevis hangers with integral insulation saddles are used, apply insulation sealant to the polypropylene saddle in accordance with the pipe hanger manufacturer's instructions;
  - .1 for hot piping, coordinate with the pipe insulation contractor to apply sealant coating to the integral saddle at the time pipe insulation is installed,
  - .2 for cold piping, seal the saddle's pipe contact surfaces with vapour-barrier sealant before the piping is installed. Finish sealing the remainder of the saddles' exposed faces when pipe insulation is installed.

### **3.12 Rooftop Supports**

- .1 For manufacturer rooftop pipe supports, conform to Specification section 20 05 06.

### **3.13 Vibration Isolation Supports**

- .1 Provide vibration isolators at pipe supports for horizontal piping in accordance with specification section 23 05 48.
- .2 Provide vibration isolators at vertical pipe (riser) supports in accordance with specification section 20 05 48.
- .3 When installed with clevis hangers, install the vibration isolators below the top surface of the clevis; do not attached the vibration isolator to the structural element.

### **3.14 Temporary Supports for Steam Piping**

- .1 Where steam piping support spacing is in accordance with Schedule A for steam and gas piping, provide temporary intermediate supports for hydrostatic pressure testing so that the support spans do not exceed the values in Schedule A for water filled pipe.

### **3.15 Set-up After Installation**

- .1 Adjust hangers to equalize hanger loads, to support piping true to line and grade, and to minimize loads transferred through connections to equipment and outlets.

### **3.16 Schedules**

- .1 The following appended schedules form part of this Specification section.
  - .1 Schedule A1(a) Horizontal Pipe Support Loads and Support Spans – Schedule 20 to 80 Pipe
  - .2 Schedule A1(b) Alternate Hanging Rod Sizes and Support Spans for Schedule 20 to 80 Pipe
  - .3 Schedule A2(a) Horizontal Pipe Support Loads and Spans – Schedule 10/10S Stainless Steel Pipe
  - .4 Schedule A2(b) Alternate Hanging Rod Sizes and Support Spans for Schedule 10/10S Stainless-steel Pipe
  - .5 Schedule A3 Horizontal Pipe Support Loads and Spans – Copper and Stainless Steel Tube
  - .6 Schedule B Pipe Support Type Selection Requirements
  - .7 Schedule C Insulation Protection Requirements

### **3.17 Standard Details**

- .1 The following standard details are appended to the end of this Specification section.
  - .1 20 05 29-010 Cold Piping and Dual-Temperature Piping – Clevis Hanger Detail
  - .2 20 05 29-011 Cold Piping and Dual-Temperature Piping – Roll Hanger Detail
  - .3 20 05 29-012 Cold Piping and Dual-Temperature Piping – Trapeze Hanger Detail
  - .4 20 05 29-013 Cold Piping and Dual-Temperature Piping – Slide Support Detail
  - .5 20 05 29-020 Hot Piping – Clevis Hanger Detail
  - .6 20 05 29-021 Hot Piping ≤ 100°C, Small Size Piping – Clevis Hanger Details
  - .7 20 05 29-022 Hot Piping – Roll and Trapeze Hanger Detail
  - .8 20 05 29-023 Hot Piping – Slide Support Detail
  - .9 20 05 29-030 Slide Supports – Guides and Seismic Restraint

**Schedule A1(a)**

**Horizontal Pipe Support Spacing  
for  
Carbon Steel, Galvanized Steel, Stainless-steel Piping  
Schedule 20 to 80 Inclusive**

**Notes for Schedule A1(a) and A1(b):**

[1] Hanging rod size for single support. Where two supports are used, the rod size may be reduced by one size but not less than Ø3/8 in..

[2] Subject to load capacity of hanger components other than the hanging rod.

[3] Where piping is hydrostatically tested with water, temporary pipe supports are required to limit pipe span to the "liquids" values.

[4] For trapeze hangers only.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Support Spacing, Liquids [Note 2] m (ft)	Maximum Support Spacing Steam, Gases [Note 2, 3] m (ft)
½	Ø 3/8	1.8 (6)	1.8 (6)
¾ to 1¼	Ø 3/8	2.1 (7)	2.1 (7)
1½	Ø 3/8	2.7 (9)	2.7 (9)
2	Ø 3/8	3.0 (10)	4.0 (13)
2½	Ø ½	3.3 (11)	4.3 (14)
3	Ø ½	3.3 (12)	4.6 (15)
4	Ø 5/8	4.2 (14)	5.2 (17)
6	Ø ¾	5.1 (17)	6.4 (21)
8	Ø ¾	5.7 (19)	7.3 (24)
10	Ø 7/8	6.7 (22)	7.9 (26)
12	Ø 7/8	7.0 (23)	9.1 (30)
14	Ø 1	7.5 (25)	9.8 (32)
16	Ø 1	8.0 (27)	10.7 (35)
18	Ø 1 [Note 4]	8.4 (28)	11.3 (37)
20	Ø 1-1/4 [Note 4]	9.0 (30)	11.9 (39.0)
24	Ø 1-1/2 [Note 4]	9.6 (32)	12.8 (42.0)
30	Ø 1-1/2 [Note 4]	10.0 (33)	13.4 (44.0)

**Schedule A1(b)**

**Alternate Rod Sizes and Pipe Spans  
For Pipe Sizes NPS 10 to 16  
Carbon Steel, Galvanized Steel, Stainless-steel Piping  
Schedule 20 to 80 Inclusive**

The following table provides alternate combinations of rod hanger size and associated support spacing for select pipe sizes.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Support Spacing, Liquids [Note 2] m (ft)	Maximum Support Spacing Steam, Gases [Note 2, 3] m (ft)
10	Ø 3/4	4.0 (13)	6.7 (22)
12	Ø 3/4	3.0 (10)	5.8 (19)
14	Ø 3/4	2.7 (9)	5.2 (17)
	Ø 7/8	5.8 (19)	9.1 (30)
16	Ø 3/4	2.1 (7)	4.6 (15)
	Ø 7/8	4.9 (16)	7.9 (26)

**Schedule A2(a)**

**Horizontal Pipe Support Spacing  
For  
Stainless-steel Pipe  
Schedule 10/10S**

**Notes for Schedule A2(a) and A2(b):**

[1] Rod size for single support. Where two supports are used, the rod size may be reduced by one size but not less than Ø3/8 in..

[2] Subject to load capacity of hanger components other than the hanging rod.

[3] Where piping is hydrostatically tested with water, temporary pipe supports are required to limit pipe span to the "liquids" values.

[4] For trapeze hangers only.

Pipe Size NPS	Rod Diameter Single Support [Note 1]	Maximum Spacing, Liquids [Note 2] m (ft)	Maximum Spacing Steam, Gases [Note 2, 3] m (ft)
½	Ø 3/8	1.83 (6)	2.45 (8)
¾	Ø 3/8	2.1 (7)	2.75 (9)
1	Ø 3/8	2.45 (8)	2.75 (9)
1¼	Ø 3/8	2.75 (9)	2.75(9)
1½	Ø 3/8	2.75 (9)	3.65 (12)
2	Ø 3/8	3.10 (10)	4.0 (13)
2½	Ø 1/2	3.35 (11)	4.3 (14)
3	Ø 1/2	3.65 (12)	4.6 (15)
4	Ø 5/8	4.25 (14)	5.2 (17)
6	Ø 3/4	4.9 (16)	6.4 (21)
8	Ø 3/4	5.5 (18)	7.3 (24)
10	Ø 7/8	5.8 (19)	7.9 (26)
12	Ø 7/8	6.1 (20)	9.2 (30)
14	Ø 1	7.0 (23)	9.7 (32)
16	Ø 1	7.3 (24)	10.7 (35)
18	Ø 1 [Note 4]	7.3 (24)	11.3 (37)
20	Ø 1-1/4 [Note 4]	7.6 (25)	11.9 (39)
24	Ø 1-1/2 [Note 4]	7.3 (25)	11.9 (42)
30	Ø 1-1/2 [Note 4]	8.5 (28)	12.8 (44)



**Schedule A2(b)**

**Alternate Rod Sizes and Pipe Spans  
For Pipe Sizes NPS 10 to 16  
Stainless-steel Pipe  
Schedule 10/10S**

The following table provides alternate combinations of rod hanger size and associated support spacing for select pipe sizes.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Spacing, Liquids [Note 2] m (ft)	Maximum Spacing Steam, Gases [Note 2, 3] m (ft)
10	Ø 3/4	4.9 (16)	4.9 (16)
12	Ø 3/4	3.7 (12)	3.7 (12)
14	Ø 3/4	2.7 (9)	2.7 (9)
	Ø 7/8	5.2 (17)	6.1 (20)
16	Ø 3/4	2.4 (8)	2.4 (8)
	Ø 7/8	4.3 (14)	5.2 (17)

**Schedule A3**

**Horizontal Pipe Support Spacing  
For  
Copper Tube and Stainless-steel Tube**

**Notes for Schedule A3:**

[1] Rod size for single support. Where two supports are used, the rod size may be reduced by one size but not less than M10 (3/8 in.).

[2] Subject to load capacity of hanger components other than the hanging rod.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Spacing, Liquids and Gases [Note 2] m (ft)
½	Ø 3/8	1.5 m (5 ft)
¾ to 1¼	Ø 3/8	1.8 m (6 ft)
1½	Ø 3/8	2.4 m (8 ft)
2	Ø 3/8	2.4 m (8 ft)
2½	Ø 1/2	3.0 m (10 ft)
3	Ø 1/2	3.0 m (10 ft)
4	Ø 5/8	3.0 m (10 ft)
6	Ø ¾	4.3 (14)
8	Ø ¾	4.9 (16)

## Schedule B

### Pipe Support Type Selection Requirements

The following tables B(1) and B(2) lists hanger types which are to be used based on pipe size and service temperature. Refer to Schedule C for additional requirements concerning insulation protection.

#### Pipe Support Type Legend

CL	Clevis hanger
CL(EY)	Clevis hanger with extended yoke for installation under pipe insulation
CL(IS)	Clevis hanger with integral insulation saddle
CL(LD)	Clevis hanger, light duty
SW	Swivel hanger
RS	Roll support
RH	Roll hanger with clevis
RB	Roll support with integral base
TS	T slide
HS	H slide
TZ	Trapeze

#### Application Legend

A	Acceptable
---	Not permitted

**Table B(1):**  
**Pipe Support Type Selection Requirements**  
**For Fluid Service Temperatures up to 100°C (212°F) or Less**

Pipe/Tube Size NPS	CL	CL (EY)	CL (IS)	CL (LD)	SW [Note 1]	RS	RH	RB	TS	HS	TZ
½ - ¾	A	A	A	A	A	---	---	---	---	---	A
1 - 4	A	A	A	A	A	A	A	A	A	---	A
6	A	A	A	---	---	A	A	A	A	A	A
8	A	A	A	---	---	---	A	A	A	A	A
10	A	A	---	---	---	---	A	A	A	A	A
12	A	A	---	---	---	---	A	A	A	A	A
14	A	---	---	---	---	---	A	A	A	A	A
16	A	---	---	---	---	---	---	A	A	A	A
18	---	---	---	---	---	---	---	A	A	A	A
20	---	---	---	---	---	---	---	---	A	A	A
24	---	---	---	---	---	---	---	---	---	A	A
30	---	---	---	---	---	---	---	---	---	A	A

**Notes:**

[1] For uninsulated ambient piping/tubing only.

**Table B(2):**

**Pipe Support Type Selection Requirements**  
**Fluid Service Temperatures greater than 100°C (212°F)**  
**Including Steam at All Pressures**

Pipe/Tube Size NPS	CL	CL (EY)	CL (IS)	CL (LD)	SW	RS	RH	RB	TS	HS	TZ
½ - ¾	A	---	---	A	---	---	---	---	---	---	A
1 - 4	A	---	---	A	---	A	A	A	A	---	A
6	A	---	---	---	---	A	A	A	A	A	A
8	A	---	---	---	---	---	A	A	A	A	A
10	---	---	---	---	---	---	A	A	A	A	A
12	---	---	---	---	---	---	A	A	A	A	A
14	---	---	---	---	---	---	A	A	A	A	A
16	---	---	---	---	---	---	---	A	A	A	A
18	---	---	---	---	---	---	---	A	A	A	A
20	---	---	---	---	---	---	---	---	A	A	A
24	---	---	---	---	---	---	---	---	---	A	A
30	---	---	---	---	---	---	---	---	---	A	A

**Schedule C**

**Insulation Protection Requirements  
For Pipe Hanger/Support**

**Notes for Schedule C:**

[1] For the column Hanger Support Position, "Insulation" means hanger or support element is outside of the pipe and insulation. "Pipe" means hanger or support element is in direct contact with the pipe and is encased in the pipe insulation.

[2] "Pipe" position only applies to clevis hangers. For all other pipe supports, use the "Insulation" hanger/support position.

[3] Include heavy-duty support plate welded to shield.

[4] Restrictions apply to minimum length of hanger rod for heating piping at this temperature range. Refer to standard details.

[5] Refer to specification section 20 07 19 Piping Insulation for type P-21, P-22 and P-23 high-density insert specifications.

[6] Where ambient piping is required to be insulated under section 20 07 19, insulation is to be protected in accordance with the requirements for Low Temperature Piping.

[7] Insulation for Dual Temperature Piping is to be protected in accordance with the requirements for Cold Piping.

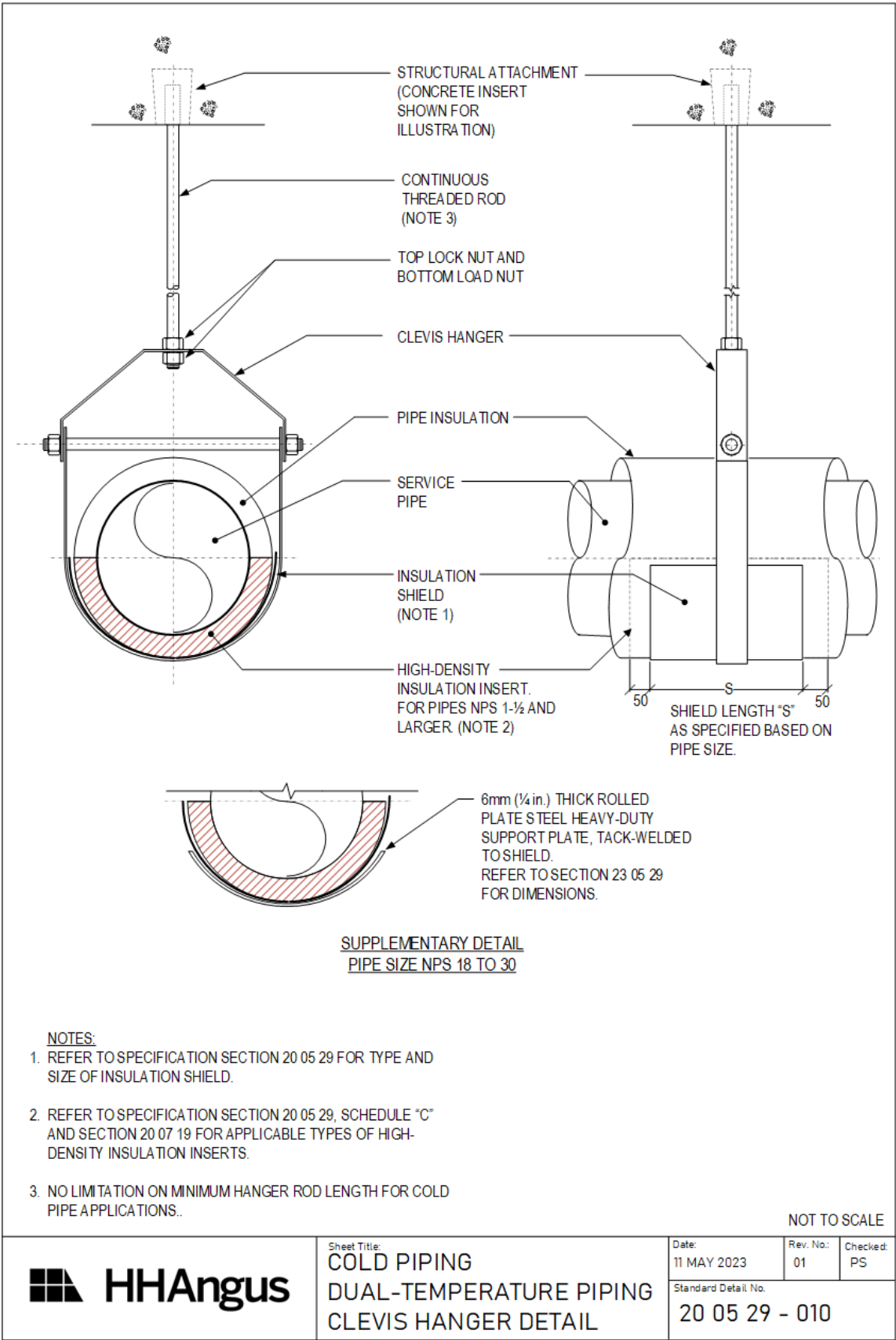
Application Legend for Insulation Saddle and Shields

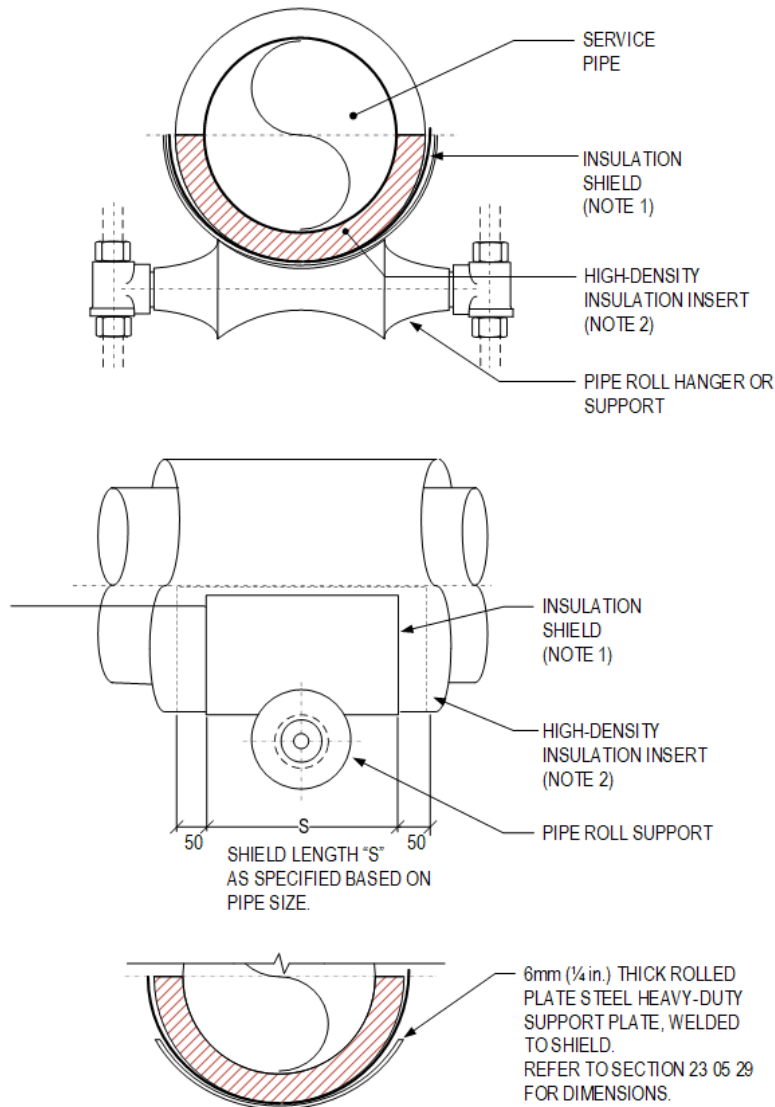
REQ	Required
ALT	Acceptable Alternate
	Not Applicable

Service Temperature °C (F)	Pipe Size NPS	Hanger/ Support Position [Note 1, 2]	Pipe Saddle	Insulation Shield	
				Shield	High-Density Insert Type [Note 5]
Hot Piping > 121 to ≤ 205 (> 250 to ≤ 400) Including steam >103 kPa (15 psi)	≥ 6	Insulation	REQ		
	>1-1/4 and ≤ 4	Insulation	ALT		
				ALT	P-23
	≤ 1-1/4	Insulation		REQ	
Hot Piping > 100 to ≤ 121 (> 212 to ≤ 250) Including steam ≤ 103 kPa (15 psi)	≥ 6	Insulation	REQ		
	>1-1/4 and ≤ 4	Insulation	ALT		
				ALT	P-21, P-22, or P-23
	≤ 1-1/4	Insulation		REQ	

Schedule C (Con't)

Service Temperature °C (F)	Pipe Size NPS	Hanger/ Support Position [Note 1, 2]	Pipe Saddle	Insulation Shield	High- Density Insert Type
Hot Piping 61 to 100 (141 to 212)	≥10 and ≤ 30	Insulation	REQ		
	≥ 6 and ≤ 16	Insulation	ALT		
				REQ	P-21, P-22, or P-23
	≥ 1-1/2 and ≤ 4	Insulation		ALT	P-21, P-22, or P-23
		Pipe [Note 4]	ALT		
	≤ 1-1/4	Insulation		ALT	
		Pipe [Note 4]	ALT		
Low Temperature Water 40 to 60 (104 to 140) [Note 6]	≥18 and ≤ 30	Insulation		REQ [Note 3]	P-21, P-22, or P-23
	≥ 6 and ≤ 16	Insulation		REQ	P-21, P-22, or P-23
	≥ 1-1/2 and ≤ 4	Insulation		ALT	P-21, P-22, or P-23
		Pipe	ALT		
	≤ 1-1/4	Insulation		ALT	
		Pipe	ALT		
Cold Piping 4 to 16 (39 to 61) [Note 7]	≥18 and ≤ 30	Insulation		REQ [Note 3]	P-21 or P-22
	≥ 1-1/2 and ≤ 16	Insulation		REQ	P-21 or P-22
	≤ 1-1/4	Insulation		REQ	
Fire protection piping	≥ 1-1/2	Pipe			
	≤ 1-1/4	Pipe			
MRI Quench Piping	All	Insulation		REQ	P-22





SUPPLEMENTARY DETAIL  
PIPE SIZE NPS 18 TO 30

NOTES:

1. REFER TO SPECIFICATION SECTION 20 05 29 FOR TYPE AND SIZE OF INSULATION SHIELD.
2. REFER TO SPECIFICATION SECTION 20 05 29, SCHEDULE "C" AND SECTION 20 07 19 FOR APPLICABLE TYPES OF HIGH-DENSITY INSULATION INSERTS.
3. NO LIMITATION ON MINIMUM HANGER ROD LENGTH.

NOT TO SCALE



Sheet Title:  
**COLD PIPING AND  
DUAL-TEMPERATURE PIPING  
ROLL HANGER DETAIL**

Date:  
11 MAY 2023

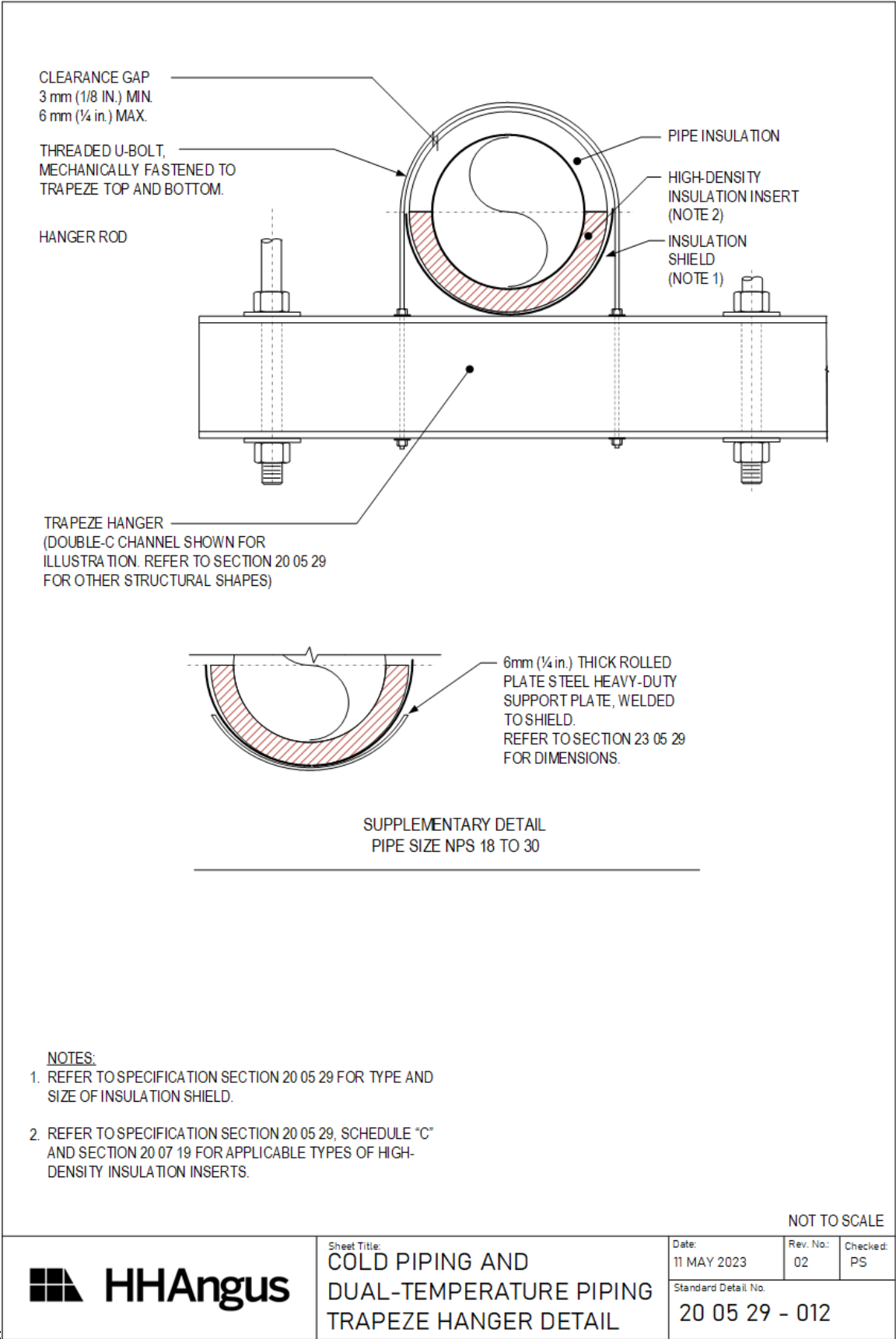
Rev. No.:  
02

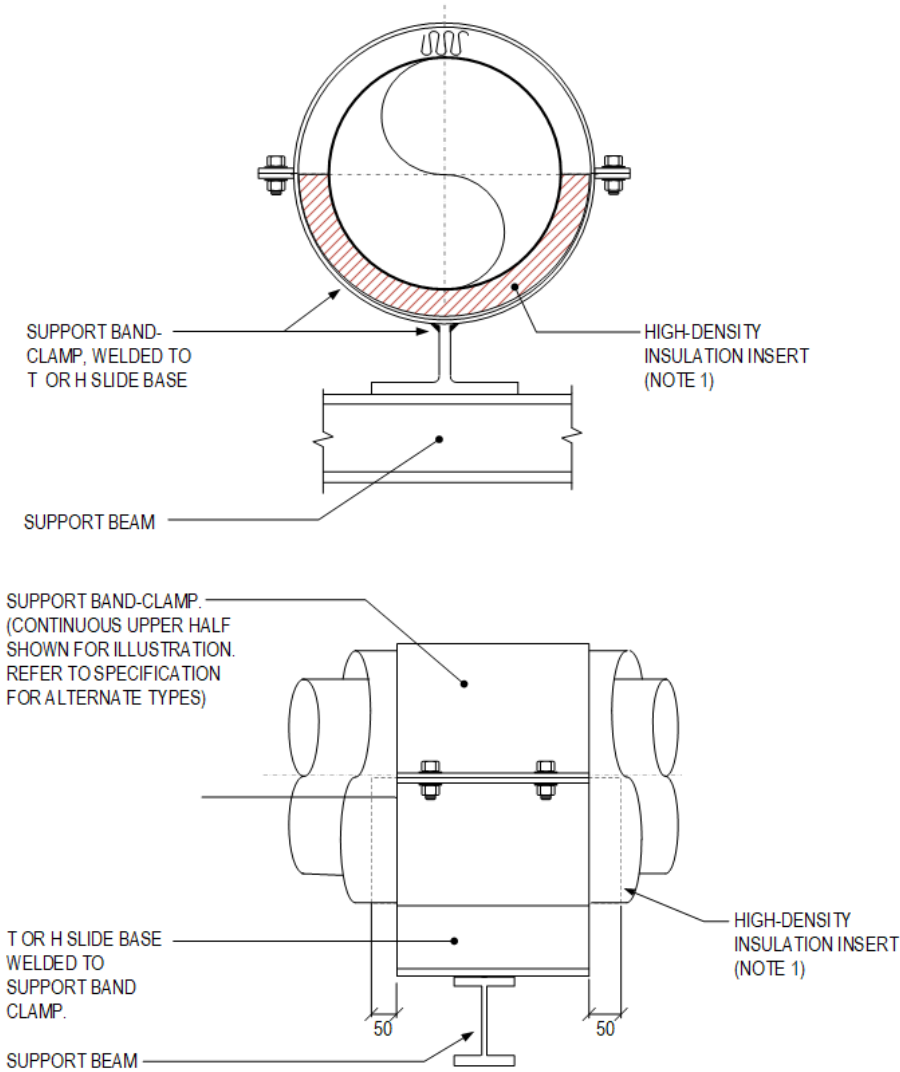
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Standard Detail No.

20 05 29 - 011







**NOTES:**

1. REFER TO SPECIFICATION SECTION 20 05 29, SCHEDULE "C" AND SECTION 20 07 19 FOR APPLICABLE TYPES OF HIGH-DENSITY INSULATION INSERTS.

NOT TO SCALE



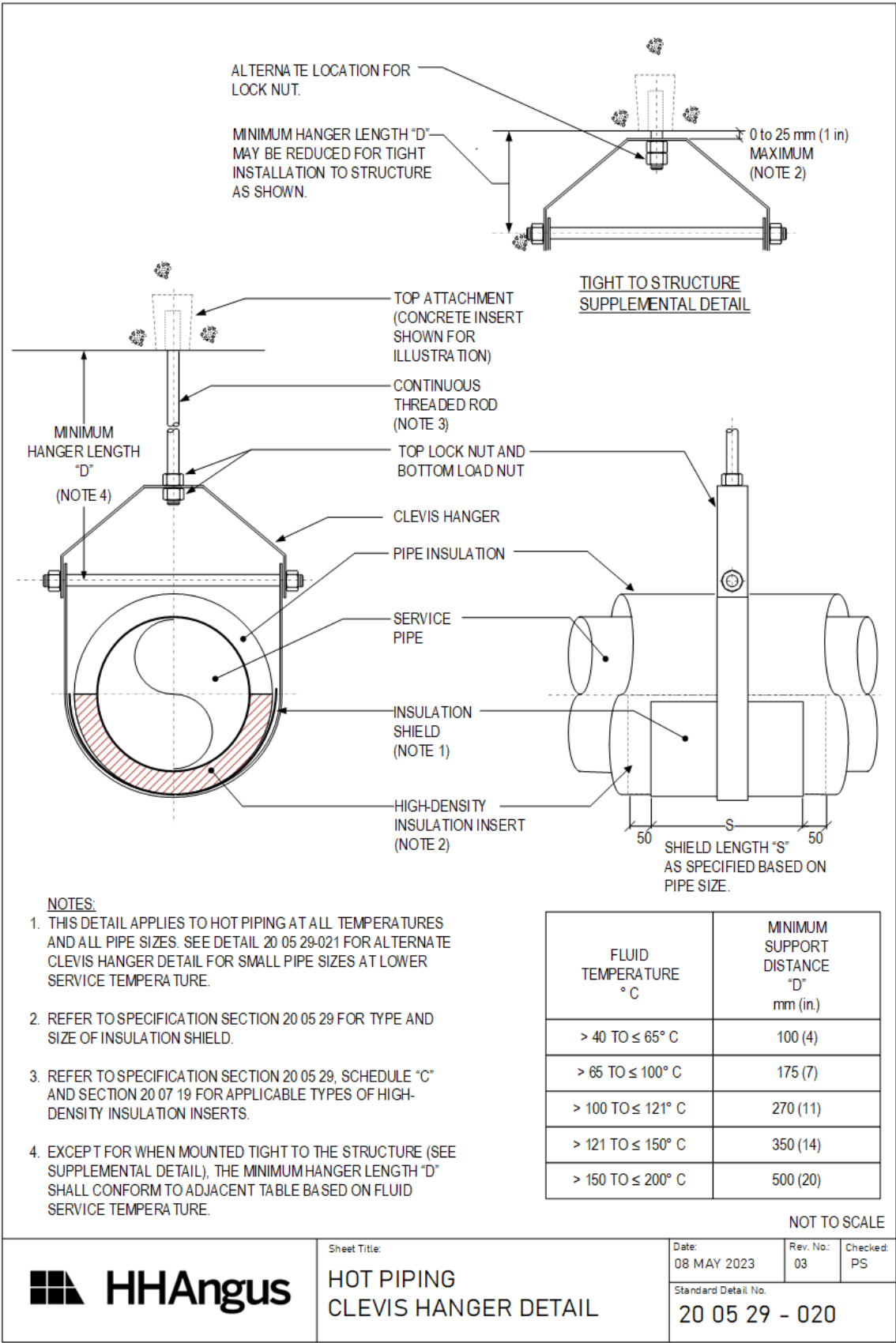
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**COLD PIPING AND  
DUAL-TEMPERATURE PIPING  
SLIDE SUPPORT DETAIL**

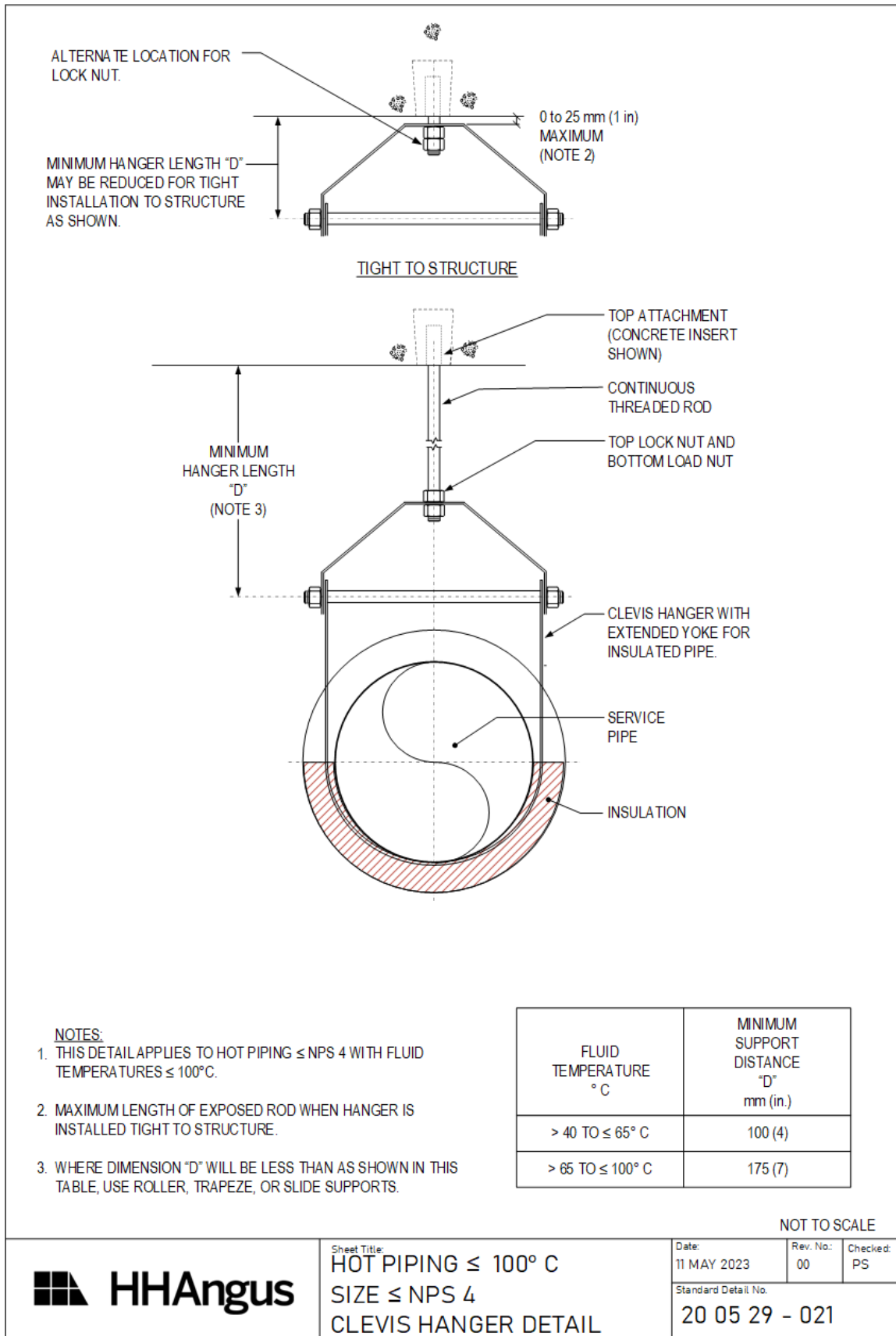
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11 MAY 2023

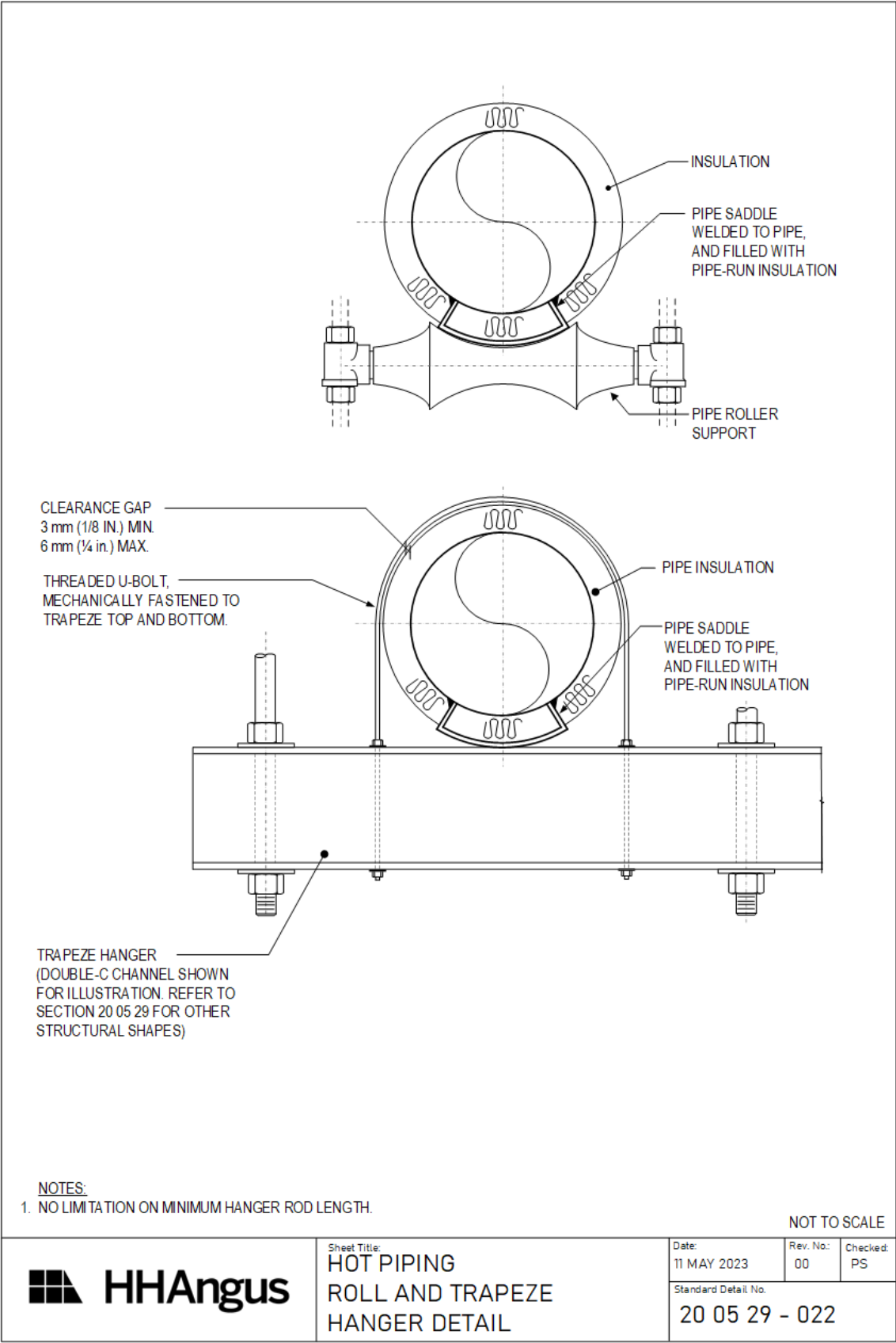
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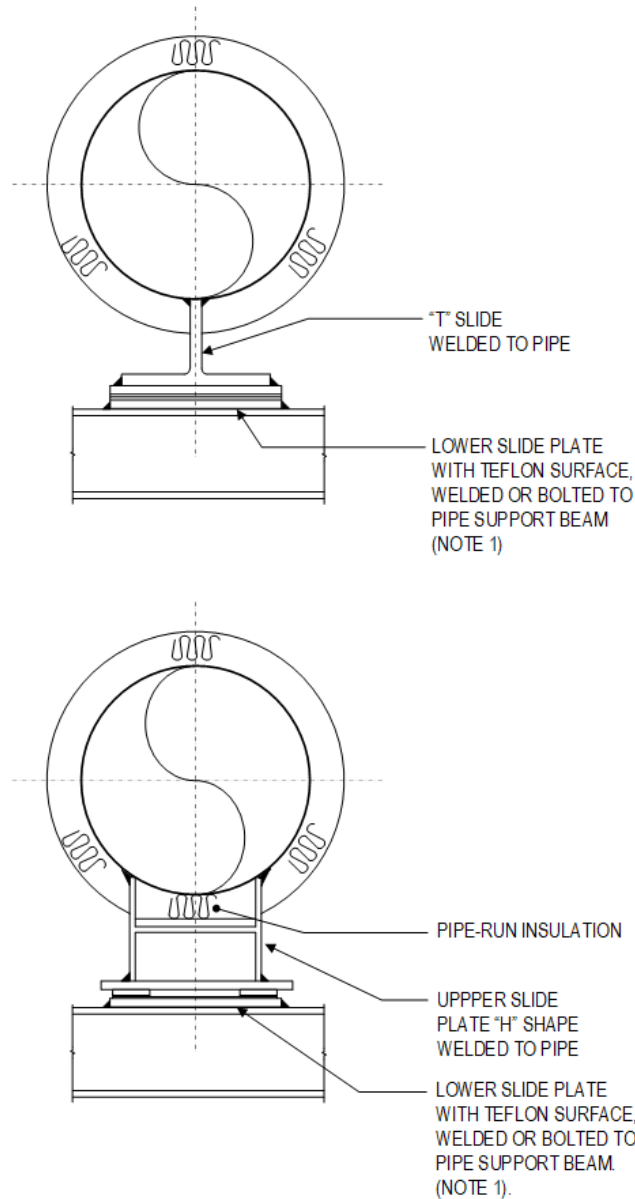
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Standard Detail No.  
**20 05 29-013**









**NOTES:**

1. TEFLON SLIDE PLATES ONLY REQUIRED FOR HOT PIPING WITH SERVICE TEMPERATURE > 121° C, INCLUDING STEAM AT PRESSURES > 103 kPa.

NOT TO SCALE



Sheet Title:

**HOT PIPING  
SLIDE SUPPORT DETAILS**

Date:

11 MAY 2023

Rev. No:

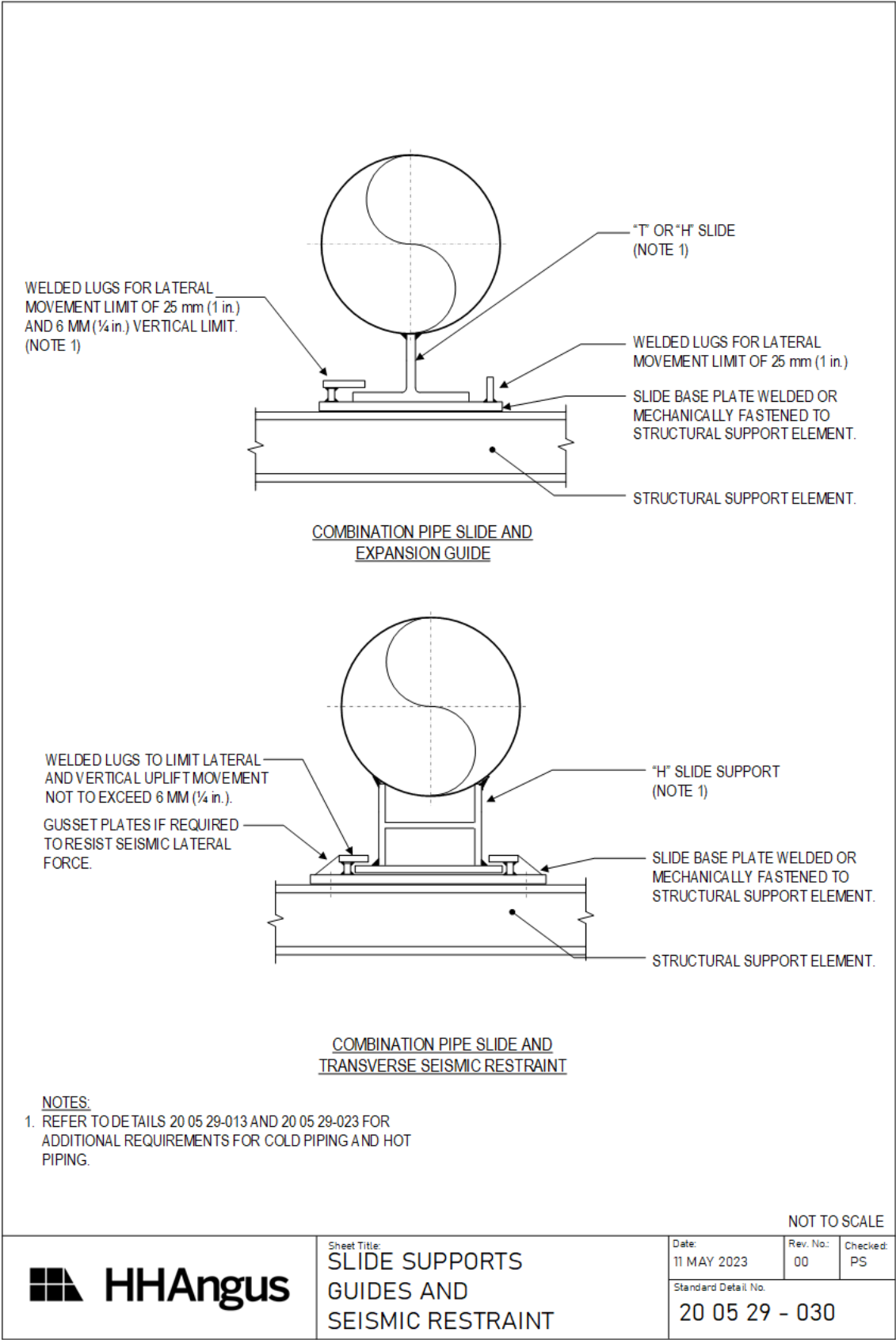
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Standard Detail No.

20 05 29 - 023



**END OF SECTION**



## **VIBRATION ISOLATION**

### **20 05 48**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide vibration isolation equipment for;
  - .1 vibration control for motor-driven mechanical equipment,
  - .2 vibration control for piping and ductwork connected to motor drive equipment,
  - .3 movement control for piping due to thermal movement, and
  - .4 movement control for piping due to building movement.
- .2 Provide engineering services associated with the design, analysis and selection of vibration isolation supports, including pipe riser supports.
- .3 Refer to specification section 20 05 29 for installation requirements for variable and constant load supports for pipe riser in excess of 25 m (82 ft) in height.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 12 Wiring Requirements for Mechanical Services
  - .2 20 05 29 Common Hanger and Support Requirements for Piping
  - .3 20 05 49 Seismic Restraint
  - .4 20 05 16 Flexible Connections, Expansion Joints, Anchors & Guides
  - .5 23 33 05 Duct Accessories

##### **1.3 Applicable Codes and Standards**

- .1 Product standards:
  - .1 ASTM A653-19 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - .2 ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus

##### **1.4 Design Criteria**

- .1 Isolator and base type designations are taken from the current ASHRAE Applications Handbook.
- .2 Base type, isolator type and minimum static deflection are shown in equipment schedules and/or equipment selection sheets.
- .3 Information shown in equipment schedules is to establish minimum standards and vibration isolation equipment to be selected to maintain noise levels in building below RC levels in following schedule.

AREA	NOISE CRITERIA (NC level)
Offices - private	32 to 34
-open plan	36 to 38
-business machine areas	40 to 42

AREA	NOISE CRITERIA (NC level)
-conference/boardrooms	30 to 32
Operating Rooms	25 to 27
Private Bedrooms	26 to 28
Hospital Wards	30 to 32
Public Areas	38 to 40

- .1 Provide a completely engineered design of pipe riser vibration isolated supports to minimize the pipe anchor loads under normal operating conditions, with engineering documents sealed by a professional engineer licensed in the jurisdiction of the Work.
- .2 Coordinate vibration isolation with seismic requirements under specification section 20 05 49.

## 1.5 Submittals

- .1 Submit shop drawings consisting of;
  - .1 product data sheets for isolation components,
  - .2 a schedule (or similar document) of vibration isolators selected for each piece of equipment, including equipment weight and isolator static deflection;
    - (a) where a common selection is used for multiple instances of the same equipment type, a single submission identifying all applicable equipment units is sufficient,
  - .3 drawing details for equipment bases, specific to each piece of equipment,
  - .4 fabrication details, location and size of anchor bolts and concrete requirements for inertia bases.
- .2 Submit shop drawings for the completely engineered pipe riser vibration isolation supports and pipe anchors;
  - .1 for each isolator, identify the estimated supported static loads, estimated supported operating loads (at temperature), spring deflections at static and operating conditions, spring deflections at static and operating condition, spring selections, and riser anchor design, including anchor loads at static and operating conditions,
  - .2 shop drawings to be sealed by a professional engineer licensed in the jurisdiction of the Work.

## 2 PRODUCTS

### 2.1 General Requirements

- .1 Provide vibration isolation equipment by one manufacturer.

#### *Standard of Acceptance*

- Vibro-Acoustics (Swegon NA)
- Kinetics
- BVA
- Korfund Mason
- Tecoustics

### 2.2 Resilient Isolator Pads – Type P1

- .1 Elastomer-in-shear pads:
  - .1 rubber waffle or ribbed pads:

- (a) 45 or 60 durometer neoprene depending on loading, minimum of 22 mm (7/8 in) thick,
- (b) load rating: up to 5 mm (0.19 in) static deflection and up to nominally 4400 kg (9700 lbs.) load,
- .2 rubber-steel-rubber pads:
  - (a) two layers of rubber waffle or ribbed pad, 13 mm (1/2 in) thick, as specified above,
  - (b) bonded to 6 mm (1/4 in) steel plate, with holes sleeved and fitted with isolation washers.
- .3 Neoprene jacketed pre-compressed moulded fiberglass pads.

## **2.3 Elastomeric Mounts – Type M1**

- .1 Molded neoprene mount:
  - .1 one piece, molded neoprene mount, with cast-in-top threaded steel load insert, and two hold down bolt openings on the bottom plate,
  - .2 load rating: up to 13 mm (0.5 in) static deflection and up to nominally 1800 kg (3960 lbs.) load,

## **2.4 Isolator Springs – Type S1**

- .1 Open spring isolator:
  - .1 free-standing, open (un-enclosed) spring isolator, selected for static deflections as shown,
  - .2 upper load plate and leveling assembly, and bottom load plate with non-skid noise isolation pad and bolt holes for fastening to the floor,
  - .3 load rating: up to 50 mm (2 in) static deflection and up to nominally 8000 kg (17,600 lbs.) load,
  - .4 ratio of lateral spring stiffness to vertical spring stiffness: 1.0 or greater,
  - .5 overload capacity: 50% minimum,
  - .6 springs coated in a colour-coded corrosion protection finish and tested with a 1000 hour salt spray rating to ASTM B117.

## **2.5 Isolator Springs – Type S2**

- .1 Enclosed spring isolator:
  - .1 free-standing, enclosed (housed) spring isolator, selected for static deflections as shown,
  - .2 suitable for equipment subject to wind loads, large changes in mass due to change in water content, torque loads, and/or seismic loads,
  - .3 load rating: up to 100 mm (4 in) static deflection and up to nominally 8000 kg (17,600 lbs.) load,
  - .4 housing: fabricated and welded steel members, hot-dipped galvanized after fabrication, with;
    - (a) top load plate with adjusting and leveling bolts,
    - (b) vertical restraints with isolation washers,
    - (c) bottom plate with non-skid noise isolation pads and bolt holes for fastening to the floor,
  - .5 ratio of lateral spring stiffness to vertical spring stiffness:
    - (a) 1.2 or greater for equipment installed outdoors,
    - (b) 1.0 or greater for equipment installed indoors,
  - .6 overload capacity: 50% minimum,
  - .7 springs coated in a colour-coded corrosion protection finish and tested with a 1000 hour salt spray rating to ASTM B117.

## **2.6 Isolation Springs - Type S3**

- .1 Restrained open spring isolator:
  - .1 free-standing, open (un-enclosed) spring isolator, with vertical limit stops, selected for static deflections as shown,
  - .2 suitable for equipment subject to changes in mass due to change in water content,
  - .3 load rating: up to 50 mm (2 in) static deflection and nominally 1500 kg (3300 lbs.) load,
  - .4 spring assembly:
    - (a) top load plate with adjusting and leveling nut and bolt,
    - (b) integral vertical restraint limit with elastomeric washer,
    - (c) bottom fastening plate with noise isolation pad and mounting holes.
  - .5 ratio of lateral spring stiffness to vertical spring stiffness: 0.8 or greater.
  - .6 overload capacity: 50% minimum,
  - .7 springs coated in a colour-coded corrosion protection finish and tested with a 1000 hour salt spray rating to ASTM B117.

## **2.7 Isolator Springs – Type S4**

- .1 Open spring thrust restraint isolators:
  - .1 horizontal arrangement, with equipment and structure mounting plates,
  - .2 open spring, with load plate and isolator bushing,
  - .3 static deflection to match equipment isolator.

## **2.8 Isolation Hangers – Type H1**

- .1 Spring isolation hanger:
  - .1 open (un-enclosed) spring isolator for connection to upper and lower hanger rods, selected for static deflections as shown,
  - .2 a stamped or welded hanger bracket mount with elastomeric washer isolating the spring,
  - .3 bracket and spring: polyester powder coat finish,
  - .4 swivel arrangement to permit hanger box or rod to move through 30° of arc without metal to metal contact,
  - .5 load rating: 10 mm (0.4 in) to 50 mm (2 in) static deflection and up to nominally 1450 kg (3190 lbs.) load,
  - .6 ratio of lateral spring stiffness to vertical spring stiffness: 1.0 or greater,
  - .7 overload capacity: 50% minimum.,

## **2.9 Isolation Hangers – Type H2**

- .1 Spring isolation hanger with elastomer-in-shear insert:
  - .1 Same as type H1 except as follows.
  - .2 includes a neoprene elastomer-in-shear insert on the upper load connection, in series to the spring,
  - .3 load rating: up to 100 mm (4 in) static deflection and up to nominally 1700 kg (3740 lbs.) load,

## 2.10 Isolation Hangers – Type H3

- .1 Neoprene isolation hanger:
  - .1 neoprene isolator for connection to upper and lower hanger rods,
  - .2 a stamped hanger bracket mount with isolator and load washer, with galvanized steel finish
  - .3 bracket and spring: polyester powder coat finish,
  - .4 swivel arrangement to permit hanger box or rod to move through 30° of arc without metal to metal contact,
  - .5 load rating: up to 15 mm (0.57 in) static deflection and up to nominally 900 kg (1980 lbs.) load,
  - .6 ratio of lateral spring stiffness to vertical spring stiffness: 1.0 or greater,
  - .7 overload capacity: 50% minimum.

## 2.11 Equipment Base – Type A

- .1 Vibration isolators attached directly to equipment,
- .2 No supplementary base required.

## 2.12 Equipment Base – Type B

- .1 Fabricated steel frame or rails (except cooling towers, evaporative fluid coolers, and evaporative condensers):
  - .1 prefabricated steel base for fans and other equipment requiring motor support,
  - .2 welded assemblies from structural sections,
  - .3 reinforced for motor and drive with;
    - (a) isolation elements attached to base brackets and
    - (b) adjustable motor slide rails.
  - .4 use height-saver isolator mounting brackets wherever possible,
  - .5 minimum vertical section of base selected on basis of motor size from following;

Motor Size Horsepower	Motor Size kW	Vertical Side mm (in)
up to 3	up to 2.2	75 (3)
7.5	5.5	100 (4)
20	15	150 (6)
50	37	200 (8)
over 50	37	250 (10)

## 2.13 Equipment Base – Type B-CT

- .1 Fabricated steel frame or rails – for cooling towers, evaporative fluid coolers, and evaporative condensers:
  - .1 prefabricated supplementary steel base for cooling towers, evaporative fluid coolers and evaporative condensers,
  - .2 fabricated from structural steel shapes, specifically designed for each equipment operating weight and support point locations,

- .3 maximum beam deflection: not greater than 1/360 of span and not to exceed 12.5 mm (1/2 in),
- .4 welded and/or bolted structural connections,
- .5 hot-dipped galvanized grade Z700 (G235) to ASTM A653 after fabrication,

#### **2.14 Equipment Base – Type C**

- .1 Concrete filled inertia base:
  - .1 Type B base and as follows,
  - .2 full depth perimeter structural section or formed plate channel frame with;
    - (a) welded in place reinforcing rods running in both directions and
    - (b) 1 mm (20 ga) metal pans,
    - (c) base section filled with concrete, vibrated into place.
  - .3 spring mount units carried by height-saver gusseted brackets welded to frame and
  - .4 'T' shaped bases to support horizontal pump elbows.

#### **2.15 Acoustic Barriers for Anchors and Guides**

- .1 Manufactured from 25 mm (1 in) thick neoprene isolation with ductile reinforcing material.

### **3 EXECUTION**

#### **3.1 General**

- .1 Install vibration isolation equipment in accordance with manufacturer's instructions and locate isolation for equipment to provide stable support under saddles, frames and projections of equipment.
- .2 Select thrust restraints for equipment mounted on vibration isolation to limit movement during start-up and normal operation.

#### **3.2 Equipment Bases**

- .1 Provide equipment bases for equipment as shown on equipment schedule drawings.
- .2 Block and shim bases level at correct operating height. Set the bottom of bases to clear housekeeping pads under full static load conditions by:
  - .1 25 mm (1 in) minimum for type C bases, and
  - .2 50 mm (2 in) minimum for type A and B bases.

#### **3.3 Equipment Vibration Isolation**

- .1 Provide vibration isolators with required static deflection for motorized equipment as shown on equipment schedule drawings, except as otherwise specified herein.
- .2 Provide Type H1 isolators for in-line duct fans and fan-powered terminal boxes.
- .3 Provide Type H3 isolators for suspended unit heaters.
- .4 Provide Type S4 horizontal thrust restraints for horizontal discharge fans developing over 1.5 kPa (6 in wg) total static pressure, arranged symmetrically on either side of unit and attached at the center-line of thrust.
- .5 Provide vibration isolation rubber washers where isolator is bolted to floors, housekeeping pads or overhead structure.

### 3.4 Vibration Isolation for Service Connections to Vibration Isolated Equipment

- .1 Make ductwork connections to vibration isolated air handling equipment with flexible connections in accordance with specification section 23 33 05.
- .2 Make electrical connections to vibration isolated equipment with flexible liquid tight conduit in accordance with specification section 20 05 12.
- .3 Make pipe connections to vibration isolated equipment in accordance with specification section 20 05 16.

### 3.5 Vibration Isolation Piping Supports – General Requirements

- .1 Provide vibration isolators on pipe supports where piping is connected to motorized equipment that is supported on vibration isolators of any type, in accordance with the following table.

Location	Pipe Size NPS	Isolator Type	Static Deflection mm (in)
The first two pipe supports adjacent to the vibration isolated equipment	$\geq 10$	Variable support hanger to section 20 05 29	Equal to the equipment isolator static deflection, but not less than 20 (0.75)
	$< 10$	S1 or H2 [Note 1]	
The third pipe support adjacent to the vibration isolated equipment	All	S1 or H2	Equal to the equipment isolator static deflection, but not less than 20 (0.75)
The 4 <sup>th</sup> and 5 <sup>th</sup> support point from the vibration isolated equipment	$\geq 6$	S1 or H2	20 (0.75)
The 6 <sup>th</sup> support point from the vibration isolated equipment	$\geq 10$	S1 or H2	20 (0.75)
Within 15 m (50 ft) pipe-run distance of outdoor equipment	All	S1 or H2	20 (0.75)

**Notes:**

[1] Order springs pre-compress to suit the installed weight of the pipe filled with the operating fluid.

- .2 Provide acoustic barrier materials at pipe anchors and guides, located within pipe shafts, duct shafts, equipment and fan rooms, and up to the first anchor outside of these rooms or areas.

### 3.6 Thermal Expansion Supports for Pipe Risers

- .1 Unless otherwise shown for pipe riser supports to use variable or constant load pipe hangers in accordance with section 20 05 29, provide spring isolators for pipe supports to accommodate pipe thermal movement for vertical pipe (risers) as follows.
- .2 Support vertical cold- and hot-piping for riser heights that are 25 m(82 ft) or less in height on spring isolators attached to the pipe riser supports;
  - .1 select springs so that the initial spring deflection is at least four (4) times the expected thermal movement at each support point,

- .2 provide the design and fabrication of brackets at the riser spring mount as well as at the pipe attachment where standard riser clamps are not sufficient, and
- .3 in accordance with specification section 20 05 29.
- .3 For support of vertical cold- and hot-piping for riser heights greater than 25 m (82 ft), refer to specification section 20 05 29.
- .4 Provide spring isolators on horizontal branch piping or the horizontal pipe mains connecting to the riser as follows:
  - .1 type S2 or H2 isolators on the first three supports on horizontal piping connecting to the pipe risers,
  - .2 spring isolators on the horizontal piping is not required where the horizontal pipe connection is within 4 m (13 ft) of a pipe riser anchor or fixed riser base support.
  - .3 select spring isolators with a static deflection of that is four (4) times the expected thermal movement of the riser pipe at the location of the horizontal pipe connection.

### **3.7 Pipe Movement Isolation Supports at Building Expansion Joints**

- .1 Where piping crosses building expansion joint, provide spring hangers at first two support locations of piping at either side of the construction joint line.

### **3.8 Start-up and Set-up**

- .1 After installation of connections to resiliently mounted equipment;
  - .1 remove shims and blocking and adjust mountings to level equipment,
  - .2 adjust connections, hangers, snubbers, and restraints,
  - .3 ensure that there is no physical contact between isolated equipment and building structure.
- .2 On completion of installation and start-up of equipment;
  - .1 make arrangements for manufacturer/supplier of vibration isolation equipment to visit site, check the performance of the vibration isolation systems, inspect their installation, and submit written report,
  - .2 make corrections to installation in accordance with manufacturer/suppliers recommendations,
  - .3 provide notice 24 hours in advance of this site visit.

**END OF SECTION**







## **SEISMIC RESTRAINT FOR MECHANICAL SERVICES**

### **20 05 49.13**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide restraint devices to limit movement of piping, ducts, conduits, and equipment under seismic force and movement conditions and, where applicable, wind loads.
- .2 Provide engineering services for the design, selection of materials, installation instructions, and inspection of seismic restraint devices.
- .3 The requirements under this Specification section are in addition to the requirements for equipment, piping and duct supports and vibration isolation specified in other sections of Division 20.
- .4 Where specifications of materials of this section differ from those in other sections of Division 20, this section governs.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 16 Flex Connections, Expansion Joints, Anchors & Guides
  - .2 20 05 29 Common Hanger and Support Requirements
  - .3 20 05 48 Vibration Isolation
  - .4 20 05 49.23 Seismic Qualifications for Mechanical Equipment
  - .5 26 05 49 Seismic Restraints for Electrical Services

##### **1.3 Definitions**

- .1 The following definitions apply for the purpose of this section.

**Transverse restraint** – means restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

**Longitudinal restraint** – means restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

**Restraint:** means a device which limits movement of an object due to imposed seismic forces acting on the object.

**Brace:** a restraint directly connected to an object that reacts against both tension and compression seismic loads.

**Cable restraint:** a restraint consisting of cables that reacts against only tension seismic forces, and that may have a small amount of slack to prevent vibration isolation short-circuiting during normal operation.

**Snubber (restraint):** a restraint that does not come into contact with the object under normal operating conditions.

**Seismically qualify (seismically qualified):** Refer to specification section 20 05 49.23.]

- .2 The following abbreviations apply to this section:

- “**C<sub>p</sub>**” the horizontal seismic force coefficient as defined in NFPA 13.
- “**K<sub>s</sub>**” horizontal seismic force coefficient equal to 0.3 S(0.2) I<sub>E</sub> S<sub>p</sub>, as defined in the 2020 National Building Code of Canada and represents a multiply of gravitational acceleration.
- “**K<sub>v</sub>**” vertical seismic force coefficient and represents a multiple of gravitational acceleration.
- “**W<sub>p</sub>**” the weight of the component subject to a seismic force.

.3 Interpretation:

- .1 In this specification, the parameter “S<sub>s</sub>” (spectral response acceleration at 5 Hz) in NFPA 13, ASHRAE, SMACNA and MSS SP-127 used for estimating the horizontal seismic force, has the same meaning as the parameter “S(0.2)” for the Project site-specific design spectral response acceleration value at 0.2 seconds as defined in article 4.1.8.18 of the 2020 National Building Code of Canada.

## 1.4 Applicable Codes and Standards

.1 Legislation

- .1 2020 National Building Code of Canada, as adopted in the jurisdiction of the Project.

.2 Installation standards and codes:

- |    |                |  |
|----|----------------|--|
| .1 | ASHRAE D-90316 | Practical Guide to Seismic Restraint   |
| .2 | ANSI/SMACNA    | Seismic Restraint Manual Guidelines for Mechanical Systems, 3 <sup>rd</sup> edition. |
| .3 | MSS SP-127     | Bracing for Piping Systems: Seismic - Wind - Dynamic Design, Selection,              |
| .4 | NFPA 13        | Installation of Sprinkler Systems  |

.3 Product standards:

- |     |              |  |
|-----|--------------|--|
| .1  | ACI 355.2    | Qualification of Post-Installed Mechanical Anchors in Concrete                                       |
| .2  | ASHRAE 171   | Method of Testing Seismic Restraint Devices for HVAC&R Equipment                                     |
| .3  | ASTM A492    | Standard Specification for Stainless Steel Rope Wire   |
| .4  | ASTM A1023   | Standard Specification for Stranded Carbon Steel Wire Ropes for General Purpose                      |
| .5  | ICC-ES AC01  | Expansion Anchors in Masonry Elements  |
| .6  | ICC-ES AC106 | Predrilled Fasteners (Screws) in Masonry   |
| .7  | ICC-ES AC156 | Acceptance Criteria for Seismic Certification by Shake-Table Testing of Non-structural Components    |
| .8  | ICC-ES AC193 | Mechanical Anchors in Concrete Elements  |
| .9  | ICC-ES AC308 | Post-Installed Adhesive Anchors in Concrete Elements   |
| .10 | MSS SP-58    | Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation |

.4 Other documents:

- |    |        |  |
|----|--------|--|
| .1 | ASCE 7 | American Society of Civil Engineers, Minimum Design Loads and Associated Criteria for Buildings and Other Structures |
|----|--------|--|

### **1.5 Seismic Analysis, Design and Inspection Services**

- .1 Provide the services of a professional engineer, licensed in the province or territory of the Work and who specializes in seismic restraint of building services and equipment (the "Seismic Engineer"), for the design of seismic restraints and to provide inspection services of the completed installation.
- .2 Seismic Engineer design services;
  - .1 Provide the design of seismic restraint systems, including seismic restraint calculations for all connections of equipment to the structure.
  - .2 Provide design drawings showing locations of restraints and details of construction and attachment of restraints. Mark-ups of Consultant drawing or Contractor installation drawings may be used for this purpose.
  - .3 Analysis of dead loads, seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis to detail anchoring methods, bolt diameter, embedment and/or welded length. Design seismic restraint devices to accept, without failure, the seismic forces acting on the equipment or components and their support and restraint attachments to the building structure.
- .3 Seismic Engineer inspection services;
  - .1 At periods during installation and at completion of the installation of the seismic restraint devices, the Seismic Engineer shall inspect the installation, identify and report deficiencies (if any) which are observed, and re-inspect the installation after deficiencies have been corrected.
  - .2 Seismic Engineer to submit periodic inspection reports and a final inspection report after all work is completed and deficiencies have been corrected, confirming the installation conforms to the seismic design requirements. Prepare and submit any required declarations or similar document to this effect where required by local legislation.
- .4 Shop drawings of custom restraints, supporting calculations, and reports shall be sealed by the Seismic Engineer.
- .5 Prepare and submit reports of inspections of the installation and a final general review report of the completed seismic installation.

### **1.6 Manufacturer's Services – Seismic Restraints**

- .1 Manufacturer of seismic control equipment are responsible for:
  - .1 determining seismic restraint sizes and locations,
  - .2 provide calculations and supply materials for restraint of vibration isolated and non-isolated equipment,
  - .3 provide installation instructions, drawings and trained field supervision to ensure proper installation and performance including welding details,
  - .4 field inspection of manufactured support systems including roof curbs and other rooftop equipment supports at time of installation.

### **1.7 Contractor Design Services – Pipe Risers**

- .1 Notwithstanding the requirements of section 20 05 29, engineered design services for pipe riser supports are required for all pipe risers. These design services may be provided by the Contractor, the Seismic Engineer, or by a seismic restraint manufacturer.
- .2 Pipe riser supports design responsibilities include:
  - .1 complete engineering design of pipe riser support system including design and selection of pipe riser anchors, riser guides and riser isolators,

- .2 provide calculations and supply materials for support of pipe risers to accommodate dead loads, dynamic loads and static seismic loads.
- .3 provide installation instructions, drawings and trained field supervision to ensure proper installation and performance including welding details.

## 1.8 Design Criteria

- .1 Design seismic restraint systems to conform to the provincial or territorial building code requirements for seismic forces and movement as applicable for the place of the Work. Seismic restraint methods as described in ASHRAE D-90316, SMACNA seismic guideline and MSS SP-127 are acceptable as the baseline requirement.
- .2 Base the design of seismic restraints on actual equipment data (dimensions, weight, center of gravity, etc.,) obtained from submittals or the manufacturers of the equipment.
- .3 Testing and calculations of seismic restraints shall include both shear and tensile loads as well as one test or analysis at 45° to the weakest mode.
- .4 Site design parameters shall be obtained for the existing building.
- .5 Building seismic force coefficient data;
  - .1 seismic horizontal force coefficients " $K_s$ " and seismic vertical uplift force coefficient " $K_v$ " for building service are listed in Schedule A attached to the end of this Section. These coefficients are the maximum values independent of the type of equipment or service being restrained. It is permitted to calculate a lower  $K_s$  coefficient where the  $C_p$ ,  $A_r$  and  $R_p$  values, as defined in the building code specific to the actual equipment or service being restrained, are used.
  - .2 seismic force coefficient " $C_p$ " for fire protection piping is listed in Table 3 of Schedule A attached to the end of this Section.
- .6 Seismic force calculation (except fire protection piping);
  - .1 the horizontal seismic force " $V_p$ " applied to a component is:
$$V_p = K_s \times W_p,$$
  - .2 the vertical seismic force " $V_{pv}$ " applied to a component is:
$$V_{pv} = K_v \times W_p$$
- .7 Seismic force calculation for fire protection piping, including automatic sprinklers constructed in accordance with NFPA 13 and fire standpipes constructed in accordance with NFPA 14;
  - .1 the horizontal seismic force applied to a component is
$$F_p = C_p \times W_p \times 1.15,$$
  - .2 the vertical seismic force applied to a component is equal to 15% of the horizontal seismic force  $F_p$ .
- .8 For suspended equipment, the building elevation height is measured to the level of the floor above the suspended equipment.
- .9 For vibration isolated equipment, where the clearance distance (air gap) between the equipment support frame and the restraint (e.g. snubber or integral limit stop) exceeds 6 mm (1/4 in.), the seismic horizontal force  $V_p$  is to be increased by 100%.
- .10 Where adhesive anchors for concrete are used, the seismic force for the restrained equipment is to be increased by multiplying the horizontal seismic force coefficient specified in Schedule A of this Specification section by the " $R_p$ " equipment category as defined in article 4.1.8.18 of the National Building Code of Canada specific to the equipment being restrained.

$$K_{s,adhesives} = K_s \times R_{p,applicable\ equipment}$$

- .11 Where concrete inserts are used, the seismic force for the restrained equipment is to be increased by multiplying the horizontal seismic force coefficient specified in Schedule A of this Specification section by the “R<sub>p</sub>” equipment category as defined in article 4.1.8.18 of the National Building Code of Canada specific to the equipment being restrained and divided by the value of 1.5.

$$K_{s,inserts} = K_s \times \frac{R_{p,applicable\ equipment}}{1.5}$$

## 1.9 Submittals

- .1 Submit shop drawings in accordance with Division 1 and as follows.
- .2 Submittals for design of seismic restraint systems shall be sealed by a Professional Engineer licensed in the province or territory of the jurisdiction of the Project.
- .3 Seismic restraints:
- .1 Provide test certificates for each seismic restraint device, identifying maximum tested load capacities.
  - .2 Provide calculations for each piece of restrained equipment, lengths of braced piping, ductwork and conduit, including seismic forces, restraint selection, and selection data.
  - .3 Provide seismic data in spreadsheet format for each piece of equipment and include the following information:
    - (a) Equipment ID,
    - (b) Building floor level,
    - (c) Horizontal seismic force factor K<sub>v</sub>,
    - (d) Equipment weight,
    - (e) Horizontal seismic force,-
    - (f) Vertical uplift seismic force (where applicable),
    - (g) Design condition (worst case) overturning moment,
    - (h) Number of restraint fastenings,
    - (i) Pull-out tension for worst case restraint,
    - (j) Compression for worst case restraint (vibration isolated equipment),
    - (k) Horizontal shear load per fastener,
    - (l) Worst case simultaneous tension and shear loads at each restraint and snubber,
    - (m) Pull-out tension load rating per fastener,
    - (n) Horizontal shear rating per fastener.
  - .4 Provide drawings for each type of restraint assembly, including details for connections to building structure, and associated bill of materials, and (where applicable) full welding details of field welds to structural elements.
  - .5 For building connections in concrete, provide concrete anchor sizes and nominal and effective embedment depth.
  - .6 Provide floorplan layout drawings indicating location of each restraint, identifying each restraint type in a manner to identify the restraint detail.
  - .7 Provide layout and construction details for reinforced housekeeping pads based on actual equipment to be restrained and selected concrete anchors. Shop drawings to include:
    - (a) minimum housekeeping pad plan dimensions and height, including reinforcement,
    - (b) details for securing the housekeeping pad to the structural floor slab,

- (c) dimensioned position of restraint devices or combination isolator/restraint devices,
- (d) minimum distance from concrete anchors to edge of housekeeping pad.
- .4 Calculations and designs shall be sealed by a Professional Engineer licensed in the province or territory of the jurisdiction of the project.
- .5 Pipe riser support system:
  - .1 Provide engineered layout drawings of pipe supports including anchors, guides, and isolators, with supporting load calculation including dead loads, dynamic loads and static seismic loads, and reaction loads at building connection.
  - .2 Include:
    - (a) riser drawing indicating location of each support element for each for each piping system,
    - (b) installation instructions for presetting of pipe guides and isolators,
    - (c) riser clamp products or fabrication details of pipe brackets,
    - (d) riser clamping details as applicable for each riser pipe material.

## 1.10 Quality Assurance

- .1 Without limiting Contractors responsibility for quality assurance of the Work, the following minimum quality control processes are required.
- .2 Pre-Construction meeting;
  - .1 Request and arrange a meeting with the Seismic Engineer and Consultant to review seismic restraint approach, prior to any restraint installation. Obtain approval from the Consultant before commencing work.
- .3 Initial installation and review;
  - .1 Install the first three transverse and three longitudinal braces for each fire protection systems, one (1) building service piping system, and one (1) ductwork system.
  - .2 Request and arrange for a review of the installation by the Seismic Engineer and Consultant. Obtain approval of the installation before commencing remainder of the work.
- .4 Provide services of the manufacturer's technical representative to conduct site inspections of the Work in progress, and to conduct a final inspection of the Work. Provide a copy of the final inspection report to the Consultant for review. For clarity, these inspections are separate from those performed by the Seismic Engineer.
- .5 Provide services by the Seismic Engineer to conduct periodic reviews of the work in progress, and final review of the completed seismic restraint installation, before any ceilings are installed or work is otherwise concealed.
- .6 All deficiencies identified by the Seismic Engineer, manufacturer, or Consultant are to be rectified before equipment or services are concealed.

## 2 PRODUCTS

### 2.1 General

- .1 Seismic restraint materials to be provided by manufacturers specializing in the field of seismic restraint.

#### *Standard of Acceptance*

- Vibro-Acoustics (Swegon North America)
- Kinetics Noise Control Inc.
- B.V.A. Systems



- Korfund (VMC)
  - Tecoustics
  - Hilti
  - nVent
- .2 Manufactured seismic restraints, anchors and related materials to be tested in accordance with ICC ES AC156 for loads meeting or exceeding the applied seismic forces of the Work.
- .3 Demonstrate conformity of seismic restraint products by:
- .1 approved by a government agency and indicate maximum restraint ratings, or
  - .2 provided with test results verified by an independent testing laboratory which state the maximum restraint ratings.
- .4 Seismic restraints for equipment supported by vibration isolators to be either:
- .1 vibration isolators as specified in section 20 05 48 and provided with separate seismic snubbers, or
  - .2 combination vibration isolators with integral seismic snubbers.
- .5 The following product articles describe the more common type of restraint devices. Other restraint devices are permissible provided they are qualified by 3<sup>rd</sup> party testing laboratories for seismic force restraint.

## **2.2 Seismic Snubbers**

- .1 Type "SS1" – Single-Axis/Single Direction Snubbers:
- .1 ASHRAE Type "I", designed to restrict movement in one axis,
  - .2 carbon steel construction with epoxy or electrostatic paint finish, attached to floor or housekeeping pad with minimum of two bolts, faced with minimum 6.4 mm (1/4 in.) thick neoprene pad of compounded to bridge bearing quality,
- .2 Type "SS2 / SS3" – Multi-Axis/Multi-Direction Snubber Assemblies:
- .1 ASHRAE Type "G" and "F", designed to restrict movement in two (2) lateral ("SS2") or three (3) axis ("SS3"),
  - .2 interlocking steel construction, attached to equipment structure and equipment, maximum of 6 mm (1/4 in) seismic movement,
  - .3 minimum 6 mm (1/4 in) thick resilient neoprene pads compounded to bridge bearing specifications, to prevent metal-to-metal impact,
  - .4 minimum two bolt attachments to the floor,

## **2.3 Seismic Restraint Brackets**

- .1 Type "SRB" – Rigid Equipment Restraint Brackets:
- .1 suitable for connection to equipment bases and tank bases,
  - .2 carbon steel "L" sections with epoxy or electrostatic paint finish, for fastening to both the floor structure/housekeeping pad and the equipment base,
  - .3 structure bolt opening equipped with neoprene bushing, compounded to bridge bearing quality,
  - .4 minimum two bolt fastening to equipment base using screws,
  - .5 suitable for equipment direct contact to floor with or without isolation pads,

## **2.4 Seismic Vibration Isolators**

- .1 Type "2-S" – All Direction Neoprene Isolator:
  - .1 ASHRAE Type "E", designed to restrict movement in all directions with no metal-to-metal contact.
  - .2 molded, oil resistant neoprene compounded to bridge bearing quality, with encapsulated cast-in-place top steel load plate, and steel base plate with anchor holes,
- .2 Type "3-S" – Restrained Spring Isolator – Constant Load:
  - .1 ASHRAE Type "B", designed to restrict movement in all directions,
  - .2 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm (¼ in.) neoprene pad,
  - .3 removable coil spring element without having to disturb supported equipment,
  - .4 lateral stiffness greater than 1.2 times rated vertical stiffness,
  - .5 minimum 50% overload capacity,
  - .6 non-welded spring elements: epoxy coated, with a minimum 1000-hour rating when tested in accordance with ASTM B-117,
  - .7 steel housing design to limit lateral and vertical movement of the supported equipment,
  - .8 neoprene snubber, to limit maximum equipment movement in any direction to 6 mm (¼ in.),
  - .9 location of snubbers designed to minimize prying action on floor bolts,
  - .10 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.
- .3 Type "4-S" – Restrained Spring Isolator – Variable Load:
  - .1 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm (¼ in) neoprene pad mounted under spring(s),
  - .2 removable coil spring element without having to disturb supported equipment,
  - .3 lateral stiffness greater than 1.2 times rated vertical stiffness,
  - .4 minimum 50% overload capacity,
  - .5 non-welded spring elements: epoxy coated, with a minimum 1000-hour rating when tested in accordance with ASTM B-117,
  - .6 steel housing design to limit lateral and vertical movement of the supported equipment,
  - .7 top load plate with adjustable and leveling bolts,
  - .8 adjustable vertical restraints to allow unloading of water-bearing equipment,
  - .9 isolation washers,
  - .10 bottom load plate with anchor holes,
  - .11 hot dipped galvanized for outdoor installations,
  - .12 neoprene snubber compounded to bridge veering quality, to limit maximum equipment movement in any direction to 6 mm (¼ in),
  - .13 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.

## **2.5 Restraints and Braces for Distribution Services**

- .1 Type "SCR" – Cable Restraints:

- .1 manufactured system consisting of cable, building attachment, and vertical hanger rod reinforcement assembly,
- .2 field-built assemblies are not acceptable,
- .3 steel wire strand cables:
  - (a) galvanized steel aircraft cable to ASTM A1023, or stainless steel to ASTM A492
  - (b) sized for seismic load with a safety factor of 2,
  - (c) arranged for restraint in both longitudinal and transverse directions under tension loads only,
  - (d) connector strength rating equal to 90% of cable breaking strength rating.
- .4 building and equipment attachment brackets:
  - (a) carbon steel assemblies, designed to permit rotation to the final installation angle, or 45° bent steel plates with holes to allow attachment of cable loops,
  - (b) protective loop thimbles at contact with connectors,
  - (c) rope connections: overlap wire "U" clips with at least two (2) bolt fasteners, or, tool-less wedge insert lock connectors,
  - (d) selected to exceed the cable working design load by 50%,
  - (e) single sided "C" beam clamps are not acceptable.
  - (f) fasteners to building structure designed to withstand simultaneous shear and tension loads, including prying action due to the bracket.
- .2 Type "SSB" – Solid Braces:
  - .1 factory-built or field assembled solid braces, consisting of structural-shapes, building attachment, and vertical hanger rod reinforcement assembly.
  - .2 sized for seismic load with a safety factor of 2,
  - .3 arranged for restraint in both longitudinal and transverse directions.
  - .4 building and equipment attachment brackets:
    - (a) carbon steel assemblies, designed to permit rotation to the final installation angle, or 45° bent steel plates with holes to allow attachment of cable loops,
    - (b) selected to exceed the working design load by 50%,
    - (c) single sided "C" beam clamps are not acceptable.
    - (d) fasteners to building structure designed to withstand simultaneous shear and tension loads, including prying action due to the bracket.
- .3 Vibration isolators for suspended pipes and ducts:
  - .1 applies where vibration isolators are specified for pipes or ducts in Specification section 20 05 48.
  - .2 type "H2" spring hanger in accordance with Specification section 20 05 48 and with two (2) travel-limit stops of neoprene washers with integral steel inserts which are located:
    - (a) on the top of the isolator housing, with an air gap of 6 mm (1/4 in.) between the neoprene washer and the structure connection point,
    - (b) on the underside of the isolator housing, supported by a nut on the hanger rod, and provided with an air gap of 6 mm (1/4 in.) between the underside of the isolator housing and the top of the neoprene washer.
- .4 Bracing of vertical hanger rods for SCR restraints and SRB braces:
  - .1 hanger rods braced to avoid potential for buckling;
    - (a) structural steel angle or formed channel brace selected to prevent support rod buckling,
    - (b) brace attached to support rod with a series of adjustable clips, without the use of hand-tools.

- .2 hanger rods are not required where two SRB braces are provided at each seismic restraint location, and are installed at 180° opposition to each other.

## **2.6 Seismic Pipe Riser Support System for Piping Subject to Thermal Expansion**

- .1 Application: for piping subject to thermal expansion including HVAC water systems, steam, domestic hot and cold water.
  - .1 not applicable to: drainage and vent piping systems, compressed gas and vacuum systems.
- .2 Complete engineered riser support system by support manufacturer.
- .3 Pipe riser anchors:
  - .1 outboard-mounted all-direction pipe anchors, designed for load bearing of pipe by means of pipe riser clamps or pipe support brackets,
  - .2 carbon-steel interlocking plates with bridge bearing quality neoprene pads, and painted finish,
  - .3 top-side loading plate with threaded UNC tapped mounting hole, for attachment by bolting to pipe riser clamp or welded to pipe bracket,
  - .4 variants for mechanical anchoring to concrete floor or field-welding to structural steel framing,
  - .5 one pair of guides per guide location.

### *Standard of Acceptance*

- Vibro-Acoustics - fig. PRA, PRA-S

- .4 Pipe riser guides:
  - .1 outboard-mounted pipe guides, designed for load bearing of pipe by means of pipe riser clamps or pipe support brackets,
  - .2 carbon-steel sliding guides with EPDM lateral bushings and bridge bearing quality neoprene end pads, and painted finish,
  - .3 top-side loading plate with threaded UNC tapped mounting hole, for attachment by bolting to pipe riser clamp or welded to pipe bracket,
  - .4 one pair of guides per guide location.

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- Vibro-Acoustics - fig. PRG, PRG-S

- .5 Pipe riser isolators:
  - .1 open spring assembly, with neoprene base and equipment loading plate, and mounting bolt hole for attachment by bolting to pipe riser clamp or welded to pipe bracket.
  - .2 springs selected for four times the riser expansion or contraction at the supported location, to not exceed a maximum 25% load change between installed and operating condition.

### *Standard of Acceptance*

- Vibro-Acoustics - fig. FST series

- .6 Pipe riser clamps:
  - .1 Carbon steel pipe:
    - (a) NPS 1-1/2 and under – carbon steel riser clamps, ANSI/MSS SP-58 type 8.

*Standard of Acceptance*

- Anvil - fig. 261

- (b) NPS 2 to 24 – 4 or 6 bolt carbon steel riser clamps, ANSI/MSS SP-58 type 42.

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- Anvil - fig. 40

.2 Stainless steel pipe:

- (a) NPS ½ to NPS 12 – T304 stainless steel, ANSI/MSS SP-58 type 8.
- (b) special pattern with extended ears and 4 bolts to allow bearing on pipe riser anchors, guides and isolators.

*Standard of Acceptance*

- Anvil - fig. 261SS special.

.3 Copper tube:

- (a) NPS ½ to NPS 4 – carbon steel with copper plated finish, ANSI/MSS SP-58 type 8.
- (b) special pattern with extended ears and 4 bolts to allow bearing on pipe riser anchors, guides and isolators.

*Standard of Acceptance*

- Anvil - fig. CT-121 special.

.7 Pipe brackets:

- .1 purpose engineered, carbon steel structural shapes with reinforcing gussets, for full welding attachment to pipe and to load plates on pipe anchors, guides or isolators.
- .2 painted finish.

**2.7 Seismic Pipe Riser Supports – Piping not Subject to Thermal Expansion**

- .1 Use pipe riser clamps and guides in accordance with Specification section 20 05 29, except select components to have a load capacity equal to at least two times the combined dead weight, dynamic load and seismic load.

**2.8 Air Handling Unit Roof Curbs**

- .1 Roof curbs for air handling units to be designed for dead weight, wind and seismic loads, for solid roof curbs and integrally isolation roof curbs.
- .2 Construction:
  - .1 galvanized steel formed channel rails, and galvanized steel roof curb with welded or bolted corners,
  - .2 galvanized steel cross-bracing for both the curb and equipment rails,
  - .3 roof curb designed specifically for the associated air handling unit and roof pitch.
  - .4 designed so that AHU attachment fasteners are loaded in shear, not in tension.
  - .5 for isolated curbs,
    - (a) combination of seismically restrained vibration isolators, or separate isolators and three-axis snubbers,
    - (b) a UV-stabilized weather flashing to protect isolation springs,

- .6 designed to allow field adjustments, inspections, leveling or replacement of springs without requiring removal or cutting of the flashing,
  - .7 for mechanical anchoring to concrete roof slab or welding to roof steel framing structure as applicable,
  - .8 supplemental cross-frames for support of duct connections to underside of air handling unit,
  - .9 supplemental curbs for piping and conduit services where applicable.
- .3 For isolated roof curb rails, vibration isolators:
- .1 spring type "S1" to Specification section 20 05 48, selected for a ratio of lateral spring stiffness to vertical spring stiffness of at least 1.2 or greater.
  - .2 spring static deflection as shown.
- .4 Roof curbs engineered and designed for static, wind and seismic load restraint and shop drawings to be sealed by professional engineer licensed in the jurisdiction of the work.

*Standard of Acceptance*

- Vibro-Acoustics - fig. VCR
- Kinetics - fig. ESR

**2.9 Cooling Tower and Outdoor Refrigeration Equipment Isolated Supports**

- .1 Supports and restraints for cooling towers, condensing units, air cooled chillers and similar outdoor refrigeration equipment, to be designed for dead weight, operating weight, wind and seismic loads.
- .2 Construction:
  - .1 galvanized steel structural channels rails for isolation and restraint of equipment,
  - .2 rails designed for continuous support for cooling towers, and continuous or point-loaded supports for refrigeration equipment as applicable,
  - .3 minimum two (2) tri-axis restraints per rail and factory located adjustable springs, either as a combined isolator/restraint, or separate isolator and restraint components,
  - .4 support designed to allow replacement of individual isolators,
  - .5 supporting rails cross-braced at all restraint locations with structural carbon steel angle sections,
  - .6 support rails factory drilled to match equipment mounting provisions, and be pre-located and drilled bolt/anchor holes and bracket attachments at each restraint location.
- .3 Vibration isolators:
  - .1 enclosed type "S2" to Specification section 20 05 48,
  - .2 field-adjustable,
  - .3 spring static deflection as shown.
- .4 Support rails engineered and designed for static, wind and seismic load restraint and shop drawings to be sealed by professional engineer licensed in the jurisdiction of the work.

*Standard of Acceptance*

- Vibro-Acoustics - fig. CTB
- Kinetics - fig. QuietRail

**2.10 Mechanical Anchors**

- .1 General:

- .1 Post-installed mechanical anchors in concrete to be seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC193, and qualified by an ICC-ES seismic evaluation report.
- .2 Anchors installed in concrete masonry units to be seismically qualified in accordance with TMS 402/602 by testing for seismic tension and shear loads in accordance with ICC-ES AC01 or AC106, and be qualified by an ICC-ES seismic evaluation report.
- .3 Anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.
- .2 Undercut anchors for post-concrete installation:
  - .1 zinc-plated carbon steel bolt, nut, washer and cone-shape bearing-bell, with tungsten-tipped cutting radial edges, to create bearing force by keying into concrete,
    - (a) for outdoor use, all materials are to be stainless steel.
  - .2 special undercut stop-drill bit and installation setting tool,
  - .3 marking system to indicate when the anchor is completely installed,
  - .4 designed for pre-setting of anchors and/or fastening of anchors through the equipment attachment opening,

*Standard of Acceptance*

- Hilti - fig. HDA (indoor), HDA-R (outdoor)

- .3 Expansion wedge anchors for post-concrete or masonry unit installation:
  - .1 zinc-plated carbon steel bolt, nut, washer, expanding segments and wedge mandrel, to create restraint force by friction and keying against/into adjacent concrete,
    - (a) for outdoor use, all materials are to be stainless steel.
  - .2 torque- loading to determine complete installation,

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- Hilti - fig. KB-TZ2 (concrete and masonry)
- Hilti - fig. HSL-3 (concrete only)

- .4 Screw anchors for masonry units:
  - .1 Zinc-plated carbon steel masonry screw with hex washer head, to create restraint force by keying into concrete masonry units.
    - (a) for outdoor use, all materials to be stainless steel.

*Standard of Acceptance*

- Hilti - fig. KH-EZ series.

- .5 Housekeeping pad anchors:
  - .1 for installation prior to pouring of the housekeeping pad and post-installation of the structural floor,
  - .2 tapered ductile iron body, with openings sized for two runs of Ø10mm (#3) reinforcing bar, and body NC threaded receiver for connection to undercut or expanding wedge anchors,
  - .3 two pieces of Ø10mm (#3) reinforcing bar, of sufficient length to tie into housekeeping pad reinforcement,
  - .4 undercut or expanding wedge anchor for connection to the structural floor slab.

*Standard of Acceptance*

- Mason Industries - fig. HPA

## **2.11 Adhesive Anchors**

- .1 Adhesive anchors for post-concrete installation:
  - .1 seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC308.
  - .2 to have an ICC-ES seismic evaluation report, and be suitable for installation in cracked and uncracked normal- and light-weight concrete.
  - .3 anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.
  - .4 injectable, two-component hybrid adhesive, matching threaded rod and accessories.

*Standard of Acceptance*

- Hilti - fig. HIT-HY 200

## **3 EXECUTION**

### **3.1 General Requirements**

- .1 Design and construct seismic restraints to;
  - .1 keep equipment and distribution services in place during and following seismic events,
  - .2 resist vertical loading simultaneously with transverse or longitudinal seismic loading.
- .2 Give special consideration to design for adjacent connections, insulation treatment, thermal movement, vibration isolation, and relation to building seismic joints.
- .3 Select restraint fastening systems so that full restraint will be provided assuming one failed fastener.
- .4 Install seismic restraint devices in accordance with manufacturer's instructions and Seismic Engineer's installation shop drawings.
- .5 Secure each transverse or longitudinal brace to the building structure, and not any other building service.
- .6 Restraint installation:
  - .1 install cable restraints with slack not exceeding a deflection of 12 mm (1/2 in.) measured at its midpoint, where equipment being restrained is supported on/by vibration isolators or for piping which is subject to thermal expansion,
  - .2 install cable restraints snug in all other applications,
  - .3 use solid braces only in rigidly supported situations,
  - .4 brace hanger rods forming a part of a seismic restraint to accept resulting compressive loads,
  - .5 install transverse and longitudinal braces at angles between 45 and 60° measured from the horizontal, unless the seismic bracing details by the Seismic Engineer states otherwise.
- .7 Concrete or masonry walls may be used as transverse duct restraints (but not pipe restraints), provide the wall is not a fire separation requiring the duct to be installed with a fire damper, and the annual space on any side of the duct does not exceed 12 mm (1/2 in.). Where the annual space exceeds this value, provide separate braces or use angle channels to secure the duct to the wall.
  - .1 drywall partitions, including demountable partitions, are not to be used for restraint.



- .8 Trapeze support and racks piping systems may have the rack braced (transverse and longitudinally) provided each pipe supported by the rack is restrained to the rack, while allowing thermal expansion as necessary.

### **3.2 Use of Pre-Engineered Bracing Details for Distribution Services**

- .1 Use of pre-engineered restraint and bracing details in accordance with SMACNA (for ducts, piping and conduit) or MSS-SP-127 (for piping) is permitted. Where the installation of these services exceeds the limits of these documents, provide specific engineering restraint devices and systems.
  - .1 for SMACNA details, refer to the seismic hazard level ("SHL") by floor level in Schedule A of this Specification Section.
- .2 Restrain fire protection automatic sprinkler systems and fire standpipe systems in accordance with NFPA 13.
- .3 Provide cable restraints or bracing for transverse and longitudinal seismic restraints at spacing and locations as specified in the above referenced standards.
- .4 Exemptions for seismic restraints for distribution services (pipes, ducts, conduit) described in ASHRAE, SMACNA or MSS SP-127 are limited to the explicit exemptions described herein.

### **3.3 Exemptions for Duct Seismic Restraints**

- .1 Except as required in paragraph .2 below, the following ductwork is not required to have seismic restraints where all the following conditions are met;
  - .1 the building is not a post-disaster building,
  - .2 ducts and duct supports are constructed to SMACNA duct construction standards,
  - .3 the extent of the free movement of the duct under seismic forces will not cause the duct to come into contact with other building services or building elements,
  - .4 HVAC ducts having a cross-sectional area of 0.56 m<sup>2</sup> (6 ft<sup>2</sup>) or less or have a linear weight for ducts and any insulation of 248 N/m (17 lb/ft) or less,
  - .5 HVAC or process ducts supported on trapeze assemblies with rod hangers, where the duct and any insulation have a linear weight of 146 N/m (10 lb/ft) or less,
  - .6 other ducts which are not subject to items.3 or .4 above are exempt where both of the following conditions apply:
    - (a) an individual duct is supported by hangers where the support height measured from the structural support to the top of the duct is 305 mm (12 in.) or less for the entire length of the run and the hanger is attached to the duct within 50 mm (2 in.) of the top of the duct with a #10 sheetmetal screws, and
    - (b) where rod hangers are used, the rod hanger at the connection to the support structure are provided with a swivel in accordance with Specification section 20 05 29 to prevent bending of the hanger rod. Where such a device only provides rotation of the hanger rod in one plane, it shall be installed to allow transverse movement of the hanger rod.
- .2 The above exemptions do not apply to ducts conveying toxic or flammable gases, chemical or biological exhaust, or ducts which are solely used for smoke control.

### **3.4 Exemptions for Pipe Seismic Restraints**

- .1 Except as required in paragraph .2 below, the following piping is not required to have seismic restraints where all the following conditions are met;
  - .1 the pipe is supported by hangers where the support height measured from the structural support to the top of the pipe is 305 mm (12 in.) or less along the continuous length of the pipe,

- .2 piping is supported on a trapeze where the support height measured from the structural support to the top surface of the trapeze is 305 mm (12 in.) or less along the continuous length of the pipe,
  - .3 the rod hanger at the connection to the support structure is provided with a swivel in accordance with Specification section 20 05 29 to prevent bending of the hanger rod. Where such a device only provides rotation of the hanger rod in one plane, it shall be installed to allow transverse movement of the hanger rod, and
  - .4 the extent of the free movement of the piping under seismic forces will not cause the pipe to come into contact with other building services or building elements.
- .2 The above exemptions do not apply to fire protection piping and piping conveying fuel oil, natural gas, propane gas and liquid, medical gases and compressed gases.

### **3.5 Building Structural Connections**

- .1 Select building connection devices based on seismic loads for actual provided equipment.
- .2 For connection to concrete structures:
  - .1 Select building structure anchors as follows:
    - (a) post-installed undercut anchors or wedge-expansion anchors,
    - (b) concrete inserts may be used in new construction but only where complete seismic design is completed and seismic forces are adjusted to suit,
  - .2 Spacing between anchors: not less than 3 x the effective embedment of the greatest embedment length.
- .3 Where adhesive anchors or concrete inserts are used, the anchors are sized for an increased seismic force as described in article "Design Criteria".
- .4 For connection to steel structures:
  - .1 use double sided beam clamp, loaded to the centerline of the beam web, or
  - .2 where permitted by the building structural engineer, specifically designed welded or bolted connection may be used.
  - .3 the use of single sided "C" type beam clamps is not permitted for the connection to the building steel structure for hanger rods and seismic restraints.

### **3.6 Construction of Housekeeping Pads**

- .1 Do not construct housekeeping pads until equipment restraint and anchors are designed and selected by the Seismic Engineer and/or seismic restraint manufacturer, and housekeeping pads detailed design are provided by the Seismic Engineer.
- .2 Provide housekeeping pads with integral reinforcement and structural anchors to the floor slab to withstand applied shear loads and anchor pull-out tension loads.
  - .1 provide reinforcing bar both directions on equal centers, and interior and perimeter floor anchors,
  - .2 in pre-installation construction, "Z-bar" shapes may only be used when housekeeping pad layouts are known prior to construction of the structural floor slab,
  - .3 in post-installations, use tapered housekeeping pad anchor assemblies,
  - .4 in post-installations, "L-rebar" shapes with adhesive anchors may be used, except the seismic forces in Schedule A of this Specification section must be increased as described above for adhesive anchors.

- .3 Pre-engineered details of construction for housekeeping pads as shown in chapter 6 of ASHRAE *Practical Guide to Seismic Restraint* may be used within its defined limits of application including but not limited to:
  - .1 housekeeping pad sizes are limited to 37 m<sup>2</sup> (400 ft<sup>2</sup>) or less,
  - .2 equipment center of gravity height does not exceed the width of the housekeeping pad,
  - .3 the ASHRAE maximum load rating includes the weight of the restrained equipment, vibration isolation equipment, support rails and bases, and the housekeeping pads,
  - .4 for values of "Fp" in ASHRAE, substitute the horizontal seismic force "Vp" as defined in the National Building Code of Canada for non-structural components (based on the seismic force coefficient "Ks" in Schedule A of this Specification section).
- .4 Size the housekeeping pad so that the distance from the equipment anchors to the edge of the pad is not less than 1.5 times the effective embedment depth of the equipment anchor, unless the anchor manufacturer requires greater separation distance.

### **3.7 Duct Restraints General Requirements**

- .1 Use cable restraints or braces. Do not mix cable restraints and rigid bar restraints on the same duct system.
- .2 Use cable restraints for ductwork suspended on vibration isolators. Provide a small amount of slack in the cable to prevent vibration short-circuiting, with the slack not exceeding a lateral displacement of 12 mm (1/2 in.) at the center point of the cable.
- .3 Provide reinforcement of hanging rods to prevent buckling of the rod.

### **3.8 Piping Restraints General Requirements**

- .1 Use cable restraints for piping subject to thermal expansion, including but not limited to chilled water, heating water, steam and glycol heating/cooling water.
- .2 Use cable restraints for piping supported on vibration isolation hangers or supports.
- .3 Use cable restraints or braces for all other piping.
- .4 Thermal expansion pipe anchors and guides on piping systems may be used as both a transverse and longitudinal seismic restraint where they are designed for concurrent thermal and seismic loadings.
- .5 Provide reinforcement of hanging rods to prevent buckling of the rod.
- .6 Where clevis hangers are used, provide a brace for the clevis cross bolt consisting of Schedule 40 pipe of the smallest size to fit over the clevis cross bolt, of a length to provide a 6 mm (1/4 in.) total gap between the reinforcement and the clevis frame.
- .7 For trapeze hangers, provide U-bolts over piping to limit lateral and vertical movement, but allow approximately 6 mm (1/4 in.) total clearance to allow pipe thermal expansion movement.
- .8 Attach restraints to pipe hangers and trapezes. For existing piping, restraints may be attached to the pipe using pipe clamp assemblies manufactured for this purpose.
- .9 Where pre-engineering restraints in accordance with SMACNA or MSS SP-127 are used, the spacing for transverse and longitudinal restraints are to be reduced to 50% of the stated spans in these documents for the following piping systems:
  - .1 steel piping with threaded joints,
  - .2 plastic piping including but not limited to PVC, CPVC, PP, and PVDF,
  - .3 fiberglass-reinforced pipe,
  - .4 cast iron drainage piping with no-hub connectors,
  - .5 glass drainage piping.

### 3.9 Piping Movement Control at Equipment Connections

- .1 Provide flexible connectors at piping connections to equipment in accordance with Specification section 20 05 16 except/and as follows.
- .1 The following table for pump connectors takes precedence over the requirements of Specification section 20 05 16.

Service	Pump Type	Limits	Connector Type
Heating pumps Glycol Heating pumps Condensate pumps	Base Mount	Flange NPS 6 to NPS 14	Bellows
		Flange NPS 4 and smaller	Corrugated
	Vertical In-Line	All	Corrugated
	Circulator	All	Flexible Metal Hose
Steam Feedwater pumps	Base Mount or Multi-stage	NPS 3 and larger	Bellows
		NPS 2 ½ and smaller	Flexible Metal Hose
Chilled water pumps Glycol cooling pumps	Base Mount	Flange NPS 10 to NPS 14	Bellows
		Flange NPS 8 and smaller	Corrugated
	Vertical In-Line	All	Flexible Metal Hose, Double-arch flexible rubber
	Circulator	All	Flexible Metal Hose
Condenser water pumps	Base Mount	All	Corrugated, Double-arch flexible rubber
	Vertical In-Line	All	Corrugated, Double-arch flexible rubber
Domestic Booster pumps	All	All	Corrugated
Sump pumps (sanitary and storm)	All	All	Flexible Metal Hose
Fire pumps	All	All	Flexible Metal Hose

- .1 The following table for equipment connectors takes precedence over the requirements of Specification section 20 05 16.

Equipment Type	Limits	Connector Type
Refrigeration Water Chillers	Chilled Water Piping	Corrugated connector, Double-arch flexible rubber

Equipment Type	Limits	Connector Type
	Condenser Water Piping	Corrugated Connector, Double-arch Flexible Rubber
	Refrigerant Relief Piping	Corrugated Connector
Cooling Towers	Condenser Water Piping	Double-arch Flexible Rubber (indoors) Corrugated Connector (outdoors)
	Domestic Water Piping	Corrugated Connector
Refrigeration Condensing Units and Condenser Units	All	Flexible Metal Hose
Steam, heating and cooling coils, and humidifiers	All	Flexible Metal Hose, Corrugated Connector
Hot water reheat coils, Fan Coil units	All	Flexible Metal Hose, Flexible Non-Metallic Hose
Duct mounted humidifiers	All	Flexible Metal Hose, Flexible Non-Metallic Hose
Heat Exchangers	All	Flexible Metal Hose, Corrugated Connector
Domestic Hot Water Tanks	All	Flexible Metal Hose, Corrugated Connector
Medical Air Compressor, Medical Vacuum Pumps, Medical Gas cylinders	All	Flexible Metal Hose (bronze internals)
Air compressors, Compressed gas cylinders	All	Flexible Metal Hose
Other equipment not specifically listed	NPS 2 and smaller	Flexible Metal Hose
	NPS 2-1/2 and larger	Corrugated Connector

- .2 Provide seismic restraints at ends of piping where connected to equipment, to limit pipe movement so that it does not cause the flexible connector devices at the equipment to exceed their lateral movement rating;
  - .1 For pipe drops to equipment, provide a pipe guide on the pipe immediately above the flexible connector device, with clearance of not more than the lateral deflection rating of the flexible connector. Line the pipe guide with 6 mm (1/4 in.) neoprene pads of bridge bearing quality. Support the guide from the floor level,
  - .2 for horizontal connections to equipment such as coils, reheat coils, duct mounted humidifiers, provide cable restraints on the rigid piping within 300 mm (12 in.) of the connection to the flexible hose,
  - .3 this requirement applies to piping that is otherwise exempt from seismic restraints.

### 3.10 Piping Connections to Duct Mounted Coils

- .1 This article applies to heating or cooling piping connections to the following equipment ("inline equipment"):

- .1 duct-mounted reheat coils,
  - .2 terminal units with reheat coils,
  - .3 duct-mounted humidifiers,
  - .4 fan-coil heating and/or cooling units.
- .2 Provide seismic restraints at ends of runout piping connections to inline equipment:
- .1 use cable restraints or rigid braces as applicable to the restraint method used for the piping systems,
  - .2 where the associated portion of the piping system is otherwise exempt from seismic restraint, use cable restraints,
  - .3 locate the cable restraint or rigid brace within 300 mm (12 in.) of the flexible hose connector to the inline equipment,
  - .4 seismically restrain the inline equipment, whether or not the associated ductwork is provided with such restraints. For terminal units and fan coil units, use cable restraints. For duct-mounted reheat coils or humidifiers, use cable restraints on ductwork within 3 m (10 ft) of each side of the coil or humidifier for.
    - (a) where the associated ductwork is not restrained, arrange cable restraints at four corners of the inline equipment / ductwork to provide both lateral and longitudinal restraints.

### **3.11 Piping Risers Restraints**

- .1 Use pipe anchors and guides for seismic restraints of vertical pipe risers. Do not use separate cable restraints or braces.
- .2 For horizontal seismic forces acting on vertical pipe risers, use the seismic force coefficient "Ks" value at the floor location of the pipe anchor or guide (as applicable), and the restrained weight is to include 50% of the pipe and fluid content weight between the anchor or guide and the next anchor or guide, in both vertical directions.
- .3 For piping subject to thermal expansion:
  - .1 provide fully engineered pipe riser support system,
  - .2 for steel pipe;
    - (a) provide an anchor at the location shown,
    - (b) construct the anchor assembly using heavy-duty pipe riser clamps or pipe brackets with full-welded connections to the pipe, and full-welded or bolted connections to the anchor. Use mechanical anchors to bolt the pipe anchor to concrete floor, and weld pipe anchors to steel framing.
    - (c) unless otherwise shown, use a heavy-duty pipe riser clamp with a load capacity not less than two times the combined dead weight of pipe and water, dynamic load and seismic loads.
  - .3 for copper tube,
    - (a) attach a copper sleeve that matches the OD of the tube and fully braze the sleeve to the tube.
    - (b) alternatively, use a slip-on flange over the tube and fully-braze the flange to the tube,
    - (c) position the sleeve or flange immediately above and bearing on a pipe riser clamp, which is bolted to the riser anchor.
  - .4 based on engineered support design, provide intermediate isolator supports.
- .4 For piping not subject to thermal expansion;
  - .1 provide pipe guides and riser clamps for piping not subject to thermal expansion in accordance with Specification section 20 05 29,

- .5 For all piping;
  - .1 for cast iron DWV pipe, plastic DWV pipe, and glass DWV pipe, provide a guide at each floor level.
  - .2 for all other piping, provide guide or riser clamp at every other floor but not to exceed 7.6 m (25 ft) spacing, unless engineering design determines other spacing dimensions,

### **3.12 Conduit Restraints**

- .1 Use cable restraints for suspended conduit and suspended wireway.
- .2 Provide reinforcement of hanging rods to prevent buckling of the rod.
- .3 For trapeze hangers, provide U-bolts over conduit to limit lateral and vertical movement.
- .4 Attach restraints to conduit or conduit hangers, and trapezes.
- .5 Where pre-engineering restraints in accordance with SMACNA are used, the spacing for transverse and longitudinal restraints are to be reduced to 50% of the stated spans for the following conduit materials:
  - .1 PVC conduit.

### **3.13 Floor Mounted Equipment Restraints**

- .1 Anchor floor mounted equipment with anchor bolts, minimum four bolts for rectangular equipment bases, and three bolts for circular equipment bases.
  - .1 friction due to gravity loads shall not be considered to provide resistance to seismic forces.
- .2 For non-isolated equipment, secure equipment directly using equipment base supports or use SRB brackets. Alternatively, use type SS1 or SS2 snubbers where equipment is not subject to overturning moments. Use type SS3 snubbers where equipment is subject to overturning moments;
  - .1 for type SS1 snubbers, provide a minimum of eight (8) snubbers for each piece of equipment, with two units placed on each corner of the equipment base frame.
  - .2 for type SS2 and SS3 snubbers, provide a minimum of four (4) snubbers for each piece of equipment, with one unit placed on each face of the equipment base frame.
- .3 For round equipment bases, such as expansion tanks with floor-support ring without mounting flanges, use type SS3 snubbers or purpose-constructed clamps to positively attach to the equipment base and anchored to the floor. Welding to the equipment base is permitted only where the equipment manufacturer information permits this method of attachment.
- .4 Provide resilient neoprene bushings and washers between equipment and anchor bolts where equipment is secured rigidly to floor or housekeeping pad.
- .5 Install snubber devices only after equipment is installed and operating, to ensure no metal-to-metal contact. Adjust snubbers so that any clearance gaps do not exceed 6 mm (1/4 in.).
- .6 For floor mounted equipment with vibration isolators;
  - .1 select basic vibration isolator in accordance with Section 20 05 48.
  - .2 select seismic restraint for each piece of equipment of either:
    - (a) integrated seismic vibration restraint type 2-S, 3-S or 4-S, or
    - (b) vibration isolator in accordance with Section 20 05 48 combined with seismic snubbers SS1, SS2 or SS3 as applicable to suit overturning moment.
  - .3 Do not mix type of restraint on the same piece of equipment.
  - .4 Where the equipment is not provided with a structural base to transfer seismic forces, provide a structural-shape or formed steel channel base or a Type C inertia base as a complete steel frames

suitably cross braced in both horizontal directions to withstand seismic induced shear force and bending moments.

### **3.14 Suspended Equipment Restraints**

- .1 For isolated equipment, select basic vibration isolator in accordance with Section 20 05 48.
- .2 Provide restraints for equipment independent of restraints provided on connecting ductwork or piping.
- .3 Provide reinforcement of hanger rods to prevent buckling.
- .4 Provide SCR type longitudinal and transverse restraints at each corner of the equipment (total of eight (8) cables). Alternatively, a single SCR cable can be installed at each corner of the equipment, positioned at 45° to both transverse and longitudinal direction and sized for concurrent transverse and longitudinal loads.

### **3.15 Rooftop Air Handling Units**

- .1 Provide manufactured roof curbs designed for each air handling unit. Fasten to the roof with mechanical anchors for concrete decks or by welding directly to structure steel framing where indicated. Use concrete anchors of the type specified by the roof curb manufacturer.
- .2 Field assemble manufactured roof curbs in accordance with manufacturer instructions. Install duct support frames to suit air handling unit duct openings.
- .3 Install concrete anchors, or make weld attachments, at restraint locations and as otherwise shown on roof curb manufacturer shop drawings.
  - .1 for concrete/metal composite roof decks, fasten through the roof deck with through bolting and fish plates. Fish plates on underside of steel deck to span at least two bottom flutes.
- .4 Adjust isolation springs in accordance with AHU and vibration isolator manufacturer instructions.
- .5 Retain the services of the rooftop curb manufacturer to inspect and report on the installation of the roof curb prior to installation of the associated air handling unit.

### **3.16 Cooling Tower and Outdoor Refrigeration Equipment Isolated Supports**

- .1 Provide manufactured structural supports designed for cooling tower and outdoor refrigeration equipment units. Fasten to the roof with mechanical anchors for concrete decks or by welding directly to structure steel framing where indicated. Use concrete anchors of the type specified by the roof curb manufacturer.
- .2 Install concrete anchors, or make weld attachments, at restraint locations and as otherwise shown on roof curb manufacturer shop drawings.
  - .1 for concrete/metal composite roof decks, fasten through the roof deck with through bolting and fish plates. Fish plates on underside of steel deck to span at least two bottom flutes.
- .3 Adjust isolation springs in accordance with HVAC equipment and vibration isolator manufacturer instructions.
- .4 Retain the services of the rooftop curb manufacturer to inspect and report on the installation of the roof curb prior to installation of the associated air handling unit.

### **3.17 Rooftop Fans**

- .1 Fasten vibration isolators (where applicable) and seismic restraints to roof curbs or sleepers with mechanical fasteners of the type determined by the seismic restraint manufacturer.
- .2 Fasten roof curbs or sleepers to the roof structure with bolted angles positioned at each restraint. Fastening of curbs or sleepers to roof with roofing adhesive only is not acceptable.



### **3.18 Equipment Restraints - Surface Wall-Mounted Equipment and Panels**

- .1 Application: for non-rotating mechanical equipment, electrical panels, control panels, motor controllers, and other electrical distribution equipment.
- .2 Attach equipment to horizontal galvanized steel channels and fasten with bolts equipped with neoprene isolation grommet washers. Channels to extend past the side of the equipment to allow anchoring to wall. Select bolts for concurrent shear dead-weight without deduction for uplift load, and tension restraint load.
- .3 Attach channels to concrete or masonry walls with not less than four (4) anchors with each anchor having a not less than a 1.5 safety factor.

### **3.19 Equipment Restraints - Recessed Wall-Mounted Equipment**

- .1 Application: for non-rotating mechanical equipment, electrical panels, control panels, motor controllers, and other electrical distribution equipment.
- .2 Mount recessed equipment through the top, bottom and sides of the equipment housing to adjacent block wall or wall studs.

### **3.20 Inspection, Testing, Adjustment and Reporting**

- .1 For equipment supported on vibration isolators, field measure air gaps on each restraint and if necessary adjust the restraint so that the clearance air gap does not exceed 6 mm (1/4 in.). Provide a written report identifying the results of each test and adjustment, to the Seismic Engineer and Consultant for review.
- .2 Arrange for the seismic restraint manufacturer to inspect and report on the installation at completion of the work. Make corrections of deficiencies identified by the manufacturer. This work is to be performed prior to the final field review by the Seismic Engineer.
- .3 Arrange for Seismic Engineer to conduct a final inspection prior to substantial performance of the Work. Make corrections of deficiencies identified by Seismic Engineer. This work is to be performed prior to the final field review by Consultant.
- .4 Make corrections of deficiencies identified by Consultant.
- .5 Submit the following reports prior to application for substantial performance of the Work, or where applicable, ready-for-takeover of the Work:
  - .1 Seismic Engineer periodic and final inspection reports,
  - .2 seismic restraint manufacturer inspection reports,
  - .3 Seismic Engineer declaration of general review.

**END OF SECTION**

## **IDENTIFICATION FOR MECHANICAL SERVICES**

### **20 05 53**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide identification nameplates, labeling for piping, ductwork, equipment, and valves, and specialty signage.

##### **1.2 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 ANSI Z535.1 Standards for Safety Signs and Labels
  - .2 ASME A13.1 Scheme for the Identification of Piping Systems
  - .3 CSA Z7396.1 Medical Gas Pipeline Systems – Part 1: Pipelines for Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging Systems

##### **1.3 Submittals**

- .1 Shop drawings:
  - .1 Submit product data sheets for materials specified herein.

#### **2 PRODUCTS**

##### **2.1 General**

- .1 Manufactured identification systems:
  - .1 resistant to general chemical, and ultraviolet stabilized for outdoor use,
  - .2 minimum operating temperature: -25°C (-12°F),
  - .3 maximum operating temperature: 121°C (250°F).
  - .4 language: English

##### *Standard of Acceptance*

- Brady - identification tapes, bands, and markers.
- Seton - Setmark Pipe Markers.
- Smillie McAdams Summerlin.
- Craftmark Identification Systems.
- Primark

##### **2.2 Engraved Equipment Identification Nameplates**

- .1 Laminated nameplates:
  - .1 laminated two-layer coloured plastic plates, with engraved lettering,
  - .2 minimum size: 90 mm x 40 mm x 2.5 mm (3 in x 1½ in x ¼ in),
  - .3 letter height:
    - (a) ID and name: 20 mm (¾ in.) minimum
    - (b) power source: 10 mm (⅜ in) minimum,
  - .4 provided with Class 125 barcode and tag file,

.5 nameplate colours:

(a) nameplate and letter colours are dependent on type of electrical power supply to equipment.

Power Source	Background Colour	Letter Colour
Normal or None	White	Black
Life-Safety/ Emergency	Red	White
Stand-by (non-life safety)	Orange	White
UPS	Blue	White

## 2.3 Piping Identification - Medical Gas Systems

.1 Self-adhesive plastic marking tape:

.1 text with integral flow direction arrow markers,

(a) reversing text may be used,

.2 text and field colour: to CSA Z7396.1,

.3 tape width: sized to suit pipe O.D. and to overlap itself a minimum 19 mm (3/4 in),

.4 text height and marker length:

Pipe/Tube NPS	Marker Length mm (in)	Text Height mm (in)
≤ 1-1/4	200 (8)	13 (0.5)
1.5 to 2	200 (8)	19 (0.75)
2.5 to 6	300 (12)	32 (1.25)

.2 Coil-wrap pipe markers are not permitted.

## 2.4 Piping Identification – Piping Systems other than Medical Gas Systems

.1 General:

.1 conform to ASME A13.1 and as shown in Schedule A at the end of this Section for marking colours and global harmonization system (GHS) hazard identification symbols.

.2 text height:

Pipe/Tube NPS	Marker Length mm (in)	Text Height mm (in)
≤ 1-1/4	200 (8)	13 (0.5)
1.5 to 2	200 (8)	19 (0.75)
2.5 to 6	300 (12)	32 (1.25)
8 to 10	600 (24)	65 (2.5)
>10	800 (32)	90 (3.5)

.2 Flexible coil-wrap manufactured markers:

- .1 PVC plastic coated markers with integral printing, or plastic cover with field applied self-adhesive markers,
- .2 reversing text with integral arrow markers,
- .3 application method:
  - (a) NPS ½ to NPS 6: full wrap of pipe
  - (b) NPS 8 and over: partial pipe wrap with perforations for securing with nylon tie-wraps, tie-wraps included.
- .3 Self-adhesive polyester pipe name marking tape:
  - .1 reversing text with integral flow direction arrow markers,
  - .2 tape height: 65 mm (2.5 in) minimum.
- .4 Self-adhesive vinyl flow direction marking bands:
  - .1 colour band tape with flow direction arrows,
  - .2 colours: as specified for pipe name markers.
  - .3 tape width: 50 mm (2 in)
  - .4 tape length: wrapped around pipe or covering with ends overlapping one pipe diameter but not less than 25mm (1 in).
  - .5 flow arrow: 20 mm (¾ in) minimum high

## **2.5 Ductwork Identification**

- .1 Punched stencils in PVC or card material, suitable for application of field painting.
- .2 Letter height: 50 mm (2 in).
- .3 Letter paint colour: black.

## **2.6 Valve and Steam Trap Identification**

- .1 Engraved plastic laminate tags:
  - .1 text for valves:
    - (a) piping system fluid service, area location description, following by a series number
    - (b) where a valve is shown on drawings to be normally closed, include "Normally Closed"
  - .2 text for steam traps: abbreviation for steam pressure (e.g. "S70") as shown, followed by a series number,
  - .3 tag background colour and test colour: same as for pipe markers in accordance with Schedule A at the end of this section.
  - .4 brass or stainless steel chain.

## **2.7 Medical Pipeline Valve Lockout Tags**

- .1 Printed vinyl lock-out valve tags with brass grommets:
  - .1 text:
    - (a) 1<sup>st</sup> line: "Medical Gas Valve"
    - (b) 2<sup>nd</sup> line: "Normally Closed" or "Normally Open" as applicable.

## **2.8 Miscellaneous Identification**

- .1 Self-adhesive polyester marking labels with global harmonized system (GHS) hazard pictograms.

- .1 red border on white field,
- .2 symbol height: 100 mm (4 in) minimum.

## 2.9 Signage

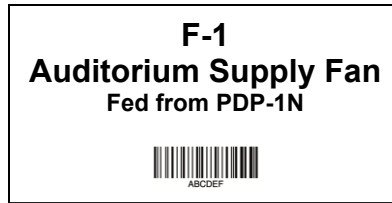
- .1 Rigid plastic signs, UV stabilized and suitable for indoor and outdoor installation, for surface mounting.
- .2 Graphic symbols:
  - .1 graphic image in accordance with WHIMS and ISO 7010,
  - .2 sign dimensions:
    - (a) indoors: 300 x 300 mm (12 in. x 12 in.)
    - (b) outdoors: 450 x 450 mm (18 in. x 18 in.)
- .3 Colours:
  - .1 Field and text colours in accordance with ANSI Z535.1

Information Type	Background Colour	Letter Colour	Primary Notification Text
General information	Blue	White	NOTICE
General Safety, Exiting	Green	White	---
Caution	Yellow	Black	CAUTION
Warning	Orange	Black	WARNING
Danger	Red	White	DANGER
Biological	Fluorescent Orange	Black	BIOHAZARD

## 3 EXECUTION

### 3.1 Equipment Identification

- .1 Where required:
  - .1 provided for equipment identified with number designations shown in equipment schedules, drawings, specifications, and/or equipment selection sheets.
  - .2 marked with equipment ID, service name, and power source using wording and numbering used in contract documents.
  - .3 for clarity, equipment identification nameplates are in addition to manufacturers plates.
- .2 Locate nameplates to be easily read, and fasten securely with mechanical fasteners. For pressure vessels, secure nameplates to equipment with high-tensile epoxy adhesive.
- .3 Do not paint over equipment manufacturer or field installed nameplates.
- .4 Provide metal standoffs on insulated equipment.
- .5 Examples:
  - .1 at equipment (fan, pump, etc.), illustrated for Normal Power:



- .2 at motor starter, adjustable frequency drive, and separate local disconnect, illustrated for Emergency Power:



### 3.2 Piping Identification - General

- .1 Except where otherwise specified herein, provide manufactured pipe markers of the following types based on area of the building:
  - .1 self-adhesive type:
    - (a) indoor uninsulated piping,
    - (b) indoor insulated piping with PVC or smooth metal jackets,
  - .2 flexible coil-wrap:
    - (a) outdoor piping,
    - (b) indoor insulated piping with any type of jacket.
  - .3 Install self-adhesive markers on cleaned and prepared surfaces free of dirt and oil.
- .2 Install pipe markers in the following locations:
  - .1 maximum every 15 m (50 ft) along length of pipe, except for natural gas and fuel oil,
  - .2 maximum every 6 m (20 ft) along length of pipe for natural gas and fuel oil,
  - .3 within 1 m (3 ft) of each side of barriers, floors and walls,
  - .4 within 1 m (3 ft) of and behind access doors ,
  - .5 within 1 m (3 ft) of piping termination point.
- .3 Marker colours and hazard identification:
  - .1 Provide pipe markers with the colour coding and hazard identification symbols in accordance with Schedule A at the end of this section.
  - .2 Use the existing piping marker colour coding system for building additions and alterations where available.

### 3.3 Piping Identification - Medical Gas Systems

- .1 Provided identification markings on medical gas systems:
  - .1 maximum every 6 m (20 ft) along length of pipe,
  - .2 before and after barriers, floors and walls,
  - .3 at each valve,

- .4 behind access doors,
- .5 inlet and outlet points including vents.
- .2 Marker colours and hazard identification:
  - .1 Provide pipe markers with the colour coding and hazard identification symbols in accordance with Schedule A at the end of this section.

### **3.4 Valve Lockout Tags – Medical Gas Systems**

- .1 Provide valve lockout tags at each valve which is not located in a zone control panel. Tags to be provided as Normally Open or Normally Closed as shown on drawings.

### **3.5 Ductwork identification**

- .1 Paint stenciled letters showing;
  - .1 duct service,
  - .2 fan number, and
  - .3 arrows showing direction of flow,
- .2 Paint stencil markings at the following locations:
  - .1 exposed ducts at 15 m (50 ft) intervals in service rooms,
  - .2 exposed ducts at wall and floor penetrations in other than service rooms,
  - .3 concealed ducts above drywall-ceilings next to access doors, and
  - .4 concealed ducts above removable tile ceilings at wall and floor penetrations, and at 15 m (50 ft) intervals.
- .3 Stencil indication on prepared surfaces, and locate on both sides of any penetration.

### **3.6 Valve Identification**

- .1 Provide valves with a numbered tag showing valve type and size, attached to valve stem or wheel handle with chain.
  - .1 Valve identification is not required at the following valves:
    - (a) inside fire hose cabinets,
    - (b) radiation heating units, unit heaters, or fixture stops,
    - (c) plumbing fixture service stops,
    - (d) within 4 m (12 ft) and in sight of equipment, fixtures, or apparatus that the valve controls provided there is no branch piping between the valve and equipment served,
    - (e) existing valves that are not provided under this project.
- .2 Identification information – manual valves:
  - .1 each valve tag to indicate fluid service, sequential valve number (unique for each service) including supply or return, location identifier, and normal operating position
  - .2 examples (colour coding shown for illustration):

Domestic Cold Water  
Riser C/1  
No. 12

Natural Gas  
Boiler Plant  
No. 2  
Normally Closed

- .3 Identification information – automatic control valves:
- .1 provide valve tags for all automatic control valves except as follows:
    - (a) within sight of equipment that the valve controls.
  - .2 each valve tag to indicate fluid service, control function, control valve identification number,
  - .3 examples (colour coding shown for illustration):

Chilled Water  
Constant Pressure  
Differential Valve  
CV-3





- .4 Provide a tag schedule for each system, designating valve numbers, fluid service, function, valve size, and location of each tagged item and normal operating position of each valve. Submit copies in original file format (Excel, Word) on two (2) removable mass storage devices.





### 3.7 Schedules

- .1 The following Schedules form part of this specification section.
  - .1 Schedule A: Piping Marker Colours and Hazard Labels











### Schedule A – Piping Marker Colours and Hazard Labels

Fluid Service Category	Piping Services	Background Colour	Lettering Colour	GHS Hazard Symbol
Water	Potable (city) water, Non-potable water, Treated City Water, Sanitary, Storm Drainage, Chilled water, Condenser water, Cooling water, Heating water, Glycol heating or cooling water, Brine water, Boiler feedwater, Steam condensate	Green	White	None
Vapour from Water	Steam, Steam Vents	White	Black	None
Fire Protection Fluids	Sprinklers, Standpipe, Foam, Gaseous	Red	White	None
Combustible Liquids	Heating oil, Diesel, Lubrication oil, Hydraulic oil	Brown	White	None
Flammable Fluids	Natural Gas, Propane	Yellow	Black	None
	Gasoline	Yellow	Black	  
Compressed Air	Compressed Air, Instrument Air, Laboratory Air	Blue	White	None
Compressed Gases	Nitrogen, Helium, Carbon Dioxide	Grey	White	
Other Gases	Vacuum, Laboratory Vacuum, Plumbing Vents	Grey	White	None

Fluid Service Category	Piping Services	Background Colour	Lettering Colour	GHS Hazard Symbol
Oxidizing Fluids	Chlorine	Yellow	Black	
Toxic and Corrosive Fluids	HVAC chemical treatment, Acid Drain, Acid Vent Decontamination Drain and Tank	Orange	Black	 
Radioactive Fluids	Isotope Drain, Isotope Vent	Orange	Black	 (ISO 7010)

### Schedule B – Ductwork and Equipment Hazard Labels

Duct System	Equipment	GHS Hazard Labels
Chemical Fume Hood Exhaust	Exhaust Fans	 
Level 1 or 2 Biological Laboratory Exhaust	Exhaust Fans	
Level 3 or 4 Biological Containment Laboratory	Exhaust HEPA Filter Housing	
Hazardous Pharmaceutical Sterile Room Exhaust	Exhaust HEPA Filter Housing	
Isolation (medical) Room Exhaust	Exhaust Fans	
Flammable Storage Exhaust	Exhaust Fans	
Perchloric Acid Exhaust	Exhaust Fans	

**END OF SECTION**

## COMMON REQUIREMENTS FOR MECHANICAL INSULATION 20 07 11

### 1 GENERAL

#### 1.1 Scope

- .1 Common requirements for insulation of mechanical services provided under Division 20 to 25 of the Work. The requirements of this specification section apply to separate specification sections for insulation of ductwork, equipment and piping.

#### 1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 29 Common Hanger and Support Requirements for Piping
  - .2 20 07 13 Duct Insulation
  - .3 20 07 16 Equipment Insulation
  - .4 20 07 19 Piping Insulation
  - .5 20 05 29 Common Hanger and Support Requirements for Piping

#### 1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
  - .1 **Ambient:** as applied to temperatures means the interior or outdoor air temperature at time of installation.
  - .2 **Coating:** light-consistency compound for indoor applications used in conjunction with reinforcing membrane, to provide either a breathable or vapour barrier finish to insulation.
  - .3 **Cold services:** means cold ductwork, equipment and/or equipment.
    - (a) **Cold ductwork:** mechanical ductwork with a service temperature greater than 1°C and up to and including 16°C (34°F to 61°F).
    - (b) **Cold equipment:** mechanical equipment with a service temperature of 16°C (61°F) or less,
    - (c) **Cold piping:** mechanical piping with a service temperature of 16°C (61°F) or less,
  - .4 **Concealed (services):** mechanical services that are located: in the space above opaque suspended ceilings; within trenches not located in service rooms; within pipe and/or duct shafts; or in non-accessible chases and wall cavities.
  - .5 **Conditioned air:** air supplied from air handling units that heats, cools, dehumidifies, or humidifies the air.
  - .6 **Conditioned space:** an enclosed space or room that is heating, cooled, dehumidified and/or humidified.
  - .7 **Dual temperature services:** means dual temperature ductwork, piping and/or equipment that operates, at different times, at both hot and cold temperatures.
    - (a) **Dual temperature ductwork:** mechanical ductwork that operates at temperatures greater than 1°C and up to and including 38°C (34°F to 100°F), at different times or at different locations in the duct system and includes cooling systems with terminal reheat.
    - (b) **Dual temperature equipment:** means mechanical equipment that operate, at different times, at cold equipment temperatures and at hot equipment temperatures.

- (c) **Dual temperature piping:** mechanical piping that operate, at different times, at cold piping temperatures and at hot piping temperatures.
- .8 **Ductwork:** includes ducts, fans, air handling equipment casings, and plenums.
- .9 **Exposed (services):** mechanical services that are located in areas that are not "concealed" as defined above for concealed services. For greater certainty, the following locations are exposed services:
- (a) services in tunnels,
  - (b) services in space beneath raised floors.
  - (c) trenches located in service rooms.
- .10 **Finish covering:** a field-applied protective layer for insulation that provides an aesthetic finish but that may also provide mechanical-impact protection, weather-protective, moisture and/or vapour barrier protection.
- .11 **Hot services:** means hot ductwork, piping and/or equipment.
- (a) **Hot ductwork:** mechanical ductwork with a service temperature greater than 28°C and up to and including 65°C (80 to 150°F) and does not have any mechanical cooling.
  - (b) **Hot equipment:** mechanical equipment with a service temperature 38°C (100°F) and greater.
  - (c) **Hot piping:** mechanical piping at service temperatures as shown in Schedule A1 of specification section 20 07 19.
- .12 **Jacket:** a factory-applied material used to contain insulation and may function as a vapour barrier. Jacketed insulation may also be further protected by covering with a finish covering.
- (a) **All Service Jacket (ASJ)** – an insulation covering suitable for hot services and functions as a vapour barrier on cold services, typically constructed of laminated white kraft paper (outside surface) reinforced with fibreglass and bounded to an inner aluminium foil substrate.
  - (b) **Foil Scrim Kraft (FSK)** – an insulation covering suitable for hot services and functions as a vapour barrier on cold services, typically constructed of a laminate aluminium foil (outside surface) reinforced with fibreglass and bounded to an inner kraft paper layer.
  - (c) **Polypropylene Scrim Kraft (PSK)** - an insulation covering suitable for hot services and functions as a vapour barrier on cold services, typically constructed of a laminate polypropylene layer (outside surface) reinforced with fibreglass and bounded to an inner kraft paper layer.
- .13 **Mastic:** heavy-consistency waterproof compound for outdoor applications, used in conjunction with reinforcing membrane that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish for outdoor insulation.
- .14 **Mechanical services:** equipment, piping, ductwork and related accessories provided under Division 20 to 25 of the Work.
- .15 **Outdoor (services):** mechanical services located outside of the building envelope including services located beneath overhangs, located in unconditioned soffits, or exposed to any outdoor condition including temperature, sun exposure, or precipitation.
- .16 **Pure water:** water that has been treated with filtration equipment, including but not limited to reverse osmosis, deionization, ultra-filtration, ultra-violet, distillation or any combination of such or similar equipment, to achieve water quality significantly free of impurities.
- .17 **Service temperature:** the highest (for hot mechanical services) or the lowest (for cold mechanical services) gas or vapour design operating temperature, or the liquid supply operating temperature.
- .18 **Surface temperature:** for the purpose of this specification, has the same meaning as service temperature.

- .19 **Unconditioned (space):** rooms or spaces that are not conditioned spaces, and includes ceiling spaces which are not part of a ceiling return air plenum system.
- .20 **Wet area:** spaces subject to high humidity or where mechanical services may be exposed to direct contact with water, including not limited to: pools, shower rooms, tub rooms, medical device reprocessing, dishwashers, sterilizers, cart-washing, vehicle washing, and emergency showers.

#### 1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
  - .1 NFPA 90-A Installation of Air-Conditioning and Ventilating Systems
  - .2 ASHRAE/IES 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
  - .3 NFPA 255 Test of Surface Burning Characteristics of Building Materials
- .2 Product standards:
  - .1 CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  - .2 CAN/ULC-S102.2 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
  - .3 CAN/ULC-S114 Standard Method of Test for Determination of Non-Combustibility in Building Materials
  - .4 ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  - .5 ASTM B240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
  - .6 ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus
  - .7 ASTM C411 Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation
  - .8 ASTM C449 Standard Specification for Mineral Fibre Hydraulic-Setting Thermal Insulation and Finishing Materials
  - .9 ASTM C518 Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flow Meter Apparatus
  - .10 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
  - .11 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
  - .12 ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation
  - .13 ASTM C552 Standard Specification for Cellular Glass Thermal Insulation
  - .14 ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
  - .15 ASTM C591 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
  - .16 ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation

- |     |                      |   |
|-----|----------------------|---|
| .17 | ASTM C795            | Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel                            |
| .18 | ASTM C892            | Standard Specification for High-Temperature Fiber Blanket Thermal Insulation  |
| .19 | ASTM C1126 (Gr.1)    | Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation                                     |
| .20 | ASTM C1139           | Standard Specification for Fibrous Glass Thermal Insulation and Sound Absorbing Blanket and Board for Military Applications |
| .21 | ASTM C1290           | Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts                 |
| .22 | ASTM C1393           | Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks     |
| .23 | ASTM E84             | Standard Test Method for Surface Burning Characteristics of Building Materials  |
| .24 | CGSB 51-GP-52MA      | Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation.                                |
| .25 | CGSB 51.53-95<br>and | Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels Round Ducts.  |

## **1.5 Qualified Tradespersons**

- .1 Work to be performed by a recognized specialist firm with an established reputation in this field.

### *Standard of Acceptance*

- Custom Insulation Systems
- White & Greer Co Ltd
- Thermax Environmental Inc.
- ICON Insulation Inc.

## **1.6 Submittals**

- .1 Submit manufacturer catalogue cut-sheets for the following materials in one bound submission;
- .1 insulation,
  - .2 coatings, mastics, and sealants,
  - .3 reinforcing membranes,
  - .4 finish covering materials,
  - .5 PVC fitting covers.
- .2 Submit an installation detail drawing indicating how insulation, coatings and vapour barriers are applied in general, and specifically for pipe fittings and equipment insulation.

## **1.7 Quality**

- .1 Manufacturers and products are listed in this section to establish quality and manufacturing standards. Products from other manufacturers with explicitly similar characteristics may be acceptable but must be submitted as an alternative product submission.

## **2 PRODUCTS**

### **2.1 General Requirements**

- .1 Adhesives, coatings, finish coverings, lagging, sealers, and tapes:
  - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.
  - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.
  - .3 exception: vapor barrier mastics on mechanical services located outside of the building.

### **2.2 Adhesives, Fasteners, and Tape**

- .1 Contact bond cement:
  - .1 for quick setting for metal surfaces.
  - .2 Volatile Organic Content: maximum 80 g/L.

#### *Standard of Acceptance*

- Bakor - fig. 220-05
- Foster – fig. Drion 85-75

- .2 Adhesive for flexible closed cell foam insulation:
  - .1 Volatile Organic Content: maximum 80 g/L.

#### *Standard of Acceptance*

- Armacell - Armaflex 520 BLV
- Armacell - Armaflex. Low VOC Spray Contact Adhesive

- .3 Lap seal adhesive:
  - .1 for joints and lap sealing of vapour barriers.
  - .2 Volatile Organic Content: maximum 250 g/L.

#### *Standard of Acceptance*

- Bakor - fig. 220-05
- Childers - fig. CHIL-STIX FRN CP-82

- .4 Fibrous insulation adhesive:
  - .1 Volatile Organic Content: maximum 250 g/L

#### *Standard of Acceptance*

- Childers - fig. CHIL-STIX FRN CP-82
- Foster - fig. 85-70

- .5 Vapour barrier tape:
  - .1 colour matched and foil faced
  - .2 listed to UL 181A.

#### *Standard of Acceptance*

- Johns Manville - fig. Zeston Z-Tape

- MacTac Canada Ltd – fig. Vinyl Scrim or Foil Scrim Kraft
- Compac Corp.
- Fattal Canvas Inc. - fig. Insultape

.6 Weld pins, studs, clips and washers:

- .1 Galvanized steel or copper plated steel, stainless steel or aluminium to match ductwork material.
- .2 Attachment method:
  - (a) welded for outdoor ducts,
  - (b) welded for indoor ducts,
  - (c) self-adhesive base may be used for vertical surfaces of rectangular ducts.

*Standard of Acceptance*

- Midwest - fig. Fasteners
- Jordahl - fig. Studwelding

.7 Staples:

- .1 Monel, flare type, minimum size 12 mm (½ in).

.8 Tie wire:

- .1 1.6 mm (16 ga) stainless steel with twisted ends.

.9 Caulking for sheetmetal finish covers (outdoor use only)

- .1 fast-drying, aluminum colour finish, flexible butyl elastomer based vapour barrier sealant.

*Standard of Acceptance.*

- Foster - fig. 95-44

## **2.3 Coatings and Reinforcing Membranes**

.1 Reinforcing membrane:

- .1 synthetic fibre:
  - (a) Leno weave,
  - (b) indoor and outdoor use.

*Standard of Acceptance*

- Foster - fig. Mast-A-Fab

.2 glass-fibre fabric:

- (a) indoor use.

*Standard of Acceptance*

- Childers - fig. Chil-Glas #5/#10

.3 glass-fibre fabric for use with elastomeric closed cell foam:

- (a) indoor use.

*Standard of Acceptance*



- Childers - fig. Chil-Glass #10

.2 Breather coating - Indoors:

- .1 for breather coatings and lagging adhesive,
- .2 Volatile Organic Content: maximum 50 g/L
- .3 white in colour,

*Standard of Acceptance*

- Childers- fig. CP-50A HV2
- Foster - fig. 30-36

.3 Breather mastic - Outdoors:

- .1 for breather coatings and lagging adhesive,
- .2 abrasion resistive, flexible,
- .3 UV stabile,
- .4 grey in colour.

*Standard of Acceptance*

- Childers - fig. Vi-Cryl CP-10/11
- Foster - fig. 35-00 / 45-00
- Bakor - fig. 120-10

.4 Vapor barrier coatings - Indoors:

- .1 Volatile Organic Content: maximum 50 g/L.
- .2 for vapor barrier coatings and lagging adhesive except for elastomeric closed cell foam,
  - (a) permeance rating 0.02 perms maximum,
  - (b) white in colour

*Standard of Acceptance*

- Childers - fig. Chil Perm CP-34/35
- Foster - fig. 30-80, 30-90

.5 Vapor barrier mastic - Outdoors:

- .1 for vapor barrier coatings and lagging adhesive,
- .2 asphalt cutback,
- .3 permeance rating 0.02 perms maximum,
- .4 grey in colour.
- .5 for outdoor use only.

*Standard of Acceptance*

- Childers - fig. Chil-Pruf CP-22
- Foster - fig. 60-25/60-26

.6 Vapour barrier coatings – elastomeric foam insulation:

- .1 for indoor and outdoor use,
- .2 water bases sealer/finishing coat, water and UV resistant.
- .3 white in colour.

*Standard of Acceptance*

- Armacell - fig. ArmaFlex WB Finish

## **2.4 Insulation Finishing Cement**

- .1 Mineral fibre, hydraulic-setting insulation cement, to ASTM C449
- .2 Temperature rating: 650°C (1200°F)

*Standard of Acceptance*

- Johns Manville - fig. CalCoat-127
- Ramco Insulation - fig. Ramcote 1200 (PKI Quick Cote)

## **2.5 Field Applied Coverings**

- .1 Fabric finish covering:
  - .1 plain weave cotton fabric at 220 g/m<sup>2</sup> (6 oz/sq yd), treated with fire retardant lagging adhesive, or
  - .2 re-wettable fiberglass lagging fabric with water activated self-adhesive.
  - .3 suitable for field painting.

*Standard of Acceptance*

- Fattal - fig. Thermocanvas
- Clairmont - fig. Diplag 60
- Newtex - fig. Zetex Rewettable

- .2 PVC finish covering:
  - .1 PVC sheeting, or pre-cut and rolled sheeting to suit OD of pipe and insulation, with UV inhibitor for white colour product,
    - (a) minimum thickness:
      - i) indoors: 0.5 mm (20 mil-in.),
      - ii) outdoors: 0.8 mm (30 mil-in.),
    - (b) maximum operating temperature: 66°C (150°F) at the material,
    - (c) listed to CAN/ULC-S102/S102.2 or ASTM E84,
  - .2 PVC fitting covering with integral insulation inserts:
    - (a) minimum 0.5 mm (20 mil-in) thickness,
    - (b) pre-molded fitting covers, one or two piece,
    - (c) maximum operating temperature: 66°C (150°F) at the material,
    - (d) self-sealing longitudinal joints or field applied sealer adhesive,
    - (e) listed to CAN/ULC-S102/S102.2 or ASTM E84,
  - .3 colour: [white][in accordance with the following:
    - (a) city water, domestic water, non-potable water: green

- (b) HVAC water: green
- (c) steam and condensate: grey
- (d) RO water: green]
- .4 foam-glass or glass-fibre insulation molded insert, including for elbows, tees, valves, end-caps, and mechanical pipe couplings,
- .5 multiple layers where required for thicker pipe insulation thicknesses.
- .6 pressure sensitive, colour matching vinyl tape.

*Standard of Acceptance*

- Johns Manville - fig. Zeston 2000
- Proto PVC - fig. LoSMOKE
- ACWIL Insulations
- Sure Fit Systems

.3 Metal finish covering:

- .1 straight pipe, duct or plenum:
  - (a) stucco embossed aluminum 3105 or 3003 to ASTM B-209, not less than 0.45 mm (0.016 in) thick sheet, with integral 3 mil polyfilm moisture barrier on the interior surface, lock-forming quality,
  - (b) stainless steel type 304 to ASTM A-240, not less than 0.25 mm (0.010 in) thick sheet, lock-forming quality;
    - i) stucco embossed,
    - ii) 0.19 mm (3/16 in) corrugated.
- .2 fittings:
  - (a) custom made swaged ring or lobster back covers on bends and die shaped fitting covers over pipe fittings, round duct fittings, valves, strainers, flanges, and grooved couplings.
- .3 bands:
  - (a) 12 mm (½ in) wide stainless steel with mechanical fasteners.

*Standard of Acceptance*

- Alcan Canada Products - fig. Thermaclad Type 1
- Childers Products Inc. - fig. Fab Straps

.4 Protective finish for elastomeric cellular foam insulation

- .1 indoors and outdoors:

*Standard of Acceptance*

- Armaflex WB Finish

## 2.6 Insulation

- .1 Refer to specification sections for duct, equipment, and piping insulation.

### **3 EXECUTION**

#### **3.1 General Requirements**

- .1 Apply insulation after pressure and leakage testing is completed and accepted, and heat tracing (if any) is installed.
- .2 Surfaces to be clean and dry before application of insulation.
- .3 Store and use adhesives, mastics, and insulation cements at ambient temperatures and conditions recommended by the product manufacturers.
- .4 Do not apply insulation on chrome plated surfaces of piping, valves, fittings, and equipment.
- .5 Cut and bevel insulation around nameplates and pressure vessel certification stamps, seals or similar markings.
- .6 Neatly finish insulation at supports, protrusions, and interruptions.
- .7 Where insulation media is exposed, seal the insulation with reinforced vapor barrier or breather coating or mastic.

#### **3.2 Installation of Insulation**

- .1 Refer to specification sections for duct, equipment, and piping insulation.

#### **3.3 Sealing of Insulation – General Requirements**

- .1 The following requirements apply to all mechanical insulation unless otherwise specified in each mechanical service insulation specification section. Refer to separate specifications for specific sealing requirements for ductwork, equipment and piping insulation.
- .2 Apply sealer coatings and mastic in accordance with the following:
  - .1 use breather coating/mastics for hot services:
  - .2 use vapour barrier coating/mastic for cold and dual temperature services:
  - .3 only use mastics on outdoor installations.
  - .4 apply mastics and coatings when ambient temperature is above 4°C (40°F), unless manufacturer's instructions permit colder ambient installation conditions.
- .3 Maintain integrity of vapour barrier through sleeves, around fittings and at hangers and supports.

#### **3.4 Insulation Finish Coverings**

- .1 Where required to be provided by other mechanical insulation specification sections, install protective finish coverings in accordance with the following.
- .2 Install protective finish coverings on insulation after breather and vapor barrier sealing is completed.
- .3 For hot services that are exposed in wet areas, secure and seal coverings in accordance with the requirements for cold and dual temperature services.
- .4 Cut finish covering materials to allow 50 mm to 100 mm (2 in to 4 in) overlaps onto adjacent sheets. On vertical services, arrange circumferential overlaps to be on the lower end of each cover section.
- .5 PVC finish covering:
  - .1 Adhesives and sealers to be compatible with PVC material.
  - .2 Hot services;

- (a) secure sheeting with colour matched tape around circumference, at least two places per section of sheet, and by stapling longitudinal and circumferential edges,
  - (b) except in wet areas, do not seal major joint edges with vapour barrier tape,
  - (c) seal PVC fitting covers at throat and heel seams by stapling and secure over adjacent insulation covers by banding or taping ends to adjacent finish covering with colour matched tape.
  - (d) Install PVC covers in accordance with the requirements for cold and dual temperature services.
- .3 Cold and dual temperature services:
  - (a) seal longitudinal edges with vapor barrier coating adhesive or colour matched vapour barrier tape for the full length and depth of the overlap,
  - (b) seal circumferential butt edges of PVC fitting covers with reinforced vapour barrier coating adhesive extending over adjacent pipe insulation section with an overlap of at least 50 mm (2 in),
  - (c) seal PVC fitting covers at throat and heel seams by solvent bonding and secured over insulation with reinforced vapor barrier coating overlapping adjacent service insulation a minimum of 50 mm (2 in),
  - (d) neatly finish exposed edges with vapour barrier sealant/mastic.
- .6 Metal finish covering:
  - .1 use stucco embossed metal finish covers on round surfaces with diameter of 2.4 m (8 ft) and smaller; refer to applicable duct, equipment and piping specification sections for metal type.
  - .2 use corrugated stainless steel metal finish covers on flat surfaces, and on round surfaces with diameters greater than 2.4 m (8 ft).
  - .3 apply metal finish coverings over mechanical services, with a 60 mm (2-1/2 in) overlap,
  - .4 use lock-on systems or secure sheeting with bands 450 mm (18 in) apart.
    - (a) make-up curved surfaces with custom made swaged ring or lobster back covers.
  - .5 for indoor mechanical services;
    - (a) seal cover joints for cold and dual temperature services with clear or colour-matched calking.
    - (b) on outdoor mechanical services;
    - (c) seal cover joints for cold and dual temperature services with clear or colour-matched calking to permit expansion of metal finish covers.
- .7 Fabric finish covering:
  - .1 Cotton lagging:
    - (a) apply cotton lagging with minimum two coatings of breather or vapor barrier coating adhesive as applicable to the piping system, and finish to provide a smooth surface free of wrinkles and sags.
    - (b) where cotton lagging with appropriate coating is used this satisfies the requirements of a sealer coating for cold and dual temperature services.
  - .2 Fiberglass lagging:
    - (a) apply re-wettable fiberglass lagging in accordance with manufacturer instructions, and finish to provide a smooth surface free of wrinkles and sags.
    - (b) for cold and dual temperature services, apply a finish coat of vapour barrier sealer.
    - (c) where re-wettable fiberglass lagging is used this satisfies the requirements of a breather coating for hot piping systems,

### **3.5 Mechanical Damage Protection - Indoors**

- .1 Protect visible pipe insulation extending up through a floor sleeve at the floor line with 1.2 mm (18 ga) thick stainless steel protection shield approximately 100 mm (4 in) high, secured to floor slab. Conceal fastenings by use of a floor plate.
- .2 For piping systems using finishes, this protection cover is in addition to the specified pipe finish cover.

### **3.6 Field Quality Control**

- .1 The Consultant reserves the right to have protective finish coverings removed on up to 1% of all cold service and dual temperature service surfaces, fittings, flanges, couplings, valves, and ductwork/pipeline accessories to review the installation of the insulation, at no additional cost.
- .2 If insulation sealing is found to be incorrect at any one sampled location, remove the protective finish on all fittings, flanges, couplings, valves, and pipeline accessories for review, at no additional cost.
- .3 Repair defective insulation sealing and replace protective coverings at no additional cost.

**End of Section**

## **DUCTWORK INSULATION**

### **20 07 13**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide insulation, coatings, finish coverings and mechanical protection for ducts, casing, plenums, fans and associated equipment.
- .2 Insulation is not required on factory insulated casings and/or over acoustically lined ductwork except as otherwise shown.
- .3 Conform to specification section 20 07 11 for common requirements for mechanical insulation.

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 07 11 Common Requirements for Mechanical Insulation
  - .2 23 31 13 Metal Ducts.

### **1.3 Definitions and Abbreviations**

- .1 Refer to Specification section 20 07 11 and as otherwise specified herein.

### **1.4 Applicable Codes and Standards**

- .1 Refer to Specification section 20 07 11.

### **1.5 Submittals**

- .1 Comply with the requirements of Specification section 20 07 11 except/and as specified herein.
- .2 Submit shop drawing details for construction of insulation for outdoor ducts, including details for
  - .1 sloping of insulation,
  - .2 installation of vapour barrier/breather coats, and protective finish covering details,
  - .3 reinforcing sheeting for larger ducts.

## **2 PRODUCTS**

### **2.1 General Requirements**

- .1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:
  - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84,
  - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84,
  - .3 exception: vapor barrier mastics on mechanical services located outside of the building.

### **2.2 Ductwork Insulation**

- .1 Type D-1 (glass-fibre roll blanket):
  - .1 flexible glass-fibre blanket, formaldehyde-free to ASTM C1290,
  - .2 density: 12 kg/m<sup>3</sup> (0.75 pcf),

- .3 service temperature with jacketed: up to 65°C (150°F),
- .4 foil skim kraft ("FSK") jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,
- .5 vapour transmission: maximum 0.02 perms to ASTM E96 Procedure A,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 minimum RSI values at a mean temperature of 24°C (75°F) at the pre-installed nominal insulation thickness:

Nominal Thickness mm (in)	RSI m <sup>2</sup> ·°C/W	Nominal Thickness mm (in)	RSI m <sup>2</sup> ·°C/W
25 (1)	0.53	55 (2.2)	1.06
40 (1.5)	0.74	110 (4.4)	2.11

*Standard of Acceptance*

- Johns Manville - Microlite FSK Duct Wrap
- Owens Corning - SOFTR Duct Wrap
- Knauf Fibreglass - Atmosphere Duct Wrap

- .8 Same as above except provided with a PSK (polypropylene-scrim-draft) vapour barrier jacket.

*Standard of Acceptance*

- Johns Manville - Microlite Black PSK

.2 Type D-2 (rigid glass fibre board):

- .1 rigid glass-fibre insulation board to ASTM C612,
- .2 density:
  - (a) indoors: 48 kg/m<sup>3</sup> (3.0 lb./ft<sup>3</sup>),
  - (b) outdoors: 96 kg/m<sup>3</sup> (6.0 lb./ft<sup>3</sup>),
- .3 service temperature:
  - (a) unfaced board: up to 232°C (450°F),
  - (b) faced board: up to 65°C (150°F),
- .4 foil skim kraft ("FSK") jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,
- .5 vapor transmission: maximum 0.02 perms,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 minimum RSI values at a mean temperature of 24°C (75°F) at the specified insulation thickness:

Nominal Thickness mm (in)	RSI m <sup>2</sup> ·°C/W	Nominal Thickness mm (in)	RSI m <sup>2</sup> ·°C/W
25 (1)	0.76	50 (2)	1.51



40 (1-1/2)	1.14	75 (3)	2.27
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*Standard of Acceptance*

- ° Johns Manville - Manville 814 Spin-Glas
- ° Owens Corning - 703 Board
- ° Knauf Fiberglass - Insulating Board

.3 Type D-3 (mineral fibre board, high temperature)

- .1 rigid-board, mineral fibre to ASTM C411,
- .2 density: 145 kg/m<sup>3</sup> (9.1 lb./ft<sup>3</sup>),
- .3 service temperature: up to 700°C (1292°F),
- .4 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .5 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
100	0.044	700	0.158

*Standard of Acceptance*

- ° Roxul - ProRox SL 980

### 3 EXECUTION

#### 3.1 Applicable Systems to be Insulated

- .1 Insulate ductwork, plenums, casings and equipment in accordance with the following, and of the insulation type and thickness in accordance with Schedule 1 at the end of this specification section.
- .2 Externally insulate casings and equipment:
  - .1 air handling units producing conditioned supply air,
  - .2 air handling units conveying exhaust air downstream of heat recovery devices,
  - .3 free-standing supply air fans (not enclosed in a casing or plenum).
- .3 Externally insulate ductwork and plenums:
  - .1 cold and dual temperature ductwork conveying conditioned supply air including downstream of reheat coils,
  - .2 hot ductwork conveying conditioned supply air up to the space served but not within the space itself,
  - .3 unconditioned supply air ducts and plenums located in unheated spaces,
  - .4 return air and exhaust air ducts and plenums in unheated spaces,
  - .5 outside air intake ducts and plenums,
  - .6 exhaust air plenums at point of discharge to outside of building,
  - .7 exhaust air ducts and plenums downstream of heat recovery devices,

- .8 exhaust air ducts between exhaust air damper and point of discharge to outside of building,
- .9 mixed air plenums and ducts;
  - (a) for recirculating type ventilation systems without cooling coils, terminate outside air intake insulation 300 mm (12 in) downstream of mixing plenum,
- .10 150 mm (6 in) entering and leaving length overlap of acoustically lined ductwork,
- .11 sheet metal blank-off plates behind unused sections of air intake louvres.
- .4 Externally insulate ductwork located outdoors:
  - .1 conditioned supply ducts,
  - .2 return ducts,
  - .3 general and process exhaust ducts between building and rooftop exhaust fan,
    - (a) excluding outdoor fan discharge duct,
  - .4 kitchen exhaust ducts between building and rooftop exhaust fan, with more than 3 m (10 ft) length of duct on roof,
    - (a) excluding outdoor fan discharge duct.
- .5 External insulation is not required on:
  - .1 casings, ducts or plenums which have been lined with acoustic insulation, except as described above,
  - .2 ducts, plenums, casings and freestanding supply fans conveying unconditioned air,
  - .3 portions of intake ducts or plenums, unit casings and conditioned air plenums which are of double wall insulated construction,
  - .4 factory insulated flexible connectors (ducts),
  - .5 factory insulated air handling units,
  - .6 for non-recirculating make-up air type ventilation systems with a supply air temperature less than 27°C (80°F),
    - (a) terminate casing insulation 300 mm (12 in) downstream of heating coil or heating unit, and
    - (b) insulation is not required on the supply ductwork.

### 3.2 Installation of Rigid Insulation - Indoors

- .1 Attach insulation fastener pins, studs and clips to all surfaces of ducts, casings, plenums and fans, at approximately 300 mm (12 in) centers, each direction, but not less than two (2) rows per duct. Attachment method:
  - .1 welded type for outdoor ducts,
  - .2 welded type for indoor ducts,
  - .3 self-adhesive base type may be used for vertical surfaces of rectangular ducts.
- .2 Install rigid board insulation with joints staggered and tightly butted and no visible gaps. Install horizontal boards to overlapping over vertical boards.
- .3 Secure rigid insulation by impaling on insulation fastener pins, apply speed washers and cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape extending at least 50 mm (2 in) beyond the washer.

- .4 Where space restrictions do not permit the use of mechanical fasteners, secure the insulation with 100% coverage of contact adhesive along with stainless steel banding on 300 mm (12 in) centers, with a band within 50 mm (2 in) of each duct corner.
- .5 Neatly finish insulation at supports, protrusions, and interruptions.
- .6 Apply colour matched vapour barrier tape neatly and firmly to all joints, including outside and inside corner joints, and at any exposed ends of insulation and cuts or damage to the insulation jacket. Alternatively, apply two heavy coats of applicable sealer coat and with reinforcing membrane. Extend tape or coating at least 50 mm (2 in) on each side of joint, exposed ends of insulation or repairs to insulation jacket.

### 3.3 Installation of Rigid Insulation - Outdoors

- .1 Secure rigid insulation for ducts and plenums located outdoors as specified for indoor rigid insulation, and as follows.
- .2 Build-up and slope insulation on top of rectangular and flat oval ducts to provide drainage and prevent ponding of water on top of the duct. Without limiting the preceding, as a minimum this includes the following work:
  - .1 provide inserts between the duct and the duct insulation, to raise the insulation to establish the required slope,
  - .2 fabricate inserts from the same material as the duct insulation, shaped to establish the required slope and to provide continuous support to the insulation. Alternatively, inserts may be fabricated from layers of high-density polystyrene insulation equal to Owens Corning Celfort 300,
  - .3 where indicated in the following table for wider ducts, locate the peak of the insulation at the midpoint of the duct and slope the insulation to both sides of the duct,
  - .4 the insert rise height shall be the greater of that determined by the minimum slope and the minimum rise height as shown in the following table.

Duct Width mm (in)	Number of Slope Directions	Minimum Slope (Rise: Run)	Minimum Rise Height
≤ 600 (24)	1	1:12	50 mm (2 in)
>600 and ≤1200 (>24 and ≤48)	2	1:12	50 mm (2 in)
>1200 and ≤2400 (>48 and ≤96)	2	1:25 and reinforced	50 mm (2 in)
>2400 (96)	2	1:25 and reinforced [Note 1]	100 mm (4 in)

**Notes:**

[1] Refer to specification section 23 31 13 on requirements for provision of a snow and rain roof for large ducts of this size.

- .5 Where required by the preceding table, reinforce the insulation as follows:
  - (a) cover the insulation on top of the duct with reinforcing sheeting, which is separate from any protective finish covering. Install the insulation components in layers as follows:
    - i) protective finish coating,
    - ii) reinforcement
    - iii) vapour barrier/air barrier
    - iv) insulation

- v) insulation slope inserts
  - (b) fabricate the reinforcement sheet from minimum 0.55 mm (0.022 in.) thick galvanized steel sheet, reinforced with 20 mm (3/4 in) deep V-breaks on 300 mm (12 in) centers,
  - (c) place the steel sheets with the V-breaks/angles pointed down and orientated to run in the direction of the slope,
  - (d) size the width of the reinforcement panel to stop 25 mm (1 in) from the edge of the duct insulation, so as not to interfere with or damage the insulation vapour barrier or protective finish covering,
- .3 Where two layers of insulation are used;
- .1 apply the first layer of insulation without integral vapour barrier jacket,
  - .2 apply the second layer of insulation with integral vapour barrier jacket,
  - .3 stagger the joints so that no second layer joints are within 100 mm (4 in) of an underlying first layer joint.

### 3.4 Installation of Flexible Insulation – Indoors

- .1 On rectangular ducts 600 mm (24 in) and wider, and round ducts 450 mm (18 in) and wider, attach mechanical fastener pins, studs and clips to the bottom exterior surface of the duct at approximately 300 mm (12 in) centers, each direction, but not less than two (2) rows per duct. For round ductwork, the bottom of the duct is measured as being half the circumference of the duct.
- .2 Except for flexible connectors, cut flexible insulation to required circumferential length and pull-out to final installed thickness in accordance with manufacturer instructions, and to overlap insulation 50 mm (2 in) on each lap joint, and tightly butt end edges together.
- .3 For flexible connectors, apply insulation to bare (uninsulated) supply flexible connectors as follows:
  - .1 remove insulation to create a minimum 50 mm (2 in.) wide lap for both the longitudinal joint and the circumferential joint,
  - .2 cut insulation to width to provide a slightly compressed longitudinal butt joint; do not pull out insulation,
  - .3 secure longitudinal and circumferential joints with staples through the laps, and then apply vapour barrier tape over joints to create a vapour barrier seal,
  - .4 secure the ends of the insulation with vapour barrier tape to the rigid duct insulation,
  - .5 secure the ends of the insulation at the diffuser or grill with a Nylon tie-wrap over the diffuser/grille spigot and recover with vapour barrier tape to fully seal end of insulation to the diffuser/grille.
- .4 Secure flexible insulation by:
  - .1 impaling on mechanical fastener pins and secure with speed washers, and either;
    - (a) secure insulation with stainless steel wire or stainless steel banding on 300 mm (12 in) centers, or by stapling laps, or
    - (b) secure insulation with 100% insulation adhesive coverage.
- .5 Cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape extending at least 50 mm (2 in) beyond the washer.
- .6 Neatly finish insulation at supports, protrusions, and interruptions.
- .7 Apply colour matched vapour barrier tape neatly and firmly to all joints, including outside and inside corner joints, and at any exposed ends of insulation and cuts or damage to the insulation jacket.

Alternatively, apply two heavy coats of applicable sealer coat and with reinforcing membrane. Extend tape or coating at least 50 mm (2 in) on each side of joint, exposed ends of insulation or repairs to insulation jacket.

- .8 [][Use flexible insulation with black PSK jackets in the following exposed locations:
- .1 •
  - .2 •
  - .3 •]

### **3.5 Installation of Flexible Insulation – Outdoors**

- .1 Flexible insulation is only permitted for use outdoors on round ducts, and on the rounded sides of flat-oval duct.
- .2 Secure flexible insulation for round or ducts located outdoors as specified for indoor flexible insulation, and as follows.
- .3 Secure insulation with stainless steel banding on 300 mm (12 in) centers.

### **3.6 Insulation of Fittings, Flanges and Accessories**

- .1 Cut and miter rigid insulation at elbows and fittings and attach to ductwork with mechanical fasteners as specified for ducts, and in addition secure insulation with 50% coverage of adhesive.
- .2 At junctions between external insulation and acoustically lined ducts, overlap external insulation 300 mm (12 in) over acoustically lined ducts.
- .3 Insulate flanges, support angles and standing seams with 100 mm (4 in) wide overlapping strips of insulation matching adjacent ductwork and of same thickness, and seal with two coats of breather mastic with reinforcing membrane.

### **3.7 Sealing Insulation - Hot Ductwork**

- .1 Seal hot ductwork insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet areas):
  - .1 apply vapour barrier tape to butt joints, overlapping by at least 50 mm (2 in) each side,
  - .2 do not tape longitudinal lap seams except as required to secure the insulation.
- .3 Indoor installations – wet areas:
  - .1 apply vapour barrier tape to:
    - (a) all longitudinal lap seams and butt edges,
    - (b) 100% coverage of insulation at pipe joints, fittings, couplings, etc.
    - (c) over insulation fasteners including pins/washers and staples.
- .4 Outdoor installation:
  - .1 apply two coats of breather mastic with reinforcing membrane to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket,
  - .2 cover mechanical fastener penetrations including staples with two coats breather mastic with reinforcing membrane.

### **3.8 Sealing Insulation - Cold and Dual Temperature Ductwork**

- .1 Seal cold and dual temperature ductwork insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet areas):
  - .1 tightly seal insulation lap seams and butt joints, using factory lap seams or field-fabricated lap seams and butt strips,
  - .2 apply [vapour barrier tape][vapor barrier coating with reinforcing membrane] to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side,
  - .3 cover insulation pin/washer fastener penetrations including staples with [vapour barrier tape] [vapour barrier coating with reinforcing membrane], overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.
- .3 Indoor installation – wet areas:
  - .1 tightly seal ductwork located within wet areas in accordance with the requirements for outdoor installation except use vapour barrier coatings.
- .4 Outdoor installation:
  - .1 apply two coats of vapour barrier mastic with reinforcing membrane to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket,
  - .2 cover mechanical fastener penetrations including staples with two coats vapour barrier mastic with reinforcing membrane, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.

### **3.9 Insulation Finish Covering**

- .1 Provide insulation protective finish coverings selected in accordance with Schedule 2 at the end of this specification section and installed in accordance with specification section 20 07 11 and/except as specified herein.

### **3.10 Painted Ductwork**

- .1 Not applicable.

### **3.11 Mechanical Damage Protection - Indoors**

- .1 Protect exposed insulated ductwork from floor level up to a height of 1200 mm (4 ft) above the floor with 0.9 mm (20 ga.) galvanized steel jacket, with riveted longitudinal seams and mechanically fastened to the floor with countersunk stainless steel screws.
- .2 Where waterproof floor sleeves are required, the floor sleeve may be combined with this requirement.

### **3.12 Insulating and Finishes Tables**

- .1 The insulating and finishing tables follow:
  - .1 Schedule 1 - Ductwork, Insulation Type and Thickness
  - .2 Schedule 2 - Ductwork Insulation Protective Finishes.

**Schedule 1:  
Ductwork Insulation Type and Thickness**

Duct Air Service Temperature	Location	Equipment Description	Insulation Type	Insulation Thickness mm (in) [Note 1]
5°C to 65°C (40 to 150°F)	Indoors	Air handling unit casings and plenums, Free standing supply fans	D-2	50 (2)
		Rectangular ducts and plenums – exposed or concealed	D-2	25 (1)
		Rectangular ducts - concealed	D-1	25 (1)
		Round and Oval ducts - exposed		
	Unconditioned Space	Rectangular ducts and plenums	D2	40 (1-1/2)
			D1	55 (2.2)
		Round and Oval ducts	D1	55 (2.2)
	Outdoors	Rectangular and Oval – Supply, Return	D-2	75 (3)
		Round and Oval – Supply, Return	D-1	110 (4.4) [Note 2, 3]
		Rectangular – Process and General Exhaust	D-2	1 (25)
		Round – Process and General Exhaust	D-1	1.5 (40)
		Rectangular - Kitchen Exhaust	D-3	50 (2)

.... continued on next page

**Table 1: (continued)**  
**Ductwork Insulation Type and Thickness**

Duct Air Service Temperature	Location	Equipment Description	Insulation Type	Insulation Thickness mm (in) [Note 1]
-40 to +40°C (-40 to 104°F)	Indoors	Plenums and Casings – Air Intakes	D2	Two layers 50 (2)
-10 to +40°C (14 to 104°F)	Indoors	Plenums and Casings – Exhaust	D2	50 (2)
5 to 16°C	Indoors	Drain Pans	D2	1 (25)

**Notes:**

[1] Type D-1 flexible duct insulation thickness is “out of box” before installation.

[2] Insulation thickness may be provided by two layers, so that the total insulation thickness “out of the box” is equal to or greater than the specified thickness.

[3] Flexible duct may be used only on the rounded sides of flat oval ducts.

**Schedule 2:**  
**Ductwork Insulation Protective Finish Coverings**

Location	Exposed/ Concealed	System/ Space	Protective Finish Covering
Indoors	Concealed	All	None
	Exposed	Service Rooms	Metal
		Public Spaces	Metal
Outdoors	Any	All	Metal

**End of Section**



## **PIPING INSULATION**

### **20 07 19**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide insulation, coatings, finishing coverings and mechanical protection of piping, valves, fittings, and pipeline accessories.
- .2 Conform to Specification section 20 07 11 for common requirements for mechanical insulation.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other Specification sections, the work under this section directly integrates with or refers to the following Specification sections:
  - .1 20 05 29 Common Hanger and Support Requirements for Piping
  - .2 20 07 11 Common Requirements for Mechanical Insulation

##### **1.3 Definitions and Abbreviations**

- .1 Refer to Specification section 20 07 11 and as otherwise specified herein.

##### **1.4 Applicable Codes and Standards**

- .1 Refer to Specification section 20 07 11.

##### **1.5 Submittals**

- .1 Comply with the requirements of Specification section 20 07 11 except/and as specified herein.
- .2 Submit a shop drawing illustrating the method of insulation of pipe fittings, flanges and couplings for Cold and Dual Temperature piping. Submittal to include:
  - .1 type of insulation material being used (mitered preformed piping insulation sections, insulation inserts or blanket); this may vary based on pipe size,
  - .2 for insulation inserts and blanket methods, indicate the insulation thickness and number of layers required for each pipe size, the adjacent pipe insulation thickness, and the final compressed thickness of the fitting insulation,
  - .3 method and shop details of application of vapour barrier, including details for sealing of PVC jackets.
- .3 When requested by Consultant, submit full size mock-up examples of pipe fitting insulation for Cold and Dual-Temperature piping, complete with selected vapour barrier method. Submittal to include one elbow and one Tee based on pipe size as selected by Consultant.

#### **2 PRODUCTS**

##### **2.1 General Requirements**

- .1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:
  - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.
  - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.
  - .3 exception: vapor barrier mastics on mechanical services located outside of the building

## 2.2 Pipe Insulation

### .1 Type P-1 (molded glass-fiber):

- .1 factory molded rigid glass-fiber to ASTM C547,
- .2 nominal pipe size: NPS 24 and smaller,
- .3 service temperature, jacketed: -18°C (0°F) to 65°C (150°F),
- .4 jacket: all-service-jacket (ASJ) of white kraft paper bonded to aluminum foil, reinforced with glass fiber yarn, and laminated to an interior kraft paper face,
- .5 vapor transmission: maximum 0.02 perms to ASTM E96,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 reduced environmental impact feature of either: bio-based binders, 25% minimum recycled glass content, and/or paper-free ASJ jacket material,
- .8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.034	93	0.040

#### *Standard of Acceptance*

- Johns Manville - fig. Micro-Lok HP (25% recycled content)
- Owens Corning - fig. Fiberglas Evolution (paper-free ASJ)
- Knauf Fiberglass - fig. Earthwool 1000 Ecosse (bio-based binders)

### .2 Type P-2 (semi-rigid glass-fiber roll):

- .1 glass fiber semi-rigid roll insulation for tanks and pipes, to ASTM C1393,
- .2 glass-fiber oriented to maintain uniform thickness when installed on round surfaces,
- .3 density: 40 kg/m<sup>3</sup> (2.5 lb./ft<sup>3</sup>),
- .4 nominal pipe size: NPS 14 and larger,
- .5 service temperature with jacket: up to 65°C (150°F),
- .6 jacket: all-service-jacket ("ASJ") of white kraft paper bonded to aluminum foil, reinforced with glass fiber yarn, and laminated to an interior kraft paper face,
- .7 vapor transmission: maximum 0.02 perms to ASTM E96,
- .8 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .9 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	93	0.046

#### *Standard of Acceptance*

- Johns Manville - fig. Micro-Flex Pipe and Tank Wrap
- Owens Corning - fig. Fiberglas Pipe and Tank
- Knauf Fibreglass - fig. KwikFlex Pipe and Tank

.3 Type P-3 (molded mineral fiber):

- .1 factory molded mineral fiber to ASTM C547,
- .2 density: 128 kg/m<sup>3</sup> (8.0 lb./ft<sup>3</sup>),
- .3 nominal pipe size: NPS 30 and smaller,
- .4 service temperature: up to 650°C (1200°F),
- .5 jacket: integral foil skim-kraft (FSK) jacket of aluminium foil reinforced with glass fiber yarn, and laminated to kraft paper,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.036	149	0.049

*Standard of Acceptance*

- Rockwool - fig. ProRox PS 960
- Johns Manville - fig. MinWool-1200
- Industrial Fiber-Tek - fig. IFT 1200 Pipe

.4 Type P-4 (molded mineral fiber, high temperature):

- .1 factory molded mineral fiber, high temperature, to ASTM C547,
- .2 density: 145 kg/m<sup>3</sup> (9.1 lb./ft<sup>3</sup>),
- .3 nominal pipe size: NPS 6 and larger,
- .4 service temperature: up to 760°C (1400°F),
- .5 jacket: none,
- .6 compressive strength: 53 kPa (8 psi) at 10% compression,
- .7 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.039	149	0.049

*Standard of Acceptance*

- Rockwool - fig. ProRox PS 980

.5 Type P-5 (cellular glass):

- .1 fabricated pipe and fitting shapes, cellular glass to ASTM C552,

- .2 density: 120 kg/m<sup>3</sup> (7.5 lb./ft<sup>3</sup>),
- .3 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .4 nominal pipe size: NPS 16 and smaller,
- .5 service temperature: -268°C (-450°F) to 480°C (900°F),
- .6 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .7 jacket: none,
- .8 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .9 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
10	0.040	24	0.042

*Standard of Acceptance*

- Owens Corning - fig. Foamglas

.6 Type P-6 (elastomeric foam plastic):

- .1 flexible elastomeric closed cell foam, tubular with self-sealing seams, to ASTM C534,
- .2 nominal pipe size: NPS 2 and smaller,
- .3 service temperature: -183°C (-297°F) to 82°C (183°F),
- .4 jacket: none,
- .5 manufacturer specific sealer/adhesive,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	32	0.037

*Standard of Acceptance*

- Armacell - fig. AP Armaflex SS Pipe Insulation
- KFlex USA - fig. Insul-Tube

.7 Type P-7 (calcium silicate):

- .1 fabricated pipe and fitting shapes, calcium silicate, asbestos-free, to ASTM C533 Type I,
- .2 density: 232 kg/m<sup>3</sup> (14.5 lb./ft<sup>3</sup>),
- .3 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .4 integral corrosion inhibitor to reduce under insulation corrosion,
- .5 nominal pipe size: NPS 4 to NPS 24,

- .6 service temperature: 20 to 649°C (70 to 1200°F).
- .7 jacket: none,
- .8 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .9 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.
- .10 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.050	93	0.056

*Standard of Acceptance*

- Johns Manville - fig. Thermo-12 Gold

- .8 Type P-8 (removable high-temperature insulated jackets):
  - .1 custom fabricated, removable/reusable high temperature insulated jackets for hot surfaces,
  - .2 suitable for indoor and outdoor use,
  - .3 process surface temperature: as shown in Schedule A,
  - .4 maximum outer jacket touch-safe temperature protection: 95°C (203°F),
  - .5 jacket: silicone impregnated glass-fiber, for temperatures up to 260°C (500°F),
  - .6 insulation: mineral or fiberglass insulation suitable for system operating temperature,
  - .7 internal liner: silicone impregnated fiberglass fabric, or stainless steel knitted wire mesh,
  - .8 fasteners:
    - (a) stainless steel laced wire, for pipe sections,
    - (b) stainless steel mesh straps with buckle rings, for valves, strainers, meters and similar pipeline accessories,
  - .9 metal identification tag, referenced equipment served.

*Standard of Acceptance*

- Firwin Corporation
- Thermohelp Canada Inc.

- .9 Type P-10 (ceramic wool)
  - .1 alkaline earth silicate fibers (AES), roll insulation for tanks and pipes, to ASTM C892,
  - .2 free of binders and lubricants,
  - .3 density: 96 kg/m<sup>3</sup> (6 lb./ft<sup>3</sup>),
  - .4 continuous service temperature: 1000°C (1830°F),
  - .5 jacket: none,
  - .6 non-combustible,
  - .7 no requirement for labelling under the Global Harmonized System for classification labels for chemicals,

- .8 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
800	0.21	1000	0.29

*Standard of Acceptance*

- Morgan Thermal Ceramics - fig. Superwool Plus]]

.10 Type P-11 (pipe fitting blanket insulation):

- .1 Glass-fiber blanket, faced and unfaced,
- .2 maximum pipe service temperature limit:
  - (a) faced: 121°C (250°F),
  - (b) unfaced: 177°C (350°F),
- .3 flexible glass-fiber blanket, formaldehyde-free to ASTM C1139,
- .4 density: 16 kg/m<sup>3</sup> (1.0 lb./ft<sup>3</sup>),
- .5 jacket: FSK or PSK jacket, unless otherwise specified as unfaced,
- .6 vapour transmission (jacketed insulation only): 0.02 perms or less,
- .7 listed to CAN/ULC-S102/S102.2,
- .8 compressed thermal conductivity: 0.058 W/m°C @ 93°C (0.40 BTU•in/(hr•ft<sup>2</sup>•°F) @ 200°F)

*Standard of Acceptance*

- Knauf Fibreglass - Atmosphere Duct Wrap

.11 Type P-12 (pipe fitting insulation insert)

- .1 manufactured pre-cut shaped inserts specifically formed for insulation of pipe fittings,
- .2 maximum pipe service temperature limit: 454°C (850°F),
- .3 flexible glass-fiber blanket, formaldehyde-free to ASTM C547,
- .4 density: 16 kg/m<sup>3</sup> (1.0 lb./ft<sup>3</sup>),
- .5 service temperature: minimum -18 to 454°C (0 to 850°F),
- .6 jacket: none (unfaced),
- .7 vapour transmission: not applicable,
- .8 listed to CAN/ULC-S102/S102.2,
- .9 compressed thermal conductivity: 0.058 W/m°C @ 150°C (0.40 BTU•in/(hr•ft<sup>2</sup>•°F) @ 300°F)

*Standard of Acceptance*

- Johns Manville - fig. Zeston Hi-Lo Temp Insulation Inserts

## **2.3 Pipe Support Insulation Inserts**

- .1 General:

- .1 molded or fabricated high-density molded insulation inserts for pipe supports.
- .2 Type P-21 – factory insulated shields:
  - .1 factory assembled high-density insulation insert with insulation shield,
  - .2 nominal pipe size: NPS 1/2 to NPS 30,
  - .3 service temperature: -40 to +125°C (-40 to +275°F),
  - .4 insulation:
    - (a) rigid phenolic foam insulation, to ASTM C1126, Gr.2, Type III,
    - (b) thickness: to match thickness of adjacent pipe insulation,
    - (c) nominal density:
      - i) NPS 10 and under: 60 kg/m<sup>3</sup> (3.75 lb./ft<sup>3</sup>),
      - ii) NPS 12 to 30: 80 kg/m<sup>3</sup> (5.0 lb./ft<sup>3</sup>),
    - (d) minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
    - (e) pipe circumference coverage: 360°,
    - (f) insulation length: to extend at least 38 mm (1-1/2 in.) past each end of the integrated shield.
    - (g) vapour barrier jacket: three-ply composite polyester film and aluminium foil with self-securing lap-seal, with zero perm rating,
    - (h) listed to CAN/ULC-S102/S102.2 or ASTM E84.
  - .5 insulation shield:
    - (a) Z275 (G90) coating-weight galvanized steel to ASTM A653, with formed ribs to center clevis hanger or strut,
    - (b) edges flared or hemmed to prevent damage to insulation,
    - (c) adhered to bottom of insulation insert,
    - (d) width: covering 180° arc of insulation,
    - (e) length and thickness: as required to not exceed the compression strength of the insulation insert when supporting piping filled with water based on the maximum pipe support spans as defined in MSS SP-58.
  - .6 heavy-duty insulation shield (designation P-21HD):
    - (a) as specified above for insulation shield except/and as follows,
    - (b) shield thickness: 2.75 mm (12 ga),
    - (c) with structural steel plate welded to bottom of shield.
  - .7 sliding protection shield (designation P-21SL)
    - (a) as specified above for insulation shield except/and as follows,
    - (b) secondary shield located below the primary protection shield, with PTFE layer bonded to the upper surface of the secondary shield,
    - (c) designed to allow relative movement between the primary shield and secondary shield.

*Standard of Acceptance*

- Buckaroos Inc. - fig. CoolDry Insulated Saddles
- Buckaroos Inc. - fig. CoolDry Heavy Duty Insulated Saddles
- Buckaroos Inc. - fig. CoolDry Sliding Insulated Saddles

- .3 Type P-22 - cellular glass:
  - .1 cellular glass to ASTM C552,

- .2 nominal pipe size: NPS 1-1/2 to NPS 24,
- .3 density: nominal 120 kg/m<sup>3</sup> (7.5 lb./ft<sup>3</sup>),
- .4 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .5 service temperature: -73°C to +121°C (-100°F to 250°F),
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84.

*Standard of Acceptance*

- ° Owens Corning - fig. Foamglas

.4 Type P-23 - calcium silicate:

- .1 calcium silicate to ASTM C533 Type I, with integral corrosion inhibitor to reduce under insulation corrosion, asbestos-free,
- .2 nominal pipe size: NPS 1-1/2 to NPS 24,
- .3 density: nominal 232 kg/m<sup>3</sup> (14.5 lb./cu ft),
- .4 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .5 service temperature: 20 to 649°C (70 to 1200°F),
- .6 thermal performance: 0.058 W/m/C @ 149°C (0.40 btu/hr/in/sq ft/F @ 300°F).

*Standard of Acceptance*

- ° Johns Manville - fig. Thermo-12 Gold

### **3 EXECUTION**

#### **3.1 General**

- .1 Where repairs are made to existing insulated piping due to connections of new piping work, the insulation thickness for the existing piping is permitted to match the existing insulation nominal thickness, provided the extent of new insulation does not exceed a length of 1000 mm (39 in).

#### **3.2 Applicable Systems – Hot piping**

- .1 Insulate Hot piping systems including pipe, valves, fittings, and pipeline accessories in accordance with the Schedule A at the end of this Specification section.
  - .1 Table 1A for all piping except engine combustion gas exhaust piping,
  - .2 Table 1B for engine combustion gas exhaust piping.
- .2 Insulate condensate piping in accordance with the same criteria as its associated steam system.
- .3 Insulate inlet and discharge piping for safety valves or safety relief valves that is located;
  - .1 less than 2.4 m (8 ft) above a floor or work surface, or
  - .2 within 1 m (39 in) horizontally of, and less than 2.4 m (8 ft) above, an elevated work surface.

#### **3.3 Applicable Systems - Cold and Dual Temperature Piping**

- .1 Insulate Cold and Dual temperature piping systems including pipe, valves, fittings, and pipeline accessories in accordance with Schedule B at the end of this Specification section.
- .2 Insulate the following drainage services or equipment:
  - .1 storm water drainage systems in the following locations:



- (a) roof drain bodies,
  - (b) rainwater leaders (storm water piping) from roof drain bodies to the floor level below the drain body,
  - (c) rainwater leaders in or above data and telecommunication rooms,
  - (d) rainwater leaders in or immediately above wet areas.
- .2 sanitary piping in the following locations:
- (a) horizontal sanitary drainage piping NPS 3 and larger in ceiling spaces,]]
  - (b) sanitary drainage piping in or above wet areas,
  - (c) sanitary drainage piping in or above data and telecommunication rooms,
  - (d) exposed sanitary drainage piping in service tunnels,
  - (e) exposed sanitary drainage piping serving spaces located in a parking garage,
  - (f) and where shown on drawings.

### **3.4 Insulating Hot Piping**

- .1 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn for each butt joint.
- .2 For insulation having ASJ or FSK jackets, secure longitudinal flaps by either:
  - .1 use of press-on tacks or stapling the lap flap on 75 mm (3 in) centers, or
  - .2 by use of self-sealing lap adhesive strips, or
  - .3 with the use of colour-matched vapour barrier tape.
- .3 Secure insulation that does not have an integral ASJ or FSK jacket by use of stainless steel wire or bands at not less than 300 mm (12 in) centers, or by a continuous wire helix on the same center spacing.
- .4 For type P-2 and P-4 insulation, or where the required pipe insulation thickness is greater than 50 mm (2 in);
  - .1 provide two layers of approximately equal insulation thickness such that the total thickness is as specified,
  - .2 install straight pipe sections by staggering adjacent section longitudinal seams 1/4 turn for each section, and stagger butt joints between the first layer and second layer by at least 1/4 of the insulation section length, and
  - .3 secure the first layer of insulation with stainless steel wire or bands on 300 mm (12 in.) centers and secure the second layer with band straps on 300 mm (12 in) centers.
- .5 Secure butt joints with vapour barrier tape or insulation butt strips.
- .6 For piping service temperatures greater than 121°C (250°F);
  - .1 apply insulation finishing cement at all exposed edges of insulation where the insulation is interrupted by valves, connections to other equipment, and piping supports and anchors.

### **3.5 Insulating Cold and Dual Temperature Piping**

- .1 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn for each butt joint.
- .2 For insulation having ASJ or FSK jackets, secure longitudinal flaps by either:
  - .1 use of press-on tacks or stapling the lap flap on 75 mm (3 in) centers, or
  - .2 by use of self-sealing lap adhesive strips, or
  - .3 with the use of colour-matched vapour barrier tape.
- .3 Except for type P-6 insulation, secure insulation that does not have an integral ASJ or FSK jacket by:

- .1 use of 12 mm (1/2 in.) wide reinforced filament tape on approximately 150 mm (6 in.) centers for piping NPS 4 and smaller, and use stainless steel banding on 225 mm (9 in.) centers for piping NPS 6 and larger, and
  - (a) apply an all-service-jacket with 100% coverage of adhesive suitable for the insulation material, with longitudinal and butt seams having a 50 mm (2 in) overlap, and seal the laps with vapour barrier adhesive/ coating, or
  - (b) apply a heavy brush coat of vapour barrier coating at the rate of 1.2 L/m<sup>2</sup> (2.5 Imp.gallon per 100 ft<sup>2</sup>), embed a layer of reinforcing membrane, and then applying a second heavy brush coat of vapour barrier coating at the rate of 1.0 L/m<sup>2</sup> (2.1 Imp. gallon per 100 ft<sup>2</sup>).
- .4 For type P-2 insulation, or where the required pipe insulation thickness is greater than 50 mm (2 in);
  - .1 provide two layers of approximately equal thickness such that the total thickness is as specified,
  - .2 install straight pipe sections by staggering adjacent section longitudinal seams 1/4 turn for each section, and stagger butt joints between the first layer and second layer by at least 1/4 of the insulation section length, and
  - .3 secure the first layer of insulation with stainless steel wire on 300 mm (12 in.) centers and secure the second layer with stainless steel banding on 225 mm (9 in) centers.
- .5 For type P-6 insulation:
  - .1 secure insulation with field-applied adhesive or self-adhesive longitudinal edge seams and apply vapour barrier adhesive/sealant to butt joints.
- .6 Secure butt joints for all insulation types with vapor barrier tape, unless otherwise sealed using vapour barrier adhesives and coatings.
- .7 Expansion joints:
  - .1 provide an insulation expansion joints for straight pipe runs greater than 15 m (50 ft) and at every 15 m (50 ft) length thereafter,
  - .2 expansion joint consisting of 50 mm (2 in) wide type P-11 insulation for full depth of pipe insulation. Seal adjacent pipe insulation ends with vapor barrier coating.
- .8 Where pipe anchors are attached to chilled water piping or Dual Temperature piping;
  - .1 cover exposed ends of cut insulation with reinforced vapour barrier coating, with the fabric and coating overlapping by at least 50 mm (2 in.) onto the pipe anchor,
  - .2 insulate the pipe anchor with type P- 6 insulation (in round or equivalent sheet form) to a distance equal to 10 times the largest outside dimension of the anchor structure element, but not less than 150 mm (6 in) beyond pipe insulation outer surface.
- .9 Notwithstanding the method of securing the insulation, all seams and joints are to be provided with a vapor barrier seal as specified herein.

### **3.6 Insulation of Pipe Fittings**

- .1 Insulate pipe fittings including but not limited to elbows and tees.
- .2 Unless otherwise specified, build-up layers of insulation inserts or blanket insulation for pipe fittings with multiple insulation layers so that the installed insulation in its compressed thickness is not less than the insulation thickness of the adjoining pipe.
- .3 NPS 1½ and smaller (Type P-1 to P-4 insulation:
  - .1 miter cut insulation to create tight fit,
  - .2 where PVC covers are used, trim backside of insulation on elbows to suit cover but do not reduce total thickness less than that of adjacent pipe insulation,

- .3 secure fitting insulation with vapour barrier tape.
- .4 NPS 2 and larger (type P-1 to P-4 insulation):
  - .1 **METHOD 1 – Mitered Rigid Insulation:**
    - (a) neatly cut rigid pre-formed pipe insulation in multiple-mitered sections to follow the curve of the pipe fitting,
    - (b) number of mitered segments to be sufficient to maintain thickness of insulation around throat of elbow or tee,
    - (c) secure insulation without an ASJ or FSK jacket with stainless steel wire,
    - (d) secure insulation with ASJ or FSK jacket with vapour barrier tape, covering all seams.
  - .2 **METHOD 2 – Preformed rigid fitting insulated fittings:**
    - (a) use matching preformed rigid fitting insulation units,
    - (b) secure fitting insulation using stainless steel wire or vapor barrier tape.
  - .3 **METHOD 3 – flexible inserts or blanket insulation:**
    - (a) for grooved joints and flanges: install a collar of oversized rigid pipe insulation over the end of the pipe-run insulation adjacent to the grooved coupling or flange, to achieve an overall insulation height equal to the adjacent coupling or flange height,
    - (b) wrap fittings with type P-11 or P-12 insulation, neatly applied in sufficient layers to build up total compressed insulation thickness to match adjacent pipe-run insulation thickness,
    - (c) where multiple insulation layers are used for Type P-11 insulation blanket, only the outer layer may have an integral vapour barrier jacket.
    - (d) secure insulation inserts by overlapping ends under the throat of the fitting and secure with vapour barrier tape,
    - (e) secure unfaced insulation blanket with stainless steel,
    - (f) secure jacketed insulation blanket with vapour barrier tape.
- .5 Where type P-5 or P-7 insulation is used;
  - .1 insulate fittings, flanges, and couplings as described above except use factory made rigid insulation fittings or fabricate mitered fittings, of the same material as the pipe-run insulation.
- .6 Where type P-6 insulation is used;
  - .1 insulate fittings, flanges, and couplings as described above except using type P-6 insulation and adhere insulation to fitting, flange, or coupling with 100% coverage of adhesive,
  - .2 do not adhere insulation across bolted connections - insulate on each side of connection and add additional insulation layer across connection and fix in place with bands and seal joints.

### **3.7 Insulation of Pipeline Accessories – Hot, Cold and Dual Temperature Piping**

- .1 Insulate pipeline accessories depending on service temperature:
  - .1 valves,
  - .2 strainers,
  - .3 pressure reducing valves,
  - .4 control valves,
  - .5 meters,
  - .6 steam separators.
- .2 Insulate pipeline accessories for Hot piping systems with service temperatures greater than 93°C (200°F) as follows:

- .1 insulated with type P-8 removable/reusable fitted insulation covers, designed to allow free movement of valve actuator,
- .2 insulation is not required at this service temperature range for drain valves, blowoff/blowdown valves, and drip caps or plugs.
- .3 Insulate pipeline accessories for Hot piping systems with service temperature greater than 60°C (140°F) and up to 93°C (200°F) or less, as follows:
  - .1 insulated with:
    - (a) type P-8 removable/reusable fitted insulation covers designed to allow free movement of valve actuator, or
    - (b) insulated with fitted pipe insulation segments, or oversized sections of insulation arranged to permit its removal and reinstallation, or
    - (c) tightly placed flexible insulation and covered with PVC fitting covers.]
  - .2 insulation is not required at this service temperature range for drain valves, drain caps/plugs, and for pipeline accessories NPS 1 and smaller.
- .4 Insulation of pipeline accessories is not required for Hot piping with service temperatures less than 60°C (104°F).
- .5 Insulate pipeline accessories for chilled water, liquid refrigerant, and Dual Temperature heating/cooling systems as follows:
  - .1 METHOD 1 - Detachable insulated box type:**
    - (a) fabricate detachable insulated box to encapsulate the pipeline accessory,
    - (b) materials: embossed aluminum or stainless steel enclosure, with minimum 25 mm (1 in.) thick internal insulation of board version of type P-6 insulation,
  - .2 METHOD 2 – Type P-6 insulation:**
    - (a) for accessories NPS 8 and larger,
    - (b) install one layer of 25 mm (1 in) blanket version of type P-6 insulation adhered to pipeline accessories with 100% adhesive coverage,
    - (c) seal all joints with manufacturers sealant, including the joint between P-6 insulation and adjacent piping insulation,
    - (d) at locations requiring access, extend insulation to create a collar around bolted connection, and install a compression fit piece of insulation to cover equipment.
  - .3 METHOD 3 – Fitted insulation:**
    - (a) for accessories NPS 4 and smaller,
    - (b) insulate with fitted pipe insulation or mitered blocks with all joints sealed with two coats of vapour barrier coating complete with reinforcing membrane.
- .6 Insulate accessories for all other Cold piping systems as follows:
  - .1 insulate with flexible blanket insulation, fitted pipe insulation inserts or mitered block of same material and thickness of adjacent piping and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane or vapour barrier tape.
- .7 At locations requiring access including valve handles, valve actuators, drain valves, etc. cut-back insulation and seal exposed edges.

### **3.8 Additional Requirements for Insulation of Drainage Systems**

- .1 In addition to the general requirements for Cold and Dual Temperature piping insulation specified herein, insulate the underside of roof drain hoppers with Type P-11 insulation except with FSK or PSK

jacket and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane, or, seal with vapour barrier tape.

### 3.9 Insulation Protection at Pipe Supports

- .1 Installation of pipe insulation saddle protection for Hot piping:
  - .1 pipe saddles provided under Specification section 20 05 29,
  - .2 insulate the interior void spaces of pipe saddles, using the same material as adjacent pipe insulation,
  - .3 butt insulation up to sides and end of pipe saddle and leave bottom surface of saddle exposed for direct contact with pipe support.
- .2 Installation of pipe insulation shield protection for hot and cold piping:
  - .1 pipe insulation shields are provided under Specification section 20 05 29 except where specified herein as a factory assembled insulation insert and shield.
  - .2 provide high-density insulation inserts at pipe hanger locations as specified herein and in accordance with Specification 20 05 29 subject to fluid service temperature and pipe size,
    - (a) insert length: at least 50 mm (2 in) longer than the shield length to allow application of vapour barrier sealant or tape, but not less than the following:

Pipe Size NPS	Insulation Insert Length mm (in)
1 ½ to 4	400 (16)
6	550 (22)
8 - 24	700 (28)

- (b) arc width: one-half of the pipe diameter for type P-22 and P-23 inserts,
- .3 fabricate the high-density inserts so their thickness is the same as the adjacent installed pipe-run insulation, with finished surface thickness within +3 mm/-0 mm (+1/8 in / -0 in) of adjacent pipe insulation thickness,
- .4 for cold water piping, apply insulation cover and vapour barrier sealant to fully cover and seal the high-density insert, and to overlap the adjacent pipe-run insulation by at least 50 mm (2 in) on all edges,
- .5 install the insulation shield between the finished insulation and the support pipe; the pipe support is sized for the outside dimension of pipe and insulation.

### 3.10 Insulation at Floor and Wall Openings

- .1 Extend pipe insulation at full required thickness through floor and wall openings for Hot, Cold and Dual Temperature piping. Vapour barrier jackets for Cold and Dual Temperature piping are to extend unbroken through the wall or floor penetration. Finish coverings for Hot piping with service temperatures not exceeding 93°C (200°F) may terminate on each side of the opening.
- .2 Reduction in insulation thickness through floor or wall openings is not permitted except by prior approval of Consultant on specific exceptional case basis;
  - .1 exception: Hot piping with service temperature not exceeding 93°C (200°F) may be reduced by one-half the required thickness stated in Schedule A1 through wall and floor penetrations, but such thickness reduction shall not extend more than 25 mm (1 in.) on each side of the opening.

- .3 For penetrations through fire rated separations, provide finishes in accordance with fire stopping manufacturer's listing requirements.
- .4 For outdoor piping passing through exterior walls or roof, terminate mastic lagging at outside face of sleeve and provide storm flashing to protect insulation, caulked to jacket and to building structure.

### **3.11 Sealing of Insulation – Hot Piping**

- .1 Seal hot piping insulation in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet areas):
  - .1 except where separate protective finishing jacket is used, apply vapour barrier tape to butt joints, overlapping by at least 25 mm (1 in) each side,
  - .2 where a separate protective finishing jacket is provided, no additional sealing of the insulation is required.
- .3 Indoor installations – Wet Areas:
  - .1 In Wet Areas, seal Hot piping in accordance with the requirements of chilled water piping and Dual Temperature piping in Wet Areas.
- .4 Outdoor installation:
  - .1 for outdoor piping, apply two coats of breather mastic complete with reinforcing membrane to all lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket.

### **3.12 Sealing of Insulation – Cold and Dual Temperature Piping Without All Service Jacket**

- .1 Provide vapour barrier jackets for Cold and Dual Temperature piping insulation which does not have an all service jacket (unfaced) in accordance with Specification section 20 07 11 and/except as specified herein, where piping is installed indoors in non-Wet Areas.
- .2 For exposed or concealed Cold Piping and Dual Temperature piping insulation without an integral all service jacket (unfaced), tightly seal pipe-run insulation longitudinal seams and butt joints using of the following methods:
  - .1 apply two coats of vapour barrier coating with reinforcing membrane over all insulation and pipe fittings, or
  - .2 cover insulation and pipe fittings, flanges and couplings with sealed PVC jackets as specified herein.

### **3.13 Sealing of Insulation – Cold and Dual Temperature Piping Without All Service Jacket**

- .1 Provide vapour barrier seals of Cold and Dual Temperature piping insulation in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 For chilled water and Dual Temperature pipe-run insulation with integral all service jackets (ASJ), tightly seal pipe-run insulation longitudinal seams and butt joints in accordance with the following method types and applicable locations in Table 1 which identifies where each method is permitted or required to be used:
  - .1 METHOD 1 – Vapour Barrier Tape:**
    - (a) with complete coverage of insulation seam and joint with colour-matched 75 mm (3 in.) wide vapour barrier tape,
  - .2 METHOD 2 – Vapour Barrier Coating:**
    - (a) with two coats of vapor barrier coating complete with reinforcing membrane,

(b) coating to overlap seam or joint by at least 50 mm (2 in.) on each side.

**.3 METHOD 3 – Sealed PVC Jacket:**

(a) with sealed PVC pipe-run insulation finish cover.

.4 In the following table 1, “Critical Environment” rooms are defined as:

- (a) Data and telecommunication rooms,
- (b) Medical diagnostic imaging equipment rooms and technical support spaces,
- (c) Food production and handling spaces,
- (d) Pharmacy dispensing and compounding rooms,
- (e) Wet chemistry laboratories,
- (f) Animal holding and laboratories,

<b>Table 1</b> <b>Pipe-Run Insulation Joint Sealing Method</b> <b>Chilled Water and Dual Temperature Piping</b> <b>With All Service Jacket</b>				
Piping Location	Insulation Location	Method 1 Vapour Barrier Tape	Method 2 Vapour Barrier Coating	Method 3 Sealed PVC Jacket [Note 1]
Mechanical Service Rooms	Exposed or Concealed	No	Permitted	Permitted
Tunnels	Exposed	No	Permitted	Permitted
Vertical Service Spaces (shafts)	Concealed	Permitted	Permitted	Permitted
Trenches	Exposed	No	Permitted	Permitted
	Concealed	No	Permitted	Permitted
Critical Environment rooms	Exposed or Concealed	No	Permitted	Permitted
Below raised floors	Exposed	No	Permitted	Permitted
Wet Area	Concealed	No	No	Required
	Exposed	No	No	Required
All other indoor spaces	Concealed	Permitted	Permitted	Permitted
	Exposed	No	Permitted	Permitted
Outdoors	---	No	Required [Note 2]	Permitted

**Notes:**

[1] Where PVC finish jacket is also specified.

[2] Required where metal finish jacket is specified.

- .5 apply seal to overlap insulation edges and butt joint by minimum 40 mm (1.5 in) each side,
- .6 seal the butt end of the insulation with vapour barrier coating, overlapping onto the piping, at every fourth length of piping, but not to exceed 4 m (13 ft) in pipe run length,
- .7 seal exposed ends of insulation shoulders at pipe flanges and couplings with vapour barrier coating.

- .3 Seal insulation on pipe fittings, flanges and gaskets using Method 1, 2 or 3 in article on sealing of such pipe materials.

### 3.14 Sealing of Insulation on Pipe Fittings, Flanges and Couplings - Cold and Dual Temperature Piping

- .1 Seal insulation on Cold and Dual Temperature pipe fittings, flanges, and couplings by one of the following methods and selected in accordance with Table 2.
- .2 METHOD 1 – Vapour Barrier Tape:**
- .1 with complete coverage of insulation with colour-matched 75 mm (3 in.) wide vapour barrier tape with minimum 40 mm (1-1/2 in.) wide overlaps of each pass and onto adjacent piping,
- .3 METHOD 2 – Vapour Barrier Coating:**
- .1 with two coats of vapor barrier coating complete with reinforcing membrane,
- .2 coating to overlap adjacent pipe-run insulation by at least 50 mm (2 in.).
- .4 METHOD 3 – Sealed PVC Jacket:**
- .1 with sealed PVC fitting cover,
- .2 for clarity, use of PVC jacket would apply for both concealed and exposed piping, whether or not the pipe-run insulation has a PVC jacket.
- .5 Where a conflict occurs between what is permitted in this Table 2 and those of Table 1, the requirements of Table 1 takes precedence.

<b>Table 2</b> <b>Sealing of Fittings, Flanges and Couplings (F/F/G)</b> <b>Chilled Water and Dual Temperature Piping</b>					
Pipe Size NPS	Pipe Location	F/F/G Insulation Type	Method 1 Vapour Barrier Tape [Note 1]	Method 2 Vapour Barrier Coating	Method 3 Sealed PVC Jacket
≤ 2-1/2	Concealed	Rigid	Permitted	Permitted	Permitted
≥ 3	Concealed	Rigid, Mitered-sections	Permitted	Permitted	Permitted
≥ 3	Concealed	Flexible Blanket or Inserts	No	Permitted	Permitted
All	Exposed	Rigid, Mitered-sections	Permitted [Note 2]	Permitted [Note 3]	Permitted
All	Exposed	Flexible Blanket or Inserts	No	Permitted	Permitted
All	Wet Area, Concealed	All	No	No	Permitted
All	Wet Area, Exposed	All	No	No	Permitted
All	Outdoors	All	No	Required [Note 4]	Permitted

**Notes:**



- [1] Only where vapour barrier tape is permitted to seal pipe-run insulation in accordance with Table 1.
- [2] Provide separate finish jacket as specified.
- [3] May be final finish as well unless otherwise specified.
- [4] Required where metal finish jacket is specified.

[4] For exposed and concealed areas.

### **3.15 Sealing of Cold and Dual Temperature Piping – Miscellaneous Requirements**

- .1 Cover mechanical fastener penetrations including staples with colour matched vapour barrier tape, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.
- .2 Where factory lap seams are damaged, apply colour matched vapor barrier tape along the damaged edges.

### **3.16 Sealing of Insulation Using PVC Jackets (“Sealed PVC Jackets”)**

- .1 Applies where other requirements in this specification section requires sealed PVC jacket to provide a vapour barrier seal.
- .2 Seal overlap with PVC manufacturers adhesive sealant by applying a continuous bead of sealant between the PVC jacket layers and between the PVC jacket and adjacent pipe-run insulation or PBC jackets. Roll overlaps to provide tight contact to the adhesive sealant.
- .3 In locations other than Critical Environment rooms, Wet Areas, and Outdoors, PVC jackets may be sealed on the overlaps and onto adjacent pipe-run insulation or PVC jackets with 75 mm (3 in.) wide colour-matched vapour barrier tape.

### **3.17 Insulation Finish Covering**

- .1 Provide insulation finish coverings selected in accordance with Schedule C at the end of this Specification section and installed in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 PVC jackets:
  - .1 for Hot piping, secure PVC jackets on piping and fittings in accordance manufacturer recommendations,
  - .2 for Cold and Dual Temperature piping, seal PVC jackets on piping and fittings with either vapour barrier coating/adhesive or by use of colour-matched vapour barrier tape as specified above.
- .3 Where concealed Cold and Dual Temperature piping use PVC fitting covers to provide a vapour barrier seal at fittings, flanges and couplings, the use of PVC jackets at these locations does not require application of PVC jackets on piping runs unless otherwise required in Schedule C.

### **3.18 Mechanical Damage Protection - Indoors**

- .1 Protect exposed pipe insulation extending up through a floor sleeve at the floor line with 1.2 mm (18 ga) stainless steel jacket approximately 200 mm (8 in) high, secured with rivets and mechanically fastened to the floor with countersunk stainless steel screws.
  - .1 Exception: where piping is protected by a housekeeping curb or pad of at least 100 mm (4 in.) high and which extends at least 150 mm (6 in.) in front of the insulated pipe.
- .2 Where waterproof floor sleeves are required, the floor sleeve may be combined with this requirement.
- .3 For clarity, where piping systems use finish covering in accordance with Schedule C of this Specification section, this mechanical damage protection cover is in addition to the specified pipe finish cover.

**3.19 Painted Piping**

- .1 Not applicable.

**3.20 Standard Details**

- .1 Refer to Specification section 20 05 29 for illustration of coordination of insulation with pipe supports, unless otherwise shown on drawings.

**3.21 Schedules**

- .1 The following appended schedules form part of this Specification section.
  - .1 Schedule A1 Hot piping Systems, Insulation Type and Thickness  
(excluding engine combustion gas exhaust piping)
  - .2 Schedule B Cold and Dual Temperature Piping Systems, Insulation Type and Thickness
  - .3 Schedule C Piping Insulation Protective Finishes.

**Schedule A1**  
**Hot Piping Insulation Type and Thickness**  
**(excluding engine combustion gas exhaust piping)**

System	Fluid Nominal Temp. °C (F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Steam and Condensate > 860 kPa (125 psi)	177 to 315°C (351 to 600°F)	P-3	115 (4.5) [Note 3]	125 (5) [Note 3]	125 (5)	125 (5)	125 (5)
		P-4	---	---	---	---	125 (5) [Note 1, 2]
		P-7	200 (8) [Note 3]	200 (8) [Note 3]	200 (8)	175 (7)	175 (7)
Steam and Condensate > 100 kPa (15 psi) and ≤ 860 kPa (125 psi)  Boiler Feed Water	122 to 176 (251 to 350)	P-1 P-3	80 (3) [Note 3]	100 (4) [Note 3]	115 (4.5)	115 (4.5)	115 (4.5)
		P-2 P-4	---	---	---	---	150 (6) [Note 1, 2]
		P-7	125 (5) [Note 3]	175 (7) [Note 3]	175 (7)	175 (7)	150 (6)
Safety Relief Piping	122 to 176 (251 to 350)	P-1 P-3	40 (1½)	40 (1½)	40 (1½)	40 (1½)	40 (1½)
Steam and Condensate ≤ 100 kPa (15 psi)  High temperature hot water heating	94 to 121 (201 to 250)	P-1 P-3	65 (2.5) [Note 3]	65 (2.5) [Note 3]	80 (3)	80 (3)	90 (3½)
		P-2 P-4	---	---	---	---	100 (4) [Note 1, 2]
		P-7	125 (5) [Note 3]	100 (4) [Note 3]	125 (5)	125 (5)	125 (5)
Hot Water Heating  Glycol Heating  Pumped Condensate	61 to 93 (141 to 200)	P-1 P-3	40 (1½) [Note 3]	40 (1½) [Note 3]	50 (2)	50 (2)	50 (2)
		P-2 P-4	---	---	---	---	65 (2½) [Note 1, 2]
		P-7	65 (2½) [Note 3]	65 (2½) [Note 3]	65 (2½)	65 (2½)	65 (2½)
Hot Water Heating (Buried)	61 to 93 (141 to 200)	P-5	50 (2) [Note 3]	50 (2) [Note 3]	65 (2.5)	65 (2.5)	65 (2.5)

...continued on next page

**Schedule A1 (Continued)**  
**Hot Piping Insulation Type and Thickness**  
**(excluding engine combustion gas exhaust piping)**

System	Fluid Service Temperature °C (°F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Pure Water (with heat sanitization)	25 to 93 (77 to 200)	P-1 P-3	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)
Low Temperature Hot Water Heating  Low Temperature Glycol Heating	41 to 60 (105 to 140)	P-1 P-3	25 (1)	25 (1)	40 (1½)	40 (1½)	40 (1½)
Domestic Hot Water  Domestic Hot Water Recirculation  Not-Potable Hot Water  Non-Portable Hot Water Recirculation	41 to 60 (105 to 140)	P-1 P-3	25 (1)	25 (1)	40 (1 ½)	40 (1 ½)	40 (1 ½)
Condenser Water (outdoors)	16.5 to 40 (61 to 104)	P-3 P-4 P-5	40 (1½)	40 (1½)	40 (1½)	40 (1½)	40 (1½)
Fire protection Sprinkler piping and valves,  Fire protection Standpipe piping and valves  [Note 4]	4 to 40 (50 to 104)	P-1 P-3	25 (1)	25 (1)	40 (1 ½)	40 (1 ½)	40 (1 ½)

**Notes:**

[1] For NPS 14 and larger.

[2] Install in two layers of insulation to make up total thickness.

[3] For piping NPS 1-1/4 and smaller located in partitions within conditioned spaces, insulation thickness may be reduced by up to 25 mm, but final thickness shall not be less than 25 mm.

[4] For heat-traced fire protection piping only, including drum drip assemblies on dry systems.

**Schedule B**  
**Cold and Dual Temperature Piping Insulation Type and Thickness**

System	Fluid Service Temperature °C (°F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Dual Temperature Heating/Cooling	4 to 93 (39 to 200)	P-1 P-3	40 (1½)	40 (1½)	50 (2)	50 (2)	50 (2)
		P-2	---	---	---	---	65 (2½) [Note 1, 2]
Domestic Cold Water Non-potable Water	4 to 16 (39 to 61)	P-1 P-3	25 (1)	25 (1)	40 (1½)	40 (1½)	40 (1½)
Storm and Sanitary Drainage	4 to 16 (39 to 61)	P-1	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)
		P-6	15 (1/2)	20 (3/4)	25 (1) [Note 3]	---	---
Equipment Drains	4 to 16 (39 to 61)	P-6	15 (1/2)	20 (3/4)	25 (1) [Note 3]	---	---
Chilled Water, Glycol Heat Recovery	4 to 16 (39 to 61)	P-1 P-3 P-5	25 (1)	25 (1)	40 (1½)	40 (1½)	50 (2)
Chilled Water (Outdoors)	4 to 16 (39 to 61)	P-3	50 (2)	50 (2)	50 (2)	75 (3)	75 (3)
Chilled Water (Buried)	4 to 16 (39 to 61)	P-5	25 (1)	25 (1)	40 (1½)	40 (1½)	40 (1½)
Refrigerant Suction	< 4 (< 39)	P-6	25 (1)	25 (1)	25 (1) [Note 3]	---	---
MRI Quench Vent	-268 (-450)	P-3 (inner layer)	---	---	---	25 (1)	25 (1)
		P-6 (outer layer)	---	---	---	25 (1)	25 (1)

**Notes:**

[1] For NPS 14 and larger.

[2] Install in two layers of insulation to make up total thickness.

[3] Do not use on pipe size NPS 2-1/2 to 3.

**Schedule C**  
**Piping Insulation Finish Coverings**

Location	Exposed/ Concealed	Piping System	Finish Covering
Indoors	Concealed	MRI quench vent piping	SAWB
		Engine combustion gas exhaust piping	Metal
		Piping with insulation types P-4, P-5, P-7, P-10	PVC
		All other piping	None (factory jacket only)
	Exposed	Steam 345 kPa (50 psig) and over	[Fabric] [Metal]
		Wet Areas	PVC
		Piping (insulation) which will be painted	Fabric
		Fire Protection Piping	PVC (red in colour)
		Engine combustion gas exhaust piping	Refer to Schedule A2
		All other piping	[PVC] [Fabric] [Metal]
Outdoors	Any	Engine combustion gas exhaust piping	Stainless Steel
		MRI quench vent piping	Stainless Steel
		All other piping	Stainless Steel

**END OF SECTION**

## **TESTING OF INTEGRATED MECHANICAL FIRE PROTECTION AND LIFE SAFETY SYSTEMS**

**20 08 11**

### **1 GENERAL**

#### **1.1 Scope**

- .1 Provide testing of integrated fire protection and life safety systems and related equipment provided under Division 20 to 25 with those provided under other Divisions of the Work, in accordance with Division 01.
- .2 This specification is limited to testing of the interconnections between fire protection and/or life safety systems. Refer to separate technical specification sections for the individual testing and commissioning requirements for those systems.

#### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 Division 01

#### **1.3 Definitions and Abbreviations**

- .1 Refer to Division 01.

#### **1.4 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 CAN/ULC-S1001 Integrated Systems Testing of Fire Protection and Life Safety Systems

#### **1.5 Qualified Tradesperson**

- .1 Refer to section Division 01.

### **2 PRODUCTS**

- .1 Not used.

### **3 EXECUTION**

#### **3.1 General Requirements**

- .1 Conduct complete and thorough testing and documentation of the systems interface and integration between various FPLS systems provided under Divisions 20 to 25 and those provided under other Divisions of the Work.
- .2 Include all labor and material as required to participate in and implement the integrated FPLS testing process for equipment and systems provided under Division 20 to 25.

#### **3.2 Integrated Test Plan and Procedures - Development**

- .1 Participate in the development of the integrated FPLS test plan and procedures in accordance with the requirements of specification section Division 01.
- .2 Supply manufacturer's operating and testing instructions to the ITC prior to the development of the integration FPLS test plan.

### **3.3 Integration Test Plan – Implementation**

- .1 Complete related FPLS system testing in accordance with the applicable technical specification sections of Divisions 20 to 25, prior to implementation of integrated FPLS testing. Where testing of such systems inherently test the FPLS system interconnection(s), such testing is not required to be duplicated for the integrated FPLS testing provided the results of the integration test are recorded in accordance with the requirements of the integrated FPLS test plan.
- .2 Prior to implementing any integrated FPLS test,
  - .1 provide written confirmation from each trade contractor under Divisions 20 to 25 of the Work, that their respective FPLS related equipment or systems, or parts thereof, have been installed in accordance with the design and are ready for integrated FPLS testing,
  - .2 provide test verification reports from the organization that verified the installation of any FPLS system as required by referenced codes or standards, such as NFPA or ULC.
  - .3 provide a copy of inspection reports from an authority having jurisdiction governing a FPLS system.
- .3 Coordinate with the ITC and provide all necessary resources to implement the integrated FPLS test plan.

### **3.4 Final Test Results Report**

- .1 The final test report will be prepared by the ITC.

**END OF SECTION**



## **MECHANICAL COMMISSIONING**

### **20 08 15**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide commissioning of mechanical systems provided under Division 20.
- .2 Mechanical system installation, start-up, testing, balancing, preparation of Operating and Maintenance manuals and operator training are the responsibility of the Division 20 Contractors, with the coordination of the commissioning process the responsibility of the Contractor.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 08 01 Start-up and Performance Testing
  - .2 20 08 05 Testing, Adjusting and Balancing
  - .3 20 08 11 Testing of Integrated Mechanical Fire Protection and Life Safety Systems

##### **1.3 Definitions**

- .1 The following definitions apply to this section.
  - .1 **Contractor** – means the general contractor or construction manager who is responsible for the management and overall execution of the Work as applicable to the type of project delivery method used.
  - .2 **Major deficiency** – an item which if not corrected renders the equipment or system unsuitable or un-safe for use by the Owner. Major deficiencies must be corrected as a condition for achieving Substantial Performance.
  - .3 **Minor deficiency** – an item which does not impact on the operation of the equipment or system and will allow the Owner to use the system safely. Minor deficiencies may be corrected before or after Substantial Performance, but will not prevent certification of Substantial Performance of the Work.

##### **1.4 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 ASHRAE Guide 0 The Commissioning Process
  - .2 ASHRAE Guide 1.2 Technical Requirements for the Commissioning Process for Existing HVAC&R Systems and Assemblies
  - .3 ASHRAE Guide 1.3 Building Operations and Maintenance Training for the HVAC&R Commissioning Process

##### **1.5 Commissioning Process**

- .1 The Commissioning process develops, coordinates, and documents the following:
  - .1 equipment start-up,
  - .2 control system calibration,
  - .3 testing and balancing,
  - .4 verification and Performance Testing,

- .5 operation documentation,
- .6 operator training.
- .2 The Commissioning Program is divided into the following parts:
  - .1 Part 1: Pre-Start and Start-Up testing
  - .2 Part 2: Installation Verification testing
  - .3 Part 3: Performance Validation testing
  - .4 Part 4: Systems Operating Manuals
  - .5 Part 5: Operator Training

## **1.6 Work Included**

- .1 Commissioning work of Division 20 includes, but is not limited to:
  - .1 testing and start-up of equipment,
  - .2 testing, adjusting and balancing of hydronic and air systems,
  - .3 cooperation with the Commissioning Authority in developing and implementation of the commissioning plan,
  - .4 providing qualified personnel for participation in implementing commissioning test procedures, including seasonal testing required after the initial testing,
  - .5 providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process,
  - .6 providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification,
  - .7 providing training and demonstrations for the systems specified in this Division.
- .2 Conduct complete and thorough evaluation and documentation of the operation and performance of all components, systems, and sub-systems, including the following equipment and systems:
  - .1 air handling systems,
  - .2 cooling generation systems,
  - .3 heating generation systems,
  - .4 hydronic distribution systems,
  - .5 electric heating systems,
  - .6 air distribution and exhaust systems,
  - .7 domestic hot water systems,
  - .8 domestic cold water systems,
  - .9 fire protection systems / suppression systems,
  - .10 constant speed motor controllers and variable frequency drives,
  - .11 building automation systems,
  - .12 kitchen HVAC systems,
  - .13 medical gas systems.

- .3 Commission equipment which has been pre-tendered, pre-purchased, or pre-ordered by the Owner or their Agent, and the value of which has been assigned to the Mechanical Contractor or their sub-trades and is included in the value of the Work.
- .4 Commission services to equipment, but not the equipment itself, where the supply of the equipment does not form part of the mechanical Work.
- .5 Provide the following commissioning documentation:
  - .1 recording completed Pre-start and Start-up procedures test results,
  - .2 recording completed Installation Verification and Performance Validation test results,
  - .3 as-built records.
  - .4 operation and maintenance manuals
- .6 The final commissioning report will be prepared by the Commissioning Authority.

#### **1.7 Excluded Work**

- .1 Unless otherwise specified, equipment which is not supplied by the mechanical contractor or their sub-trades, where the value for the supply of equipment is not included as part of the Work, such as:
  - .1 Supplied by Owner (SBO) equipment,
  - .2 Equipment marked Not in Contract (NIC) or Not in Mechanical Contract (NIMC).

#### **1.8 Submittals - Commissioning Schedule**

- .1 Provide a detailed commissioning schedule for consolidation into the main construction schedule.
- .2 Include:
  - .1 equipment and systems start-up predecessors
  - .2 time periods for pre-start and start up testing, verification and validation testing for each equipment and system.

#### **1.9 Submittals - Documentation**

- .1 Identify documents including test documents, binder covers, etc. using equipment ID numbers provided on equipment schedules.
- .2 Scan original signed test reports, including verification and performance test reports, manufacturers service reports, etc. in Adobe Acrobat \*.pdf version 8 format. For original document chapters, provide Adobe chapter referencing.
- .3 Submit three (3) copies of each completed and accepted Verification and Functional Performance Test reports, both preliminary and final issues.
- .4 Collate final, accepted and signed test results in separate binders as follows:
  - .1 Fire Protection
  - .2 Plumbing and Drainage
  - .3 HVAC Systems
  - .4 Building Management Systems
- .5 Provide three (3) CD-R or DVD-R copies of commissioning documentation.

#### **1.10 Substantial Performance**

- .1 Application for Substantial Performance of the Work is precedent on the Work being ready for Owner's use which includes completion of the following commissioning elements:

- .1 start-up and testing, including TAB reports,
- .2 commissioning Verification testing including submission of completed records,
- .3 commissioning Performance Validation testing including submission of completed records, except for alternate season tests,
- .4 commissioning Controls Validation testing,
- .5 training of Owner's operations personnel,
- .6 as-built documentation issued for Consultant's review,
- .7 Operations and Maintenance manuals which have been reviewed by the Consultant and accepted by the Owner.

## **2 PRODUCTS**

### **2.1 Test Equipment**

- .1 Furnish tools and equipment required during the commissioning process.
- .2 Utilities (water, gas, fuel oil, electrical power) are provided by the Owner
- .3 Provide any proprietary test equipment and software required by equipment manufacturer for programming and / or start-up, whether specified or not.
- .4 Manufacturer provides test equipment, demonstrate its use, and assists in the commissioning process as needed.
- .5 Turn-over proprietary test equipment to the Owner upon completion of the commissioning process, where such requirement is specified in the relevant equipment specification sections.

## **3 EXECUTION**

### **3.1 General**

- .1 Perform commissioning in accordance with ASHRAE Guide 0, Guide [1.1][1.2] except/and as specified herein.
- .2 Complete all phases of work so that the systems can be started, tested, balanced, and owner's acceptance procedures be undertaken in a timely manner such that only one acceptance test is conducted at any one time.
- .3 Participate and assist in the development of the Commissioning Plan and schedule by the Contractor, by providing necessary information pertaining to the equipment and installation. Provide commissioning schedule information to be incorporated into the overall Construction Plan schedule.
- .4 Acceptance procedures may begin prior to completion of a system and/or sub-system. Start of acceptance procedures before system completion does not relieve the Contractor from completing those systems in accordance with the commissioning and construction schedule.

### **3.2 Participants**

- .1 Commissioning Team consists of multiple parties with separate responsibilities.
- .2 Owner:
  - .1 establishes acceptance criteria,
  - .2 provides operations staff to receive training, and to witness any or all tests at their discretion,
  - .3 final acceptance of commissioning results.
- .3 Design Consultant:

- .1 responsible for the construction review activities in accordance with local building code requirements,
- .2 may participate in development and / or review of commissioning procedures,
- .3 reviews commissioning test results,
- .4 Commissioning Authority:
  - .1 develops commissioning plan and procedures,
  - .2 coordinates Owner's commissioning team members who witnesses tests,
  - .3 selectively witnesses commissioning tests on an audit basis to confirm compliance by the Contractor to the Commissioning Plan,
  - .4 reviews commissioning test results and makes recommendations to the Owner for acceptance.
- .5 Contractor:
  - .1 coordinates and manages commissioning activities,
  - .2 develops and integrates commissioning activities into the construction schedule,
  - .3 ensures commissioning procedures are completed and documented, and commissioning records including any required attachments are submitted.
- .6 Mechanical trades subcontractors:
  - .1 Provide the services of qualified technician(s) who are familiar with the construction and operation of the system, to start-up and debug equipment and systems within the Division 20 scope of Work. Include for labour, materials, and subsistence costs for these same technicians to assist the Commissioning Authority in completing the commissioning program.
  - .2 Provide access to the contract plans, shop drawings, and equipment cut sheets of all installed equipment.
  - .3 Ensure the qualified technician(s) are available and present during commissioning testing to complete the tests, make adjustments and to assist in problem resolutions.
  - .4 Should any equipment or system experience performance problems and/or reconstruction or replacement of components is required, include for additional technician time for subsequent retesting of systems until required system performance is achieved.
  - .5 The Commissioning Authority reserves the right to approve proposed technicians with regard to the technical skill level required for each type of equipment and/or system, and a willingness by the individual(s) to work within the Commissioning Group.
- .7 Controls subcontractor, in addition to the requirements described above:
  - .1 Provide test reports using own documentation formats, for wiring tests, loop testing, loop tuning, and sequence functional tests.
  - .2 Provide details of the control system, schematics, and a narrative description of control sequences of operation.
- .8 Electrical subcontractor:
  - .1 provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life-safety systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces and interlocks.
- .9 Equipment suppliers:
  - .1 provide the services of manufacturers' service personnel to provide assistance with pre-start and initial start-up of the equipment, as required.

### **3.3 Commissioning Meetings**

- .1 Participate in periodic commissioning team meetings, and trade commissioning meetings.
- .2 Pre-construction:
  - .1 participate in a pre-construction meeting of commissioning team members, to familiarize parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
- .3 Construction and Post-Construction:
  - .1 participate in commissioning meetings as scheduled by the Contractor.
  - .2 participate in trade commissioning meetings as required, in addition to the regular commissioning team meetings,
  - .3 identify to the commissioning group problems relating to the commissioning schedule, identification of start-up issues, etc., and participate in the resolution of these problems.

### **3.4 Commissioning Procedures**

- .1 The Owner's designated Commissioning Authority provides the commissioning procedures (checklists, etc.) for use by the Contractor and trade subcontractors.
- .2 Each commissioning procedure tests the equipment and systems, and consists of the following elements:
  - .1 Document sign-off
  - .2 Pre-start and Initial test
  - .3 Installation Verification - Equipment
  - .4 Installation Verification - Systems
  - .5 Performance Validation
  - .6 Controls Validation
  - .7 Appendices.
- .3 Document Sign-Off:
  - .1 each completed procedure is signed off by the following parties:
    - (a) Contractor, for testing,
    - (b) Commissioning Consultant, for review and witnessing,
    - (c) Owner, for test acceptance.
- .4 Pre-Start and Initial Test:
  - .1 Checklists included: confirmation of authorities inspections, pre-start safety checks (where applicable), system cleaning and pressure testing, and confirmation of availability of supporting systems.
- .5 Installation Verification - Equipment
  - .1 Checklists to verify the installation of equipment, including: design specification requirements, drawing requirements, manufacturer installation requirements, and other experience-related items.
  - .2 Use of pre-printed manufacturer installation and start-up checklists are permitted and encouraged; however, the commissioning procedure checklists may contain supplemental items.
- .6 Installation Verification - System:

- .1 Checklists to verify the installation of the system associated with the equipment.
- .7 Performance Validation:
  - .1 Specific test procedures and record documentation requirements for performance measurements of the various systems.
- .8 Controls Validation:
  - .1 Step-by-step testing methodologies to prove the functional operation of control systems, for normal and abnormal operating conditions, and alarm conditions.
- .9 Appendices:
  - .1 Collate test reports from authorities having jurisdiction, manufacturer start-up and test reports, balancing reports, etc.

### 3.5 Commissioning Test Methodology

- .1 Step 1: complete the pre-start, start-up and testing, and adjusting and balancing tests. On completion of this phase, complete the related documentation and submit to the Commissioning Authority and Consultant.
- .2 Steps 2 and 3: on completion of Step 1, conduct the Verification and Validation testing of the operating systems. Identify deficiencies and correct. After the deficiencies have been corrected, notify the Commissioning Authority and agree on dates to demonstrate the commissioned systems.
- .3 Step 4: where the Commissioning Authority identifies systems which require witness demonstration, repeat Steps 2 and 3. These demonstrations may be coordinated with training demonstrations of Owner's operations staff.
- .4 On completion of systems which do not require witness demonstration, finalize the report and submit to the Commissioning Authority and the Consultant for review.
- .5 On completion of systems which have been witness demonstrated, the Commissioning Authority is to sign-off the completed document, before they are issued for review.

### 3.6 Commissioning Implementation

- .1 Conduct operating tests and checks to verify that all components, equipment, systems, and interfaces between systems, operate in accordance with contract documents.
- .2 Demonstrate and verify operating modes, interlocks, specified control sequences, specific responses to abnormal or emergency conditions, and verification of the proper response of the Building Automation System.
- .3 Validate the results of the TAB report.
- .4 Roles and Responsibilities:

Organized by:	Contractor
Test sheets provided by:	Commissioning Authority
Testing conducted by:	Div. 20 trade subcontractors
Testing recorded by:	Div. 20 trade subcontractors
Tests witnessed by:	Commissioning Authority (selected tests) Design Consultant (selected tests)

Reports reviewed by:	Contractor Commissioning Authority Design Consultant Owner
Reports Accepted by:	Owner

### 3.7 Operating Checks

- .1 The Commissioning Authority witnesses selected equipment and system tests on an audit basis.
- .2 Set the system equipment into operating mode to be tested including but not limited to:
  - .1 Normal shut-down
  - .2 Normal auto position
  - .3 Normal manual position
  - .4 Unoccupied cycle
  - .5 Emergency power operation, including transition states.
  - .6 Alarm conditions
- .3 Inspect and verify the position of each device and interlock identified on the checklist.
- .4 Repeat the above tests for each operating cycle that applies to the system being tested.
- .5 Check the operating condition of the following elements during all modes of operation of the system:
  - .1 Safety interlocks
  - .2 Alarms
  - .3 Smoke control and smoke venting interlocks
  - .4 Life safety systems
- .6 For failed test items, provide appropriate comments to the checklist data sheet and classify whether it is a "Major" or "Minor" deficiency.
  - .1 The Consultant retains the right to make the final decision regarding classifications of deficiencies.
- .7 Verify the operational control of the systems through the Building Management System as follows:
  - .1 TAB airflow rates and calibrate terminal boxes in all modes of operation
  - .2 Equipment operation in both heating and cooling modes.
  - .3 Minimum outdoor air intake positions, air-side economizer cycles, and multi-set outdoor air damper positions as required for each operating sequence and mode.
  - .4 Building pressurization and other specialty programs
- .8 Verify the proper responses of instrumentation and control devices (actuators) as follows:
  - .1 For each controller or sensor, record the indicated monitoring and control system reading, and the test instrument reading.
  - .2 If the initial test indicates that the test reading is outside of the control range of the installed device, check the calibration of the installed device and adjust as required. Re-test the deficient device and record the results on the checklist data sheets.
- .9 The Commissioning Authority witnesses the field verification of the final TAB report as follows:



- .1 Select, at random, 10% of the report data for verification.
- .2 The TAB contractor will be provided advance notice of the date of retesting, but not the equipment to be tested.
- .3 The TAB contractor uses the same equipment and instruments used for collecting the original data.
- .10 Test failure is defined as:
  - .1 For all readings other than sound, a deviation of more than 10 percent from the TAB report results.
  - .2 For sound pressure readings, a deviation of 2 dB at any bandwidth, not including differences in background noise readings.
  - .3 A failure rate greater than 10% of the selected items (1% of all TAB test results) will result in rejection of the final TAB report.
- .11 Acceptance
  - .1 The final reports will be reviewed by the Commissioning Authority and the Consultant, to determine if verification is complete and the operating systems are functioning in accordance with the contract documents.
  - .2 The Commissioning Authority, in conjunction with the Consultant, reviews and makes final classification of all noted deficiencies. Correct deficiencies classified as "Major" before acceptance of the Verification stage.
  - .3 The Owner will make the final acceptance of test results.

### **3.8 Performance Validation Testing**

- .1 Conduct performance tests and checks to validate that equipment and system components are providing the required heating and cooling performance (capacity), including but not limited to:
  - .1 Capability of the Chilled water system to deliver the required flow rate, and water temperature at design conditions.
  - .2 Capability of the hydronic and domestic water heating systems to deliver the required flow rate, and temperature.
  - .3 Capacity of electric heating systems at design temperatures.
  - .4 Confirm the ability of the HVAC systems to deliver the required cooling/heating services, at the design supply air temperature, required static pressure, and proper outside air ventilation rate.
- .2 Special testing requirements:
  - .1 Test water chillers in accordance with ARI 590 and 591, at design conditions for full load ratings, and IPLV ratings.

### **3.9 Problem Resolution**

- .1 In the event that additional work is required to either correct systems, misapplied equipment, and/or deficient performance under varying load conditions, assist the Owner and Commissioning Authority in developing an acceptable resolution to the problem, including the resources of equipment suppliers.
- .2 The Owner has final approval over any additional work required to achieve the required level of performance.
- .3 Complete corrective work in a timely fashion to permit the completion of the commissioning process.

### **3.10 Acceptance**

- .1 Any identified deficiencies will be reviewed by the Consultant in conjunction with the Contractor to determine if correction of the deficiency is as a result of a defect in the equipment or installation.
- .2 If it is determined the performance deficiency is as a result of a defect in the equipment or its installation, rectify the deficiency and repeat the performance test until the required performance levels are achieved.
- .3 If it is determined the equipment or system has been constructed in accordance with the contract documents, the Owner will decide whether to accept the performance as is, or, direct the installation contractor to make changes to the system as required to obtain performance levels which meet the design intent, and retest the system.

### **3.11 Seasonal Commissioning**

- .1 Commence initial performance validation testing commissioning at the completion of the installation and verification testing phase. Conduct performance testing, which is weather dependent, as applicable to current seasonal conditions. Complete performance testing on non-weather dependent systems in accordance with the agreed commissioning plan schedule.
- .2 For out-of-season system performance testing, conduct initial performance tests to demonstrate off-peak load performance. Schedule peak load performance testing over the succeeding nine (9) months to ensure all equipment is tested at peak load prior to the expiry of the warranty period.
- .3 Test heating equipment/systems during winter design extremes.
- .4 Test cooling systems during summer design extremes with a fully occupied building.
- .5 Alternatively, provide temporary equipment (load banks, etc.) to simulate full load conditions. Submit proposed methodology for review by the Commissioning Authority and Consultant.

### **3.12 Additional Commissioning**

- .1 Additional commissioning activities may be required after completion of system performance testing. Include in the tender cost a reasonable reserve to complete this work, including assistance from manufacturers' service technicians.

### **3.13 Systems Operating Manuals**

- .1 Provide Operating and Maintenance Manuals in accordance with the requirements of section 20 01 01.
- .2 The Systems Operating Manuals (SOM) are in addition to the Operating and Maintenance Manuals (OMM) required under Section 20 01 01.
  - .1 Provided by Commissioning Authority and/or Consultant.

### **3.14 Training**

- .1 Perform training in accordance with ASHRAE Guideline 1.3 except/and as specified herein.
- .2 Equipment Training:
  - .1 Provide equipment training in accordance with Section 20 01 01. The manufacturer's representative training will emphasize operating instructions and preventative maintenance.
  - .2 In addition to the equipment training described above, provide additional training to describe the operational requirements and design intent of each system.
  - .3 Include classroom instruction, delivered by competent instructors. Place emphasis on overall systems diagrams and descriptions, and design criteria and conditions.

- .4 If required, obtain and pay for the services of the Design Consultant to provide the instructor services and to provide lecture material for inclusion in the training manual.
- .5 Training topics to include:
  - (a) Types of installed systems
  - (b) Design intent and design criteria
  - (c) Design constraints
  - (d) Different operating modes – occupied, unoccupied, emergency conditions, etc.
  - (e) Seasonal operating modes
  - (f) IAQ
  - (g) Energy efficiency
  - (h) System operation
  - (i) Automatic controls
  - (j) Service, maintenance, diagnostics and repairs
  - (k) Use of reports and logs
  - (l) Troubleshooting
- .6 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, with the services of the manufacturers' representative as required. Demonstrate the start-up and shut-down of each system.
- .7 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each topic, separated by approximately one week each, to allow for shift coverage.
- .8 Structure each training session based on type of maintenance personnel attending the training session, i.e. Plumbers, fitters, general maintenance, controls technicians, etc. Develop the proposed training plan and obtain approval from the Owner before commencing the training.
- .9 Complete the training as close to Substantial Performance as possible, so that the Owner's operations staff are prepared to operate the system after Substantial Performance is certified.
- .3 Training Manuals
  - .1 Provide training material hand-outs for each session.
  - .2 Collect training material and bind into separate binders.

**END OF SECTION**

## **CLOSEOUT REQUIREMENTS FOR MECHANICAL WORK**

### **20 77 19.20**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide documentation deliverables at completion of the Work for the following milestone events:
  - .1 Occupancy permit (where applicable) (Form OP1M),
  - .2 Substantial Performance of the Work (Form SP1M),
  - .3 Ready for take-over by Owner (Form RFT1M),
  - .4 Total Performance of the Work (Form TP1M).

##### **1.2 Definitions**

- .1 The following definitions apply to this section.
  - .1 **Occupancy permit** – means either: (i) a permit issued by a regulatory authority to allow the Owner to occupy the building subject to the building permit, or (ii) a building permit close-out procedure where documentation must be submitted to the building authority for that purpose.

##### **1.3 General**

- .1 The prerequisites and submittal of supporting documentation for the aforementioned milestone events may be combined as a single submission at one point in time for the following combination of events:
  - .1 Occupancy Permit, and Substantial Performance.
- .2 Where a prerequisite is listed in more than one milestone event, it shall be included in the earliest-occurring milestone event unless expressly specified otherwise.

##### **1.4 Occupancy Permit**

- .1 Submit the reviewed final record of the Testing of Integrated Life Safety and Fire Protection Commissioning report two weeks prior to application for occupancy permit, where such a report is required.
- .2 Complete the Occupancy Permit Checklist and submit with required documentation to support the Owner's application for occupancy.

##### **1.5 Substantial Performance**

- .1 Complete the Substantial Performance Checklist and submit with required documentation when applying for Substantial Performance of the Work.
- .2 Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.
- .3 Within five working days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

##### **1.6 Ready-for-Takeover by Owner**

- .1 The basic prerequisites to attaining Ready-for-Takeover of the Work are described in the General Conditions and Supplementary General Conditions of the Contract.
- .2 Complete the Ready-for-Takeover Checklist and submit with required documentation when applying for Ready-For Takeover of the Work.

**1.7 Total Performance**

- .1 Complete the Total Performance Checklist and submit with required documentation when applying for Total Performance of the Work.

Form OP1M: OCCUPANCY PERMIT CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

*The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.*

- ☐ Building department inspection reports.
- ☐ AHJ pressure piping inspection reports (if applicable).
- ☐ AHJ fuel system inspection reports (if applicable).
- ☐ AHJ electrical systems inspection reports.
- ☐ Sprinkler installation certification report to NFPA 13.
- ☐ Standpipe installation certification report to NFPA 14.
- ☐ Fire pump installation and test certificate to NFPA 20.
- ☐ Integrated Fire Protection and Life Safety test report to ULC-S1001.
- ☐ Medical gas inspection report and certificate.
- ☐ Air and Water Balancing reports (Interim) for ventilation and heating.

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

Form SP1M: SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

*The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.*

- ☐ Occupancy permit has been issued by the AHJ (where applicable).
- ☐ Systems have been started-up, tested, and demonstrated to Owner or Consultant.
- ☐ First submission TAB reports have been submitted to Consultant.
- ☐ Acoustic survey report submitted to Consultant (if specified).
- ☐ Vibration survey report submitted to Consultant (if specified).
- ☐ Controls / BMS operation report submitted to Consultant (if specified).
- ☐ Equipment, pipeline, and valve identification completed
- ☐ Spare parts and replacement parts turned over to Owner, transmittal attached.

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

Form RFT1M: READY-FOR-TAKEOVER APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

*The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.*

- ☐ Substantial Performance has been certified or verified.
- ☐ Occupancy permit has been issued by the AHJ (where applicable).
- ☐ Final cleaning and waste removal completed.
- ☐ Delivery to Owner of Operating and Maintenance documents for systems being taken-over by Owner.
- ☐ Submit copies of up-to-date as-built drawings.
- ☐ Final start-up, testing and balancing reports completed and submitted to Owner, including any items requiring corrections identified by Consultant.
- ☐ The portions of the building being turned over to the Owner can be secured by Owner.
- ☐ Demonstration and training are completed, or Contractor and Owner has agreed to a schedule to provide such training to be completed within one month after the date of Ready-for-Takeover.
- ☐ All commissioning activities except for those activities that are identified or otherwise agreed by the Owner to be deferred commission activities which may be completed after Ready-for-Takeover of the Work.
- ☐ Integrated systems testing of fire protection and life safety systems.
- ☐ All warranties have been submitted to the Owner.
- ☐ A comprehensive list of items to be completed or corrected is provided to Owner and Consultant and included in the application for Ready-for-Takeover, and includes a schedule of when such work will be completed.

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	



Form TP1M: TOTAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

*The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.*

- ☐ All final Operating and Maintenance documents have been delivered to Owner.
- ☐ All final up-to-date as-built drawings have been delivered to Owner.
- ☐ Any follow-up testing and balancing reports, including alternate season testing reports, have been submitted to Owner.
- ☐ All demonstration and training are completed.
- ☐ All commissioning activities are completed, including deferred alternate season commissioning activities.
- ☐ All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- ☐ All inspections and tests required to be performed by Contractor or manufacturer's prior to expiry of the warranty period have been completed, and documentation for those inspections and tests are included in this application.

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

**End of Section**

## **COMMON WORK RESULTS FOR FIRE SUPPRESSION**

### **21 05 01**

#### **1.1 GENERAL**

#### **1.2 Scope**

- .1 Fire suppression work includes;
  - .1 Fire Extinguishers,
  - .2 Wet Pipe Sprinkler System.
- .2 Piping materials specified herein are limited to design pressures not exceeding 2000 kPa (300 psi).

#### **1.3 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 24 Welding and Brazing
  - .2 20 05 29 Common Hanger and Support Requirements for Piping

#### **1.4 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 Fire suppression work to conform to standards of the National Fire Prevention Association (NFPA) and relevant sections of the provincial Building Code applicable to the location of the Work.
  - .2 CSA B64.10 Selection and Installation of Backflow Preventers / Maintenance and Field Testing of Backflow Preventers
- .2 Product standards:
  - .1 ANSI B1.20.1 Pipe Threads, General Purpose (inch)
  - .2 ASME B16.1 Cast Iron Pipe Flanges And Flanged Fittings
  - .3 ASME B16.3 Malleable Iron Threaded Fittings.
  - .4 ASME B16.4 Cast Iron Threaded Fittings, Class 125 and 250
  - .5 ASME B16.5 Pipe Flanges and Flanged Fittings
  - .6 ASME B16.9 Factory Made Wrought Steel Buttwelding Fittings
  - .7 ASME B16.11 Forged Steel Fittings, Socket-Welding and Threaded
  - .8 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
  - .9 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
  - .10 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges.
  - .11 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
  - .12 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
  - .13 ASME B16.39 Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300.
  - .14 ASME B18.2.1 Square and Hex Bolts and Screws,
  - .15 ASME B18.2.2 Square and Hex Nuts

.16	ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
.17	ASTM A135	Standard Specification for Electric-Resistance-Welded Steel Pipe
.18	ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High-Pressure or High-Temperature Service, or Both.
.19	ASTM A795	Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire suppression Use
.20	CSA B64.4	Backflow Preventers, Reduced Pressure Principle Type (RP)
.21	ULC-B65.5	Backflow Preventers, Double Check Valve Type (DCVA)
.22	CSA B242	Groove and Shoulder Type Mechanical Pipe Couplings
.23	UL 203	Pipe Hanger Equipment for Fire suppression Service
.24	UL 393	Indicating Pressure Gauges for Fire Protection Service
.25	UL 1468	Standard for Direct Acting Pressure Reducing and Pressure Restricting Valves
.26	UL 1739	Standard for Pilot-Operated Pressure-Control Valves for Fire-Protection Service
.27	ULC/ORD-C203	Pipe Hanger Equipment for Fire suppression Service
.28	ULC/ORD-C213	Rubber Gasketed Fittings for Fire suppression Service
.29	ULC/ORD-C213B	Welded Outlet Fittings
.30	ULC-S548	Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems

**1.5 Qualified Tradesmen**

- .1 Work to be performed by qualified and recognized firm with an established reputation in this field, using tradesmen holding certificates of competency.

**1.6 Water Supply Test Results**

- .1 Provide water flow test on municipal water service in proximity to building connection, in accordance with NFPA 14 and NFPA 291. Flow test must be conducted within one (1) year prior to system design. Submit record of test including static pressure, and residual pressure and flow.
  - .1 Obtain municipal approval and pay fees associated with testing.

**1.7 Design Criteria**

- .1 Pressure piping design conditions and applicable codes are specified herein. Where different operating and design pressures are shown on drawings, the drawings govern.
- .2 System design criteria are described in the relevant Division 21 system specifications.
- .3 Where a "Class" is indicated on drawings, this refers to Class as defined in the applicable ASME B16 series of product standards. Notwithstanding the maximum allowable pressure-temperature ratings defined for each ASME Class designation, the applicable Class designation by floor level shown on the drawings may identify lower maximum allowable design pressures applicable to any Class rating.

## 2 PRODUCTS

### 2.1 Carbon Steel Pipe

- .1 Piping materials:
  - .1 to ASTM A53 Grade B, seamless or electric-resistant-welded (ERW),
  - .2 to ASTM A135 Grade B, ERW,
  - .3 to ASTM A795. Grade B, ERW.
- .2 Pipe wall thickness: as specified in each applicable fire suppression specification section.
- .3 Piping to be hot-dipped galvanized where required in each system specification section in Division 21.

### 2.2 Steel Pipe Joints and Fittings

- .1 Threaded fittings:
  - .1 end connections: NPT thread to ANSI B1.20.1.
  - .2 fittings:
    - (a) Class 125 cast iron to ASME B16.4,
    - (b) Class 150 and Class 300, malleable iron to ASME B16.3.
  - .3 unions: Class 150 and Class 300, malleable iron body with ground joint and bronze face to ASME B16.39.
  - .4 threaded joint compound: pulverized lead paste or Teflon pipe tape sealant.

#### *Standard of Acceptance*

- Masters Pro-Dope
- Masters Orange or White Tape.

- .2 Welding fittings:
  - .1 butt weld fittings:
    - (a) forged to ASME B16.9,
    - (b) wall thickness to match pipe,
    - (c) long radius elbows.
  - .2 welding outlet fittings:
    - (a) forged to ASTM A105,
    - (b) dimensions and pressure ratings to MSS SP-97, Standard Class for buttwelding branch connection and Class 3000 for threaded or socket welded branch connection,
    - (c) NPT ends to ASME B1.20.1.
  - .3 special welding outlet fittings for fire protection:
    - (a) weld-on branch outlet fittings for groove-end and threaded-end connections for fire protection services,
    - (b) listed to ULC/ORD-C213B for fire protection service,
    - (c) forged from materials meeting ASTM A53 Gr. B.,
    - (d) pressure rating: 2067 kPa (300 psi) for fire protection water,
  - .4 socket welded fittings:
    - (a) forged to ASTM A105,
    - (b) dimensions and pressure ratings to ASME B16.11, Class 3000.

- .5 half couplings:
  - (a) forged carbon steel to ASTM A105,
  - (b) dimensions and pressure rating to ASME B16.11, Class 3000 socket weld or threaded ends,
  - (c) NPT ends to ASME B1.20.1.

.3 Flanges:

- .1 flat-faced cast iron to ANSI B16.1, Class 125.
- .2 raised-face forged carbon steel to ASME B16.5, Class 150 and Class 300, weld neck with wall thickness to match pipe, or slip on type.
- .3 studs, bolts and nuts to ANSI B18.2.1, ANSI 18.2.2 and ASTM A194, "high strength" type.
- .4 gaskets:
  - (a) styrene butadiene rubber sheet to ANSI B16.21.
  - (b) 1.6 mm (1/16 in) thick.

*Standard of Acceptance*

- Chesterton - fig. 100
- Beldam

.4 Grooved fittings and couplings:

- .1 couplings listed to CSA B242,
- .2 listed for combination of fittings, couplings and gaskets to ULC/ORD-C213,
- .3 rolled or cut grooved (depending on pipe wall thickness), standard or rigid style,
- .4 fittings and couplings NPS 2 to 12: malleable iron to ASTM A47 or ductile iron to ASTM A536,
- .5 gaskets: dry lubricated EPDM,
- .6 design temperature rating: -34°C (-30°F) to 110°C (230°F),
  - (a) design pressure rating: 2400 kPa (350 psig),

*Standard of Acceptance*

- Victaulic
- Gruvlok

## 2.3 Pipe Supports

- .1 Pipe supports and hangers to conform to specification section 20 05 29 except/and as specified herein.
- .2 Pipe hangers and supports to be listed ULC/ORD-C203 or UL 203 for fire suppression service, except where such listing requirement is excluded under applicable NFPA standards.

## 2.4 Ancillary Devices and Accessories

- .1 Pressure gauges:
  - .1 listed to UL 393 and FM approved.
  - .2 90 mm (3½ in) dial type, , dual kPa/psi scale readings,
  - .3 suitable for air and water.

*Standard of Acceptance*

- Winters - fig. PFE series

- Ashcroft

.2 Supervisory switches:

- .1 listed to ULC-S548 and FM approved for fire service,
- .2 mechanically secured, with N.O. and N.C. contacts and supervisory capability,

*Standard of Acceptance*

- Potter Electric - fig. OSYSU - for OS&Y gate valves
- Potter Electric - fig. PCVS – for post indicating valves and butterfly valves
- Potter Electric - fig. RBCS - for ball valves.

.3 Pressure switches on alarm check valves:

- .1 listed to ULC-S548 and FM approved for fire service,
- .2 for loss of normal water pressure on wet sprinkler system,
- .3 for monitoring of low water pressure on wet sprinkler system with excess pressure pump.

*Standard of Acceptance*

- Potter Electric - fig. PS100-21: for detecting water flow alarm condition
- Potter Electric - fig. PS120A: for monitoring low water pressure

.4 Flow switches:

- .1 listed to ULC-S548 and FM approved for fire service,
- .2 vane-type flow switch, for mounting in sprinkler zone piping.
- .3 fitted with;
  - (a) sealed retard,
  - (b) visual indication of switch activation,
  - (c) mechanical delay adjustment

*Standard of Acceptance*

- Grinnell - fig. F-620
- Potter Electric - fig. VSR
- System Sensor - fig. WFD

### **3 EXECUTION**

#### **3.1 Piping Installation General Requirements**

- .1 General layout of mains, risers, run-outs and connection details of piping systems are shown.
- .2 Install concealed pipes close to building structure to keep furring spaces to minimum and minimize obstruction to other services in ceiling spaces.
- .3 Run exposed piping parallel to walls and conserve headroom and space, except where specific installation details are shown.
- .4 Support piping in accordance with the requirements of the NFPA standard applicable to the system type, subject to and in accordance with the requirements of specification section 20 05 29.
- .5 Ream pipe after cutting to length and clean off scale and dirt inside and outside of pipe before threading, grooving or welding.
- .6 Provide bends, expansion loops, hoses or joints to compensate for pipe seismic movement.

- .7 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.
- .8 Erect piping so that gravity forces and thrust from changes in direction do not stress connections to apparatus.
- .9 Provide di-electric couplings or flanges where steel pipe connects to copper tube.
- .10 Install drain valves at low points in water piping systems and in valved run-outs from risers so that system or isolated parts of system can be drained.
- .11 Do not use galvanized materials in contact with glycols.
- .12 Personnel involved in installation of grooved joint piping and fittings to be trained by product manufacturer and be conversant with;
  - .1 pipe end preparation and special tools,
    - (a) pipe ends to be clean and free from indentations, projections and roll marks in area from pipe end to groove.
    - (b) dimensions to be according to standard cut groove or roll groove in accordance with CSA
  - .2 coupling and fitting selection.
  - .3 joint assembly to accommodate expansion, contraction, and flexibility,
  - .4 specifications and/or recommendations with respect to support, anchorage and guiding of pipe systems.

### **3.2 Pipe Joints**

- .1 Refer to applicable fire suppression system specification sections for permissible type of pipe joints to be used and any restrictions therein.
- .2 Use flat-faced steel flanges when attaching to cast iron flanges.

### **3.3 Welding Procedures**

- .1 Welding of fire suppression piping to be in accordance with specification section 20 05 24 except as otherwise required by the NFPA standard applicable to the type of fire suppression system.
- .2 Welding acceptance criteria to be in accordance with the NFPA standard applicable to the type of fire suppression system.

### **3.4 Pressure and Leak Testing**

- .1 In accordance with the applicable specification sections of Division 21.

**END OF SECTION**

## PORTABLE FIRE EXTINGUISHERS 21 12 29

### 1 GENERAL

#### 1.1 Scope

- .1 Provide extinguishers as shown.

#### 1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 63 Safety Bollards and Machine Guards

#### 1.3 Definitions

- .1 The following definitions apply to this section.
  - .1 **Electronics rooms** – means a room whose primary function is for the installation of sensitive electronic data equipment, including but not limited to Data Server rooms, IT/Data service rooms, and other similar spaces.

#### 1.4 Applicable Codes and Standards

- .1 Product standards:
  - .1 CAN/ULC-S503 Carbon-Dioxide Fire Extinguishers
  - .2 CAN/ULC-S504 Standard for Dry Chemical Fire Extinguishers
  - .3 CAN/ULC-S507 Standard for Water Fire Extinguishers
  - .4 CAN/ULC-S508 Standard for the Rating and Fire Testing of Fire Extinguishers
  - .5 CAN/ULC-S512 Standard for Halogenated Agent Hand and Wheeled Fire Extinguishers
  - .6 CAN/ULC-S554 Standard for Water Based Agent Fire Extinguishers
  - .7 CAN/ULC-S566 Standard for Halocarbon Clean Agent Fire Extinguishers

### 2 PRODUCTS

#### 2.1 General

- .1 Portable fire extinguishers to be rated and identified in accordance with CAN/ULC-S508.
- .2 Bilingual operating instructions labels in English and French.

##### *Standard of Acceptance*

- National Fire Equipment Ltd
- Flag Fire Equipment Ltd
- Badger Fire Protection
- Wilson & Cousins

#### 2.2 Multipurpose Dry Chemical Extinguishers (Type “ABC”)

- .1 Stored pressure type, squeeze-grip operated, stainless steel cylinder with protective skirt,
- .2 Extinguishing medium: dry chemical
- .3 Listed to ULC S504,



- .4 Capacity: 4.5 kg (10 lbs.)
- .5 Rating: 6A:80B:C unless otherwise shown.
- .6 Operating temperature range: -54 to 49°C (-65 to 120°F).
- .7 With wall mounting bracket

*Standard of Acceptance*

- National Fire Equipment Limited - fig. SF-ABC680

### **2.3 Kitchen Extinguisher (Type “K”)**

- .1 Stored pressure water type, squeeze-grip operated, stainless steel cylinder with protective skirt,
- .2 Extinguishing medium: wet chemical.
- .3 Listed to ULC S554,
- .4 Capacity: 6.0 L (1.6 USG)
- .5 Rating: 1A:K
- .6 Operating temperature range: 2 to 49°C (35 to 120°F).
- .7 With wall mounting bracket

*Standard of Acceptance*

- National Fire Equipment Ltd. - fig. SF-6LK

### **2.4 Extinguisher brackets**

- .1 Supplied by extinguisher manufacturer.

### **2.5 Identification of Extinguishers**

- .1 Service tags:
  - .1 each fire extinguisher provided with a bilingual English/French tag attached to the extinguisher, to indicate month and year of installation, with space for service dates.
  - .2 include bilingual tag or label attached to extinguishers, in accordance with recommendations of NFPA 10, indicating month and year of installation, with space for service dates.
- .2 Fire extinguisher signage:
  - .1 rigid plastic signs, UV stabilized and suitable for indoor and outdoor installation,
  - .2 graphic fire extinguisher image in accordance with ISO 7010, type F001,
  - .3 bidirectional viewing.

## **3 EXECUTION**

### **3.1 Installation General Requirements**

- .1 Provide fire extinguishers of the class and size in accordance with the requirements of the Ontario Fire Code except/and as specified herein and in accordance with Schedule A at the end of this specification section, to meet the fire hazard type, maximum area coverage and travel distance requirements.

- .2 Except where fire extinguishers are shown to be installed in a fire extinguisher cabinet, mount fire extinguishers on wall brackets specifically manufactured for this purpose. Site fabricated hangers are not permitted.
- .3 Mount extinguishers on walls so that the top of the extinguisher is not more than the following heights above local floor level:
  - .1 1.5 m (5 ft) for extinguishers with a gross weight of 18 kg (40 lb.) or less,
  - .2 1.0 m (3.5 ft) for extinguishers with a gross weight in excess of 18 kg (40 lb.).
- .4 In addition, ensure that the bottom of the extinguisher is not less than 100 mm (4 in.) above the floor level.
- .5 Where fire extinguishers are mounted in extinguisher cabinets, install the cabinets so that the above mounting heights are met.
- .6 Install extinguishers at project completion. Confirm location with local building or fire department prior to installation.

### **3.2 Fire Extinguishers for Occupancy Hazard Class A Fires**

- .1 Unless otherwise shown on floorplan drawings, for fire hazard class A occupancies, determine the number of required fire extinguishers as follows:
  - .1 calculate the number of required fire extinguishers by dividing the protected area by the maximum area per fire extinguisher as defined in Schedule A, and round up to the next whole number,
  - .2 where the protected area is served by a standpipe system equipped with Ø38 mm fire hose stations, divide the number of calculated fire extinguishers by two and round up to the next whole number,
    - (a) notwithstanding the above calculated number, provide one fire extinguisher of the required type and size in each fire hose cabinet.
  - .3 Except for fire extinguishers installed in fire hose cabinets, install the number of required fire extinguishers uniformly spaced within the protected area.
- .2 For fire hazard class B, class C and class K, provide at least one fire extinguisher for each protected area unless a greater number are shown.

### **3.3 Fire Extinguishers for Kitchens**

- .1 Unless otherwise shown, provide at least one Class K fire extinguisher in each kitchen that contains appliances that use combustible cooking media, including vegetable or animal oil or fats, unless additional extinguishers are shown.
- .2 Install extinguishers in a surface or recessed extinguisher cabinet as shown.
- .3 Where cooking appliances are protected by a separate automatic fire suppression system, provide a notice mounted on the extinguisher cabinet or immediately beside it, stating "ACTUATE THE FIXED FIRE PROTECTION SYSTEM BEFORE USING THIS FIRE EXTINGUISHER".

### **3.4 Signage for Fire Extinguishers**

- .1 Provide signage indicating location of fire extinguishers in the following locations;
  - .1 in warehouses and manufacturing facilities,
  - .2 outdoors.
- .2 Install signage above the location of fire extinguisher, at a height of 2100 mm (7 ft) above local grade level.
- .3 Mount to exterior walls, or for remote fire extinguishers mount to a minimum 38 x 38 mm (1-1/2 x 1-1/2 in.) aluminium angle which is fastened to the fire extinguisher cabinet support frame.

### **3.5 Schedules**

- .1 The following schedules are appended to the end of this section.
  - .1 Schedule 1: Fire Extinguisher Selection Requirements.

<b>Schedule 1: Fire Extinguisher Selection Requirements</b>						
Occupancy or Space Type	Occupancy Hazard	Fire Hazard Class	Extinguisher Type	Floor Area Coverage m <sup>2</sup> [Note 1]	Maximum Travel Distance m	Extinguisher Rating
Group A, B, C, D, general spaces	Light	A	ABC	1100	25	6A:80B:C
Group E. Parking garages, Light manufacturing	Ordinary	A	ABC	900	25	6A:80B:C
Group F, Group E storage	Extra	A	ABC	600	25	6A:80B:C
Mechanical and Electrical Service Rooms	All	C	ABC	---	15	6A:80B:C
Electronics Rooms	Light	C	BC-CL, BC-CO2	---	15	1A:10B:C
Fuel Oil Storage Tank Rooms	All	B	ABC	---	15	6A:80B:C
Fuel Pump Rooms	All	B, C	ABC	---	15	6A:80B:C
Generator Rooms	All	B, C	ABC	---	15	6A:80B:C
Kitchens	All	K	K	---	---	1A:K

**Notes:**

[1] Area coverage per fire extinguisher.

**END OF SECTION**

## **WET PIPE SPRINKLER SYSTEM**

### **21 13 13**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide wet pipe automatic sprinkler systems.
- .2 Provide installation drawings and hydraulic calculations, designed and sealed by a professional engineer licensed in the province or territory of the Work.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 08 11 Testing of Integrated Mechanical Life Safety and Fire Protection Systems
  - .2 21 05 01 Common Work Results for Fire Suppression

##### **1.3 Definitions**

- .1 The following definitions apply to this section.
  - .1 **Pressure reducing valve** – a valve that reduces the inlet water pressure to a regulated constant outlet pressure under static (no flow) and dynamic (water flowing) conditions (“pressure reducing” and “pressure controlling” valves have the same meaning).

##### **1.4 Applicable Codes and Standards**

- .1 Legislation:
  - .1 Ontario Building Code
- .2 Installation codes and standards:
  - .1 ASTM C636 Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustic Tile and Lay-In Panels
  - .2 NFPA 13 Standard for the Installation of Sprinkler Systems
- .3 Insurance company standards:
  - .1 FM Global Engineering Data Sheets
- .4 Product standards:
  - .1 ASTM C635 Standard Specification for Manufacture, Performance and Testing of Metal Suspension systems for Acoustic Tile and Lay-in Panel Ceilings
  - .2 UL 199 Standard for Automatic Sprinklers for Fire Protection Services
  - .3 UL 1478A Standard for Pressure Relief Valves for Sprinkler Systems
  - .4 UL 2443 Flexible Sprinkler Hose with Fittings for Fire Protection Service
  - .5 ULC/ORD-C312 Check Valves for Fire Protection Service

##### **1.5 Qualified Subcontractors**

- .1 Sprinkler work to be undertaken by specialist fire protection installation firm with an established reputation in this field, and licences or otherwise qualified to perform such work where required by regulation.

## **1.6 Design Criteria**

- .1 Piping design temperature: 38°C (100°F)
- .2 Piping design pressure: 1200 kPa (175 psig)
- .3 Sprinkler system type: stand-alone
- .4 Consultant's indicative system layout is designed to NFPA 13 and FM requirements using hydraulic method for hazard classification shown with design densities and design areas for each zone as detailed.

## **1.7 Design Services**

- .1 Provide engineering design services for the [automatic sprinkler systems][combination automatic sprinkler/standpipe systems], including piping system detailed fabrication and installation drawings, supported by contractor's own hydraulic calculations and water supply test flow data.
- .2 Design of wet-pipe sprinkler systems is to conform with the requirements of NFPA 13 of the edition adopted by the AHJ, except/and as otherwise specified herein.
- .3 Coordinate sprinkler system layout with the work of other Trades. Prepare fabrication/installation drawings taking into account this coordination.
- .4 Conduct a site water flow test and prepare hydraulic calculations based on those test results.

## **1.8 Submittals**

- .1 Submit manufacturer data sheets for products specified herein.
- .2 Prepare and submit shop drawings for sprinkler system fabrication and installation drawings including hydraulic calculations;
  - .1 forward three copies to Owners Insurers for review and acceptance,
  - .2 after shop drawings are accepted by reviewing authority, submit copies of these stamped shop drawings and product data sheets to Consultant for review.
- .3 Samples:
  - .1 Submit samples of;
    - (a) sprinkler heads,
    - (b) signs.

## **1.9 Maintenance Materials**

- .1 Provide cabinet, containing special sprinkler wrench, and spare stock of sprinklers. Include at least one head of each type and temperature rating installed in system.

# **2 PRODUCTS**

## **2.1 Pipe, Fittings and Valves**

- .1 Pipe and fittings: in conformance with specification section 21 05 01 except/and as specified herein.
- .2 Valves: in conformance with specification section 21 05 23.
- .3 Pipe minimum wall thickness: in accordance with Table 1 except as follows:
  - .1 use schedule 40 of either ASTM A53 or A135 in the following locations:
    - (a) exposed vertical piping in parking garages, truck docks and other areas subject to vehicular traffic, between floor level and to a height of 3.0 m (10 ft) above floor level,

- (b) exposed vertical piping in factories and manufacturing plants, between floor level and to a height of 5.0 m (15 ft) above floor level or the bottom of the roof structural steel, whichever is lower,
- (c) do not use ASTM 795 in the above listed locations.

<b>Table 1: Pipe Selection and Minimum Pipe Wall Thickness</b>			
Pipe Size	Joining Method	ASTM A53, ASTM A135	ASTM A795
≤ 2-1/2	Threaded, Cut Groove	Schedule 40	Standard Weight
2-1/2 to 6	Welded, Roll Groove	Schedule [10][40]	[Light-Weight] [Standard-Weight]
	Cut Groove	Schedule 40	Standard- Weight
8 to 10	Welded Roll Groove	Schedule [20][30][40]	[Light-Weight] [Standard-Weight]
	Cut Groove	Schedule 40	Standard-Weight
≥ 12	Welded, Roll Groove	9.5 mm (0.375 in)	Not applicable

.4 Mechanical Tees for grooved pipe fittings:

- .1 restricted use; refer to Part 3,
- .2 gasket-sealed mechanical Tee's, for installation of branch piping to mains pipe,
- .3 ductile iron body to ASTM A-395, with EPDM gasket,
- .4 gull-wrap coupling around pipe mains; half-coupling with U-bolt arrangement not permitted.

*Standard of Acceptance*

- ° Victaulic - fig. 920/920N
- ° Gruvlock

## 2.2 Pipe Supports, Hangers and gaskets

- .1 To section 21 05 01.

## 2.3 Sprinkler Heads

.1 Ratings:

- .1 listed to UL 199 for Canada and FM approved for fire service,
- .2 standard temperature rating 57°C to 74°C (135°F to 165°F) with intermediate or high temperature rating to suit local conditions.
- .3 thermal sensitivity:
  - (a) Quick Response type for Light and Ordinary hazard applications
  - (b) Standard response type for Extra hazard applications.

*Standard of Acceptance*

- Viking
- Tyco
- Reliable
- Victaulic

.2 General purpose sprinkler head types in accordance with Table 1.

<b>Table 1: Sprinkler Head Types</b>						
Type	Orientation	Feature	Body Finish	Escutcheon Finish	Release	Remarks
U-1	Upright	---	Bronze body	---	Glass Bulb	12 mm (½ in) diameter orifice or 13 mm (17/32 in) diameter orifice as shown
P-2	Pendent	Concealed	Bronze	White	Glass Bulb	Fusible cover plate

.3 Dry sprinkler heads:

- .1 pendant style dry-heads, with white escutcheon,
- .2 extension barrel with remote seat and plug at the pipeline connection.
- .3 minimum ambient operating temperature: -30°C (-22°F),
- .4 coverage: standard,
- .5 response: standard,
- .6 temperature rating: 68°C (155°F),

*Standard of Acceptance*

- Tyco - fig. DS-1
- Viking
- Reliable

## 2.4 Signage

.1 Construction:

- .1 1.2 mm (18 ga.) thick aluminium, with Mylar protective facing, red enamel background, white letters, inscription in accordance with NFPA standards,

.2 Size:

- .1 230 x 180 mm (9 x 7 in) for automatic control valves and alarm valves,
- .2 50 x 150 mm (2 x 6 in) for other valves,
- .3 130 x 180 mm (5 x 7 in) for hydraulic calculation signs,

## 2.5 Maintenance Materials

- .1 Storage cabinet: steel cabinet with lockable doors, baked enamel red finish,
- .2 Included maintenance materials:
  - .1 special sprinkler wrench,



- .2 spare stock of sprinklers, with at least one head of each type and temperature rating installed in the system.

### **3 EXECUTION**

#### **3.1 Piping Installation General Requirements**

- .1 Install sprinkler piping and supports in accordance with specification section 21 05 01 except/and as specified herein.
- .2 Provide headers, alarm check valve assemblies, valves, test valves, and fire department connections.
- .3 Install excess pressure pump across alarm check valve.
- .4 Extend piping from existing mains and branches and connect to sprinklers.
- .5 Provide NPS  $\frac{3}{4}$  drain valves with hose end and caps in the following locations:
  - .1 at the bottom of sprinkler risers,
  - .2 at trapped low points in piping system.
- .6 Provide NPS  $\frac{3}{4}$  manual air vent valve with cap and chain at the top of each sprinkler riser and where shown;
  - .1 run NPS  $\frac{3}{4}$  air vent piping from top of riser and down to a location where the manual vent valve is accessible,
  - .2 manual vent valve to be located at a height of not more than 2.1 m (7 ft) above local floor level, and positioned so outlet is pointed down.
- .7 Install Fire Department connection for main fire line as shown, with check valve and NPS  $\frac{3}{4}$  automatic drip connection in line between connection and check valve.
- .8 Provide additional sprinkler heads with associated piping for sprinkler protection under ducts, under obstructions, and in blind spaces. Identify additional sprinkler heads on shop drawings with capital letter "A" and resubmit drawings to permit inclusion of these sprinkler heads in hydraulic calculations.
- .9 Combination drains or hub drains will be provided at headers and control cabinets under Division 22.
- .10 Run NPS 2 drain through wall to outside for Inspectors water flow testing in locations shown.

#### **3.2 Pipe Joints (other than Mechanical Tees for Branch Piping)**

- .1 Make pipe joints using jointing methods in accordance with Specification section 21 05 01.

#### **3.3 Mechanical Tees for Branch Piping**

- .1 The use of mechanical Tees for grooved joint installation is restricted by the following conditions:
  - .1 may be used in existing buildings for connection of single- sided branch piping connections to existing installations,
  - .2 may be used in new buildings, for single-sided branch piping connections in areas without ceilings, and
  - .3 where specifically authorized by Consultant on a case-by-case basis.

#### **3.4 Sprinkler Head Selection and Layout**

- .1 Use concealed pendant sprinklers where suspended ceilings occur. Locate sprinklers in symmetrical pattern to suit reflected ceiling plans and to avoid speakers, fire alarm components, lighting fixtures, ductwork and diffusers. In general, centre heads in ceiling tiles. Examine architectural reflected ceiling plan to coordinate sprinkler head layout and locations.

### 3.5 Pressure Testing

- .1 Conduct pressure testing of sprinkler piping systems in accordance with requirements of NFPA 13 and building insurer requirements, if any, and as follows.
- .2 In existing buildings, conduct an initial pneumatic pressure test of the new and modified work before connection to the existing system, to test for significant leaks before filling the modified installation or new work with water.
  - .1 isolate the new piping from the existing system,
  - .2 pressure test the new piping at 280 kPa (40 psig) using oil-free compressed air or nitrogen,
  - .3 maintain pressure test for one hour without loss of pressure,
  - .4 if any leaks are discovered, repair leaks and retest.
- .3 Conduct hydrostatic pressure tests at the test pressures and for the test durations as follows:
  - .1 for new piping systems with a working pressure of 1030 kPa (150 psi) or less:
    - (a) a minimum of 1380 kPa (200 psi) for a test period of not less than two hours,
  - .2 for new piping systems or portion thereof with a working pressure of greater than 1030 kPa (150 psi):
    - (a) a minimum of the working pressure plus 345 kPa (50 psi) for a test period of not less than two hours,
  - .3 for modifications or additions to an existing systems involves more than 20 sprinkler heads:
    - (a) the test pressure and duration as specified for a new installation, except only the new piping is to be tested with the new piping isolated from the existing systems,
    - (b) the new piping section may be isolated by a service valve at the tie-in point to the existing system, or it may be isolated by installation of a temporary plug,
    - (c) for installation of a temporary test plug, a section of the new pipe at the connection to the existing system is removed; this spool piece is not to exceed a length of 300 mm (12 in.) nor contain more than two pipe joints.
    - (d) after pressure testing is completed and the spool piece is reinstalled, conduct an in-service pressure test of the spool piece and its joints.
  - .4 where the work only involves the modification to an existing system that impacts not more than 20 sprinkler heads, only an in-service pressure test is required,
  - .5 where modifications to an existing system only involves relocating sprinkler heads and associated pipe drops (but without any changes to any other system piping), only an in-service pressure test is required.
- .4 In-service pressure test:
  - .1 where an in-service pressure test is required, return the sprinkler system to its normal operating condition and bleed-off trapped air as much as possible,
  - .2 visually inspect the subject joints, using joint leak detection solution.
- .5 Pressure testing of multi-storey buildings:
  - .1 pressure test the sprinkler risers separate and isolated from on-floor piping, except that the feed main connecting the risers may be included in the riser pressure test,
  - .2 pressure test each on-floor sprinkler zones separately and independently of the system sprinkler risers; isolate each floor from the system riser during the test.
- .6 Pressure test acceptance criteria:

- .1 pressure loss not exceeding 10 kPa (1.5 psi) as measured by installed pressure gauge, or where visual examination of all pipe joints determines there are no visible leaks.

### **3.6 Operational Testing**

- .1 Conduct an operational test of all flow control and alarm devices. Test sprinkler systems in accordance with requirements of NFPA 13, and building insurer requirements (if any).
- .2 Schedule testing to give at least two weeks' notice to AHJs having jurisdiction for:
  - .1 building/plumbing Inspector,
  - .2 fire department representative,
  - .3 insurer's representative,
  - .4 Owner, and
  - .5 Consultant.
- .3 Prior to testing, ensure that valves, flow switches, pressure switches, supervisory switches and other devices are functioning and in-service.

### **3.7 Integrated Testing of Life Safety and Fire Protection Systems**

- .1 Participate as required in the integrated system testing of the standpipe system in accordance with specification section 20 08 11.

### **3.8 Testing Reports and Certificates**

- .1 Provide completed and signed Contractor's Material and Test Certificate for above ground piping.
- .2 Submit copies of completed Certificates to the Consultant, and include copies in the Operating and Maintenance manuals.

**END OF SECTION**

## **COMMON WORK RESULTS FOR PLUMBING PIPING**

### **22 05 01**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide piping systems for plumbing, drain and vent systems for:
  - .1 potable (domestic) water systems,
  - .2 non-potable water piping systems,
  - .3 drainage system including:
    - (a) sanitary drainage and vent systems.

##### **1.2 Applicable Codes and Standards**

- .1 Legislation:
  - .1 Ontario Building Code
  - .2 Municipal bylaws regarding potable water, water services, and sewage systems.
- .2 Installation standards and codes:
  - .1 AWWA C651 Disinfecting Water Mains.
- .3 Product standards:
  - .1 CSA B272 Pre-Fabricated Self Sealing Roof Vent Flashings

##### **1.3 Qualified Tradesmen**

- .1 Work to be performed by qualified and recognized firm with an established reputation in this field, using tradesmen holding certificates of competency.

##### **1.4 Design Criteria – Pressure Piping Systems**

- .1 The following design conditions apply unless otherwise shown on drawings.
- .2 System design criteria:
  - .1 Domestic Cold Water Service (to building):
    - (a) Design pressure: 900 kPa (130 psig)
    - (b) Design temperature: 25°C (77°F)
  - .2 Potable water:
    - (a) Design pressure: 900 kPa (130 psig)
    - (b) Design temperature: 107°C (225°F)
  - .3 Non-potable water:
    - (a) Design pressure: 900 kPa (130 psig)
    - (b) Design temperature: 107°C (225°F)

#### **2 PRODUCTS**

##### **2.1 Flashings**

- .1 Through-roof penetration flashing, and other waterproofed areas:
  - .1 manufactured from composite material in accordance with CSA B272,

- .2 minimum dimensions of 500 mm x 500 mm (20 in x 20 in),
- .3 with sleeve extending at least 150 mm (6 in) above roof.

## **2.2 Dielectric Unions**

- .1 Construction:
  - .1 Bronze or brass body with non-metallic fitting or coating the FNPT tailpiece.
  - .2 FNPT x Copper sweat connection.
  - .3 Pressure rating; ASME Class 3000 at 121°C (250°F)

### *Standard of Acceptance*

- ° Hart Industrial Unions - fig. D-3136 or Polymer Composite Coating

## **2.3 Dielectric Flanges**

- .1 Construction:
  - .1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece.
  - .2 Flange provided with a powder coated finish, and an EPDM insulator to isolate the copper tailpiece from contact with the flange.
  - .3 Minimum MCPR:
    - (a) Class 150: 1400 kPa (200 psi) at 121°C (250°F)
    - (b) Class 300: 2800 kPa (400 psi) at 121°C (250°F)

### *Standard of Acceptance*

- ° CTS Flange Canada - fig. BF / WBG

## **3 INSTALLATION**

### **3.1 Piping**

- .1 Piping system routing is shown diagrammatically. Locate mains, risers and runouts concealed behind furrings or above ceilings except in mechanical equipment rooms and access spaces where piping is to be exposed.
- .2 Determine areas without ceilings from Architectural Drawings and Room Finish Schedules, and in these areas keep piping as high as possible.
- .3 Anchor, guide and support vertical and horizontal runs of piping to resist dead load and absorb thrust.

### **3.2 Domestic Cold Water System Distribution**

- .1 Extend existing domestic cold water system with
  - .1 distribution pipe and fittings,
  - .2 valves,
  - .3 premises backflow isolation,
  - .4 zone or equipment backflow protection.
- .2 Minimum water pressure at street level: approximately 500 kPa (70 psi).
- .3 Provide valved connections from supply system, to fixtures and other equipment requiring cold water.

### **3.3 Domestic Hot Water System Distribution**

- .1 Extend existing domestic hot water system with
  - .1 distribution pipe and fittings
  - .2 valves
  - .3 zone or equipment backflow protection.
- .2 Provide cold water connections to hot water tank, with shut-off and expansion tank on supply and valved drain at bottom of tank.
- .3 Provide valved connections from hot water supply system to fixtures and other equipment requiring hot water.

### **3.4 Domestic Hot Water Recirculation System**

- .1 Extend existing domestic hot water recirculation system with
  - .1 distribution pipe and fittings
  - .2 valves
  - .3 pumps
- .2 Connect ends of hot water risers to recirculation mains and extend to recirculation pump.
- .3 Provide minimum flow balancing valves at each connection between the domestic hot water loop and the hot water recirculation loop.

### **3.5 Dissimilar Metals Galvanic Isolation**

- .1 Provide dielectric unions or flanges to separate copper and copper alloy tube and fitting materials from contact with carbon (plain and galvanized) steel material.
  - .1 For clarity, dielectric unions or flanges are not required when connecting copper to T304 or T316 stainless steel pipe or tubing.
- .2 Refer to specification section 23 05 01 for exemptions when connecting domestic water copper piping or stainless steel piping to HVAC piping systems.

### **3.6 Drainage**

- .1 Provide roof drains and storm drainage piping system.
- .2 Provide waste and vent connections to plumbing fixtures and equipment.
- .3 Drainage fittings;
  - .1 do not use double hubs, straight crosses, double T's, or double TY's in soil or waste pipe below any fixture,
  - .2 do not use branch fittings other than full "Y" or "Y" and an eighth bend, on soil or waste pipe running in horizontal direction,
  - .3 do not use quarter bend placed on its side,
  - .4 do not use inverted joints below fixtures,
  - .5 do not install cleanouts above food preparation or patient treatment areas. In these areas carry rodding connection up to floor cleanout fitted with adjustable gasketed access cover and plug, with cleanout body cast in floor slab above,
  - .6 drainage fittings to match connected piping for quality and wall thickness.

**3.7 Flashings**

- .1 Provide flashing for piping penetrations through roofs and other waterproofed areas. Leave flashing ready for Roofing or Waterproofing Trades to make watertight connections.

**3.8 Vent Termination (VTR)**

- .1 Fit vents passing through roof with vent stack sleeve terminating not less than 150 mm (6 in) above roof, above flood level of roof, and 900 mm (3 ft) above or 3500 mm (11.5 ft) horizontally from any air intake, door, or operable window.

**3.9 Water and Waste Connections**

- .1 Provide hot and cold water, waste and vent connections to building service equipment. Provide connections to Owners equipment and equipment supplied by Divisions of the Work other than Division 20 to 25, as specified herein and in accordance with specification section 20 05 73.13.
- .2 Provide vacuum breakers and backflow preventers on equipment connections, and hose bibs, and on fixture connections without adequate air gaps.
- .3 Where hot and cold water supply pipes connect to combination supply fitting with shut-off valve on discharge, or where combination supply fitting is equipped with manual or thermostatic mixing valve, equip each hot and cold water supply pipe with composition disc swing check fitting.
- .4 Provide shut-off valve on each service line close to the apparatus and brass traps complete with cleanout on waste connection unless waste discharges directly into floor drain or funnel drain.
- .5 Where specific sizes are not shown, valves, and final connections to equipment to be one pipe size larger than equipment tapping size, and trap and drain size to be one pipe size larger than waste connection on apparatus.

**3.10 Pressure Testing – Water Pressure Piping Systems**

- .1 Pressure test piping before insulation is applied.
- .2 Initial pneumatic leak test:
  - .1 Conduct an initial pneumatic pressure test at a maximum pressure of 70 kPa (10 psig) prior to hydrostatic pressure test, to check for large leaks or incomplete joints.
  - .2 Remove compressed air source and maintain this pressure for the time necessary to inspect for leaks, but not less than 2 hours.
  - .3 Maintain pressure and examine each joint with commercial leak detector solution.

*Standard of Acceptance*

- Snoop
  - Leak-tec
- .4 Repair leaks where found prior to performing hydrostatic pressure tests.
- .5 During pneumatic pressure tests, comply with the site safety requirements for notification and guarding during testing with compressed gasses.
- .3 Final hydrostatic pressure test:
  - .1 Use the system design pressure for the entire installation, unless different design pressures are indicated for each floor.
  - .2 Fill the system with water and gradually increase the system pressure to 150% of the design pressure and hold for 10 minutes, then reduce pressure to the design pressure.
  - .3 Inspect each pipe joint for leaks.

- .4 As an alternative to inspection of each joint for leaks, conduct a 24 hour standing pressure test:
  - (a) raise the water pressure to 150% of the design pressure for 10 minutes, then reduce pressure to design pressure,
  - (b) record the test pressure one (1) hour after establishing the system hydrostatic test pressure at the design pressure. Record ambient air temperature at the same time.
  - (c) at the end of the 24 hour standing test period, record the test pressure and ambient air temperature. Make adjustments to the measured end-of-test pressure to account for change in fluid density due to change in ambient air temperature,
  - (d) acceptance criteria: maximum pressure loss over 24 hours not to exceed 1% of test pressure, corrected for ambient temperature,
  - (e) where acceptance criteria is not met, inspect pipe joints for leaks.
- .5 Where leaks are found, repair leaks and retest piping as specified above.
  - (a) for soldered or brazed joints, one attempt at repairing the joint is permitted. If joint continues to fail, cut-out and replace the fitting.

### 3.11 Pressure Test Report

- .1 Maintain a log of all pressure tests, including locating of where leaks have been repaired. Submit the log to the Consultant for review when requesting prior to substantial completion of the Work. Where a piping system is subject to AHJ inspection, provide evidence of such inspection by means of an AHJ inspection report or name of the AHJ inspector and the date they witnessed the pressure test.

### 3.12 Flushing and Disinfecting - Water Service Pipe

- .1 Complete piping pressure tests prior to flushing and disinfecting operations. Notify Consultant at least two days in advance of date when disinfecting operations are proposed, so that the Consultant may witness the tests.
- .2 Isolate the water service pipe inside the building at the point of entry, from the building water distribution system. Flush water service pipes for a minimum of 10 minutes to produce a water velocity of 1.5 m/s (5 fps) and discharge water to drain or other acceptable area.
  - .1 Minimum flushing flow rates:

Pipe size	Minimum Flow	
NPS	L/s	USGPM
2	3.3	52
2 1/2	4.7	75
3	7.3	115
4	12.6	200
6	23.4	450
8	49	780
10	76	1200
12	110	1750

- .3 Disinfect water service pipes NPS 4 and larger:



- .1 Provide chemicals and equipment to clean, disinfect and flush domestic water service pipes in accordance with AWWA C651.
- .2 Drain down system to remove flushing water.
- .3 Isolate service water pipe from the building distribution system.
- .4 Disinfect water supply pipe by introducing chlorine close to point of connection to the municipal water supply and evenly add to water as water service pipe is refilling, to provide an initial concentration of 50 mg/L.
- .5 Close off drains and maintain chlorinated water in mains pipe for 24 hours.
- .6 At the end of 24 hours, arrange and pay for laboratory testing of water samples taken from newly disinfected main. If the residual chlorine is < 25 mg/L, drain down water and repeat disinfection for an additional 24 hours and lab testing until a residual of minimum 25 mg/L is obtained.
- .7 After the lab test indicates a residual of 25 mg/L, flush line to remove chlorine solution.

### 3.13 Flushing and Cleaning - Building Water Distribution Piping

- .1 Conduct first fill and pressure testing of building distribution piping only after completion of flushing and disinfection of water service pipe.
- .2 Complete piping pressure tests prior to flushing and cleaning operations.
- .3 Flush water distribution piping through available outlets with sufficient flow to produce velocity of 1.5 m/s, within pipe for 10 minutes, or until foreign materials have been removed and flushed water is clear.
- .4 Minimum flushing flowrates:

Pipe size	Minimum Flow	
NPS	L/s	USGPM
2	3.3	52
2 1/2	4.7	75
3	7.3	115
4	12.6	200

- .5 Open and close valves, hydrants and service connections to ensure thorough flushing

### 3.14 Testing and Balancing – Water Pressure Piping Systems

- .1 Balance domestic water piping systems where double regulating valves are installed, including hot water recirculation piping and as otherwise shown.

**END OF SECTION**

## **GENERAL-DUTY VALVES FOR PLUMBING PIPING**

### **22 05 23.13**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide valves for general duty service in plumbing piping systems, including shut-off valves, check valves, manual balancing valves, and automatic flow balancing valves.
- .2 Valves under this specification section are provided for:
  - .1 Domestic (potable) water systems using copper tubing, stainless steel pipe or tube, ductile iron water piping, and galvanized steel piping.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section integrates with or refers to the following specification sections:
  - .1 20 05 23 General Requirements for Valves
  - .2 22 05 01 Plumbing - General

##### **1.3 Definitions**

- .1 The following definitions apply to this section.
  - .1 **Contaminant-free:** means the material is free of contaminants and impurities to the prescribed limits of NSF/ANSI 61 – section 8 (NSF/ANSI 61/8), but excludes evaluation for lead.
  - .2 **Lead-free:** means the weighted average lead content does not exceed 0.25% when evaluated in accordance with the test methods in NSF/ANSI 61-Annex G or NSF/ANSI 372.

##### **1.4 Submittals**

- .1 Conform to the requirements of Specification section 20 05 23 except/and as follows.
- .2 For double regulating valves, in addition to manufacturer data sheets, submit a schedule listing all double regulating valves and include the following information:
  - .1 a valve reference number,
  - .2 valve service (e.g. associated equipment, or distribution piping service by drawing, room, etc.)
  - .3 associated pipeline size, NPS
  - .4 valve body size, NPS
  - .5 specified design flow rate,
  - .6 valve minimum and maximum flow rate limits,
  - .7 valve pressure drop at specified design flow rate,
  - .8 expected valve open position (number of valve turns open, percent valve stroke, etc.).
- .3 For automatic flow balancing valves, in addition to manufacturer data sheets, submit a schedule listing all automatic flow balancing valves and include the following information:
  - .1 a valve reference number,
  - .2 valve service (e.g., where the valve is located, floor, room, etc.),
  - .3 associated pipeline size, NPS
  - .4 valve body size, NPS

- .5 specified design flow rate,
- .6 valve fixed flow rate,
- .7 valve operating differential pressure range.

## 1.5 Applicable Codes and Standards

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Product standards:
  - .1 CSA B125.3 Plumbing Fittings
  - .2 NSF/ANSI 61 Drinking Water System Components – Health Effects
  - .3 NSF/ANSI 372 Drinking Water System Components – Lead Content (formerly NSF/ANSI 61, Annex G).

## 2 PRODUCTS

### 2.1 General

- .1 Where products are specified as being lead-free, they shall be listed to either:
  - .1 CSA B125.3;
  - .2 NSF/ANSI 61-G; or
  - .3 NSF/ANSI 372.
- .2 Where products are specified as being contaminant-free, they shall be listed to either:
  - .1 CSA B125.3;
  - .2 NSF/ANSI 61-G; or
  - .3 NSF/ANSI 61/8

### 2.2 Ball Valves: Brass Body (type BV-1)

- .1 NPS 4 and under, copper alloy body:
  - .1 To MSS SP-110, 600 CWP, two-piece bronze or DZR brass body, full port, stainless steel or chrome plated bronze ball, PTFE seat rings, solder or NPT threaded ends.
  - .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
  - .3 Required MCPR: 2500 kPa (363 psig) at 93°C (200°F).
  - .4 Certified for lead-free and contaminant-free service.
  - .5 Soldered ends: NPS 2 and under.

#### *Standard of Acceptance*

- Kitz - fig. 859
- Apollo - fig. 77FLF-20x
- Nibco - fig. S-685-66-LF
- Watts - fig. LFB6081

- .6 Threaded ends: NPS 4 and under.

#### *Standard of Acceptance*

- Kitz - fig. 858

- Apollo - fig. 77FLF-10x
- Nibco - fig. T-685-66-LF
- Watts - fig. LFB6080

### **2.3 Ball Valves: Stainless Steel Body (type BV-2)**

#### **.1 NPS 4 and under, threaded ends:**

- .1 To MSS SP-110, 600CWP, two piece T316 stainless steel body, full port, stainless steel or chrome plated bronze ball, PTFE seat rings, NPT threaded ends.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 Required MCPR: 2500 kPa (363 psig) at 93°C (200°F).
- .4 Certified for lead-free and contaminant-free service.

##### *Standard of Acceptance*

- Apollo - fig. 76F-10x series (NPS 2 and under)
- Watts - fig. S-FBV-1 series

#### **.2 NPS 1- ½ to NPS 12, flanged ends:**

- .1 To MSS SP-72, two piece CF8M stainless steel body, full port, stainless steel ball, PTFE seat rings, flanged ends.
- .2 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .3 Certified for lead-free and contaminant-free service.
- .4 ASME Class 150:
  - (a) Required MCPR: 1600 kPa (232 psig) at 93°C (200°F).

##### *Standard of Acceptance*

- Apollo - fig. 87A-200 series

#### **.5 ASME Class 300:**

- (a) Required MCPR: 4000 kPa (580 psig) at 93°C (200°F).

##### *Standard of Acceptance*

- Apollo - fig. 87A-900 series

### **2.4 Globe Valves (type GLV-1)**

#### **.1 NPS 2 and under:**

- .1 To MSS SP-80, Class 125 bronze body valves, brass or bronze disc, threaded bonnet, threaded or soldered ends.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Soldered ends:

##### *Standard of Acceptance*

- Kitz - fig. 812
- Apollo - fig. 121S-LF

## .5 Threaded ends:

*Standard of Acceptance*

- Kitz - fig. 811
- Apollo - fig. 121T-LF

**2.5 Gate Valves: Bronze Body (type GTV-1)**

## .1 NPS 2 and under:

- .1 To: MSS SP-80, Class 125; or MSS SP-139, 300 CWP, bronze body, solid wedge brass or bronze disc, non-rising stem, screw in or union bonnet.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Soldered ends:

*Standard of Acceptance*

- Kitz - fig. 828
- Apollo - fig. 102SLF
- Crane (GGC) - fig. LF1320
- Nibco - fig. S-111-LF

## .5 Threaded ends:

*Standard of Acceptance*

- Kitz - fig. 827
- Apollo - fig. 102TLF
- Crane (GGC) - fig. LF438
- Nibco - fig. T-113-LF

**2.6 Gate Valves: Cast Iron Body (type GTV-2)**

## .1 NPS 2 to 12:

- .1 To: MSS SP-70, Class 125, cast iron body, solid wedge bronze disc and bronze seat rings, adjustable graphite stem packing, bolted bonnet.
- .2 Finish: FDA food grade epoxy power coat,
- .3 Required MCPR: 1380 kPa (200 psi) at 38°C (100°F).
- .4 CRN to CSA B51,
- .5 Certified for lead-free and contaminant-free service.
- .6 End connections: flat-faced flanged, suitable for ASME Class 125 and Class 150 pipe flanges,
- .7 Non-rising stem:

*Standard of Acceptance*

- Apollo - fig. 610F-LF

## .8 Outside screw and yoke:

*Standard of Acceptance*

- Apollo - fig. 611F-LF

## **2.7 Gate Valves, Non-Potable Applications (type GTVNP)**

- .1 For non-potable water systems only. Do not use on potable water systems.
- .2 NPS 2½ to NPS 12, cast iron:
  - .1 To MSS SP-70, Class 125, cast iron body with flat faced flange, bronze or bronze faced solid wedge disc with bronze seat rings, OS & Y, bolted bonnet, flanged ends.
    - (a) Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

### *Standard of Acceptance*

- Kitz - fig. 72
- Crane - fig. 465 ½
- Jenkins - fig. 454J
- Nibco - fig. F-617-O

- .3 NPS 2½ to NPS 24, stainless steel:
  - .1 To ASME B16.34, Class 150, ASTM A216 grade WCB cast steel body with raised faced flange, flexible Type 416 stainless steel disc and hard faced seat rings, rising stem, OS & Y, bolted bonnet, flanged ends.
  - .2 ASME Class 150:
    - (a) Required MCPR: 1700 kPa (246 psi) at 93°C (200°F).

### *Standard of Acceptance*

- Kitz - fig. 150 SCLS
- Crane - fig. 47 XU-F
- Jenkins - fig. J1009B8F
- Powell - fig. 1503-FC8G

- .3 ASME Class 300:
  - (a) Required MCPR: 4000 kPa (580 psi) at 93°C (200°F).

### *Standard of Acceptance*

- Kitz - fig. 300 SCLS
- Crane - fig. 33 XU-F
- Powell - fig. 3003-FC8G

## **2.8 Butterfly Valves - Flanged**

- .1 NPS 2 to NPS 12, ductile iron (type BFV-1):
  - .1 To MSS-SP-67, ductile iron lug body style, with flange bolt holes drilled and tapped for ANSI 150 flange pattern.
  - .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
  - .3 Stainless steel shaft, aluminum bronze or 316 stainless steel or ductile iron/nickel plated disc, and replaceable EPDM resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
  - .4 ISO 5211 mounting pad.
  - .5 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
  - .6 Certified for lead-free and contaminant-free service.

### *Standard of Acceptance*

- Nibco - fig. LD-2000
- Apollo - fig. LD 141, LD 145
- Kitz - fig. 6122EL
- MA Stewart - fig. L-D-4-A-E-LH
- Watts - fig. DBF-03
- Milwaukee - fig. ML233E, ML333E
- Crane Center Line fig. 200

.2 NPS 2 to NPS 12, stainless steel (Type BFV-2):

- .1 To MSS-SP-68, Class 300, CF8M stainless steel lug body style, with flange bolt holes drilled and tapped for ANSI 300 flange pattern.
- .2 Required MCPR: 4000 kPa (580 psi) at 93°C (200°F).
- .3 T316 or 17-4 stainless steel disc and shaft, TFM-PTFE seat complete with titanium or 316 stainless steel spiral wound back-up ring to provide bubble tight shut-off under system pressure from either side, when installed with single flange.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .6 Certified for lead-free and contaminant-free service.

*Standard of Acceptance*

- Apollo - fig. 230
- Keystone - fig. K-Lok 37

## 2.9 Inline Silent Check Valves

.1 NPS 2 and under:

- .1 To MSS SP-80, Class 125, bronze or stainless steel body, inline spring-actuated disc or ball type, and PTFE or EPDM seat.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Soldered ends:

*Standard of Acceptance*

- Nibco – fig. S-480-Y-LF
- Apollo – fig. CVB-LF (61LF-600)
- Kitz – fig. 826

.5 Threaded ends:

*Standard of Acceptance*

- Nibco - fig. T-480-Y-LF
- Apollo - fig. CVB-LF (61LF-500)
- Kitz - fig. 836

.2 NPS 2 to NPS 12:

- .1 To MSS SP-125, cast iron body with flat faced flange or wafer body, inline spring-actuated silent type, replaceable PTFE or BUNA-N seats, bronze faced iron or bronze disc.

- .2 Required MCPR: 13200 kPa (188 psi) at 65°C (150°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Class 125:
  - (a) Required MCPR: 1380 kPa (200 psi) at 65°C (150°F).

*Standard of Acceptance*

- Nibco - fig. F-910-W-LF, W-910-LF
- Valmatic - fig. VM-8802-S

- .5 Class 250:
  - (a) Required MCPR: 2700 kPa (392 psi) at 65°C (150°F).

*Standard of Acceptance*

- Nibco - fig. F-960-W-LF, W-910-LF
- Valmatic - fig. VM-8802-S

- .3 NPS 2 and over, grooved ends:
  - .1 CF8M stainless steel body with spring-assisted twin stainless steel discs, and fluoroelastomeric seat.
  - .2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).
  - .3 Certified for lead-free and contaminant-free service.

*Standard of Acceptance*

- Victaulic - fig. 816

**2.10 Double Regulating Valves (DRVLF)**

- .1 NPS 3 and under, threaded or soldered:
  - .1 Brass body, plug type stem with flow measurement ports and tamper-proof setting.
  - .2 NPT threaded or soldered ends.
  - .3 Required MCPR:
    - (a) Soldered: 2000 kPa (300 psig) at 93°C (200°F).
    - (b) Threaded: 2750 kPa (400 psi) at 93°C (200°F).
  - .4 Certified for lead-free and contaminant-free service.

*Standard of Acceptance*

- Bell and Gossett - fig. CB-\*-LF, RF-\*-LF
- Nexus - fig. Ultra MBNL
- Victaulic/Tour and Anderson - fig. 78BL

- .2 Flow meter for DRVs:
  - .1 Differential pressure gauge with calibration charts or digital flow meter type.
  - .2 Hoses and fittings to suit manual double regulating valves.

*Standard of Acceptance*

- Bell and Gossett - Readout Kit
- Nexus - Meter Kit, MKM series



**2.11 Automatic Flow Balancing Valve (AFBV)****.1 NPS ½ to NPS ¾, threaded:**

- .1 Automatic flow balancing valve providing constant flow rate over a wide differential pressure control range.
- .2 Stainless steel or brass body, with stainless steel cartridge and EPDM seals.
- .3 Performance:
  - (a) +/- 5% flow rate over 95% of control range.
  - (b) Differential pressure control range: minimum of 14 to 220 kPa (2 to 32 psi) operating range.
- .4 NPT threaded ends.
- .5 Minimum MCPR: 2750 kPa (400 psi) at 93°C (200°F).
- .6 Certified for lead-free and contaminant-free service.

*Standard of Acceptance*

- Victaulic/Tour and Andersson - fig. 76X
- Griswald Controls - fig. K Valve

**3 EXECUTION****3.1 Installation**

- .1 Refer to section 20 05 23 and as required herein.
- .2 Use certified lead-free and contaminant-free valves on potable cold, hot and recirculating water systems. Valves not certified as lead-free may only be used on non-potable water systems, pumped drainage systems and other similar systems.

**3.2 Valve Selection Based on Pressure Rating**

- .1 Unless otherwise specified herein or shown, select valves that have a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 22 05 01.
- .2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select valves as follows:
  - .1 for all valves, select a valve with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level,
  - .2 for clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

**3.3 Manual Valve Selection Based on Service and Pipe Material**

- .1 Select manual valve types based on the requirements of Table 1.

<b>Table 1: Manual Valve Selection</b>		
Piping System	Pipe and Tube Material	Manual Valve Type
Domestic Cold Water Domestic Hot Water Domestic Recirculating Water Domestic Tempered Water	Copper	BV-1 GLV-1 GTV-1, GTV-2 BFV-1, BFV-2, BFV-5

Table 1: Manual Valve Selection		
Piping System	Pipe and Tube Material	Manual Valve Type
Non-potable water	Stainless Steel	BV-2 BFV-2, BFV-4
	Ductile Iron	BFV-1, BFV-2, GTV-2
	Copper	BV-1 GLV-1 GTV-1 BFV-1, BFV-2, BFV-5
	Stainless Steel	BV-2 BFV-2, BFV-4
	Galvanized Steel	BV-1, BV-2 GLV-1 GTV-1, GTV-2, GTVNP BFV-1, BFV-2, BFV-3, BFV-4

### 3.4 Check Valves

- .1 Select check valves based on the requirements of Table 2.

Table 2: Check Valve Type Selection	
General use	Inline silent check
Temperature mixing valves	Inline silent check

### 3.5 Double Regulating Valves Installation

- .1 Consult with double regulating valve manufacturer to ensure correct valve selection. Balancing valves to be sized according to design flow rate.
- .2 Size and select valves for flows as shown, based on at 6 kPa (2 ft) pressure drop across the valve in the fully open position, and in accordance with manufactures recommendation. Table 3 identifies the nominal valve size selection:

Table 3: Double Regulating Valve Nominal Sizing				
Valve Size NPS	Nominal Flow			
	Min.	Max.	Min.	Max.
	L/s	L/s	gpm	gpm
½	0.038	0.177	0.6	2.8
¾	0.126	0.379	2.0	6.0
1	0.246	0.631	3.9	10.0
1-¼	0.316	0.947	5.0	15.0
1-½	0.416	1.262	6.6	20.0

2	0.795	2.272	12.6	36.0
2-½	2.398	6.310	38.0	100.0
3	1.956	8.203	31.0	130.0
4	4.291	12.620	68.0	200.0
5	5.679	20.192	90.0	320.0
6	11.48	28.395	182.0	450.0
8	23.16	51.742	367.0	820.0
10	34.07	82.030	540.0	1300.0
12	60.58	94.650	960.0	1500.0

- .3 Install double regulating valves with five pipe diameters of straight pipe on inlet side, two pipe diameters on outlet side and 10 pipe diameters from any pump.
- .4 Install double regulating valves with ports facing horizontal or facing up. Do not install with ports facing down to prevent debris from falling and accumulating inside the ports.

### **3.6 Automatic Flow Balancing Valves Installation**

- .1 Select automatic flow balancing valves to suit the flow rates as shown at a pressure differential of 35 kPa (5 psig). Where the indicated flow rate falls between two catalogued values, select the lower flow rated valve.

**End of Section**

## TESTING ADJUSTING AND BALANCING FOR PLUMBING 22 05 93

### 1 GENERAL

#### 1.1 Scope

- .1 Test, adjust, and balance ("TAB") plumbing systems installed, modified or extended as part of this work, including:

- .1 domestic cold water booster pumps,
- .2 domestic hot water systems,
- .3 domestic hot water recirculation systems

#### 1.2 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

*Standard of Acceptance* (no alternatives)

- Air & Water and Precision Balancing – Matthew Crittenden matt@awpbgroup.com – 647-896-5353

#### 1.3 Accuracy

- .1 Adjust systems until operating values are within the acceptance criteria stated for each system type. Where an acceptance criterion is not stated, balance the system so that measured values are within  $\pm 5\%$  of design value.
- .2 Measurement device accuracy:

Measurement	Application	Device	Accuracy
Liquid Flow	Piping	Installed meter	As per meter rating
Liquid Flow	Equipment	Differential Pressure and equipment data	See below
Temperature	Liquids	Digital Electronic Thermometer	$\pm 0.2^{\circ}\text{C}$ over 0 to $+40^{\circ}\text{C}$
Temperature	Liquid	Digital Electronic Thermometer	$\pm 0.4^{\circ}\text{C}$ < $0^{\circ}\text{C}$ and $>+40^{\circ}\text{C}$
Pressure	Liquid, Gas, Steam	Bourbon type	$\pm 1.0\%$ of reading
RPM	Motor, fans	Chronometer tachometer	$\pm 1.0\%$ of reading
Voltage	All	Portable	$\pm 2.5\%$ of reading
Current	All	Portable clamp-on ammeter	$\pm 2.5\%$ of reading

#### 1.4 Audit Verification

- .1 After review of the draft TAB report by Consultant, the Consultant may at their sole discretion require re-measurement of TAB results on an audit sample rate of 5% of all measured equipment, at no cost extra to the Contract Price or change to project schedule.

- .2 If audited results indicate a variance of more than 10% between the original reported value and the audit measured value for a piece of equipment, re-balance the audited device. If this excessive variance condition occurs at more than 25% of the number of audited equipment sample, re-balance the entire affected system at no cost extra to the Contract Price or change to project schedule.

## **1.5 Preparatory Work**

- .1 Review design drawings and specifications, shop drawings, interference drawings and other related documentation to become familiar with their intended performance.
- .2 Carry out site visits during later stages of construction to ensure that arrangements for TAB are incorporated. Confirm proper placement of thermometer wells, test ports, pressure gauge cocks, and balancing valves.
- .3 Commence TAB measurements when building is “closed in” and work is sufficiently advanced including;
- .1 permanent heating is in operation,
- .2 potable water systems have been flushed and cleaned.

## **1.6 Measurement Parameters**

- .1 Reporting units of measure:

Parameter	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Volume	litre	L
Volume flow rate	Litres per second	L/s
Time	seconds	s
Temperature	Celsius	°C
Pressure	kilopascal	kPa
Pump Head	metre	m
Pump Pressure	kilopascals	kPa
Mass flow rate	kg per second	kg/s
Heat flow rate	kilowatts	kW
Electrical Power	kilowatts	kW
Voltage	Volts	V
Electrical Current	amps	A
Rotation speed	Rotations per minute	RPM

## **2 PRODUCTS**

### **2.1 Not used.**

## **3 EXECUTION – DOMESTIC WATER DISTRIBUTION**

### **3.1 Measurement Parameters**

- .1 The following measurement parameters identify the minimum requirements for inclusion in the TAB process:
  - .1 volume flow rate,
  - .2 temperature,
  - .3 pressure (gauge),
- .2 Measurement are required to characterize system performance;
  - .1 water flowrates at plumbing fixtures,
  - .2 hot water recirculation flow rates.

### **3.2 General Requirements**

- .1 Use permanent water flow meters, temporary non-invasive flow meters, or metered fittings and pressure gauges to determine flow rates for system balance.
- .2 Base flow balance flow rates on (in order of preference):
  - .1 permanent flow meters,
  - .2 temporary non-invasive flow meters,
  - .3 double regulating valves,

### **3.3 Hot Water Recirculation Balancing Procedure**

- .1 Where circuit-balancing valves are used on hot water recirculation systems, adjust each valve to obtain the required design flow rate.
- .2 Where pressure-independent flow regulating valves are used in a hot water recirculation system, for each valve;
  - .1 measure system static pressure at the closest service sink to the pressure-independent flow control valve where a pressure gauge may be added to the faucet outlet ("adjacent system inlet static pressure"), and record system static pressure at the at-test system operating condition,
  - .2 measure system static pressure at the inlet to the recirculating pump,
  - .3 verify model type and size of each pressure-independent flow regulating valve and record results in the TAB report. Include the following data for each valve:
    - (a) location of flow control valve (i.e. floor level, room reference),
    - (b) adjacent system inlet static pressure,
    - (c) recirculation pump inlet static pressure,
    - (d) calculated differential pressure estimate (excluding pipe friction losses),
    - (e) valve model and size, with flow rate at the calculated differential pressure.

### **3.4 Plumbing Fixtures Hot Water Test Procedure**

- .1 At each floor level, measure the cold and hot water static pressure at the outlet of any fixture that can have a pressure gauge attached to it.

- .2 For plumbing fixtures with automatic hot water temperature or pressure control, test and set each fixture as follows:
  - .1 flow hot water from the fixture for a sufficient time to stabilize hot water temperature,
  - .2 if hot water temperature is greater or less than specified water supply temperature, adjust fixture to obtain required hot water outlet temperature,
  - .3 record adjusted temperature results for all fixtures.
- .3 For sinks and lavatories, perform the following hot water time-to-delivery test;
  - .1 randomly select 10% of all fixtures, evenly distributed by type and over each floor, with selections approved by Consultant,
  - .2 do not select a fixture where it shares a portion of a hot water dead-leg pipe with another selected test fixture,
  - .3 allow each floor to be at rest (no water flow from plumbing fixtures) for a period of 24 hours prior to conducting the time-to-delivery test,
  - .4 at each fixture, run hot water (or tempered water for fixtures with blending valves) into a receptacle that has a bottom outlet, with the outlet sized to allow water to collect in and simultaneously drain from the receptacle. Record the time required for the hot water in the receptacle to stabilize at the expected water outlet temperature,
  - .5 after completion of the preceding test, measure the flow rate from the fixture using another receptacle and a stop-watch,
  - .6 record the time-to-delivery of design hot water temperature and measured flow rate for each selected fixture. Include the fixture type and room location of the fixture.

## **4 EXECUTION - MISCELLANEOUS**

### **4.1 Balance Position Marking**

- .1 Mark the balance position of valves at the completion of the final testing:
  - .1 valves: self-adhesive label, placed on piping (insulated or not) adjacent to valve, neatly filled in with either % valve open, or number of valve turns to open.
- .2 Additional requirements for circuit-balancing valves with test ports:
  - .1 remove valve handle or other protective device, and set memory stop to limit valve open travel. Replace valve handle or protective cover.

## **5 EXECUTION - REPORT PRESENTATION AND VERIFICATION**

### **5.1 Required Reports**

- .1 Provide the following reports:
  - .1 Water balancing and equipment test report.

### **5.2 Record Keeping**

- .1 Keep records of trial and final balance and submit preliminary report as each system is completed.
- .2 Do not submit the final TAB report until all audit verification re-measurements, and any required re-balancing, is completed to the satisfaction of Consultant.

### **5.3 Report Format**

- .1 Reports to incorporate approved standard forms, with values expressed in the same units as shown on Contract Documents.
- .2 Include "as-built" system schematics, marked-up to show as-measured flow quantities and measurement points. Use as-built drawings and ventilating line diagrams for reference.
- .3 Submit an electronic PDF copy of the draft TAB report for review by Consultant. Where a report page length is more than 20 pages, include bookmarks in the PDF document organizes by system number and/or name.
- .4 After any revisions requested by Consultant have been made and final review accepted by Consultant, submit the final TAB report in the following formats:
  - .1 two (2) hard copies of the completed report, each with index tabs and bound in "D" ring binders,
  - .2 electronic file PDF copies by email or drop-box as coordinated with Owner and Consultant.

### **5.4 Completion**

- .1 Continue TAB until reports are approved.
- .2 The Substantial Performance of the Mechanical Work will be considered reached when the initial Start-Up and Performance Testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance.
- .3 The substantial performance of the Work is not dependent upon alternate season testing.
- .4 The total performance of the Work will not be considered reached until the alternate season testing and balancing is completed and the final report submitted has been reviewed by Consultant and accepted by the Owner.

**END OF SECTION**



## DOMESTIC WATER PIPING - COPPER 22 11 16.13

### 1 GENERAL

#### 1.1 Scope

- .1 Provide copper tube and fittings for potable domestic water piping systems for aboveground installations.

#### 1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 24 Welding and Brazing
  - .2 22 05 01 Plumbing Piping Systems – General Requirements
  - .3 22 05 23.13 General-duty Valves for Plumbing Piping
  - .4 20 05 29 Common Hanger and Support Requirements for Piping

#### 1.3 Definitions

- .1 The following definitions apply to this specification section:
  - .1 **Exposed areas:** include inside service rooms and above lay-in tile ceilings, but excludes: vertical and horizontal service shafts; above any other ceiling construction; and inside walls and partitions.

#### 1.4 Applicable Codes and Standards

- .1 Installation standards:
  - .1 Copper Development Association (CDA) Copper Tube Handbook
- .2 Product standards:
  - .1 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
  - .2 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
  - .3 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
  - .4 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
  - .5 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
  - .6 ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature
  - .7 ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
  - .8 ASTM B32 Standard Specification for Solder Metal
  - .9 ASTM B88 Standard Specification for Seamless Copper Water Tube
  - .10 ASTM B813 Standards Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
  - .11 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
  - .12 AWS A5.8 Brazing Filler Metal.

- |                |  |
|----------------|--|
| .13 AWS A5.31  | Specification for Fluxes for Brazing and Braze Welding                 |
| .14 AWS C3.4   | Specification for Torch Brazing  |
| .15 MSS SP-106 | Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300 |

## **2 PRODUCTS**

### **2.1 Copper Tube**

- .1 Hard drawn, type L.
- .2 Listed to ASTM B88 and to have certification markings made by testing agency accredited by Standards Council of Canada.

### **2.2 Fittings**

- .1 Brass or bronze flanges and flanged fittings: to ASME B16.24.
- .2 Brass or bronze threaded fittings: to ASME B16.15.
- .3 Solder/brazed fittings: cast bronze to ASME B16.18, or wrought copper and bronze to ASME B16.22.
- .4 Threaded fittings including unions to ASME B16.15, Class 250.

### **2.3 Joints**

- .1 Solder: 95:5 tin-antimony solder to ASTM B-32.
- .2 Silver brazing alloy to AWS A5.8 classification BCUP-5.

#### *Standard of Acceptance*

- Handy Harman "SIL-FOS"
- All-State Welding Alloys "SILFLO 15"

#### **.3 Flanges:**

- .1 Threaded end connection: flat face, cast copper alloy to ASME B16.24, class 150 and 300, NPT threaded,
- .2 Brazed end connection: flat face, cast copper alloy to MSS SP-106, class 150 or 300.
- .3 Dielectric flanges: to specification section 22 05 01.
- .4 Studs and bolts: stainless steel to ASTM A193.
- .5 Nuts: stainless steel type 316, to ASTM A194.

#### **.4 Flange gaskets:**

- .1 Full flat-faced style to ANSI B16.21.
- .2 Suitable for use in potable water service and listed to NSF/ANSI 61.
- .3 Ethylene propylene diene monomer (EPDM);
  - (a) required working pressure: 1700 kPa (250 psi) at up to 95°C (203°F)
- .4 Compressed mineral fibers bonded with nitrile (NBR);
  - (a) required working pressure: 2750 kPa (400 psi) at up to 95°C (203°F)

#### *Standard of Acceptance*

- American-Biltrite (EPDM) – fig. AB-576
- Durlon (NBR) – fig. 7910

### 3 EXECUTION

#### 3.1 Installation

- .1 Refer to section 22 05 01 for piping design criteria and general requirements for piping installation.
- .2 Install tubing close to building structure to minimize furring and conserve headroom. Group tubing and run parallel to walls and ceilings.
- .3 Cut tube square, ream tube ends and clean tubing and tube ends before joint assembly.
- .4 Before making solder or brazed joints, remove working parts of valves, clean inside of solder fittings and outside of mating pipe with emery paper and coat with applicable flux.

#### 3.2 Pipe Supports

- .1 Support piping and tubing in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal copper tubing at intervals in accordance with Table 1:

Table 1: Horizontal Pipe Support Spacing for Copper Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ to 1¼	M10 (3/8 in)	1.8 m (6 ft)
1½	M10 (3/8 in)	2.4 m (8 ft)
2	M10 (3/8 in)	2.4 m (8 ft)
2½	M12 (½ in)	3.0 m (10 ft)
3	M12 (½ in)	3.0 m (10 ft)
4	M16 (5/8 in)	3.0 m (10 ft)

- .1 Support vertical pipe and tube risers;
  - .1 at the base (bottom) of the riser by a support that is independent of any adjacent horizontal pipe supports,
  - .2 at every other floor level with pipe riser clamps, but not to exceed a vertical spacing of more than 7.5 m (24.5 ft).

#### 3.3 Class Rated Fittings

- .1 Select ASME Class rated fittings and flanges in accordance with the following Table 2 for design pressure limits at coincident design temperature limits unless otherwise shown on drawings.

Table 2: Pressure and Temperature Limits for Class Rated Fittings		
Class	Maximum Design Pressure	Maximum Coincident Design Temperature
150	1720 (250 psi)	≤ 38°C (100°F)

Table 2: Pressure and Temperature Limits for Class Rated Fittings		
Class	Maximum Design Pressure	Maximum Coincident Design Temperature
150	1400 kPa (200 psi)	≤ 121°C (250°F)
300	3700 kPa (535 psi)	≤ 38°C (100°F)
300	3100 kPa (450 psi)	≤ 121°C (250°F)

### 3.4 Joints and Fittings

- .1 Joints in tubing:
  - .1 NPS ½ to NPS 2:
    - (a) soldered.
  - .2 NPS 2-1/2 and larger:
    - (a) brazed, flanged joints.
- .2 Make solder joints in accordance with the recommendations of the CDA handbook.
- .3 Make braze joints in accordance with specification section 20 05 24.
- .4 Use manufactured fittings. Use of fabricated pulled-tee's is subject to approval by the local municipal authority for plumbing, and only brazed butt weld joints shall be used.
- .5 For flange joints, select gasket materials in accordance with the following Table 3 so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

Table 3: Flange Gasket Selection				
Gasket Temperature Limit	Gasket Pressure Limit	Gasket Material	Gasket Thickness	Figure
95°C (203°F)	1720 kPa (250 psig)	EPDM	1.5 m (1/6 in)	A-B AB-576
	2750 kPa (400 psig)	NBR	1.5 m (1/6 in)	Durlon 7910

### 3.5 Equipment Connections

- .1 Make pipe connections to equipment as follows.
  - .1 NPS 2 and smaller: threaded fittings.
  - .2 NPS 2 ½ and larger:
    - (a) flanged connections, or
    - (b) grooved end where equipment has compatible factory-prepared grooved ends.

- .2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.
- .3 For threaded flanges, provide a sweat x NPT adaptor; do not thread tubing directly.
- .4 Provide a dielectric union or dielectric flange in accordance with specification section 22 05 01 when connecting potable water piping to equipment with carbon steel connections. Dielectric fittings are not required when connecting to equipment with stainless steel connections.

### **3.6 Valves**

- .1 Provide valves in accordance with specification section 22 05 23.13.
  - .1 Isolate equipment, fixtures and branches with gate, ball or butterfly valves.
  - .2 Use globe, DRVs, ball or butterfly valves for throttling service.

### **3.7 Pressure Testing, Flushing and Balancing**

- .1 Pressure test, flush and balance water systems to specification section 22 05 01.

**END OF SECTION**

## **DOMESTIC WATER PIPING SPECIALTIES**

### **22 11 19**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide domestic water piping specialties and accessories.

##### **1.2 Applicable Codes and Standards**

- .1 Product standards:
  - .1 ANSI/ASSE 1010 Water Hammer Arrestors
  - .2 CSA-B125 Plumbing Fittings.
  - .3 CSA B.64.1.1 Atmospheric Vacuum Breakers (AVB)
  - .4 CSA B.64.1.2 Pressure Vacuum Breakers (PVB)
  - .5 CSA B64.2.1 Hose Connection Vacuum Breaker (HCVB) with Manual Drain Feature
  - .6 CSA B64.4 Backflow Preventers, Reduced Pressure Principle (RP)
  - .7 CSA B64.5 Backflow Preventers, Double Check Valve Type (DCVA)
  - .8 CSA B64.10 Manual for the Selection and Installation of Backflow Prevention Devices/Manual for the Maintenance and Field Testing of Backflow Prevention Devices
  - .9 CSA B137.6 Chlorinated Polyvinylchloride (CPVC) Pipe, Tubing, and Fittings for Hot- and Cold-Water Distribution Systems
  - .10 CSA C22.2 No. 14 Industrial Control Equipment
  - .11 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
  - .12 NSF/ANSI/CAN 61 Drinking Water System Components – Health Effects
  - .13 NSF/ANSI/CAN 372 Drinking Water System Components – Lead Content
  - .14 PDI-WH201 Plumbing and Drainage Institute - Standard Water Hammer Arresters

##### **1.3 Submittals**

- .1 Submit product data sheets for materials specified herein.

#### **2 PRODUCTS**

##### **2.1 Water Hammer Arresters**

- .1 Stainless steel construction with precharged air chamber of nesting bellows.
- .2 Selected in accordance with Plumbing and Drainage Institute Standard PD1-WH201.
- .3 Listed to ANSI/ASSE 1010

##### *Standard of Acceptance*

- Jay R. Smith - fig. Hydrotrol 5000 series
- Mifab - fig. WHB series
- Zurn - fig. Shocktrol Z-1700 series]

## **2.2 Trap Seal Primers**

### **.1 Electrically operated manifold units – Type A:**

- .1 factory assembled in 1.5 mm (16 ga) recessed metal cabinet with hinged stainless steel lockable access door,
- .2 atmospheric vacuum breaker,
- .3 24 hr controller with manual over ride switch,
- .4 120 Volt solenoid valve,
- .5 NPS ¾ or NPS ½ valved inlet water connection,
- .6 calibrated water distribution manifold,
- .7 NPS ½ outlet compression fittings,
- .8 power supply: 120 VAC.

#### *Standard of Acceptance*

- Precision Plumbing Products - fig PT-3 thru PT-30
- Mifab - fig.MI-100

### **.2 Electrically operated manifold units – Type B:**

- .1 Same as Type A electronic trap seal primer, except distribution manifold is shipped loose for field installation external to the trap primer cabinet.

## **2.3 Back-flow Preventers - Reduced Pressure Principle ("RP")**

### **.1 Listed to CSA B.64.4.**

### **.2 Type: two independent check valves with intermediate relief valve and drain port,**

### **.3 NPS ½ to 2:**

- .1 quarter turn full port resilient seated ball valves on inlet and discharge connections,
- .2 bronze inlet strainer,
- .3 four (4) ball-valve test cocks,
- .4 air gap drain,
- .5 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.
- .6 required MCPR: 1200 kPa (175 psi) at 82°C (180°F).

#### *Standard of Acceptance*

- Watts - fig. LF909QT
- Apollo - fig. RPLF4A

### **.4 NPS 2 to 10:**

- .1 butterfly or OS&Y resilient seated gate valves on inlet and discharge connections,
- .2 four (4) ball-valve test cocks,
- .3 air gap drain body,
- .4 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.
- .5 required MCPR: 1200 kPa (175 psi) at 60°C (140°F).

*Standard of Acceptance*

- Watts - fig. LF909-OSY
- Apollo - fig. RPDA40
- Cla-val Company - fig. RP-1EX

**2.4 Back-flow Preventers – Double Check Valve Assemblies (“DCVA”)**

- .1 Listed to CSA B64.5.
- .2 Type: double check valve backflow preventers, with two positive seating spring-loaded check valves.
- .3 NPS ½ to 2:
  - .1 bronze body, replaceable seats and seat discs,
  - .2 quarter turn full port resilient seated ball valves on inlet and discharge connections,
  - .3 bronze inlet strainer,
  - .4 four (4) ball-valve test cocks,
  - .5 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.
  - .6 required MCPR: 1200 kPa (175 psi) at 82°C (180°F).

*Standard of Acceptance*

- Watts - fig. LF007QT series
- Apollo - fig. DCLF4A series
- 

- .4 NPS 2-1/2 to NPS 10:
  - .1 T304 stainless steel body and stainless steel, bronze and EPDM trim,
  - .2 OS&Y resilient seated gate valves, or butterfly valves on inlet and discharge connections,
  - .3 four (4) ball-valve test cocks,
  - .4 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.
  - .5 required MCPR: 1200 kPa (175 psi) at 60°C (140°F).

*Standard of Acceptance*

- Watts - fig. LF757, LF757N
- Apollo - fig. DCLF4A series (NPS 2-1/2 to 8 only).

**2.5 Vacuum Breakers**

- .1 Atmospheric type (“AVB”):
  - .1 listed to CSA B.64.1.1.
  - .2 NPS ¼ to 3:
    - (a) atmospheric type (AVB), with single float and disc, and
    - (b) large atmospheric port.

*Standard of Acceptance*

- Watts - fig. 288A
- Cash Acme - fig. V-101

- .2 Pressure type (“PVB”):



- .1 listed to CSA B.64.1.2.
- .2 NPS ½ to 2:
  - (a) pressure type (PVB) with spring loaded single float and disc,
  - (b) independent first check, shut off valves, and ball type test cocks.

*Standard of Acceptance*

- Watts - fig. 800

- .3 Hose connection type ("HCVB"):

- .1 listed to CSA B.64.2
- .2 NPS ¾:
  - (a) atmospheric vent vacuum breaker with non-removable single check,
  - (b) hose connection,
  - (c) drainage feature to prevent freezing,

*Standard of Acceptance*

- Watts - fig. 8
- Cash Acme – fig. V-3

## **2.6 Backflow Preventer Valve Cabinets**

- .1 Recessed mount, [stainless steel with No. 4 satin polish finish][primed steel for field painting];
- .2 1.2 mm (16ga) welded one piece tub with adjustable face frame,
- .3 Solid door with rounded safety cornered door, continuous exposed piano hinge and cam latch,
- .4 Integral 50mm (2") high drain pan at bottom of tub, sloping to an NPT 1" center drain outlet,
- .5 Hole punching for piping penetrations as shown.
- .6 Cabinet size:
  - .1 single valve : 826mm x 762mm x 152mm (32 ½" x 30" x 6") deep
  - .2 double valve: 826mm x 1219mm x 152mm (32 ½" x 48" x 6") deep

*Standard of Acceptance*

- Acudor - fig. BFP-1 for single valves
- Acudor - fig. BFP-2 for double valves

## **2.7 Pressure Reducing Valves**

- .1 Bronze body, self-contained type, single renewable nickel alloy seat and resilient disc.
- .2 Diaphragm suitable for 90°C (200°F) service.
- .3 Close coupled bronze strainer with stainless steel screen.
- .4 Required MCPR: 2060 kPa (300 psi) at 49°C (120°F).
- .5 Flow rates and pressure reduction: as shown on drawings.
- .6 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.

*Standard of Acceptance*

- Watts
- Cash Acme Valve
- Singer Valve
- Leslie
- Victaulic Bermad

## **2.8 Pressure Relief Valves**

- .1 Brass body to ASME Section IV.
- .2 Preset pressure settings: 515, 700, 860 and 1030 kPa (75, 100, 125 and 150 psi).
- .3 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.

### *Standard of Acceptance*

- Watts - fig. LF3L

## **2.9 Strainers**

- .1 NPS ½ to NPS 3:
  - .1 wye pattern, bronze body, solid retainer cap with gasket, and NPT threaded or soldered end,
  - .2 type 304 stainless steel baskets: 1.2 mm (3/64 in) diameter perforations,
  - .3 required MCPR: 2750 kPa (400 psi) at 93°C (200°F)
  - .4 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.

### *Standard of Acceptance*

- Watts - fig. LF777, LFS777
- Zurn - fig. YBXL
- Cash Acme

- .2 NPS 4 to NPS 10:
  - .1 simplex basket strainer, cast iron body, bolted screen retainer cover, plugged drain/blowdown NPT connection, ASME Class 125 flat faced flange ends,
  - .2 type 304 stainless steel baskets: 3.2 mm (1/8 in) diameter perforations,
  - .3 required MCPR: 1370 kPa (200 psi) at 66°C (150°F),
  - .4 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.

### *Standard of Acceptance*

- Watts - fig. LF98FB-CIB

## **3 EXECUTION**

### **3.1 Water Hammer Arresters**

- .1 Select, supply and install water hammer arrestors in accordance with PDI-WH 201 on branch supplies to each fixture or group of fixtures.
- .2 In addition, provide water hammer arrestors on branch supplies to each piece of owner's process equipment, of the size as shown.

### **3.2 Trap Seal Primers**

- .1 Electronic manifolds:

- .1 Install trap seal primer panels in the locations as shown on drawings to serve individual or groups of floor drains and/or hub drains.
- .2 120V/1ph/60 Hz power supply will be brought directly to trap seal primers units under Division 26 and connected under Division 22.
- .3 For Type B trap primer unit, pipe the outlet of the primer unit in type L hard-drawn copper down through the floor slab and connect to the trap primer distribution manifold located in ceiling space below.
- .2 Trap primer tubing:
  - .1 Use soft annealed copper tube to connect trap primer distribution manifold to floor drains and/or funnel drains.

### **3.3 Back-Flow Preventers and Vacuum Breakers**

- .1 Provide back-flow preventers and vacuum breakers in accordance with CSA B64.10.
- .2 Install backflow preventers horizontally, in accordance with manufacturer's recommendations, but not less than 750 mm (30 in.) and not greater than 1500 mm (59 in.) above the floor level, or a fixed work platform, in front of the valve.
- .3 Install pressure vacuum breakers not more than 1500 mm (56 in.) above the floor level, or a fixed work platform, in front of the valve.
  - .1 exception: where the pipe connection to the protected fixture or equipment is higher than 1500 mm (56 in.) above the floor, locate the pressure vacuum breaker at an elevation just high enough so that the outlet pipe to the fixture/equipment does not rise above the vacuum breaker.
- .4 Pipe relief ports and air vents from backflow preventer, with an air gap, to nearest floor/hub drain or service sink using hard-drawing DWV copper tube.
- .5 Position backflow preventers and pressure vacuum breakers so that test ports are accessible.
- .6 Provide cabinets for backflow preventers as shown.

### **3.4 Additional Requirements for Reduced Pressure Backflow Preventers**

- .1 For reduced pressure type (RP) backflow preventers, install an inline spring-loaded disc or ball type check valve with threaded ends, within 300 mm (12 in.) of the inlet connection to the RP backflow preventer. Provide a pipe union on the upstream side of this check valve.

### **3.5 Pressure-Reducing Valves**

- .1 Install pressure-reducing valves ("PRV") with upstream and downstream shut-off valve and unions and provide a 115 mm (4½ in) pressure gauge immediately downstream of the PRV.
- .2 For high-flow/low-flow parallel PRV arrangements, install the high-flow valve in the pipe main run and the low-flow valve in the offset run. Set the low-flow PRV setpoint to be 35 to 70 kPa (5 to 10 psi) greater than the high-flow PRV setpoint.

### **3.6 Pressure Relief Valves**

- .1 Provide pressure relief valves as follows:
  - .1 after each pressure reducing valve,
  - .2 after each backflow preventer, and
  - .3 where shown on drawings.
- .2 Select relief valve setpoint to be not more than the design pressure of the piping system.

### **3.7 Strainers**

- .1 Install with sufficient space to remove baskets.
- .2 Provide a valved blow-down drain line on NPS 4 to NPS 10 basket strainers, and pipe blow-down line in hard type L copper tube and terminate over floor drain, hub drain or trench drain.

**END OF SECTION**

## **SANITARY WASTE AND VENT PIPING – CAST IRON AND COPPER**

### **22 13 16.13**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide cast iron pipe and fittings and/or copper tube and fittings for sanitary soil and waste drain and vent piping, for aboveground and buried services.

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 29 Common Hanger and Support Requirements for Piping

### **1.3 Applicable Codes and Standards**

- .1 Installation standards and codes:
  - .1 Cast Iron Soil Pipe Institute (CISPI) Technical Manual
- .2 Product standards:
  - .1 ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings: DWV
  - .2 ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings-DWV
  - .3 ASTM B32 Standard Specification for Solder Metal
  - .4 ASTM B306 Standard Specification for Copper Drainage Tube (DWV)
  - .5 ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
  - .6 ASTM C1540 Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
  - .7 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
  - .8 CSA B70 Cast Iron Soil Pipe, Fittings, and Means of Joining
  - .9 CSA-B125 Plumbing Fittings.
  - .10 CSA B158.1 Cast Brass Solder Joint Drainage, Waste, and Vent Fittings
  - .11 CSA B602 Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

## **2 PRODUCTS**

### **2.1 Copper DWV Pipe and Fittings**

- .1 Application: inside of buildings only. Do not use for buried drain or vent.
- .2 Pipe:
  - .1 copper DWV tube to ASTM B306
  - .2 certification markings made by testing agency accredited by Standards Council of Canada.
- .3 Fittings:
  - .1 copper or copper alloy to ASME B16.23, or ASME B16.29.
- .4 Solder

- .1 tin-antimony 95/5 to ASTM B32 alloy Sb5.

## **2.2 Cast Iron DWV Pipe and Fittings**

- .1 Application: inside of buildings and buried drain and vent.
- .2 Pipe and fittings:
  - .1 cast to CSA B70,
  - .2 with heavy bituminous coating for buried service.
  - .3 riser fittings with integral riser support ring for hub-less piping installed in vertical risers.
- .3 Joints above ground:
  - .1 Plain end made up using mechanical sleeve joints to CSA B602 and ASTM C1540 with neoprene or butyl rubber compression gaskets to ASTM C564, with stainless steel sleeve and not less than four stainless steel drive clamps with stainless steel worms.
  - .2 Hub and spigot made up neoprene gasket to ASTM C564 and lubricating compound.

## **3 EXECUTION**

### **3.1 Installation General**

- .1 Install soil, waste and vent piping in accordance with the requirements of the plumbing code applicable at the project location. Except as otherwise shown, venting of fixtures may use any method permitted in the plumbing code.
- .2 Install suspended piping to grade, parallel and close to walls and ceilings to conserve headroom and space.
- .3 Install piping close to building structure to minimize furring. Group piping and run parallel to walls and ceilings.

### **3.2 Cast Iron Piping**

- .1 Install cast iron drainage piping in accordance with Cast Iron Soil Pipe and Fittings (CISPF) Technical Manual.
- .2 Lay buried piping in bedding prepared in accordance with specification section 20 05 25. Support piping on 150 mm (6 in.) thick bedding material, shaped to accommodate hubs and fittings, to line and grade as shown. Backfill with cover material to 300 mm above top of pipe or to underside of floor slab whichever is less.
- .3 Assemble and tighten mechanical sleeve joints to coupling manufacturers recommended torque value with torque wrench.
- .4 Install cast iron hub-and-spigot joints with neoprene compression gasket and lubrication in accordance with manufacturer requirements.
- .5 Provide thrust restraints consisting of pipe clamps and restraint rods installed across tees, elbows, and blind plugs (cleanouts), for cast iron drainage piping NPS 5 and larger.
- .6 Provide sway braces on all horizontal piping where the hanger length is greater than 450 mm (18 in) measured from the top of the pipe to the structure connection point, as follows:
  - .1 transverse brace at 12 m (40 ft) intervals,
  - .2 longitudinal brace at 24 m (80 ft) intervals,

- .3 a transverse brace of one pipe section may act as a longitudinal brace for a second pipe section connected perpendicular to the first section, provided the brace is located within 600 mm (24 in) of the connection.
- .4 for clarity, these braces are required even where seismic restraint is not required.

### 3.3 Copper Tubing

- .1 Cut copper tube square, ream tube ends and clean tubing and tube ends before joint assembly.
- .2 Before assembling solder joints, clean inside of solder fittings and outside of mating pipe with emery paper and coat with flux.
- .3 Solder joints in copper pipe with blow torch or oxy-acetylene flame.

### 3.4 Pipe Supports

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal copper DWV tubing in accordance with Table 1A:

Table 1A: Horizontal Pipe Support Spacing for Copper Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ to 1¼	M10 (3/8 in)	1.8 m (6 ft)
1½	M10 (3/8 in)	2.4 m (8 ft)
2	M10 (3/8 in)	2.4 m (8 ft)
2½	M12 (½ in)	3.0 m (10 ft)
3	M12 (½ in)	3.0 m (10 ft)
4	M16 (5/8 in)	3.0 m (10 ft)

- .3 Support horizontal cast iron DWV piping in accordance with Table 1B and as follows;
  - .1 one pipe support for each end of the pipe, located at or within 150 mm (6 in) of each hub or mechanical joint,
  - .2 for mechanical joints, if the pipe length between adjacent fittings is 300 mm (12 in) or less, reduce the support spacing to a maximum of 1000 mm (39 in),
  - .3 where multiple joints occur within a 1000 mm (39 in) developed pipe length;
    - (a) support may be reduced to every other hub or mechanical joint, or
    - (b) where the pipe run is made of multiple fittings connected end-to-end, provide a 1.6 mm (16 ga) galvanized steel half sleeve underneath the pipe and fittings, and support the sleeve with a support at each end of the sleeve.

Table 1B: Horizontal Pipe Support Spacing for Cast Iron DWV Piping			
Pipe Size NPS	Maximum Spacing	Clevis Hanger: Minimum Rod Diameter	MJ Hanger: Minimum Rod Diameter
1-1/2	3 m (9.8 ft)	---	M10 (3/8 in)
2	3 m (9.8 ft)	---	M10 (3/8 in)
3 to 4	3 m (9.8 ft)	M10 (3/8 in)	M10 (3/8 in)
6	3 m (9.8 ft)	M12 (1/2 in.)	M12 (1/2 in.)
8 to 12	3 m (9.8 ft)	M16 (5/8 in)	---
15	3 m (9.8 ft)	M20 (3/4 in)	---

- .4 Support vertical pipe and tube risers at the base (bottom) of the riser and as follows:
  - .1 for cast iron drain and vent piping,
    - (a) support piping at every floor level with a pipe clamp, arranged so that the pipe clamp is above the pipe section center of gravity,
    - (b) support the pipe below a hub, or support the pipe with a riser fitting for hub-less joints.
    - (c) support the base of a riser at a fitting hub, or for mechanical joints support the riser pipe at a riser fitting,
    - (d) for pipe sizes NPS 5 and larger, provide sway braces at the base support to limit movement in both horizontal directions.
  - .2 for other piping, support piping at every other floor level with pipe riser clamps,
  - .3 for all piping and tubing, do not exceed a vertical spacing of more than 7.5 m (24.5 ft),
  - .4 in addition, for cast iron drainage piping provide lateral guides;
    - (a) at the base and top of the pipe riser,
    - (b) and at every 9 m (30 ft) except where the pipe riser clamp is restrained to prevent lateral movement.

### 3.5 Testing

- .1 Test drainage piping in accordance with the requirements of the plumbing code applicable at the project location.
- .2 Test before piping is concealed.
- .3 Cut-out and replace leaking soldered fittings, remake joints in cast iron piping, and retest.

**END OF SECTION**



## SANITARY DRAINS 22 13 19.13

### 1 GENERAL

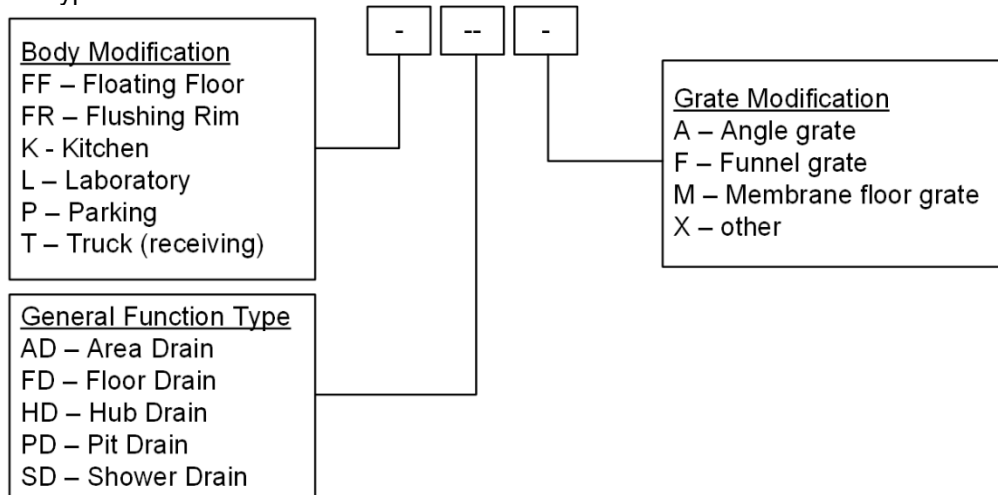
#### 1.1 Scope

- .1 Provide sanitary waste piping accessories including floor drains, area drains and cleanouts.

#### 1.2 Definitions

- .1 The following definitions apply to this specification section.
- .1 **Grate:** the finished exposed element of the floor or area drain which is suitable for heavy loads including vehicle loads.
  - .2 **Sheet waterproof flooring:** includes vinyl sheet or tiles, linoleum sheet or tiles, and rubber sheet or tiles, which have an installed thickness of 6 mm (1/4 in.) or less.
  - .3 **Strainer:** the finished exposed element of the floor or area drain which is suitable for foot traffic only.
  - .4 **Strainer shank:** the strainer supporting element which connects to the drain body. Grate shank has the same meaning.
  - .5 **Tile (floors):** includes ceramic or porcelain tiles and similar materials that are thicker than 6 mm (1/4 in.) including mortar/adhesive bed.
- .2 Load ratings of Light Duty, Medium Duty, Heavy Duty, Extra Heavy Duty and Special Duty: in accordance with CSA B72 / ASME A112.3.1 / ASME A112.6.3.

- .3 Drain type nomenclature:



#### 1.3 Applicable Codes and Standards

- .1 Product standards:
- .1 ASME A112.3.1      Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications, Above-ground and Below Ground
  - .2 ASME A112.6.3      Floor and Trench Drains
  - .3 ASME A112.36.2M      Cleanouts

.4 CSA B79 Commercial and Residential Drains and Cleanouts

**1.4 Submittals**

- .1 Submit product data sheets for materials specified herein.

**2 PRODUCTS**

**2.1 Floor Drains (type "FD")**

- .1 Floor drains to be listed to CSA B79 and marked in accordance with ASME A112.3.1 (stainless steel floor drains), or ASME A112.6.3 (non-stainless steel floor drains).
- .2 The following requirements apply to all floor drains, combination drains, and hub drains except as otherwise specified.
- .3 Construction:
- .1 application: general purpose floor drains, for floors with or without a sub-floor membrane.
  - .2 loading: Light Duty to CSA B79, for foot traffic,
  - .3 body:
    - (a) coated cast iron with minimum Ø200 mm (8 in.) diameter anchor flange with primary and secondary drainage (seepage) openings,
    - (b) sub-floor membrane clamp,
    - (c) bottom hub outlet pipe connection.
    - (d) NPS ½ NPT trap seal primer connection.
    - (e) No-hub outlet.
  - .4 strainer:
    - (a) adjustable height, nickel bronze or stainless steel strainer secured with stainless steel tamper resistant (Allen key) screws,
    - (b) openings not exceeding 8 mm (5/16 in.) in any direction,
    - (c) round shape for poured monolithic floor finishes,
    - (d) square shape for tiled or similar floor finishes,
    - (e) minimum size: based on location in accordance with the following table.

Drain Pipe Size, NPS	Strainer/Grate Size mm (in.) diameter or square		
	General Purpose, Kitchens	Service Rooms, Wash Down Rooms, Emergency Fixtures	Parking, Loading Docks
2	125 (5)	125 (5)	---
3	175 (7)	200 (8)	---
4	200 (8)	250 (10)	250 (10)
6	250 (10)	250 (10)	250 (10)

- .5 Drain body pipe size as shown on drawings.

*Standard of Acceptance*

- Watts - fig. FD-100-C-A
- Zurn - fig. Z415 series
- Mifab - fig. F1100-C series
- Jay R. Smith - fig. 2005-C series

## **2.2 Funnel Floor Drain (type “FDF-”) – General Purpose**

- .1 Application: floors in general purpose spaces and service rooms.
- .2 Type FD floor drains and/except as follows:
  - .1 floor drains other than in service rooms: one piece integral funnel and open-throat strainer, Ø100mm (4 in. dia.) round funnel,
  - .2 floor drains in service rooms: one piece integral funnel and open-throat strainer, 100 mm x 225 mm (4 in. x 9 in.) elliptical funnel.

## **2.3 Shower Drains (type “SD”)**

- .1 Application: for tiled floor showers and other wet areas with sub-floor membrane,
- .2 Type FD floor drain and/except as follows:
  - .1 Strainer: polished T304 stainless steel strainer and strainer shank.

## **2.4 Cleanouts**

- .1 Listed to CSA B79 and marked in accordance with ASME A112.36.2M.
- .2 In floors:
  - .1 line size for NPS 2, NPS 3 and NPS 4, and NPS 4 in larger lines.
  - .2 body: cast iron body with sub-floor membrane clamp, and with gas-tight plug.
  - .3 head - unfinished floor areas including service rooms:
    - (a) coated cast iron frame heavy duty scoriated cast iron round.
  - .4 head - finished floor areas:
    - (a) round, coated cast iron frame and polished nickel bronze adjustable head cover.

### *Standard of Acceptance*

- Watts - fig. C-100 series
- Zurn - fig. Z-1400 series
- Mifab - fig. C1100 series
- Jay R. Smith - fig. 4000 series

- .3 In exposed areas, ceiling spaces and accessible pipe chases,
  - .1 cast iron caulking ferrule with neoprene jacket and plug secured to body with cap screws.

## **3 EXECUTION**

### **3.1 Installation - General**

- .1 Install sanitary drainage specialties in accordance with the applicable provincial plumbing code, and the requirements of the local authority having jurisdiction.
- .2 Install sanitary drainage specialties in accordance with the manufacturers installation instructions and as described herein.

**3.2 Floor Drains and Area Drains**

- .1 For floors constructed with a sub-floor membrane;
  - .1 install bodies flush to top of structural slab, and provide temporary coverings to protect top surface of anchor flange, receiver threads and body openings during concrete pour,
  - .2 after the sub-floor membrane is installed, install the membrane clamp and strainer and set the strainer top to be at the finished floor level or slightly lower,
- .2 For floors constructed as a single concrete pour without a sub-floor membrane, set the body and the strainer to suit the final floor elevation prior to concrete pour. Provide temporary covering of the strainer top surface.
- .3 For all types of floors, place clear pea gravel around the top of the anchor flange to protect the primary and secondary weeping drainage openings from being plugged with concrete or other flooring material.
- .4 Where shown on drawings for a combination floor drain, install a hub of specified type by attaching to the floor drain strainer.

**3.3 Cleanouts**

- .1 Install cleanouts at the base of soil and waste stacks, at changes in direction of sanitary drainage piping, at intermediate locations on long runs of piping, and as shown.
- .2 Extend cleanouts flush to wall or up to finished floor above except as follows:
  - .1 clean-outs may be terminated in accessible ceiling spaces except where drawings indicate the clean-out is to be extended up through the floor.
- .3 Install cleanouts located in floors clear of obstructions.

**END OF SECTION**

## PLUMBING FIXTURES 22 42 00

### 1 GENERAL

#### 1.1 Scope

- .1 Provide plumbing fixtures and trim, and temperature mixing valves for fixtures.
- .2 This specification section does not apply to temperature mixing valves located remote from individual plumbing fixtures, or for process equipment; refer to specification section 22 39 13 *Domestic Water Temperature Mixing Valves*.
- .3 This specification section does not apply to temperature mixing valves for emergency shower and eye-wash stations; refer to specification section 22 45 13 *Emergency Plumbing Fixtures*.

#### 1.2 Definitions

- .1 The following definitions apply to this section.
  - .1 **Barrier-free:** has the same meaning as the applicable building code of the place of the Work, or in its absence, means, when applied to plumbing fixtures and emergency plumbing fixtures, the fixture can be approached, entered, and used by persons with physical or sensory disabilities.

#### 1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
  - .1 CSA Z317.1 Special Requirements for Plumbing Installations in Health Care Facilities.
  - .2 CSA Z318.3 Commissioning of Plumbing Systems in Health Care Facilities
- .2 Product standards:
  - .1 ASME A112.6.1 Supports for Off-the-Floor Plumbing Fixtures for Public Use
  - .2 ASSE 1016/ASME A112.1016/CSA B125.16  
Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations
  - .3 ASSE 1066 Performance Requirements for Individual Pressure Balancing Valves for Individual Fixture Fittings
  - .4 ASSE 1070 Performance Requirements for Water Temperature Limiting Devices
  - .5 CSA-B45 Series Plumbing Fixtures.
  - .6 CSA-B125 Plumbing Fittings.
  - .7 NSF/ANSI 61 Drinking Water System Components – Health Effects, including Annex G
  - .8 NSF/ANSI 372 Drinking Water System Components – Lead Content
  - .9 UL 1951 Electrical Plumbing Accessories

#### 1.4 Fixture Count and Location

- .1 Determine the number and location of plumbing fixtures from Architectural drawings in the first instance, followed by the mechanical drawings.
- .2 In the event of a conflict as to location of plumbing fixtures between the architectural drawings and the mechanical drawings, the location as shown on the architectural drawings govern.

## 1.5 Submittals

- .1 Submit product data sheets for materials specified herein. Organize the submission in accordance with the following requirements:
  - .1 make one consolidated submission for all products specified,
  - .2 indicate the fixture type designation for each product on each submittal page,
  - .3 where a fixture type consists of multiple product components, organize the information in a cohesive presentation by fixture type designation,
  - .4 where a data sheet includes multiple figures/options, clearly mark the applicable model number and/or option that is being proposed as meeting the specification requirement.

## 2 PRODUCTS

### 2.1 General Requirements - Fixture Quality

- .1 Fixtures and trim of the same type to be the product of one manufacturer and must have proven hospital performance from previous installations.
- .2 Finished surfaces to be clear, smooth and bright, and guaranteed not to craze, discolour or scale.
- .3 Visible parts of faucets, escutcheons, wastes, strainers, traps, shower heads, supplies and stops to be chrome plated.
- .4 Do not include aerators in water supply faucets in healthcare facilities. Provide faucets with plain outlets with laminar flow control in the base of the spout.
- .5 Fixtures will not have an overflow.
- .6 All electronic sensor-activated fixtures shall be hardwired and on delayed vital emergency power.
- .7 Floor mounted water closets fitted with china bolt caps; plastic bolt caps are not acceptable.
- .8 Fixtures will be "lead-free" and meet or exceed the requirement of NSF/ANSI 61 & NSF/ANSI 372.
- .9 Faucet water discharge will not discharge directly in fixture drain grid strainer. As necessary, mock-up the proposed plumbing fixtures and associated faucets to verify this compliance requirement is being met. Submit written confirmation to the consultant that the compliance requirement has been met with the proposed plumbing fixtures and associated faucets.
- .10 Provide accessible cleanouts for all sinks and lavatories. Cleanouts for sinks and lavatories shall be located above the flood-level rim of the fixture. Include provisions for cleanouts for future sinks and lavatories where indicated on the architectural or mechanical drawings.
- .11 Compression fittings shall not be used except for connection of trap primer lines run in the slab.
- .12 Where fixtures and trim are identified by manufacturers' catalogue designation these references are to establish quality standards not otherwise specified. For the purposes of this section of the specification, fixtures or trim from manufacturers listed below are equally acceptable when conforming to the same level of quality.

#### *Standard of Acceptance*

- Delta Commercial
- Kindred
- Franke
- Moen Commercial

## 2.2 Water Closet Type "WC-1"

- .1 Bowl: white, vitreous china with antimicrobial surface, wall hung, siphon jet flush action, elongated bowl, 40mm (1 1/2") top spud, with carrier to mount rim 480 mm (18.9 in) from finished floor.

*Standard of Acceptance*

- ii) Clark Flushometer Bowl 4765CEX

- .2 Flush valve: exposed flushometer for top spud, Polished chrome plated vandal resistant, 292mm (11 1/2") chrome plated flush valve tube with high pressure vacuum breaker, 6 lpf (1.6 US gpf) flush factory set flow (field adjustable from 4.8L to 25 lpf (1.27 to 6.6 gpf))

*Standard of Acceptance*

- ii) Delta 81T201

- .3 Seat: heavy duty, for elongated bowl, open front, white solid plastic, less cover, with self-sustaining stainless steel check hinge, metal flat washers stainless steel posts and nuts.

*Standard of Acceptance*

- Centoco - #500STSCCSS

- .4 Toilet back rest: 304 stainless steel 1.2mm (18 Ga) bar, 152mm (6") back to front, 32mm (1-1/4") tubing diameter, antique white solid core plastic laminate panel.

*Standard of Acceptance*

- Franke Commercial Midland – CM-16104-WM

- .5 Installation height shall be barrier-free where required per architectural drawings.

## 2.3 Lavatory Type "L-1"

- .1 Basin: Vitreous china wall hung basin modified with sealed overflow, ledge back, single center faucet hole and supplied with concealed arm carrier, complete with shroud/knee contact guard, mounting bracket and hardware

*Standard of Acceptance*

- Clayton 4610CHZ-SO with 4644CHZ shroud

- .2 Faucet: Heavy duty cast brass sink faucet, 203 mm (8") centers, two handle, polished chrome plated finish, Spout: R7 - Smooth End Gooseneck 9" (229mm) long, 12.7" (323mm) high (unmounted), Standard rigid/swivel field installation, vandal resistant .090" wall thickness, smooth spout end with laminar flow control in spout base, 1.0 GPM, 4 - 102 mm (4") wrist handles, ADA compliant, sanitary hoods, metal colour indexed vandal resistant screws

*Standard of Acceptance*

- Delta 26C3974-R7

- .3 Drain: NPS 1 1/4 chrome plated cast brass tailpiece with cleanout and open grid strainer

*Standard of Acceptance*

- Delta 33T260-1

- .4 Angle stops: Chrome plated NPS 3/8 rigid angle or flexible supplies with lockshield stops and associated supply kit components

*Standard of Acceptance*

- Brasscraft Supply Kit KTSCS400AX C

- .5 TMV: Point of use thermostatic mixing valve, nickel plated, bronze body, temperature adjusting spindle, 10mm (3/8") inlets and outlet FNPT connections, integral checks, high temperature limit stop set to a maximum 43 °C (109.4 °F), tempered water to hot water side of faucet,

*Standard of Acceptance*

- Delta R3270-MIXLF

- .6 P-trap: NPS 1¼ chrome plated brass "P" trap with cleanout

*Standard of Acceptance*

- Delta 33T311

- .7 Carrier: steel pipe legs, block base feet support, concealed arms and pedestal plate. For narrow wall installation provide 'Z' type sleeve for arms.

*Standard of Acceptance*

- Smith SQ-0-4437
- Zurn Watts CA-401-D for back to back carrier

- .8 Installation height shall be barrier-free where required per architectural drawings.

**2.4 Lavatory Type "L-2"**

- .1 Basin: existing
- .2 Faucet: Heavy duty cast brass sink faucet, 203 mm (8") centers, two handle, polished chrome plated finish, Spout: R7 - Smooth End Gooseneck 9" (229mm) long, 12.7" (323mm) high (unmounted), Standard rigid/swivel field installation, vandal resistant .090" wall thickness, smooth spout end with laminar flow control in spout base, 1.0 GPM, 4 - 102 mm (4") wrist handles, ADA compliant, sanitary hoods, metal colour indexed vandal resistant screws

*Standard of Acceptance*

- Delta 26C3974-R7

**2.5 Lavatory Type "L-3"**

- .1 Not used.

**2.6 Hand Hygiene Sink "HHS-1"**

- .1 Basin: Vitreous china deep wall hung basin, white finish, with sealed overflow, single hole, faucet ledge, drilled for concealed arm carrier, fixture to include removable acrylic shroud, offset grid drain and p-trap. Overall Dimensions: 508 mm (20") long, 432 mm (17") wide, 663 mm (26-3/32") high, Bowl Dimensions: 260 mm (10-1/4") long, 419 mm (16-1/2") wide, 235 mm (9-1/4") deep.

*Standard of Acceptance*

- American Standard ICU 9118.111.020

- .2 Faucet: Deck mounted remote faucet, polished chrome finish, single hole centerset, 5.7 LPM (1.5 GPM) maximum flowrate, gooseneck rigid/swivel spout, non-aerating, laminar flow control in base of spout, plain outlet, vandal proof, 133 mm (5-1/4") projection, 273 mm (10-3/4") high.



*Standard of Acceptance*

- Chicago Faucets 626-FCABCP

- .3 Foot Pedals: hot and cold water pedal box with extended pedals, chrome plated

*Standard of Acceptance*

- Chicago Faucets 834-EPSLOABCP

- .4 Drain: NPS 1¼ chrome plated cast brass tailpiece with plug and open grid strainer

*Standard of Acceptance*

- Cambridge Brass 33T260-1

- .5 Supplies: Chrome plated NPS 3/8 rigid angle or flexible supplies with lockshield stops.

*Standard of Acceptance*

- Cambridge Brass 47T312

- .6 P-trap: Cast brass body material, Chrome-plated finish, 1-1/4" x 1-1/4" PTrap, 279 mm (11") distance, With cleanout plug, Steel box flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend.

*Standard of Acceptance*

- McGuire 8872CBSAN

- .7 Mixing Valve: Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle

*Standard of Acceptance*

- Lawler 570-86820

- .8 Carrier: steel pipe legs, block base feet support, concealed arms and pedestal plate. For narrow wall installation provide 'Z' type sleeve for arms.

*Standard of Acceptance*

- Smith SQ-0-4437
- Zurn
- Watts – CA-401-D for back to back carrier

**2.7 Janitor's Sink Type "JS-1"**

- .1 610mm x 610mm x 305mm deep (24 in x 24 in x 12 in deep) terrazzo floor mounted mop sink composed of pearl grey marble chips and white Portland Cement ground smooth and sealed, one piece stainless steel cast integral on all sides, tiling flange (number of tiling flanges to be confirmed based upon architectural placement of mop sink), 75mm (3") cast brass drain with stainless steel strainer,

*Standard of Acceptance*

- Stern Williams model SB-902 with "BP" back splash panel (0.9mm (20 Ga) type 304 stainless steel)

- .2 Two handle faucet, chrome plated, 203mm (8") centreset, solid brass exposed body, ceramic ¼ turn cartridge, unrestricted hose end outlet, 146mm (5 ¾") projection rigid vacuum breaker spout with pail

hook, 102mm (4") metal vandal proof wristblade handles with blue and red index buttons, wall brace support, 914mm (36") long hose with 20mm (3/4") chrome coupling, stainless steel wall bracket,

*Standard of Acceptance*

- Chicago Faucets – 445-317-897SRCXKCP (Faucet)
- Chicago Faucets – "T-35" – (Hose and Wall hook)
- Chicago Faucets – "T-40" (Mop Hanger)

**2.8 Stainless Steel Sink Type "S-1" (single compartment)**

- .1 Basin: Single compartment self rimming topmount sink with faucet ledge. 18 gauge (0.9 mm), type 304 (CNS 18/10) stainless steel. Exposed surfaces are #4 satin finished. Factory applied rim seal, cutout template, and factory installed EZ TORQUE fasteners. Centre back waste location. 3 1/2" (89 mm) crumb cup strainer with 1 1/2" (DN38) brass tailpiece.

*Standard of Acceptance*

- Franke LBS6808P-1

- .2 Faucet: Heavy duty cast brass sink faucet, 203 mm (8") centers, two handle, polished chrome plated finish, Spout: R7 - Smooth End Gooseneck 9" (229mm) long, 12.7" (323mm) high (unmounted), Standard rigid/swivel field installation, vandal resistant .090" wall thickness, smooth spout end with laminar flow control in spout base, 1.0 GPM, 4 - 102 mm (4") wrist handles, ADA compliant, sanitary hoods, metal colour indexed vandal resistant screws

*Standard of Acceptance*

- Delta 26C3974-R7

- .3 P-trap: NPS 1½ chrome plated brass "P" trap with cleanout, adjustable

*Standard of Acceptance*

- Delta 33T360

- .4 Supplies: Rough brass NPS ½ lockshield stop on each supply.

- .5 Mixing valve: Point of use thermostatic mixing valve, nickel plated, bronze body, temperature adjusting spindle, 10mm (3/8") inlets and outlet FNPT connections, integral checks, high temperature limit stop set to a maximum 43 °C (109.4 °F), tempered water to hot water side of faucet,

*Standard of Acceptance*

- Delta R3270-MIXLF

**2.9 Stainless Steel Sink Type "S-2" (single compartment)**

- .1 Basin: Single compartment self rimming topmount sink with faucet ledge. 18 gauge (0.9 mm), type 304 (CNS 18/10) stainless steel. Exposed surfaces are #4 satin finished. Factory applied rim seal, cutout template, and factory installed EZ TORQUE fasteners. Centre back waste location. 3 1/2" (89 mm) crumb cup strainer with 1 1/2" (DN38) brass tailpiece. 22 x 30 1/16" (559 x 764 mm) Overall. 17 x 28 x 8" (432 x 711 x 203 mm) Bowl. (FB x LR x D).

*Standard of Acceptance*

- Franke LBS7808P-1

- .2 Faucet: Heavy duty cast brass sink faucet, 203 mm (8") centers, two handle, polished chrome plated finish, Spout: R7 - Smooth End Gooseneck 9" (229mm) long, 12.7" (323mm) high (unmounted), Standard rigid/swivel field installation, vandal resistant .090" wall thickness, smooth spout end with laminar flow control in spout base, 1.0 GPM, 4 - 102 mm (4") wrist handles, ADA compliant, sanitary hoods, metal colour indexed vandal resistant screws

*Standard of Acceptance*

- ° Delta 26C3974-R7

- .3 P-trap: NPS 1½ chrome plated brass "P" trap with cleanout, adjustable

*Standard of Acceptance*

- ° Delta 33T360

- .4 Supplies: Rough brass NPS ½ lockshield stop on each supply.

- .5 Mixing valve: Point of use thermostatic mixing valve, nickel plated, bronze body, temperature adjusting spindle, 10mm (3/8") inlets and outlet FNPT connections, integral checks, high temperature limit stop set to a maximum 43 °C (109.4 °F), tempered water to hot water side of faucet,

*Standard of Acceptance*

- ° Delta R3270-MIXLF

**2.10 Stainless Steel Sink Type "S-3" (Kitchen sink)**

- .1 Not used.

**2.11 Stainless Steel Sink Type "S-4" (Kitchen sink)**

- .1 Not used.

**2.12 Shower Fixture – Barrier Free (SH-1)**

- .1 Not used.

**2.13 Thermostatic Mixing Valves – Lavatories, Under-Sink Mount ("TMV")**

- .1 General:

- .1 application: temperature mixing valve at an individual lavatories or sinks, for under-basin mounting.
- .2 type: thermal actuated mixing valve,
- .3 listed to ASSE 1070,
- .4 listed to NSF 61+G or NSF 372.

- .2 Performance:

Primary Parameter	Secondary Parameter	Value
Cold water inlet temperature	Range	4 - 20°C (39 - 68°F)
Hot water inlet temperature	Range	49 - 82°C (120 - 180°F)
Maximum Approach Temperature	Hot Inlet to Mixed Temperature	+ 3.8°C (5°F) ΔT

Primary Parameter	Secondary Parameter	Value
Controlled Temperature Range	High temperature unit	27 to 49°C (80 to 120°F)
Temperature stability, at flow rate range	0 – 0.3 L/s (0 – 5 gpm)	± 1.7°C (±3°F)
	0.3 to 2.5 L/s (5 to 40 gpm)	± 2.8°C (± 5°F)
Maximum Flow Rate	at 100 kPa (15 psi)	0.03 L/s (0.5 gpm)
Minimum Flow Rate	---	0.016 L/s (0.25 gpm)
Maximum Differential Pressure	Between hot and cold supplies	20% of cold water pressure
Minimum design pressure	---	860 kPa at 93°C (125 psi at 200°F)

.3 Construction:

- .1 brass or bronze body, with corrosion resistant internals,
- .2 four port design - cold inlet and outlet, hot inlet, tempered outlet,
- .3 filed-convertible to be suitable for installation as a;
  - (a) dual-outlet for two-handle or single handle faucet, or
  - (b) single-outlet for tempered water to an automatic lavatory faucet,
- .4 thermal actuated movement, with adjustable temperature selection, and maximum temperature limiter,
- .5 tamper resistant setting handle,
- .6 pipe ends: NPS 3/8 compression fittings,
- .7 integral inlet debris screens.

*Standard of Acceptance*

- Watts (Powers) - fig. LFUSG-B
- Lawler - fig. TMM-1070T

**2.14 Sealant Between Fixture and Wall Finish:**

- .1 One-part acetoxysilicone sealant
- .2 White or clear colour.
- .3 Formulated with fungicide

*Standard of Acceptance*

- Tremco - fig. Tremsil 200
- Dow Corning
- GE

### 3 EXECUTION

#### 3.1 Fixture Installation - General

- .1 Support fixtures level and square and connect with supplies, drains, traps and vents.
- .2 Where a faucet has separate hot and cold water handles, position the hot water handle on the left side of the faucet.
- .3 Where fixtures are located on exterior walls, run the water supplies up through the floor. For other fixture locations, run water supplies in the wall cavity.
- .4 Provide resilient, watertight and gas-tight seals for every joint in a floor flange or between a floor-outlet fixture and the drain.

#### 3.2 Fixture Supports

- .1 Provide plates, brackets, wall carriers, cleats, and supports to secure fixtures in place.
- .2 Fasten wall brackets with bolts attached to double steel supporting plates.
- .3 Bolt fixture to wall through cored holes under lavatory wall flange, using chrome plated carriage bolts with integral washers, and expansion shields.
- .4 Install extra-heavy-duty chair carriers for fixtures not directly supported from floor.
- .5 Conceal vertical supports and baseplates in wall construction.
- .6 Apply sealant bead between wall mounted fixture and finished wall and finish with a smooth concave profile.
- .7 Set floor mounted water closet bowls in mastic, and seal the floor flange with a resilient, watertight and gas-tight flange seal.

#### 3.3 Plumbing Fixture Installation Heights and Clearances

- .1 Install plumbing fixtures at heights as shown on architectural drawings and specifications. Where such information is not provided therein, install fixtures at heights as described in the following table.
  - .1 Mounting heights are in reference to the top of the finished floor level unless otherwise stated.

Fixture Type	Mounting Height Reference (above finished floor)	Mounting Height Mm (inch)	
		Barrier-Free	All Other
Water Closet	Top of seat	≥ 430 and ≤ 460 (≥ 17 and ≤ 18)	≥ 430 and ≤ 460 (≥ 17 and ≤ 18)
Urinal	Front rim	400 to ≤ 430 (16 to ≤ 16.5) [Note 1]	575 to ≤ 600 (22.5 to ≤ 23.5)
Lavatory	Rim	850 to ≤ 865 (33.5 to ≤ 34)	[850 to ≤ 865 (33.5 to ≤ 34)] [885 to ≤ 910 (35 to ≤ 36)]
Shower	Valve control handle	1150 to ≤ 1200 (45 to ≤ 47)	1150 to ≤ 1200 (45 to ≤ 47)
	Hand-held shower head: Two positions	1200 and 2300 (45 and 90) [Note 2]	1200 and 2300 (45 and 90) [Note 2, 3]

Fixture Type	Mounting Height Reference (above finished floor)	Mounting Height Mm (inch)	
		Barrier-Free	All Other
Bathtub	Faucet centerline (above tub rim)	425 to $\leq$ 450 (16.5 to $\leq$ 17.5)	425 to $\leq$ 450 (16.5 to $\leq$ 17.5)
	Hand-held shower head; Two positions	1200 and 2300 (45 and 90) [Note 2]	1200 and 2300 (45 and 90) [Note 2, 3]

**Notes:**

[1] Where there are two or more urinals in a washroom, one urinal is to be mounted at this height.

[2] An adjustable hand-held shower head mounted on a vertical shower bar, that can be set at these positions.

[3] If specified.

- .2 Mount manually-operated flushing control for water closets;
  - .1 between 500 and 900 mm above the finished floor, and
  - .2 for barrier-free water closets, located on the transfer side of the water closet.
- .3 Mount manually-operated flushing control for urinals;
  - .1 between 900 and 1100 mm above the finished floor level for barrier-free urinals, and
  - .2 at a height to suit the urinal fixture and flush-control valve for all other urinals.
- .4 For barrier-free lavatories not equipped with a fixture-skirt barrier, arrange piping beneath the lavatory so that the hatched area shown in figure 1 is clear of any obstruction.

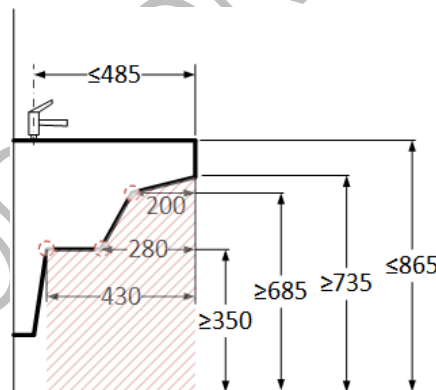


Figure 1: Barrier-Free Lavatory Clearances

### 3.4 Hand-Held Showers

- .1 Install hand-held shower head hook on independent mounting rail located centered on the shower enclosure wall.
  - .1 Do not install shower hooks on grab-bars provided under other Divisions of the Work.

### 3.5 Thermostatic Mixing Valve Installation

- .1 Install a fixture Thermostatic Mixing Valve at individual faucets where specified as an accessory for the fixture type, or as otherwise shown.

- .2 Provide field installed bass-bodied, in-line spring-loaded check valves on the hot and cold water supplies to each TMV unit, regardless of whether or not the TMV is equipped with integral check valves. For greater certainty, if the TMV unit is supplied with integral check valves they are deemed not to meet this requirement.

### 3.6 Protection

- .1 Cover plumbing fixtures and trim with plywood, cardboard or heavy paper and kept protected before, during and after installation and until work is completed and accepted.
- .2 Clean fixtures, and trim immediately prior to building completion.

### 3.7 Start-Up and Testing

- .1 Test, adjust and set high temperature limit stops on fixtures to supply a maximum water temperature, including faucets with integral or remote temperature mixing valves, as follows.

Fixture Type	Occupancy	Temperature Setpoint
Combination tub/shower, Showers	Healthcare, Long-Term Care, Retirement Homes	43°C (109°F)
	Other Occupancies	49°C (120°F)
Faucets	Healthcare, Long-Term Care, Retirement Homes	43°C (109°F)
	Other Occupancies	49°C (120°F)
Group (Sitz Baths)	Healthcare	40°C (105°F)

### 3.8 Commissioning Program

- .1 Comply with the project commissioning requirements in accordance with specification section 20 08 15.
- .2 The verification and testing requirements specified in this section may be concurrent with, or conducted separately from, the commissioning program, as coordinated with the Contractor and the commissioning agent.

### 3.9 Test and Installation Records

- .1 Provide a report of this testing and include:
  - .1 fixture reference,
  - .2 measured maximum temperature,
  - .3 date of test(s),
  - .4 signature of person(s) conducting test.
- .2 Submit a copy of each report to the Consultant and Owner for review and acceptance.
- .3 The above tests are subject to a demonstration test audit of up to 10% of the total fixture count to verify compliance. If audit tests are not satisfactory to the Consultant, additional testing and verification will be conducted by the Contractor until such time as a demonstration audit provides satisfactory results to the Consultant.

### 3.10 Plumbing Fixture Service Requirements

- .1 Unless otherwise shown on the drawings, plumbing fixture service requirements shall be in accordance with Table 1.

**Table 1.**

DRAWING TAG	DESIGNATION	MINIMUM SERVICE CONNECTION SIZE (mm)					QUANTITY OF FIXTURES SERVED BY A SINGLE BRANCH LINE					REMARKS
		TYPICAL DRAIN MATERIAL	VENT	COLD WATER	HOT WATER	1	2	3	4	5		
WC-1	Water Closet (Flush Valve)	100	x	40	25	x	25	50	50	65	65	
L-1	Lavatory	x	32	32	15	15	15	15	20	20	25	
HHS-1	Hand Hygiene Sink	x	40 per Z8000-11 requirements	32	15	15	15	15	20	20	25	
JS-1	Janitor Sink	80	x	40	20	20	20	x	x	x	x	
S-1, S-2	Sink	x	40	32	15	15	15	x	x	x	x	
BF-1	Bottle Filler	x	40	32	15	x	x	x	x	x	x	
MAC	Macerator	100	x	40	25	x	x	x	x	x	x	

**END OF SECTION**



## MEDICAL GAS PIPING 22 60 13.70

### 1 GENERAL

#### 1.1 Scope

- .1 Provide medical gas pipeline distribution systems including:
  - .1 piping, fittings, and valves,
  - .2 local gas regulation control panels,
  - .3 emergency oxygen inlet stations,
  - .4 line pressure regulators and safety valves,
  - .5 terminal units, including terminal units to be installed in Medical Supply Units.
  - .6 pipe hangers and accessories,
- .2 Applicable systems:
  - .1 Medical pressure gases intended for patient care:
    - (a) oxygen USP.
  - .2 Medical vacuum.

#### 1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 24 Welding and Brazing
  - .2 20 05 29 Common Hanger and Support Requirements for Piping

#### 1.3 Definitions

- .1 The following definitions apply to this section and reference sections:
  - .1 **Certification Agency:** a testing organization of medical gas systems accredited to the requirements of ISO/IEC 17025 by Standard Council of Canada (has the same meaning as “testing body” as used in CSA Z7396.1.
  - .2 **Corrugated Metal Tubing (“CMT”):** flexible copper metallic tubing
  - .3 **Diameter index safety system (“DISS”):** threaded connections that comply with the requirements of CGA V-5.
  - .4 **Medical gas, medical support gas, medical vacuum and AGSS:** means all services within the scope of CAN/CSA-Z7396.1.
  - .5 **Medical supply unit:** means prefabricated equipment of Class I, Type B, that supplies medical gases, medical support gases, medical vacuum and AGSS singly or in combination with other services at the point of patient care and within the scope of CSA Z305.8. Commonly used terms such as headwall, ceiling mounted service column(s), ceiling column, ceiling pendants, articulating arms, boom arms are all types of Medical Supply Unit.
  - .6 **Pipe (piping):** has the meaning as defined in ASME B31.3 and is used interchangeable with “tube” or “tubing”, except where the context indicates otherwise.
  - .7 **Pipeline distribution system:** the portion of a medical gas, medical support gas, medical vacuum or AGSS located: (a) from and including the main supply shut off valve to (and including all terminal units), junction pints, or demarcation points; (b) intake piping from indoors or outdoors to medical

air or instrument air compressors; and (c) exhaust piping from medical vacuum supply systems and AGSS supply systems to the outdoors.

- .8 **Qualified installer:** a competent person or company responsible for the installation of medical gas pipeline systems or components within a medical gas system.
- .9 **Terminal unit:** an outlet assembly (inlet for medical vacuum and AGSS) in a medical gas pipeline system at which the operator makes connections and disconnections.
- .10 **USP:** United States Pharmacopeia.
- .11 **USP-NF:** USP National Formulary
- .12 **Zone, zone alarm, and zone valve:** have the same meaning as defined in CAN/CSA-Z7396.1

#### 1.4 Applicable Codes and Standards

- .1 Legislation:
  - .1 Ontario Regulation 220/01 Boiler and Pressure Piping Regulation
  - .2 Ontario Regulation 213/07 Fire Code
- .2 Installation codes and standards:
  - .1 ASME B31.3 Process Piping
  - .2 CSA B51 Boiler, Pressure Vessels and Pressure Piping Code.
  - .3 CSA Z7396.1-22 Pipelines for Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging Systems
  - .4 CAN/CSA Z15001 Anaesthetic and Respiratory Equipment - Compatibility with Oxygen
  - .5 CGA G-4.1 Cleaning Equipment for Oxygen Service.
- .3 Product standards:
  - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
  - .2 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
  - .3 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
  - .4 ASTM B819 Standard Specification for Seamless Copper Tube for Medical Gas Systems.
  - .5 AWS A5.8 Brazing Filler Metal.
  - .6 CGA V-5 Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)
  - .7 CSA Z305.8 Medical Supply Units
  - .8 CAN/CSA-Z5359 Anaesthetic and respiratory equipment — Low-pressure hose assemblies for use with medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems
  - .9 CSA-Z9170-1 Terminal units for medical gas pipeline systems - Part 1: Terminal units for use with compressed medical gases, vacuum, and anaesthetic gas scavenging systems
  - .10 CAN/CSA-Z10524-2 Pressure Regulators for Use with Medical Gases - Part 2: Manifold and Line Pressure Regulators

## **1.5 Qualified Tradesperson**

- .1 Work on medical gas systems to be performed by:
  - .1 a specialist firm that: has experienced in this type of work; is knowledgeable of the applicable regulations, installation codes and standards pertaining to medical gas systems; has registered procedures for silver brazing; and regularly employs tradespersons qualified in pressure piping installation,
  - .2 a qualified, licensed and recognized firm which has the requisite license to perform medical gas piping installation, issued by the AHJ for boiler and pressure vessels where such licensing is required under applicable provincial legislation,
  - .3 tradespersons holding applicable certificates of competency for pressure piping and brazing work, and
  - .4 tradespersons who are certified in accordance with the *CSA Medical Gas Piping & Systems Installation Personnel Certification Program*.
- .2 Prior to commencing work on site,
  - .1 supply copies of certification record to the Owner for each qualified tradesperson performing work on the medical gas system, and
  - .2 supply copies of tradespersons certificates of competency for brazing to the Owner for their records.
- .3 Installers of CMT shall complete and pass the manufacturer's training course and supply copies of the certificate to the Owner for their records.

## **1.6 Registration and Inspection**

- .1 Pressure piping:
  - .1 Before commencing work, make arrangements and pay for registration and inspection of pressure vessels and pressure piping by the AHJ responsible for Pressure Piping safety, unless otherwise exempt by regulation.
  - .2 All materials which operate with an internal gas pressure greater than 100 kPa (15 psi) above atmospheric pressure shall have a CRN in accordance with CSA B51.
  - .3 Collect and record CRNs for components and fittings and obtain and coordinate equipment CRNs or field registration of composite equipment.
  - .4 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.
- .2 Fire safety:
  - .1 Before commencing work, make arrangements and pay for permits and inspection of medical gas piping systems by the AHJ responsible for fire safety where required by legislation in the place of the Work.

## **1.7 Design Criteria – Medical Gas and Vacuum Piping**

- .1 Piping design and installation code:
  - .1 to ASME B31.1
- .2 System design criteria:

<b>System</b>	<b>Design Temp. °C (°F)</b>	<b>Maximum Operating Pressure kPa (psig)</b>	<b>Design Pressure kPa (psig)</b>
Oxygen	38 (100)	415 (60)	700 (100)
Medical Vacuum	38 (100)	-70 (-20 in.Hg.)	-100 (-30 in.Hg.)

## 1.8 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the following materials;
  - .1 piping/CMT,
  - .2 valves,
  - .3 terminal units,
  - .4 line pressure regulators, safety valves and assemblies,
  - .5 emergency oxygen inlet stations.

## 1.9 Quality Control

- .1 Site Acceptance Testing;
  - .1 Manufacturer to provide services of manufacturer's authorized service personnel to provide field services in accordance with the requirements of Part 3 of this specification.
- .2 Brazing Quality Control;
  - .1 Maintain records of in-process examination of not less than 5% of production brazed joints in accordance with ASME B31.3. Submit copies of examination records of selected joints (or nearest examined joint) when requested by the Certification Agency or the Consultant.
  - .2 Include a copy of in-process examination records in the maintenance and operations manual.
- .3 Commissioning and Certification;
  - .1 The medical gas installation contractor(s) shall be responsible for commissioning the medical gas systems in accordance with the requirements of CSA Z7396.1 and as specified herein.
  - .2 The medical gas systems will be certified by an independent Certification Agency, hired directly by the Owner, to verify that the installation is in accordance with CSA-Z7396.1. The medical gas installation contractor shall include labour, superintendence and all other costs associated with co-ordination, attendance and participation during certification testing of the medical gas systems.

## 1.10 Material Shipping, Handling and Storage

- .1 Valves, piping, CMT and terminal units shall be cleaned in accordance with CGA G-4.1 or CAN/CSA Z15001, capped and sealed in a plastic bag, labelled to state that the product has been so cleaned and visually inspected, and shipped to the project site in packaging to prevent contamination by dirt, grease, or other foreign matter.
- .2 Where such material protection is damaged prior to installation, including damage to the packaging, the material shall not be installed and shall be removed from the site.
- .3 Store materials in clean and dry conditions.

### **1.11 Operating and Maintenance Data**

- .1 In addition to the requirements of Division 01, submit operating and maintenance data including:
  - .1 equipment list identifying components used in each system,
  - .2 equipment manufacturer's names and addresses,
  - .3 wiring diagrams of alarms and electrical components,
  - .4 detailed drawings of equipment and components,
  - .5 manufacturers service manuals, including recommended maintenance tasks and frequency, and recommended spare parts,
  - .6 manufacturers' warranties,
  - .7 valve schedule listing valves in system with location.
  - .8 Canadian Registration Numbers (CRN) for components and fittings.
  - .9 manufacturer instructions for the non-destructive and non-invasive procedures for testing of alarms,

## **2 PRODUCTS**

### **2.1 Copper Tube**

- .1 Hard drawn copper to ASTM B819;
  - .1 type "L" except as follows:
    - (a) type "K" for tube size NPS 3 and larger with design pressures in excess of 1275 kPa (185 psi),
    - (b) type "K" for buried (underground) services.
  - .2 factory cleaned and marked with classification symbols for medical gas use,
  - .3 cleaned for oxygen service,
  - .4 shipped with pipe end sealed.

### **2.2 Fittings**

- .1 Wrought copper or copper alloy to ASME B16.22 or ASME B16.50, and
- .2 For pipe sizes NPS 1/2 or less, fittings that are not made especially for soldered or brazed connections may be used, provided that the fitting as installed is visible in the room or is readily accessible for maintenance.
- .3 Dielectric fittings may be used where required by the manufacturer of special medical equipment to electrically isolate the equipment from the pipeline distribution system.
- .4 Axially swaged, elastic strain preload fittings providing metal-to-metal seal may be used provided that the fittings have pressure and temperature ratings not less than that of a brazed joint and, when complete, are permanent and non-separable.
- .5 All fittings to be cleaned for oxygen service.

#### *Standard of Acceptance*

- LOKRING Technology

### **2.3 Flanges and Gaskets**

- .1 Flange:

- .1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece, suitable for brazed connection to copper tubing. Flange designed to prevent contact of carbon steel material and copper material.
- .2 flange provided with a powder coated finish, and an EPDM insulator to isolate the copper tailpiece from contact with the flange.
- .3 minimum MCPR:
  - (a) Class 150: 1400 kPa (250 psi) at 38°C (100°F)
  - (b) Class 300: 2800 kPa (400 psi) at 38°C (100°F)

*Standard of Acceptance*

- CTS Flange Canada - fig. BF / WBG

.2 Flange gaskets:

- .1 full flat-faced style to ANSI B16.21.
- .2 material: PTFE with silica, suitable for use in oxygen service and nitrous oxide.
  - (a) thickness: 1.6 mm (1/16 in.).
  - (b) required working pressure: 7000 kPa (1000 psi), from -268°C (-450°F) to +260°C (500°F)

*Standard of Acceptance*

- Garlock - fig. Gylon 3502

## 2.4 Joints

.1 Brazed joints:

- .1 for copper-to-copper joints: silver brazing alloy to AWS A5.8 classification BCuP-3 or BCuP-5, and no flux.
- .2 for brazing dissimilar metals: silver brazing alloy to AWS A5.8 classification BCUP-5 with brazing flux No. 3A.

*Standard of Acceptance*

- Handy Harmon "SIL-FOS"
- All-State Welding Alloys "SILFLO 15"

.2 Threaded joints:

- .1 for connections to valves and other equipment: NPT to ASME B1.20.1.
- .2 thread sealant: oxygen compatible Teflon tape.

*Standard of Acceptance*

- Masters - Oxygen compatible T-Tape

## 2.5 Pipe Hangers and Supports

- .1 Refer to section 20 05 29 except as specified herein.
- .2 Trapeze Hangers:
  - .1 12 ga galvanized steel channel frames, solid backs.

*Standard of Acceptance*

- Taylor Figure TS
- Unistrut

.3 Pipe/Tubing Clamps:

- .1 two piece, epoxy coated clamp, with thermoplastic liner to separate piping from clamp.

*Standard of Acceptance*

- Taylor Figure 8500 Strut-Clamp
- Unistrut

.4 Spacers:

- .1 U-shape splice plates used as spacer control between adjacent piping clips.

*Standard of Acceptance*

- Taylor UF series
- Unistrut

## 2.6 Ball Valves

.1 NPS 4 and under – general requirements:

- .1 to MSS SP-110, 600 CWP, three-piece forged brass or bronze body, full port, stainless steel ball or chrome plated bronze ball, PTFE seat rings, and blow-out resistant with Viton seals, solder ends.
- .2 required MCPR: 4100 kPa (600 psig) at 38°C (100°F).
- .3 lever handle with locking device.
- .4 factory assembled with type K" copper tube extensions to ASTM B819, complete with 1/8" FNPT inlet purge port, and an outlet purge/gauge ports.
- .5 cleaned for oxygen service and with tube ends capped.

*Standard of Acceptance*

- Amico - fig. VV-ISO-G2L series
- Class I - fig. 7300 series
- Beacon Medaes - fig. 21160 series

.2 Additional requirements for Zone Valves, up to NPS 3:

- .1 application: ball valves installed inside of zone valve boxes/stations.
- .2 ball valves as specified above. and as follows:
  - (a) copper tube extensions to a minimum of 100 mm (4 in) beyond sides or back of zone valve box,
  - (b) an additional 1/8" FNPT port on the discharge end for connection of pressure transducers,
  - (c) identification bracket bolted over valve body for application of medical gas identification label,
  - (d) fitted with line pressure gauges suitable for each gas or vacuum service,

## 2.7 Butterfly Valves

.1 NPS 2-1/2 and over:

- .1 application: for medical vacuum and AGSS services only.

- .2 to MSS-SP-67, ductile iron lug body style, with flange bolt holes drilled and tapped for ANSI 150 flange pattern.
- .3 stainless steel shaft, aluminum bronze or 316 stainless steel or ductile iron/nickel plated disc, and replaceable EPDM or BUNA-N resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .4 required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .5 ISO 5211 mounting pad.
- .6 locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .7 cleaned for oxygen service.

*Standard of Acceptance*

- Class 1 - fig. BFC-Lug
- Nibco - fig. LD-2000
- Apollo - fig. LD 141, LD 145
- Kitz - fig. 6122EL

## 2.8 Check Valves

- .1 In-line Silent Check, NPS 4 and under:
  - .1 three-piece bronze body with swing out core, spring-loaded duo-disc, EPDM seat, socket ends.
  - .2 factory assembled with type "K" copper tube extensions to ASTM B819, complete with 1/8" FNPT inlet purge port, and an outlet purge/gauge ports.
  - .3 cracking pressure less than 3.5 kPa (1/2 psi).
  - .4 required MCPR: 2000 kPa (300 psi) at 93°C (200°F).
  - .5 cleaned for oxygen service and with tube ends capped.

*Standard of Acceptance*

- Amico - fig. Medical Check Valve with Extensions
- Class 1 - fig. CVE series
- US Valve - fig. Medical Check Valve with Extensions

- .2 In-line Silent Check Valves, NPS 2 and over:
  - .1 to ASME B16.34, Class 150, ASTM A351 grade CF8M stainless steel wafer body, stainless steel trim and spring-controlled dual-disc check, EPDM or PTFE seat.
  - .2 required MCPR: 1800 kPa (260 psig) at 38°C (100°F).
  - .1 cleaned for oxygen service.

*Standard of Acceptance*

- Dezurik - fig. APCO CDD-9000T
- Crane - fig. Duo-Chek
- Mueller - fig. Sure Check 72D

## 2.9 Line Pressure Gauges

- .1 For pipeline distribution system, not including zone valves.



- .2 To ASME B40.100 Grade 2A, direct pressure measurement, Ø115 mm (4½ in) dial type, silicone-free dampening, bronze tube, black solid front case, blow-out back, 0.5% full scale accuracy, adjustable pointer.
- .3 Measurement units and ranges:
  - .1 Gases: dual units kPa/psi;
    - (a) 0 to 700 kPa / 0 to 100 psig for all gases except Nitrogen, and Instrument Air,
    - (b) 0 to 2000 kPa / 0 to 300 psi for Nitrogen and Instrument Air,
  - .2 Vacuum: dual units kPa/in.Hg;
    - (a) -100 to 0 kPa / 30 in.Hg. to 0 for Medical Vacuum and AGSS.
- .4 Cleaned for oxygen service.

*Standard of Acceptance*

- ° Terice - 450B

- .5 Accessories:
    - .1 pressure snubbers:
      - (a) brass construction, NPT threaded ends.
      - (b) cleaned for oxygen service.
- Standard of Acceptance*
- ° Terice – 872-1
- .2 needle valves:
    - (a) rising stem, brass or T316 stainless steel construction, NPT threaded ends.
    - (b) cleaned for oxygen service.

*Standard of Acceptance*

- ° Terice - 735 / 740

## **2.10 Pipeline Distribution System Terminal Units**

- .1 Connector type: Diameter Index Safety System (DISS) to CGA V-5.
- .2 Main body:
  - .1 rough-in mounting box or plate,
  - .2 one-piece brass body:
    - (a) with secondary check valve rated for 1380 kPa (200 psig) for positive pressure gasses,
    - (b) designed to swivel 360° for multi-direction connection,
    - (c) O-ring seal or seats.
  - .3 type K copper tube to ASTM B819 inlet connection stubs;
    - (a) NPS 1/2 for pressure gasses,
    - (b) NPS 3/4 for medical vacuum and AGSS.
    - (c) gas service identified on tube stub.
  - .4 provided with dust-cover to protect body during construction after rough-in installation.
- .3 Primary valve body style:
  - .1 gas specific latch type
- .4 Outlet cover:

- .1 gas specific 1.5 mm (16 ga) mounting plates, and modular design to allow on-site ganging of multiple outlets, with a minimum center-to-center spacing of 127 mm (5 in.),
- .2 colour coded front plate with English language printed service identification, and indexing pins for safety keying gas specific cover plate to appropriate steel rough-in mounting plate.
- .3 chrome plated, satin finish, or epoxy powder-coated fascia plate,
- .4 outlet to be adjustable for variable wall thickness at least between 12 mm (1/2 in.) and 25 mm (1 in.) wall thickness,
- .5 pressure test plug for medical vacuum and AGSS outlets, rated for 1000 kPa (150 psi).
- .5 Model variants:
  - .1 terminal units designed for various installation locations including:
    - (a) recess wall mount for concealed piping,
    - (b) surface wall mount for exposed piping,
    - (c) recess mount for ceilings,
    - (d) recess mount for medical supply units,
    - (e) non-ferrous material compatible for installation in MRI Rooms.
    - (f) recess mount in tamper-proof enclosure for psychiatric mental health rooms
  - .2 Listed to CAN/CSA-Z9170-1.
  - .3 Each unit tested for pressure-leak tested and flow tested.
  - .6 Cleaned for oxygen service and tube ends capped.

*Standard of Acceptance*

- Amico - fig. O-DIS series
- Class 1 - fig. M series
- BeaconMadaes - fig. B series

## **2.11 Valve Identification**

- .1 Valve tags:
  - .1 plastic valve tags, nominally 115 mm x 80 mm (4-5/8 x 3-1/8 in.), rounded corners with pre-punched fastening holes, orange colour, suitable for application of a printed adhesive label.

*Standard of Acceptance*

- Brady - fig. 87695

- .2 Valve tag label marking system:
  - .1 labels: 50 mm (2 in.) high, low-shrinkage vinyl labels for indoor and outdoor use, high tack permanent adhesive, black lettering on white background.
  - .2 printer: portable printer with LCD display and full QWERTY keyboard, capable of multiline printing on 50 mm (2 in.) wide labels.

*Standard of Acceptance*

- Brady - fig. BMP71

### 3 EXECUTION

#### 3.1 Field Cleaning

- .1 Field cleaning of copper tubing, CMT, valves, pressure regulators, safety valves and terminal units is not permitted. If factory shipping packaging is damaged or tube ends are missing prior to installation, these materials shall not be used and shall be removed from site.
- .2 Keep cutting and reaming tools scrupulously clean and free from oil or grease.
- .3 Do not use organic solvents such as carbon tetrachloride under any circumstances.

#### 3.2 Piping Fabrication

- .1 Install piping in accordance with CSA Z7396-1.
- .2 Make pipeline joints by brazing or mechanical swage coupling except as follows:
  - .1 butterfly valves and pressure relief valves: threaded or flanged,
  - .2 connections to source equipment: threaded or flanged,
  - .3 pressure sensors and switches: DISS connector,
  - .4 pipeline DISS check bodies for pressure sensors and switches: threaded,
  - .5 pressure gauges and other instruments including instrument isolation valve: threaded.
- .3 For threaded joints;
  - .1 use Sweat x NPT adapters for connection to equipment with threaded joints.
  - .2 make-up threaded joints with Teflon tape.
- .4 Use ells, tees, caps and couplings to make offsets and changes in direction and to route piping between connections. Do not bend hard drawn tubing except for long sweep cold bending with minimum bending radius of 20 x OD, without deformation or reduction in pipe diameter.
- .5 Cap off open ends of piping at the end of each work shift, using shipping dust caps overlayed with plastic and held in place with tape.

#### 3.3 Pipe Supports

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 For multi-service support, provide tubing clips on trapeze channels to secure piping to channel. Install U-plates or similar on each side of pipe clamp to prevent horizontal movement of each pipe,
- .3 For individual horizontal support, provide adjustable PVC coated clevis hangers, rods and anchors as specified,
- .4 Support horizontal piping at intervals in accordance with the following Table 1:

Table 1: Horizontal Tube Support for Medical Gas Piping		
Pipe/Tube Size NPS	Support Horizontal Spacing m (ft)	Support Vertical Spacing m (ft)
1/2	1.8 (6)	1.8 (6)
3/4	2.4 (8)	1.8 (6)

Table 1: Horizontal Tube Support for Medical Gas Piping		
Pipe/Tube Size NPS	Support Horizontal Spacing m (ft)	Support Vertical Spacing m (ft)
1	2.4 (8)	2.4 (8)
1-1/4	3.0 (10)	2.4 (8)
1-1/2	3.0 (10)	2.4 (8)
2 and larger	3.0 (10)	3.0 (10)

- .5 Support vertical tubing risers:
  - .1 at the base (bottom) of the riser by a support that is independent of any adjacent horizontal pipe supports,
  - .2 at every other floor level with pipe riser clamps, but not to exceed a vertical spacing of more than 10 m (33 ft).
- .6 Do not support medical gas piping from other building services. Do not support other building services from medical gas piping.

### 3.4 Brazed Joints

- .1 Make brazed joints in accordance with specification section 20 05 24 and as specified herein.
- .2 Make up joints between copper and copper materials without the use of flux. Joints between dissimilar metals may use flux as follows:
  - .1 use AWS brazing flux No. 3A,
  - .2 brush flux over end of fitting and keep inside of pipe and fittings free from flux,
  - .3 after brazing dissimilar metals, wash exterior surfaces with hot water to remove residual flux,
  - .4 wire brush joints after brazing.
- .3 During brazing, continuously purge the inside of the pipe to maintain a nitrogen atmosphere. Prior to brazing, purge air from the tube with nitrogen so that the oxygen content inside the pipe does not exceed 1% by volume (10,000 ppm) before brazing commences.
- .4 Where connections of new piping are made to an existing system, for the final connection to the existing system;
  - .1 in the new piping portion, relieve the nitrogen purge gas pressure down to atmospheric pressure before making tie-in connection to the existing piping systems,
  - .2 during brazing of the tie-in joint, do not introduce nitrogen purge gas to the pipeline system.

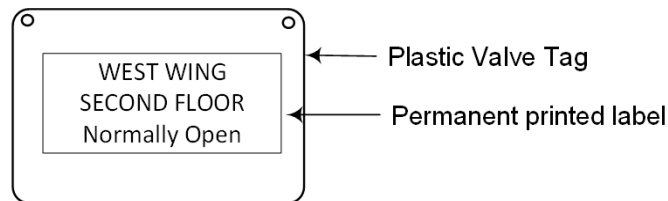
### 3.5 Valves

- .1 Provide valves as shown.
- .2 Provide zone valves and/or combination zone valves/zone alarm panels in accordance with specification section 22 63 26. Install zone valves or combination zone valve/zone alarm panels so that the height of the center-most valve is approximately 1500 mm (5 ft.) above floor level.

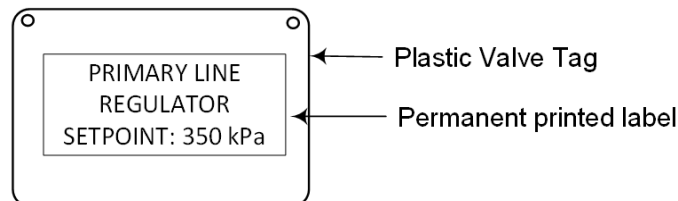
- .3 For pipeline distribution system valves other than those located in zone valve boxes, provide common-keyed padlocks on each valve. Leave valves padlocked in the open position and turn five (5) copies of the common-key over to the owner. Padlocks are not required on valves located in a locked service room containing the medical gas source equipment.

### 3.6 Identification

- .1 Label medical gas systems in accordance with CSA Z7396-1.
- .2 Label piping progressively on a daily basis as piping is installed.
- .3 For service valves and line pressure regulators, provide a gas specific pipeline marker identifying the gas immediately adjacent to the inlet or outlet side of the valve or regulator with no visible obstruction between the valve/regulator and the marker. For zone valves, provide the pipe marker inside the zone valve cabinet.
- .4 For service valves, provide a valve tag with a machine printed label identifying the area or zone served, and "Normally Open" or "Normally Closed" as applicable to the valve. Secure the valve tag to the valve with stainless steel tie-wire to the valve body, not the valve handle.



- .1 For line pressure regulators, provide a valve tag with a machine printed label identifying whether the regulator is the Primary or Secondary regulator, and the regulator setpoint valve in kPa units.



### 3.7 Terminal Units

- .1 Install terminal units in accordance with manufacturer's instructions. Protect backbody openings during rough-in stage to prevent contamination of main body.
- .2 Refer to architectural drawings for set-out heights of wall mounted individual or ganged terminal units. In the absence of such information, set wall mounted terminal outlets at a height of 1500 mm (5 ft) above the floor as measured to the center of the DISS outlet.

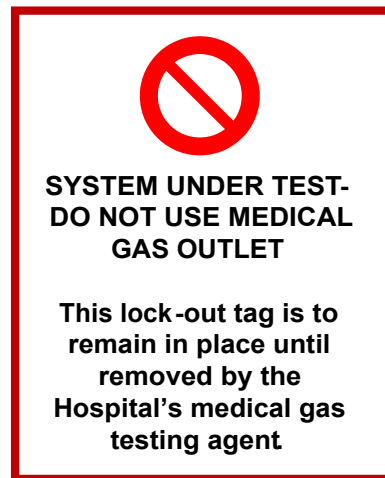
### 3.8 Terminal Units for Installation in Medical Supply Units

- .1 Medical supply units are provided under Division 11 and/or Division 26 and include:
  - .1 internal medical gas, pipeline distribution system piping using copper tubing or flexible hose as applicable to the equipment,
  - .2 installation of terminal units.
- .2 Supply pipeline distribution system terminal units to the vendor supplying the medical supply units for factory installation in the medical supply units.

- .3 Coordinate with the Division providing the medical supply units including:
  - .1 Scheduling delivery of pipeline distribution system terminal units to the medical supply unit's vendor(s) manufacturing facility.
- .4 Make connections of pipeline distribution system piping to medical supply units provided with capped tube connections as follows:
  - .1 A permanently brazed connection between the pipeline and the medical supply unit.
- .5 Make connections of pipeline distribution system piping to medical supply units equipped with flexible hoses as follows:
  - .1 terminate each pipeline with a gas/vacuum specific DISS body without check valve (and complete with gas tight specific cap) and mount it on the medical supply unit mounting plate (unless it has been confirmed by the Contractor that the DISS body without check valve has been provided as part of the medical supply unit.)
- .6 Where a zone valve controls a single (1) medical supply unit equipped with flexible hoses, provide a gas tight cap for the specific DISS body adapter for each medical gas, medical support gas, medical vacuum and AGSS serving the medical supply unit.
- .7 Where a zone valve controls two (2) or more medical supply units, each equipped with flexible hoses, each medical supply unit shall be isolated for maintenance and repair as follows:
  - .1 provide dedicated service isolation ball valves downstream of the zone valve on each medical gas, medical support gas, medical vacuum and AGSS pipeline supplying a medical supply unit.
  - .2 for clarity, service isolation ball valves shall isolate the gas/vacuum service to one (1) medical supply unit only without interruption of gas/vacuum service to other medical supply units controlled by the same zone valve.
- .8 Witness the final testing of the installed medical supply units and assist the certification agency as necessary. The responsibility for pipeline distribution system piping inside the medical supply unit including pressure testing remains with the medical supply unit vendor.
- .9 Refer to architectural and/or electrical design documents for locations of medical supply units and quantity of terminal units required.

### **3.9 Commissioning**

- .1 Conduct commissioning on piping systems in accordance with CSA Z7396-1 as summarized herein, prior to 3rd party certification testing by the independent certifier retained by the Owner,
- .2 Prepare a written commissioning test plan which verifies and documents the completed commissioning work. Provide a copy of the completed test plan/report to the Owner upon completion.
- .3 Conduct commissioning after the terminal units are installed, but before medical gas piping is concealed in walls, above ceilings or in vertical service spaces.
- .4 Tag-out / Lock-out requirements:
  - .1 Tag-out each terminal unit outlet prior to testing of associated piping system with a tag as shown or similar:



.5 Brazing quality test:

- .1 When requested by the hospitals inspection body (agent), cut-out a brazed joint as selected by the inspection body who will review the inside of the joint for soundness and evidence of oxidation.
- .2 If samples show improper brazing or oxidation, cut-out the joints immediately upstream and downstream of the first joint, plus three other joints randomly selected by the inspection body. If any of these joints fail the inspection, the Contractor shall then remove additional joints as directed by the Owner until the inspection body is satisfied with the quality of the brazing work. Make good all joints which were removed.

.6 Pressure testing and cross connection testing:

- .1 Pressure testing and cross connection testing of pipeline distribution system piping shall conform to CSA Z7396.1, as summarized and as amended in the following articles. Perform this testing in the following order:
  - (a) disconnect flexible hoses inside of Medical Supply Units (as applicable) and install test caps on medical vacuum and AGSS DISS terminal units,
  - (b) perform the "Initial pressure test",
  - (c) perform the "Final pressure test".
  - (d) perform the "Purge test",
  - (e) perform the "Cross connection test",
  - (f) perform the "Combined Medical Supply Units test".
- .2 Test gas for all tests: oil-free dry air or oil-free dry nitrogen.

.7 Initial pressure test:

- .1 Conduct a standing 24 hour initial pressure test as follows:
  - (a) perform the test before terminal unit outlet covers are installed, and disconnect the pressure transducers and switches from their DISS bodies,
  - (b) disconnect flexible hoses inside of Medical Supply Units (as applicable) and install test caps on medical vacuum and AGSS DISS terminal unit,
  - (c) do not manifold piping systems together - test each system independently,
  - (d) charge each piping system with the test gas to the required test pressure, and then isolate the test gas source,

- (e) test pressure for medical gases and medical support gases: 150% of design pressure or 1035 kPa (150 psi) whichever is greater,
- (f) test pressure for medical vacuum and AGSS: minimum 415 kPa (60 psig),
- .2 Acceptance criteria: no change in pressure during the test period except due to change in ambient temperature around the piping.
- .3 If leaks exist, identify and repair any detected leaks and retest pipe system. Use an oxygen compatible leak detector at each joint,

*Standard of Acceptance*

- Swagelock Snoop
- American Gas & Chemical Co. Ltd Leak-tec

- .4 An acceptable initial test shall be completed before final acceptance pressure testing can occur.
- .8 Acceptance pressure test:
  - .1 Conduct the final standing 24 hour acceptance pressure test as follows:
    - (a) install terminal unit outlet covers, and reconnect pressure transducers and switches,
    - (b) keep flexible hoses inside of Medical Supply Units (as applicable) disconnected and keep test caps on medical vacuum and AGSS DISS terminal units,
    - (c) do not manifold piping systems together - test each system independently,
    - (d) charge each piping system with the test gas to the required test pressure, and then isolate the test gas source,
    - (e) test pressure for medical gases and medical support gases: at system design pressure.
    - (f) test pressure for medical vacuum and AGSS: at system design vacuum. Medical vacuum pumps and AGSS source equipment may be used to create the vacuum conditions, and then source equipment to be isolated during the 24 hour test period.
  - .2 Acceptance criteria: no change in pressure during the test period except due to change in ambient temperature around the piping.
  - .3 Submit a report to the Owner documenting the test methodology and test results.
- .9 Purging test:
  - .1 After acceptance of pressure testing, reconnect the flexible hoses inside of Medical Supply Units (if applicable) and purge the pipeline distribution system piping. Purge terminal units until test gas is clear of particulate matter and visible moisture as droplets or mist.
- .10 Particulate filter test:
  - .1 At completion of purging, test medical gases and medical support gases for particulate matter:
    - (a) fabricate the test-flow apparatus in accordance with Annex D of CSA Z7396.1, including a 0.3 µm particulate filter connected to the outlet of the apparatus,
    - (b) apply the test to at least one terminal unit for each medical pressure gas in each zone,
    - (c) adjust the test apparatus to provide a flow rate of 120 l/min (4 SCFM) for 15 seconds per test, and then remove the filter.
  - .2 Acceptance criteria: when examined under good light, the filter shall be free of visible particulate matter.
  - .3 Maintain a test record of each outlet tested (the room and a description to identify the terminal unit), the date of the test and the name of the person who performed the test.
- .11 Cross-connection tests:



- .1 Conduct cross-connection tests in accordance with Cross-connection Test - Method 2 of CSA Z7386.1, as summarized and as otherwise specified herein.
  - (a) Test special gas mixtures individually in accordance with Cross-connection Method 1 of CSA Z7396.1, with all other piping systems depressurized.
- .2 Disconnect flexible hoses inside of Medical Supply Units (as applicable) and install test caps on medical vacuum and AGSS DISS terminal units.
- .3 Isolate vacuum transducers and vacuum switches from the test gas pressure.
- .4 Use a set of pressure gauges with each gauge equipped with a DISS nut and nipple specific for each pipeline distribution system.
  - (a) Label each gauge with the applicable pipeline distribution system name and provide a colour coded tape around the body perimeter in accordance with the following table.
  - (b) Mark each gauge to indicate the expected test pressure for each specific pipeline distribution system terminal unit.
- .5 Apply the test gas to all systems at the same time, to pressurize each system in accordance with the following table. Use the medical vacuum pumps for medical vacuum.

Piping System	Test Pressure kPa (psi)	Gauge Marking Tape Colour
Medical vacuum	-35 (10 in.Hg.)	Yellow
AGSS	0 (0)	Red or Orange
Helium	70 (10)	Brown
Carbon Dioxide	140 (20)	Grey
Nitrogen	205 (30)	Black
Nitrous Oxide	275 (40)	Blue
Oxygen	345 (50)	Green
Medical Air	415 (60)	Half Black, Half White
Instrument Air	550 (80)	4 stripes Black, 4 stripes White

- .6 Connect the applicable pressure gauges to each terminal outlet in each room based on DISS connector at each unit, Confirm that each terminal unit is correct for DISS connector, test gas pressure, terminal unit name and colour code.
- .7 Periodically check the distribution system test pressure. If the test pressure drops by more than 14 kPa (2 psi) in any system due to loss of test gas during application of pressure gauges, re-establish required test pressure before continuing with the test.
- .8 If the testing indicates the presence of cross-connected terminal units or piping distribution, correct the cross-connection and re-test the system. Continue re-testing until it is demonstrated there are no cross-connections.
- .9 Maintain a record log of each room, listing each outlet and the test confirmation results and provide a copy to the inspection body, the Owner and the Consultant (see Exhibit B).
- .12 Combined test for Medical Supply Units:
  - .1 After completion and acceptance of the main cross-contamination test (including correction of any cross-connection defects), reconnect the internal flexible hoses in the Medical Supply Units (as applicable) and perform a final pressure test and cross-contamination test of the Medical Supply Units.

- .2 Charge each piping system with the test gas to the required test pressure described above under "Acceptance pressure test" and then close the zone valves serving each applicable Medical Supply Unit. Perform a six (6) hour standing pressure test and confirm there is no loss in test pressure at the end of the test, using the zone valve pressure gauge. If a pressure loss occurs, notify the General Contractor/Construction Manager of the defective Medical Supply Unit.
- .3 After completion of the Medical Supply Unit pressure test, individually test each pipeline distribution system service to the Medical Supply Units, with only the one specific pipeline distribution system being pressurized for each test. This can be performed with the applicable zone valves in the closed position.
- .4 Confirm that each terminal unit is correct for DISS connector, test gas pressure, terminal unit name and colour code, and record the results in the cross-connection test record.

### **3.10 Contractor Responsibilities During Certification Testing**

- .1 Pipeline distribution system certification testing will be performed by an independent accredited medical gas testing and certification company ("inspection body") directly retained by the healthcare facility. The certification shall be in accordance with CAN/CSA Z7396.1, including Annex C for source equipment, and Annex D for pipeline distribution. As a summary, certification testing of the medical gas pipeline distribution system includes:
  - .1 Source equipment tests.
  - .2 Supply system alarm tests.
  - .3 Inspection of pipelines, valves and terminal units.
  - .4 Inspections and testing of zone alarms.
  - .5 Qualitative particulate contamination testing.
  - .6 Terminal unit gas identity/cross-contamination test.
  - .7 Terminal unit performance tests including gas quality, quantitative particulate matter and flow rates.
- .2 Pipeline distribution system installation contractor shall provide qualified representative who are knowledgeable in pipeline distribution system installations in general and the Work specifically, to witness certification testing and to assist the Certification Agency in locating pipe runs, valves, alarm sensors, alarm wiring and other components of pipeline distribution systems and repair defects in equipment, workmanship or materials discovered during certification testing.
- .3 Provide a copy of the completed commissioning test reports and as-built drawings to the independent certifier prior to certification testing.
- .4 Arrange and pay for representatives of pipeline distribution system equipment vendor to provide technical support and operating instructions during the certification process.
- .5 After completion of the contractor's commissioning tests described above and while the inspection body is present, purge the medical gas pipeline system with applicable medical gases or, medical support gases sufficiently to remove the test gases. Purge airflow through each terminal unit.
- .6 Assist the inspection body in any subsequent retesting.

### **3.11 Authority Inspections**

- .1 Arrange and pay for AHJ inspections for pressure piping and fire safety. Provide a copy of the AHJ inspection report to the Owner and Consultant; if the AHJ does not issue a report, provide a written record of the AHJ inspection recording the AHJ name, AHJ personnel, contractor personal, date of inspections, a description of what was inspected, and any comments provided by the AHJ.

### **3.12 Training and Instruction**

- .1 Comply with the training requirements of specification section 20 01 01.
- .2 Arrange for manufacturers' representatives to provide instructions of Owners staff in use and maintenance of medical gas equipment.

### **3.13 Records and Reports**

- .1 At completion of commissioning, provide the healthcare facility with the following documents:
  - .1 as-built drawings,
  - .2 completed CSA Z7396.1 form L.1 *Pipeline installation test report*, (sample form follows).
  - .3 copy of installing firm's certification for installation of medical gas systems under regulatory requirements for pressure piping systems,
  - .4 copies of each brazer's certificate of competency (license) who performed all or part of the work,
  - .5 copies of each tradesperson's certificate issued under the *CSA Medical Gas Piping & Systems Installation Personnel Certification Program*,
  - .6 quality assurance program for pressure piping certificate number, or contractor pressure piping licence number (as applicable to the requirements of the provincial AHJ for boilers and pressure vessels),
  - .7 in-process examination records of brazed joints,
  - .8 pressure test reports,
  - .9 particulate matter test report,
  - .10 cross-contamination test records,
  - .11 operating and maintenance manuals which
  - .12 filled out, signed and dated commissioning test plant reports,
  - .13 AHJ inspections reports.
- .2 The submittal and acceptance by the Owner of the records and reports described herein is a condition precedent for obtaining substantial completion of the project.

## Exhibit A – Pipeline Installation Test Report

The following is a sample report for installation contractor installation test report (CSA Z7396.1)

CSA Z7396.1:22		Medical gas pipeline systems — Part 1: Pipelines for medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems	
<b>Annex L (informative)</b> <b>Pipeline installation test report</b>			
<b>Note:</b> This Annex is not a mandatory part of this Standard.			
<b>Figure L.1</b> <b>Pipeline installation test report</b> (See Clauses <a href="#">11.4.1.4</a> , <a href="#">12.3</a> , and <a href="#">12.5.2</a> .)			
Health care facility:		Area/floor:	
Medical gas installation report			
Task	Action required	Complete	
24-hour standing pressure test as per Clause <a href="#">B.2.2</a>	Provide test report		
Perform final leak test as per Clause <a href="#">B.2.3</a>	Verify performed		
Purge terminal units as per Clause <a href="#">B.2.4</a>	Verify performed		
Perform cross connection test as per Clause <a href="#">B.3</a>	Verify performed		
Perform particulate filter test as per Clause <a href="#">D.4</a>	Verify performed		
CSA medical gas piping & installation personnel certification number (Each installers individual number to be submitted) As per Clause <a href="#">11.4.1.2</a>	1. 2. 3. 4. 5.		
Brazing qualification licence number (Each installers individual licence to be submitted) As per Clause <a href="#">11.4.1.3</a>	1. 2. 3. 4. 5.		
Quality assurance program certification number as per Clause <a href="#">11.4.1.6</a>			
Installer:	Date:		
Witnessed by:			
Notes:			
<b>Note:</b> As per Clause <a href="#">12.3</a> , all of the above tests must be performed and a copy of this form is to be submitted to the health care facility before the inspection body commences commissioning.			
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## ***Exhibit B – Cross-connection Test Report***

The following is a sample report for cross-connection testing.

### **Medical Gas Cross-contamination Test Record**

Project Name: \_\_\_\_\_

Date of Test: \_\_\_\_\_

Contractor Name: \_\_\_\_\_

Test performed by: \_\_\_\_\_

Wing	Floor	Room	Number of Outlets Verified (No. outlets in rooms / No. outlets correct)								Remarks
			Ox	MA	MV	NOx	N2	CO2	IA	AGSS	
			/	/	/	/	/	/	/	/	
			/	/	/	/	/	/	/	/	
			/	/	/	/	/	/	/	/	
List of cross-connections discovered and corrected											
(Installation contractor) Results verified by:											

**END OF SECTION**

## **MEDICAL GAS CONTROL EQUIPMENT**

### **22 63 26.70**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide medical gas system controls including:
  - .1 zone alarm panels,
  - .2 zone valve stations,
  - .3 instrumentation and accessories.
- .2 Applicable systems: refer to specification section 23 63 13.70
- .3 Comply with the requirements of Part 1-General of specification section 22 60 13.70 except/and as required herein.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 12 Common Electrical Requirements for Mechanical Services
  - .2 22 60 13.70 Medical Gas Piping

##### **1.3 Applicable Codes and Standards**

- .1 Product standards:
  - .1 CSA C22.2 No. 92.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
  - .2 CSA C22.2 No. 205 Signaling Equipment
  - .3 CAN/CSA C22.2 No. 60601.1 Medical Electrical Equipment – Part 1: General Requirements for Basic Safety and Essential Performance

##### **1.4 Seismic Qualification**

- .1 Seismically qualify (certify) the following equipment specified herein:
  - .1 medical gas alarm panels (Level III)
  - .2 local zone alarm panels (Level III)
- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 20 05 49.23 for the following seismic qualification level and certification method:
  - .1 Functional seismic qualification (Level III) for electrical control equipment: by shake table testing,
- .3 The following equipment specific seismic force parameters are to be used:

C <sub>p</sub>	A <sub>r</sub>	R <sub>p</sub>	h <sub>x</sub> /h <sub>n</sub>
1.00	1.00	1.25	1.0

##### **1.5 Submittals**

- .1 Submit manufacturer catalogue cut-sheets for the materials specified herein.
- .2 Submit shop drawings for;

- .1 alarm wiring which are project specific.
- .3 Submit certification test certificate for seismic qualification in accordance with Specification section 20 05 49.

## **2 PRODUCTS**

### **2.1 General Requirements for Medical Gas Alarm Panels**

- .1 General:
  - .1 Common requirements for supply system alarm panels and zone alarm panels.
  - .2 Listed to CSA C22.2 No. 205.
  - .3 Conforms to CSA Z7396.1
- .2 Cabinet:
  - .1 Tamper-proof, painted, steel back box, for surface mounting with a maximum wall cavity depth of 105 mm (4 in.) from wall finish surface, and removable openings for gas piping and electrical connection.
  - .2 Tamper-proof, painted, hinged front panel, with front mounted display of gas information.
  - .3 Internal power transformers with overcurrent protection.
  - .4 Power supply: 120 VAC, 60 Hz.
- .3 Alarm display unit:
  - .1 Microprocessor based controller:
    - (a) Either:
      - i) one (1) 250 mm (10 in.) colour TFT LCD display for graphical and text display for all gases/vacuum, or
      - ii) multiple TFT colour LCD touchscreen displays for individual gases;
    - (b) virtual graphical display indicating gas pressure status, with continuous green-normal and continuous red-alarm display,
    - (c) LED indicators and controls for alarm silence,
    - (d) built-in web server for remote access to view alarm web page and data,
    - (e) web-page configurable to allow linking to other zone alarm web pages,
    - (f) alarm notification via email or text message through any SMTP gateway,
    - (g) graphical display of alarm panel to mobile devices via WIFI or cellular network.
    - (h) gas specific colour identification in accordance with CSA Z7396.1
  - .2 Programmable and operating functions:
    - (a) high and low gas pressure alarms for medical gases,
    - (b) low pressure alarm for medical vacuum and AGSS,
    - (c) configurable repeat alarm horn time delay,
    - (d) alarm history recall,
    - (e) transient signal detection and display,
    - (f) alarm history recall,
    - (g) self-test diagnostic function to test status indicators and alarm horn,
  - .3 System initiates an alarm if there is an open or shorted sensor circuit, or a sensor input is not connected.

- .4 Alarm horn sound level: 70 dBA at 2 m (6.5 ft.).

## 2.2 Local Zone Alarm Panels

### .1 General:

- .1 Complies with the general requirements for alarm panels specified above.
- .2 Local alarm panels to monitor zone pipeline pressures for applicable medical gases.
- .3 Graphic interface to display zone or room identification, and which cannot be altered except by authorized personnel
- .4 Display measured gas pressure/vacuum values, with selectable pressure units – kPa, psi, or in.Hg.
- .5 Custom alarm response instructions for each gas.
- .6 Capable of monitoring a minimum of eight (8) of the following gases or vacuum. Actual number and type of monitored gases or vacuum as shown on drawings:
  - (a) Oxygen,
  - (b) Nitrous Oxide,
  - (c) Nitrogen
  - (d) Instrument air
  - (e) Medical air
  - (f) Medical vacuum,
  - (g) Carbon dioxide, and
  - (h) Helium
  - (i) Anaesthetic Gas Scavenging System (AGSS)

#### *Standard of Acceptance*

- Amico - Alert-4 series
- BeaconMedaes - TotalAlert Infinity
- Tri-Tech - Med Touch Area Alarm Panel

### .2 Interface for remote alarm annunciation:

- .1 SPDT Form C dry relay contacts for:
  - (a) pressure fault conditions for each gas,
  - (b) control panel general fault.
- .2 Wired Ethernet to remotely display panel status and alarm conditions using any standard web browser.
- .3 Modbus, or BACNet /IP with PICS statement, gateway.

### .3 Pressure transducers:

- .1 Pressure transducers as specified below.
- .2 Panel mounted with gas specific pressure transducer with DISS nut and nipple, or provided with zone valve stations.
- .3 Minimum NPS 3/8 type K copper tube riser for each gas transducer, with matching gas specific DISS check body,
- .4 Cleaned for oxygen service.



## 2.3 Zone Valves

- .1 Cabinet:
  - .1 Conform to CSA Z7396.1.
  - .2 Tamper-proof, painted steel back box, for recessed mounting with a maximum wall cavity depth measured from the finished wall opening surface of:
    - (a) 105 mm (4 in.) for valves NPS 2 and smaller,
    - (b) 170 mm (6.75 in.) for valves NPS 2-1/2 to NPS 3.
  - .3 Sliding, opaque door with pull-ring, and clear gauge window. Door designed so that in an emergency the door is pulled outwards and free of the cabinet to access the valves.
  - .4 Gas/vacuum services capacity: up to 7 separate gas valves.
  - .5 Pressure indicating gauge:
    - (a) dial indicating gauge, reading kPa and psi units, with normal operating pressure in the middle third of the gauge scale,
    - (b) mounted on the downstream side of zone valve.
  - .6 Labeling:
    - (a) gas/vacuum flow direction marked on piping inside of cabinet,
    - (b) provide labelling on panel cover in accordance with CSA Z7396.1 in both English and French.
- .2 Valves:
  - .1 To specification section 22 60 13.70.
  - .2 Arranged to prevent closing of the valve box cover/door when the valve is in the closed position.
- .3 Pressure transducers:
  - .1 Pressure transducers as specified herein.
  - .2 Factory installed, and located on downstream side of zone valve.
  - .3 Pre-wired to terminal strip(s) where field wiring to a remote zone alarm panel is required.

### *Standard of Acceptance*

- Amico
- Class 1
- BeaconMedaes

## 2.4 Combination Zone Valves with Zone Alarm Panel

- .1 Combination zone valves and alarm panels may be used where they comply with the following:
  - .1 Conforms to CSA Z7396.1.
  - .2 Zone valve box as specified herein, including both pressure gauge and digital zone alarm pressure display unit.
  - .3 Zone alarm functions as specified above except use microprocessor based, modular LED numeric pressure display with LED indicator lights for pressure normal and alarm status.
  - .4 Gas/vacuum services capacity: up to 7 separate gas valves.
  - .5 Internally mounted pressure transducer with DISS nut and nipple connection downstream of each zone valve.

### *Standard of Acceptance*

- Amico - Combo Unit series
- Class 1 - CZVA series

## 2.5 Instrument and Control Wiring

- .1 Instrumentation and control wiring in accordance with Specification section 20 05 12.

## 3 EXECUTION

### 3.1 Alarm Panels Installation

- .1 Provide zone alarm panels and combination zone/valve alarm panels configured to suit the applicable medical gas and vacuum services as shown on drawings.
- .2 Install alarm panels in accordance with manufacturer instructions.
- .3 Set alarm panels with top of panel at a height of 1500 mm (5 ft.) above finished floor, unless otherwise shown on drawings.

### 3.2 Pressure Transducers and Sensing Tubing Installation

- .1 Connect pressure transducers to gas pipeline system only after the gas piping has been pressure tested.
- .2 Pressure transducers for zone alarm panels shall only be installed in either the zone alarm panel, or in a zone valve box.
- .3 Where pressure transducers are installed in the zone alarm panel;
  - .1 make tubing connections to gas main immediately downstream of zone control valve and before any connections to a terminal outlet.
  - .2 run NPS 3/8 type K copper medical gas tubing from the pipe main and connect to the copper sensing lines provided on the alarm panel.
- .4 Manual valves shall not be installed between the gas main and the pressure transducer.
- .5 Run control wiring in conduit from the transducer to the alarm panel in accordance with specification section 20 05 12.

### 3.3 Pressure and Vacuum Switches

- .1 Install pressure and vacuum switches on source equipment and mains piping as shown, unless such instrumentation is already factory installed on packaged source equipment.
- .2 Adjust and set high and low pressure and low vacuum setpoints in accordance with manufacturer instructions.

### 3.4 Pressure Switch Setpoints for Zone Alarm Panels

- .1 Adjust and set pressure/vacuum switches for zone alarm panels in accordance with the following table 2:

Alarm	Table 2: Zone Alarm Panel Pressure Setpoints				
	kPa (psi) gauge			kPa (in.Hg.)	
	Oxygen, Medical Air, Nitrous Oxide,	Nitrogen, Instrument Air	Carbon Dioxide	Medical Vacuum	AGSS
Low gas pressure Alarm setpoint	276 (40)	965 (140)	400 (56)	-40 (-12)	-27 (-8)
Nominal gas pressure	345 (50)	1100 (160)	500 (70)	-68 (-20)	-40 (-12)

Alarm	<b>Table 2: Zone Alarm Panel Pressure Setpoints</b>				
	kPa (psi) gauge			kPa (in.Hg.)	
	Oxygen, Medical Air, Nitrous Oxide,	Nitrogen, Instrument Air	Carbon Dioxide	Medical Vacuum	AGSS
High gas pressure Alarm setpoint	413 (60)	1310 (190)	600 (84)	N/A	N/A

### 3.5 Electrical supply and wiring

- .1 Dedicated emergency power circuits for alarm panels will be provided under Electrical Division 26 at 120 volt 60 Hz single phase and will terminate at the device power terminal strip in each alarm panel.
- .2 Provide wiring and conduit from these junction boxes to connect control devices being electrically powered in accordance with specification section 20 05 12.
- .3 Wiring between control and alarm panels and between panels and remote sensors to be provided in accordance with specification section 20 05 12.
- .4 Provide terminal junction boxes wherever signal and control wiring interfaces with alarm wiring.
- .5 Alarm wiring from main panel to terminal junction boxes to be Belden multi-pair colour coded 18 gauge wire with chrome PVC jacket run in EMT conduit.
- .6 Alarms to be wired to same terminal number in each terminal junction box and alarm panel.
- .7 Provide legend showing terminal number, colour code of wire and identifying common wire used for each alarm and each spare circuit.
- .8 25% of wire pairs and terminals to be provided as spare circuits in cable and spare terminals in terminal junction boxes and alarm panels.
- .9 Wire alarm panels in accordance with manufacturers wiring diagrams.

### 3.6 As-built Information

- .1 For remote mounted pressure transducers, mark-up the as-built drawings with dimensioned location of the pressure transducer.
- .2 In addition for supply system alarm panels, provide a diagram indicating the location of remotely mounted pressure transducers, directly printed on foam-core and permanently mounted in a frame (with Lexan cover), and installed adjacent to the applicable source equipment.
- .3 In addition, for zone alarm panels, provide a diagram indicating the location of remotely mounted pressure transducers and place it inside the zone alarm panel.

### 3.7 Medical Gas System Commissioning and Certification

- .1 Refer to specification section 22 60 13.70.

### 3.8 Training and instruction

- .1 Arrange for manufacturers' representatives to provide instructions of Owners staff in use and maintenance of equipment associated with medical gas systems.

**END OF SECTION**

## **HVAC PIPING SYSTEMS GENERAL REQUIREMENTS**

### **23 05 01**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide heating and cooling piping systems in accordance with the referenced piping materials, standards, specifications and piping codes described herein.
- .2 This specification applies to;
  - .1 water based piping systems, including glycol/water mixtures, for building hydronic heating and cooling systems,
  - .2 steam and condensate systems, and
  - .3 non-potable water systems for HVAC services.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 24 Welding and Brazing.

##### **1.3 Applicable Codes and Standards**

- .1 Legislation:
  - .1 Ontario Regulation 220/01 Boiler and Pressure Piping Regulation
- .2 Installation standards and codes (as adopted and amended by the AHJ for pressure vessels):
  - .1 CSA B51 Boiler, pressure vessels, and pressure piping code
  - .2 ASME B31.1 Power Piping
  - .3 ASME B31.3 Process Piping
  - .4 ASME B31.9 Building Services Piping

##### **1.4 Qualified Tradesmen**

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesmen holding applicable certificates of competency as applicable to the work.

##### **1.5 Registration and Inspection**

- .1 Before commencing work, make arrangements and pay for registration and inspection by the AHJ responsible for boiler and pressure vessel safety for the following pressure piping systems:
  - .1 Steam, including condensate piping, at pressures greater than 100 kPa (15 psig).
  - .2 Service water piping for heating a building, at design temperatures greater than 121°C (250°F) or at design pressures greater than 1100 kPa (160 psig),
  - .3 HVAC water systems (other than building heating water systems), including chilled water and condenser water systems, at design temperatures greater than 65°C (150°F) or design pressures greater than 1717 kPa (250psig).
- .2 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.

## 1.6 Design Criteria – Steam, Condensate and Feedwater Systems

- .1 Piping design and installation code:
  - .1 To ASME B31.1 for steam design pressure greater than 100 kPa (15 psig)
  - .2 To ASME B31.9 for steam design pressure 100 kPa (15 psig) or less.
  - .3 Piping code for condensate systems: same as the connected steam system.
- .2 Piping system(s) includes but is not limited to;
  - .1 condensate receivers with pumping sets,
  - .2 steam metering,
  - .3 pressure reducing valve assemblies,
  - .4 flash tanks,
  - .5 trap assemblies,
  - .6 heat exchangers,
  - .7 controls,
  - .8 water treatment.
- .3 System design criteria:
  - .1 Steam and associated gravity condensate systems:
    - (a) for the purpose of this article, “gravity condensate” means condensate which is not transmitted by a condensate pump.

System	Saturated Steam		Gravity Condensate
	Operating Pressure	Design Pressure	Design Pressure
Low Pressure	Up to 85 kPa (12 psig)	103 kPa (15 psig)	700 kPa at 121°C (100 psi at 250°F)
Intermediate Pressure	>103 kPa (15 psig) and up to 345 kPa (50 psig)	700 kPa (60 psig)	1000 kPa at 160°C (150 psi at 320°F)
Medium Pressure	>350 kPa (50 psig) and up to 900 kPa (130 psig)	1030 kPa (150 psig)	1030 kPa at 186°C (150 psi at 367°F)
High Pressure	> 900 kPa (130 psig) and up to 1400 kPa (200 psig)	1720 kPa (250 psig)	1720 kPa at 210°C (250 psig at 410°F)

- .2 Pump condensate systems:

<b>System</b>	<b>Design Temperature</b>	<b>Working Pressure</b>	<b>Design Pressure</b>
Pumped condensate	121°C (250°F)	350 kPa (50 psig)	700 kPa (103 psig)

## 1.7 Design Criteria - Hot Water Heating Systems

- .1 Piping design and installation code:
  - .1 To ASME B31.9 for piping system not subject to boiler and pressure vessel regulations.
  - .2 To ASME B31.1 for piping systems which are subject to boiler and pressure vessel regulations.
- .2 System includes but is not limited to;
  - .1 Heat exchangers,
  - .2 Pumps,
  - .3 Expansion tanks,
  - .4 Convector, s,
  - .5 Radiators,
  - .6 Radiant panels,
  - .7 Finned radiation,
  - .8 Unit heaters,
  - .9 Heating coils,
  - .10 Controls,
  - .11 Water treatment.
- .3 System design criteria:
  - .1 Design temperatures and pressures:

<b>System Type</b>	<b>Supply Temp. °C (°F)</b>	<b>Return Temp. °C (°F)</b>	<b>Design Temp. °C (°F)</b>	<b>Maximum Operating Pressure kPa (psig)</b>	<b>Design Pressure kPa (psig)</b>
Constant temperature heating	82 (180)	71 (160)	121 (250)	900 (125)	1030 (150)
Radiant ceiling panels	82 (180)	71 (160)	121 (250)	900 (125)	1030 (150)
Finned Radiation with enclosure	82 (180)	71 (160)	121 (250)	900 (125)	1030 (150)
Flat plate and cast iron radiators	82 (180)	71 (160)	121 (250)	900 (125)	1030 (150)
Terminal Reheat System	82 (180)	71 (160)	121 (250)	900 (125)	1030 (150)

## 1.8 Design Criteria - Cooling Water Systems

- .1 Piping design and installation code:
  - .1 To ASME B31.9 for piping system not subject to boiler and pressure vessel regulations.
  - .2 To ASME B31.1 for piping systems which are subject to boiler and pressure vessel regulations.

- .2 System includes but is not limited to;
  - .1 Heat exchangers,
  - .2 Pumps,
  - .3 Expansion tank,
  - .4 Cooling coils,
  - .5 Fan coil units,
  - .6 Controls,
  - .7 Water treatment.
- .3 System design criteria:
  - .1 Design temperatures and pressures:

<b>System Type</b>	<b>Supply Temp. °C (°F)</b>	<b>Return Temp. °C (°F)</b>	<b>Design Temp. °C (°F)</b>	<b>Maximum Operating Pressure kPa (psig)</b>	<b>Design Pressure kPa (psig)</b>
Chilled water	8.8 (48)	15.5 (60)	38 (100)	900 (125)	1030 (150)

## 1.9 Design Criteria - Glycol system

- .1 Piping design and installation code:
  - .1 To ASME B31.9 for piping system not subject to boiler and pressure vessel regulations.
  - .2 To ASME B31.1 for piping systems which are subject to boiler and pressure vessel regulations.
- .2 System includes but is not limited to;
  - .1 Filling pump,
  - .2 Heat exchangers,
  - .3 Mixing tank,
  - .4 Circulating pump,
  - .5 Expansion tank,
  - .6 Coils,
  - .7 Controls
- .3 System design criteria:
  - .1 Design temperatures and pressures:

<b>System Type</b>	<b>Glycol Type</b>	<b>Glycol / Water %</b>	<b>Supply Temp. °C (°F)</b>	<b>Return Temp. °C (°F)</b>	<b>Design Temp. °C (°F)</b>	<b>Maximum Operating Pressure kPa (psig)</b>	<b>Design Pressure kPa (psig)</b>
Glycol Heating – Air Handling Unit Coils	Propylene	50	60 (140)	48 (118)	93 (200)	900 (125)	1030 (150)

## 1.10 Design Criteria – Water Source and Quality

### .1 Water source sample analysis:

- .1 Take water samples and conduct laboratory analysis of the water source at the location of the project. The following table summarizes key parameters from publicly available information and is to be used for general information only.

Parameter	Value (average)	Remark
Location	City of Toronto	
Data Source	Annual Report	
Report Date	2016 reporting year	
Sample Source	Treated municipal water	
<b>General Parameters</b>		
pH	7.5	---
Conductivity	320	µmhos/cm
Total Hardness	129	mg/L (as CaCO <sub>3</sub> )
Total Alkalinity	89	mg/L
Total Dissolved Solids	208	mg/L
Iron	0.013	mg/L
Chlorine	1.37	mg/L

## 2 PRODUCTS

### 2.1 Dielectric Unions

#### .1 Construction:

- .1 Bronze or brass body with non-metallic fitting or coating the FNPT tailpiece.
- .2 FNPT x Copper sweat connection.
- .3 Pressure rating; ASME Class 3000 at 121°C (250°F)

#### *Standard of Acceptance*

- ° Hart Industrial Unions - fig. D-3136 or Polymer Composite Coating

### 2.2 Dielectric Flanges

#### .1 Construction:

- .1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece.
- .2 Flange provided with a powder coated finish, and an EPDM insulator to isolate the copper tailpiece from contact with the flange.
- .3 Minimum MCPR:
  - (a) Class 150: 1400 kPa (200 psi) at 121°C (250°F)
  - (b) Class 300: 2800 kPa (400 psi) at 121°C (250°F)

#### *Standard of Acceptance*



- CTS Flange Canada - fig. BF / WBG

## **2.3 Cam and Groove Fittings**

- .1 NPS 2 size:
  - .1 Brass body cam and groove fittings, male groove end x female NPT end, with camlock female dust cap.

## **3 EXECUTION**

### **3.1 Pipe Installation General Requirements**

- .1 General layout of mains, risers, run-outs and connection details of piping systems are shown.
- .2 Install concealed pipes close to building structure to keep furring spaces to minimum and minimize obstruction to other services in ceiling spaces.
- .3 Run exposed piping parallel to walls and conserve headroom and space. Group piping wherever practical.
- .4 Ream pipe after cutting to length and clean off scale and dirt inside and outside of pipe before threading, grooving or welding.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and special fittings such as expansion joints.
- .6 Cap ends during construction to prevent entry of foreign matter.
- .7 Provide bends, expansion loops, hoses or joints to compensate for pipe expansion and contraction.
- .8 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.
  - .1 For steam, gas and vapour piping, provide temporary intermediate supports when hydrostatically piping so that pipe support spans are not greater than that required for liquid piping service.
- .9 Erect piping so that expansion forces, gravity forces and thrust from changes in direction do not stress connections to apparatus.
- .10 Do not use galvanized materials in contact with glycols.
- .11 Refer to piping system specifications for additional requirements.
- .12 All HVAC equipment, valves, steam traps, expansion joints, and any other items requiring periodic maintenance must be installed in locations that are accessible for maintenance;
  - .1 where these items are installed inline with piping in an inaccessible location (high level above obstructions, etc.) offset and/or jog piping as required to install in an accessible location,
  - .2 provide access doors in accordance with Section 20 05 01 *Basic Materials and Methods*, and
  - .3 where applicable, provide valve kit enclosure box in accordance with Section 23 21 16 *Hydronic Piping Specialties*.

### **3.2 Drainage Piping, Drain Valves and Air Vents**

- .1 Provide drain valves at low points in water piping systems and in valved run-outs from risers so that system or isolated parts of system can be drained. Locate piping system drain valves as close to the system pipe as possible.
- .2 Provide an additional drain valve at the drain termination point where;
  - .1 the drain valve is not accessible from a floor with or without the use of a 2.4 m (8 ft) high ladder, or from an elevated work platform,

- .2 upstream of each isolation valve,
- .3 and as otherwise specified herein.
- .3 Provide drain valves on equipment drains, including but not limited to heat exchangers and water treatment and filtration equipment.
- .4 For copper tube drains, connect copper drain tubing to the outlet side of equipment drain valves or piping system drain valves; do not make connections of copper drain tubes directly to carbon or stainless steel HVAC liquid piping.
- .5 Drain sizes:
  - .1 NPS 2 for large water-filled equipment including exchangers.
  - .2 NPS ¾ for other equipment drains, including integral or field installed condensate and drip pans.
  - .3 NPS 2 for piping system drains, unless otherwise shown.
- .6 Run large equipment drains to floor trenches unless otherwise shown to terminate in a specific location.
- .7 Run other equipment drains to nearest floor drain unless otherwise shown to terminate in a specific location. Where NPS ¾ drains terminate at a floor drain, provide a funnel of at least 200 mm x 100 mm (8 in x 4 in) on the floor drain cover.
- .8 Install piping system drains as follows;
  - .1 In mechanical service rooms and permanently accessible service spaces, extend drains down along a wall or column and terminate approximately 1000 mm (40 in) above the floor level in the service room, or above the lowest accessible level in a vertical service space.
  - .2 In other service rooms including non-accessible service spaces, electrical rooms, telecom rooms or data rooms, extend drains to a location outside of these service room to a location agreed with by the Engineer unless otherwise shown and provide a drain valve at the termination point.
  - .3 Where piping system drains are located in finished areas above accessible ceilings that are not more than 3 m (10 ft) high, terminate the drains approximately 200 mm (8 in) above the top of the ceiling and provide a drain valve at this termination point.
  - .4 Where piping system drains are located above non-accessible ceilings, or where an accessible ceiling is more than 3 m (10 ft) high, extend the drain tubing to a location agreed with by the Engineer unless otherwise shown and provide a drain valve at this termination point.
- .9 Terminate drain ends with a 45° elbow and a brass body, male-end, cam-and-groove (Camlock) coupling fitting with dust cap. Supply the matching hose-end female connector and turn over to the owner.
- .10 Provide air vents with isolation ball valves at high points to allow effective drainage of the system and to facilitate removal of air from the system.

### **3.3 Dissimilar Metals Galvanic Isolation**

- .1 Provide dielectric unions or flanges to separate copper and copper alloy tube and fitting materials from contact with carbon steel material. This includes equipment such as coils with copper header connections.
- .2 Dielectric unions or flanges are not required when all of the following conditions are met:
  - .1 the hydronic water treatment program (existing or new) includes a cathodic and/or anodic filming chemistry for mixed metals,
  - .2 copper tubing is not used in the piping system, except for the final 1 m (40 in) length connection to terminal equipment and in which the tubing is isolated from the carbon steel piping by a bronze body or carbon steel body valve (no brass) , and

- .3 terminal equipment which contains copper or copper alloy tubing is connected to carbon steel piping with a flexible connector having an internal non-metallic hose.
- .3 For clarity, where copper tubing is installed in a part of a carbon steel piping system, dielectric unions or flanges are required.

### **3.4 Pressure and Leak Testing - Liquid Service Piping**

- .1 This test procedure applies to piping normally containing water, including HVAC and process water and glycol/water mixes, and steam-condensate piping.
- .2 Pressure test liquid piping systems unless otherwise specified in other sections of Division 23.
- .3 Initial pneumatic leak test:
  - .1 Conduct an initial pneumatic leak test to locate and repair major leaks.
    - (a) test pressure for ASME B31.1 systems: 175 kPa (25 psig),
    - (b) test pressure for ASME B31.9 systems: 70 kPa (10 psig).
  - .2 Remove compressed air source and maintain this pressure for the time necessary to inspect for leaks, but not less than 2 hours.
  - .3 Maintain pressure and examine each joint with commercial leak detector solution.

#### *Standard of Acceptance*

- Snoop
  - Leak-tec
- .4 Repair leaks where found prior to performing hydrostatic pressure tests.
- .5 During pneumatic pressure tests, comply with the site safety requirements for notification and guarding during testing with compressed gasses.
- .4 Final hydrostatic pressure test:
  - .1 Use the system design pressure for the entire installation, unless different design pressures are indicated for each floor.
  - .2 Pressure test condensate piping to the same test conditions as the steam system to which they are connected.
  - .3 Fill the system with water and gradually increase the system pressure to 150% of the design pressure and hold for 10 minutes, then reduce pressure to the design pressure.
  - .4 Inspect each pipe joint for leaks.
  - .5 As an alternative to inspection of each joint for leaks, conduct a 24 hour standing pressure test:
    - (a) raise the water pressure to 150% of the design pressure for 10 minutes, then reduce pressure to design pressure,
    - (b) record the test pressure one (1) hour after establishing the system hydrostatic test pressure at the design pressure. Record ambient air temperature at the same time.
    - (c) at the end of the 24 hour standing test period, record the test pressure and ambient air temperature. Make adjustments to the measured end-of-test pressure to account for change in fluid density due to change in ambient air temperature,
    - (d) acceptance criteria: maximum pressure loss over 24 hours not to exceed 1% of test pressure, corrected for ambient temperature,
    - (e) where acceptance criteria is not met, inspect pipe joints for leaks.
  - .6 Where leaks are found, repair leaks and retest piping as specified above.

### 3.5 Pressure and Leak Testing - Steam

- .1 This test procedure applies to piping normally containing steam.
- .2 Test steam piping in accordance to the requirements for liquid piping described above, except as follows:
  - .1 for hydrostatic pressure testing of steam piping, install temporary pipe supports for steam piping to provide spans between supports equal to that for heating water piping.

### 3.6 Pressure Test Report

- .1 Maintain a log of all pressure tests, including locating of where leaks have been repaired. Submit the log to the Consultant for review when requesting prior to substantial completion of the Work. Where a piping system is subject to AHJ inspection, provide evidence of such inspection by means of an AHJ inspection report or name of the AHJ inspector and the date they witnessed the pressure test.

### 3.7 Piping Material Selection Schedule

- .1 Provide piping material in accordance with schedule Table 1 at the end of this specification section.

Table 1: Piping and Valve Material and Specification by System Type				
Piping System	Abbrev	Pipe Material	Pipe Specification	Valve Specification
Hydronic heating and cooling - closed loop (with or without glycol)	HTS/R HS/R LTS/R GHS/R CHS/R GCS/R RV	Carbon Steel	23 21 13.23	23 05 23.13
		Copper	23 21 13.33	23 05 23.13
Distribution Steam and Condensate	S-xxx PC-xxx GC, HD V, RV	Carbon Steel	23 22 13.23	23 05 23.23
Non-potable make-up water (no pre-treatment, no added chemicals)	NPWH	Copper	23 21 13.33	23 05 23.13
		Stainless Steel (tube or pipe)	22 11 16.16 or 23 21 13.26	23 05 23.16
Water Pre-Treatment for HVAC Services (softened water and dealkalized water)	SWH DALK	Copper	23 21 13.33	23 05 23.13
		Galvanized Steel	23 21 13.23	23 05 23.13
Chemical Feed (chemical water treatment)	CF, CS	Various	23 25 11	
		Stainless Steel Tube	23 26 16	
	DR	Galvanized Steel	23 21 13.23	23 05 23.13

<b>Table 1: Piping and Valve Material and Specification by System Type</b>				
Piping System	Abbrev	Pipe Material	Pipe Specification	Valve Specification
Equipment and piping system drainage for HVAC liquid systems		Copper	23 21 13.33	23 05 23.13
Equipment and piping system drains for steam and condensate system.	DR	Same as associated steam and condensate system.		

**END OF SECTION**

## **GENERAL-DUTY VALVES FOR HVAC WATER PIPING**

### **23 05 23.13**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide valves for general duty service in HVAC water piping systems, including shut-off valves, check valves, and manual balancing valves, for piping systems with a design pressure of 3500 kPa (507 psig) or less and a design temperature of 121°C (250°F) or less.
- .2 This specification applies to hydronic heating and cooling water systems (with or without glycol additives) and other piping systems required to be carbon steel pipe, galvanized steel pipe, and/or copper tubing as specified in section 23 05 01, except as otherwise required for specific duty valve in other specification sections.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section integrates with or refers to the following specification sections:
  - .1 20 05 23 General Requirements for Valves
  - .2 23 05 01 Heating and Cooling Piping Systems

##### **1.3 Submittals**

- .1 Conform to the requirements of Specification section 20 05 23 except/and as follows.
- .2 For double regulating valves, in addition to manufacturer data sheets, submit a schedule listing all double regulating valves and include the following information:
  - .1 a valve reference number,
  - .2 valve service (e.g. associated equipment, or distribution piping service by drawing, room, etc.)
  - .3 associated pipeline size, NPS
  - .4 valve body size, NPS
  - .5 specified design flow rate,
  - .6 valve minimum and maximum flow rate limits,
  - .7 valve pressure drop at specified design flow rate,
  - .8 expected valve open position (number of valve turns open, percent valve stroke, etc.)

##### **1.4 Applicable Codes and Standards**

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Where an HVAC liquid piping system is subject to registration as a pressure piping system as identified in specification section 23 05 01, all valves shall have Canadian Registration Numbers in accordance with CSA B51. In the following valve specifications, where the identified model does not have a current CRN, provide a valve of equal or greater performance which has a current CRN from the same manufacturer.
- .3 For the purpose of this article, "current CRN" means a registration which does not expire for at least 12 months from the date of submittal of shop drawings.

## 2 PRODUCTS

### 2.1 Ball Valves – bronze/brass body

#### .1 NPS 2 and under:

- .1 To MSS SP-110, 600 CWP/150 SWP, two-piece bronze or DZR brass body, full port, solid stainless steel or chrome plated bronze ball, PTFE seat and seals.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 Required MCPR: 2300 kPa (335 psig) at 121°C (250°F).
- .4 Solder ends:

#### *Standard of Acceptance*

- Kitz - fig. 59, 69AM-LL
- Apollo - fig. 77-200
- Nibco - fig. S-585-70
- Anvil - fig. 171S

#### .5 NPT threaded ends.

#### *Standard of Acceptance*

- Kitz - fig. 58, 68AM-LL
- Apollo - fig. 77-100
- Nibco - fig. T-585-70
- Anvil - fig. 171N

### 2.2 Ball Valves – carbon steel body

#### .1 NPS 2 and under:

- .1 To MSS SP-110, 1500 CWP/150 SWP, carbon steel body, regular port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 ISO 5211 mounting pad.
- .4 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).
- .5 Two-piece body style, NPT threaded ends:

#### *Standard of Acceptance*

- Apollo - fig. 89-100
- MAS - fig. CSCR-2
- Velan - fig. S-M1102-SSGA

#### .6 Three-piece body style, NPT threaded ends:

#### *Standard of Acceptance*

- Apollo - fig. 83A-140
- Nibco - fig. TM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N
- Velan - fig. S-K1802-SSGA

#### .7 Three-piece body style, socket weld ends:

*Standard of Acceptance*

- Apollo - fig. 83A-240
- Nibco - fig. KM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N-SW
- Velan - fig. W-K1802-SSGA

.2 NPS ½ to NPS 4:

- .1 To MSS SP-72, ASME Class rated, carbon steel two-piece split body, full port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals, ASME Class 150 flanged ends.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 ISO 5211 mounting pad.
- .4 Class 150:
  - (a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 150SCTDZM-N
- Apollo - fig. 88A-200
- Nibco - fig. F-515-CS-F-66-FS
- Velan - fig. SB-150

.5 Class 300:

- (a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 300SCTDZM-N
- Apollo - fig. 88A-900
- Nibco - fig. F-535-CS-F-66-FS
- Velan - fig. SB-300

## 2.3 Globe Valves

.1 NPS 2 and under:

- .1 To MSS SP-80, Class 150, bronze body, renewable PTFE composition disc, union bonnet, and lockshield handles where shown.
  - (a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).
  - (b) Solder ends.

*Standard of Acceptance*

- Kitz - fig. 10
- Crane - fig. 1310 (class 300)
- Jenkins - fig. 106BPJ (class 300)
- Nibco - fig. S-235-Y

- (c) NPT threaded ends.

*Standard of Acceptance*

- Kitz - fig. 09
- Crane - fig. 7TF



- Jenkins - fig. 106BJ
- Nibco - fig. T-235-Y

- .2 To MSS SP-80, Class 300, bronze body, hardened stainless steel plug, renewable seat and union bonnet, with NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 17S
- Crane - fig. 382P
- Jenkins - fig. 592J
- Nibco - fig. T-276-AP

- .3 To ASME B16.34, Class 800, forged steel body, bolted bonnet, hard faced disc and seat ring, with NPT threaded ends.

(a) Required MCPR: 12 MPa (1740 psig) at 121°C (250°F).

*Standard of Acceptance*

- Crane - fig. B3644XU-T
- Powell - fig. LG08TA58GB
- Beric - fig. 502-T-X-8-A-08

- .2 NPS 2½ and over, flanged:

- .1 To MSS SP-85, Class 125, cast iron body, bronze trim, OS & Y bolted bonnet, bronze disc and seat ring, flat faced flanges,

(a) Required MCPR:

- i) NPS 2-12: 1200 kPa (174 psig) at 121°C (250°F).
- ii) NPS 14-24: 860 kPa (125 psi) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 76
- Crane - fig. 351
- Jenkins - fig. 2342J
- Nibco - fig. F-718-B

- .2 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, 13% chrome stellite trim, OS & Y, bolted bonnet, and raised face flanges.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 300SCJS
- Crane - fig. 151XU
- Jenkins - fig. J1042B2
- Powell - fig. 3031-FC8G
- Beric - fig. 203-RF-EA08-H

## 2.4 Gate Valves

- .1 NPS 2 and under:

- .1 To MSS SP-80, Class 150 with bronze body, OS&Y rising stem, bronze wedge disc and union or screw-in bonnet, and NPT threaded ends.

(a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 42
- Crane - fig. 431UB
- Nibco - fig. T-131

.2 To MSS SP-80, Class 300, bronze body, OS&Y rising stem, copper nickel alloy or stainless steel trim, solid wedge disc, union bonnet, and NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 37
- Crane - fig. 622E
- Jenkins - fig. 2280UJ
- Nibco - fig. T-174-A

.3 To ASME B16.34, Class 800, forged steel body, standard port, OS&Y rising stem, solid wedge disc, bolted bonnet, and NPT threaded ends.

(a) Required MCPR: 12 MPa (1740 psig) at 121°C (250°F).

*Standard of Acceptance*

- Bonney Forge - fig. HL-11-T
- Crane - fig. B-3604XU-T
- Powell - fig. GA08TA58GB
- Beric - fig. 501-T-X-8-A-02

.2 NPS 2½ and over, flanged:

.1 To MSS SP-70, Class 125, cast iron body, OS&Y rising stem, flat faced flanges, bronze trim, and bolted bonnet, and flat-faced flanges.

(a) Required MCPR:

- i) NPS 2-12: 1200 kPa (174 psig) at 121°C (250°F).
- ii) NPS 14-24: 860 kPa (125 psi) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 72
- Crane - fig. 465½
- Jenkins - fig. 454J
- Nibco - fig. F-617-O

.2 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, OS&Y rising stem, flexible disc, 13% chrome stellite trim, bolted bonnet, and raised face flanges.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 300SCLS
- Crane - fig. 33XU-F
- Jenkins - fig. J1010B8F
- Powell - fig. 3003-FC8G
- Beric - fig. 103-RF-AA08-H

**2.5 Butterfly Valves – Low Pressure (type “LP”)****.1 NPS 2½ to NPS 24, for flange installation:**

- .1 To MSS SP-67, ductile or cast iron flange-less lug body style, flange holes drilled and tapped for ANSI 150 flange pattern.
- .2 Stainless steel shaft, bronze or ductile iron disc with nickel chrome seating edge and replaceable EPDM resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .3 ISO 5211 mounting pad.
- .4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .5 Required MCPR:
  - (a) NPS 2 to 12: 1380 kPa (200 psig) at 107°C (225°F).
  - (b) NPS 14 to 24: 1030 kPa (150 psig) at 107°C (225°F).

*Standard of Acceptance*

- Nibco - fig. LD-2000
- Crane - fig. Center Line RS-200
- Kitz - fig. 6100 series
- DeZurik - fig. BOS-US
- Bray - fig. 31H
- Watts - fig. BF-03-M2
- MAS - fig. D series

**2.6 Inline Silent Check Valves****.1 NPS 2 and under, bronze, threaded:**

- .1 To MSS SP-80, Class 125, bronze body, spring-controlled inline style (non flapper), body guided disc, resilient EPDM or PTFE seat or disc; bronze, Inconel or stainless steel spring; with NPT threaded ends.
- .2 Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 36
- Nibco - fig. T-480-Y
- Apollo - fig. CVBB 61-500
- Valmatic - fig. 1400THR

**.2 NPS 2 ½ to NPS 12, wafer style:**

- .1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, wafer body style for installation between flat-faced flanges.
- .2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.
- .3 Required MCPR: 1200 kPa (174 psig) at 65°C (150°F).

*Standard of Acceptance*

- Dezurik - fig. APCO 300 Series
- Valmatic - fig. 1400A series
- Mueller - fig. 101MAT
- Nibco - fig. W-910

.3 NPS 2½ to NPS 24, flanged ends:

- .1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, with Class 125/150 flanges.
- .2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.
- .3 Required MCPR:
  - i) NPS 2-12: 1200 kPa (174 psig) at 65°C (150°F).
  - ii) NPS 14-24: 860 kPa (125 psi) at 65°C (150°F).

*Standard of Acceptance*

- Dezurik - fig. APCO 600 Series
- Valmatic - fig. 1800 series
- Mueller - fig. 107MAT
- Nibco - fig. F-960

.4 NPS 2½ to NPS 24, carbon steel, flanged:

- .1 To MSS SP-126, Class 150 and 300, ASTM A216 WCB carbon steel body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, stainless steel seat, with Class 150 / 300 flanges.
- .2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.
- .3 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Dezurik - fig. APCO 600 Series
- Durabla - fig. GLC
- Mueller - fig. 109MDT

## 2.7 Swing Check Valves

.1 NPS 2 and under:

- .1 To MSS SP-80, Class 125, bronze body, bronze swing disc, screw in cap, regrindable seat.
  - (a) Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).
  - (b) Soldered ends

*Standard of Acceptance*

- Kitz - fig. 23
- Crane - fig. 1342
- Jenkins - fig. 4093J
- Nibco - fig. S-413-B

(c) NPT threaded ends:

*Standard of Acceptance*

- Kitz - fig. 22
- Crane - fig. 37
- Jenkins - fig. 4037J
- Nibco - fig. T-413-B

- .2 To MSS SP-80, Class 300, bronze body, bronze swing disc, screw in cap, regrindable seat, with NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 19
- Crane - fig. 76E
- Jenkins - fig. 4962J
- Nibco - fig. T-473-B

- .2 NPS 2½ to NPS 10, cast iron, flanged

- .1 To MSS SP-71, Class 125, cast iron body, flat faced flange, renewable bronze seat ring, bronze disc, bolted cap, with ASME Class 125 flanged ends.

(a) Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 78
- Crane - fig. 373
- Jenkins - fig. 587J
- Nibco - fig. F-918-B

- .3 NPS 2 to NPS 30, carbon steel, flanged:

- .1 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, renewable stainless steel seat ring, stainless steel or 13% Cr overlay disc, bolted cap.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 300SCOS
- Crane - fig. 159XU
- Beric - fig. 303-RF-EA08

## **2.8 Double Regulating Valves ("DRV")**

- .1 NPS 3 and under:

- .1 Bronze or DZR brass body, plug type stem with flow measurement ports and tamper-proof setting.
- .2 NPT threaded or soldered ends.
- .3 Required MCPR: 1500 kPa (215 psig) at 121°C (250°F) water temperature.

*Standard of Acceptance*

- S.A. Armstong - fig. CBV
- Victaulic - fig. 787
- Bell and Gossett - fig. Circuit Setter Plus
- Preso - fig. B-Plus
- Nexus - fig. UltraMB(NL)
- Red White - fig. 9517

- .2 NPS 2½ to NPS 12:

- .1 Cast or ductile iron body, copper alloy trim, with flow measurement ports, tamper-proof setting, with groove or Class 250/300 flanges.

- .2 Required MCPR: 1720 kPa (250 psig) at 110°C (230°F)

*Standard of Acceptance*

- S.A. Armstrong - fig. CBV II
- Victaulic - fig. 788/789
- Preso - fig. B-PLUS
- Nexus- fig. UltraMB
- Red White - fig. 9519

- .3 Flow meter for DRVs

- .1 Differential pressure gauge with calibrated charters or direct digital flow meter type.
- .2 Hose and fittings to suit manual double regulating valves.
- .3 In addition to equipment and materials used during start-up and testing, supply one complete set of clean un-used calibrated flow charts or one (1) digital flow meter, to the owner at the completion of the project.

## **2.9 Plug Valves with Flow Balancing Ports**

- .1 NPS 6 to 24, flanged:

- .1 To MSS SP-78, cast or ductile iron body, lubricated bronze or nickel plated cast iron plug, lubrication assembly, short pattern, with Class 125 flat-face flange ends.
- .2 Two pressure test ports with pet cocks for differential pressure measurement, and calibrated flow charts.
- .3 Worm gear operator with memory stop.
- .4 Class 125:

(a) Required MCPR:

- i) NPS 2-12: 1200 kPa (174 psi) at 121°C (250°F)
- ii) NPS 14-24: 1000 kPa (145 psi) at 121°C (250°F)

*Standard of Acceptance*

- Hattersley - fig. 611
- DeZurik - fig. Hilton Balancing Valve

- .5 Class 250:

(a) Required MCPR:

- i) NPS 2-12: 2700 kPa (390 psi) at 121°C (250°F)
- ii) NPS 14-24: 1700 kPa (245 psi) at 121°C (250°F)

*Standard of Acceptance*

- Hattersley - fig. 602
- DeZurik - fig. Hilton Balancing Valve

## **2.10 Triple Duty Valves**

- .1 Combination discharge non-slam check valve, isolation valve and balancing valve ("triple-duty").
- .2 NPS 1-1/4 to NPS 2:
  - .1 Ductile iron body, Class 125, non-slam bronze disc with stainless steel spring, EPDM seat ring, plug type stem, flow measurement ports, tamper-proof setting, with NPT threaded ends.

- .2 Required MCPR: 900 kPa (130 psig) at 110°C (230°F)

*Standard of Acceptance*

- S.A. Armstrong - fig. FLO-TREX FTV-T
- ITT Bell & Gossett

- .3 NPS 2 to NPS 12:

- .1 Cast or ductile iron body, non-slam bronze disc with stainless steel spring, EPDM seat ring, plug type stem, flow measurement ports, tamper-proof setting, with flanged or groove pipe ends.
- .2 Class 125 required MCPR: 900 kPa (130 psig) at 110°C (230°F)
- .3 Class 250 required MCPR: 2070 kPa (300 psig) at 110°C (230°F)

*Standard of Acceptance*

- S.A. Armstrong - fig. FLO-TREX FTV series
- ITT Bell & Gossett

### **3 EXECUTION**

#### **3.1 General**

- .1 Refer to section 20 05 23 and as required herein.

#### **3.2 Valve Selection Based on Pressure Rating**

- .1 Unless otherwise specified herein or shown, select valves that have a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 23 05 01.
- .2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select valves as follows:
  - .1 For all valves, select a valve with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level.
  - .2 For clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

#### **3.3 Check Valves**

- .1 Provide an inline silent check valve on the pump discharge under any of the following conditions:
  - .1 multi-parallel pump installation,
  - .2 where the pump discharge piping rises to more than 5 m (15 ft) above the pump discharge, and
  - .3 at other locations as shown on drawings.
- .2 Provide an inline silent check valve where a check-valve is shown on drawings other than at a pump discharge.
- .3 Provide swing check or silent check valves at other locations.

#### **3.4 Double Regulating Valves Installation**

- .1 Consult with double regulating valve manufacturer to ensure correct valve selection. Balancing valves to be sized according to design flow rate.

- .2 Size and select valves for flows as shown, based on at 6 kPa (2 ft) pressure drop across the valve in the fully open position, and in accordance with manufactures recommendation. Table 1 identifies the nominal valve size selection:

<b>Table 1: Double Regulating Valve Nominal Sizing</b>				
Valve Size NPS	Nominal Flow			
	Min.	Max.	Min.	Max.
	L/s	L/s	gpm	gpm
½	0.038	0.177	0.6	2.8
¾	0.126	0.379	2.0	6.0
1	0.246	0.631	3.9	10.0
1-¼	0.316	0.947	5.0	15.0
1-½	0.416	1.262	6.6	20.0
2	0.795	2.272	12.6	36.0
2-½	2.398	6.310	38.0	100.0
3	1.956	8.203	31.0	130.0
4	4.291	12.620	68.0	200.0
5	5.679	20.192	90.0	320.0
6	11.48	28.395	182.0	450.0
8	23.16	51.742	367.0	820.0
10	34.07	82.030	540.0	1300.0
12	60.58	94.650	960.0	1500.0

- .3 Install double regulating valves with five pipe diameters of straight pipe on inlet side, two pipe diameters on outlet side and 10 pipe diameters from any pump.
- .4 Install double regulating valves with ports facing horizontal or facing up. Do not install with ports facing down to prevent debris from falling and accumulating inside the ports.
- .5 Where double regulating valves are installed, provide an isolation valve either upstream (supply piping) or downstream (return piping). Double regulating valves shall never be used in lieu of isolation valves.
- .6 Where double regulating valves are installed, provide an isolation valve either upstream (supply piping) or downstream (return piping). Double regulating valves shall never be used in lieu of isolation valves.

**End of Section**



## TESTING ADJUSTING AND BALANCING FOR HVAC 23 05 93.13

### 1 GENERAL

#### 1.1 Scope

- .1 Test, adjust, and balance ("TAB") air handling systems and hydronic systems installed, modified or extended as part of this work, including:
  - .1 air handling systems, including air handling units and ventilation fans,
  - .2 hydronic systems:
    - (a) heating and cooling equipment and piping systems
- .2 Test existing HVAC systems to record existing operating conditions, at the start of the Work but before any demolition or new construction work is performed.
- .3 Refer to Specification section 22 05 93 for TAB for plumbing systems.
- .4 Rechecking of TAB during alternate heating/cooling season.

#### 1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 22 05 93 Testing Adjusting and Balancing for Plumbing
  - .2 23 05 93.23 Testing, Adjusting and Balancing Supplement for Healthcare
  - .3 23 33 05 Duct Accessories

#### 1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
  - .1 **Induction units** – means a room air distribution device which uses primary supply air at high pressure to entrain room air into the primary airflow to create a room mixed supply airflow and may or may not include a cooling or heating coil.
  - .2 **Process cooling (loads)** – means cooling equipment dedicated to a specific process equipment cooling load, and such cooling is not intended for human comfort.
  - .3 **Terminal inlet** – means a room or space return air or exhaust air grille, or other exhaust air inlet connection.
  - .4 **Terminal outlet** - means a room or space supply air grille or diffuser,
  - .5 **Terminal unit** – means a manufactured automatic airflow control-damper unit intended to control airflow to a space or a zone, with or without a reheat coil.
    - (a) **Constant Air Volume terminal unit (CAV)** – means a terminal unit where the airflow control damper is automatically controlled to maintain a constant supply airflow, and space temperature control is by other means.
    - (b) **Exhaust Air Volume terminal unit (EAV)** – means a terminal unit used to control return or exhaust air flow from a room or space, where the automatic control damper is operated to regulate space pressure.
    - (c) **Variable Air Volume terminal unit (VAV)** – means a terminal unit where the airflow control damper is automatically controlled to vary supply airflow to maintain space temperature.
    - (d) **Limited VAV terminal unit (VAVLM)** – a terminal unit that operates as a VAV at maximum cooling or heating demand under temperature control, and as a CAV at other times to

maintain a minimum airflow rate to the room or space. For clarity, the CAV function occurs during normal occupancy times.

- .6 **Zone** – means rooms or spaces, or portion thereof, that defines the supply air and return/exhaust air flow being evaluated.
- .2 The following abbreviations apply to this section:
  - .1 **CAABC** Canadian Associated Air Balance Council
  - .2 **NEBB** National Environmental Balancing Bureau

#### 1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
  - .1 ANSI/ASHRAE 41.2 Standard Methods for Air Velocity and Airflow Measurement
  - .2 ANSI/ASHRAE 111 Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
  - .3 SMACNA HVAC Systems Testing, Adjusting, & Balancing
  - .4 AABC National Standards for Total System Balance
  - .5 NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems

#### 1.5 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.
- .2 Balancing to be performed under supervision of recognized expert with an established reputation in this field.
- .3 TAB contractor to be a member of CAABC or NEBB.

*Standard of Acceptance*(no alternatives)

- Air & Water and Precision Balancing – Matthew Crittenden matt@awpbgroup.com – 647-896-5353

#### 1.6 Quality Control

- .1 Perform testing and balancing in accordance with procedures as published by ASHRAE, SMACNA, AABC or NEBB except/and as specified herein.

#### 1.7 Accuracy

- .1 Adjust systems until operating values are within the acceptance criteria stated for each system type. Where an acceptance criterion is not stated, balance the system so that measured values are within  $\pm 5\%$  of design value.
- .2 Measurement device accuracy:

Measurement	Application	Device	Accuracy
Air Flow	Plenums	Revolving Vane Anemometer, direct reading digital type	$\pm 5.0\%$ of reading over 1 m/s
Air Flow	Ducts	Pitot-tube duct traverse with electronic gauge	$\pm 10.0\%$ of reading

Measurement	Application	Device	Accuracy
			over 5 m/s
Air Flow	Grilles and Diffusers	Revolving Vane Anemometer, direct reading digital type	$\pm 5.0\%$ of reading
Air Flow	Room air currents, Hoods (0.05 to 3.0 m/s)	Thermal Anemometer	$\pm 10.0\%$ of reading
Liquid Flow	Piping	Installed meter	As per meter rating
Liquid Flow	Equipment	Differential Pressure and equipment data	See below
Temperature	Air, Liquids	Digital Electronic Thermometer	$\pm 0.2^{\circ}\text{C}$ over 0 to $+40^{\circ}\text{C}$
Temperature	Air, Liquid	Digital Electronic Thermometer	$\pm 0.4^{\circ}\text{C}$ $< 0^{\circ}\text{C}$ and $> +40^{\circ}\text{C}$
Relative Humidity	Air	Digital Electronic Humidity Sensor	$\pm 1.5\%\text{RH}$ over 0 to 90%RH range
Pressure	Air	Magnahelic	$\pm 2.0\%$ of reading
Pressure	Liquid, Gas, Steam	Bourbon type	$\pm 1.0\%$ of reading
RPM	Motor, fans	Chronometer tachometer	$\pm 1.0\%$ of reading
Voltage	All	Portable	$\pm 2.5\%$ of reading
Current	All	Portable clamp-on ammeter	$\pm 2.5\%$ of reading

## 1.8 Audit Verification

- .1 After review of the draft TAB report by Consultant, the Consultant may at their sole discretion require re-measurement of TAB results on an audit sample rate of [5][10][30] percent of all measured equipment, at no cost extra to the Contract Price or change to project schedule.
- .2 If audited results indicate a variance of more than 10% between the original reported value and the audit measured value for a piece of equipment, re-balance the audited device. If this excessive variance condition occurs at more than 25% of the number of audited equipment samples, re-balance the entire affected system at no cost extra to the Contract Price or change to project schedule.

## 1.9 Preparatory Work

- .1 Develop a TAB work plan to communicate TAB requirements to other trades:
  - .1 Review design drawings and specifications, shop drawings, interference drawings and other related documentation to become familiar with their intended performance.
  - .2 Prior to commencement of piping and ductwork installation, mark-up Consultant's Contract Drawings or contractor's fabrication drawings to identify locations where balancing damper and valve devices, temperature wells, pipe pressure gauges and pressure test plugs are to be installed. Provide a copy to the trade contractor responsible for installation of balancing devices. Make a copy available for review when requested by Consultant.
- .2 Carry out site visits during later stages of construction to ensure that arrangements for TAB are incorporated. Confirm proper placement of thermometer wells, test ports, pressure gauge cocks, balancing valves, balancing dampers and splitter dampers, and access doors.

- .3 TAB measurements to commence when building is “closed in” and work is sufficiently advanced including;
  - .1 installation of ceilings, doors and windows is completed,
  - .2 application of sealing, caulking, and weather stripping is completed,
  - .3 allowing normal operation of mechanical systems.

#### **1.10 Pre-Construction Air and Water Measurement Audit**

- .1 Conduct an HVAC air and water audit of existing HVAC systems prior to commencement of demolition or new construction work.
- .2 Measure existing air conditions for the systems affected by the Work:
  - .1 measure supply and return airflows at each terminal outlet and inlet,
  - .2 measure supply airflow and pressure drop across each existing reheat coil serving or located within the area of work,
  - .3 measure airflow, pressure, and temperature at main supply and return ducts on each floor where Work is to be performed,
  - .4 for fans, measure airflow, motor amps, motor HP rating, motor volts, inlet and discharge static pressure, sheave position,
  - .5 for air handling unit systems including air conditioning units, measure total airflow, outdoor airflow, return airflow; outdoor, return air and supply air temperatures.
- .3 Measure existing service water conditions for the systems affected by the Work:
  - .1 measure water flow at each reheat coil serving or located within the area of work,
  - .2 measure water flow at on each floor where Work is to be performed,
  - .3 for each source equipment including chillers and boilers, measure inlet and outlet water pressure, inlet and outlet water temperature, water flow rates,
  - .4 for each pump, measure water flow rate, inlet and outlet static pressures, motor amps, motor rated HP, motor voltage.
- .4 Submit a report to Consultant to record all as-found measured values.

#### **1.11 Measurement Parameters**

- .1 Reporting units of measure:

Parameter	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Volume	litre	L
Volume flow rate	Litres per second	L/s
Time	seconds	s
Temperature	Celsius	°C
Pressure	pascal	Pa (air)
	kilopascal	kPa

Parameter	Unit	Abbreviation
		(liquid, vapour, compressed gas)
Pump Head	metre	m
Pump Pressure	kilopascals	kPa
Fan pressure	pascal	Pa
Mass flow rate	kg per second	kg/s
Heat flow rate	kilowatts	kW
Cooling flow rate	Kilowatts cooling	kWc
Electrical Power	kilowatts	kW
Voltage	Volts	V
Electrical Current	amps	A
Rotation speed	Rotations per minute	RPM
Vibration	Cycles per second	CPS or Hz

### 1.12 Submittals

- .1 Submit TAB reports in accordance with Part 7 of this section.

## 2 PRODUCTS

### 2.1 Ductwork Probe Test Plugs

- .1 Conform to Specification section 23 33 05.

## 3 EXECUTION - AIR MOVING SYSTEMS

### 3.1 Measurement Parameters

- .1 The following measurement parameters identify the minimum requirements for inclusion in the TAB process:
  - .1 Air flow parameters;
    - (a) air velocity,
    - (b) flow cross sectional area,
    - (c) static pressure,
    - (d) velocity pressure.
  - .2 Temperature parameters;
    - (a) wet bulb,
    - (b) dry bulb.
  - .3 Pressure parameters;
    - (a) gauge pressure,
  - .4 Equipment parameters;
    - (a) rotational speed (rpm),
    - (b) electrical power, kW

- (c) voltage, V
- (d) current, A,
- .2 Measurement are required at and around equipment to establish air side performance of;
  - .1 fans,
  - .2 coils,
  - .3 filters,
  - .4 dampers - outdoor, return, recirculating, and relief,
  - .5 humidifiers.
  - .6 terminal units.
- .3 Measurement are required to characterize system performance;
  - .1 at main ducts,
  - .2 at submain ducts,
  - .3 at branch ducts.
  - .4 at each supply air outlet diffuser or grille, and exhaust and return air inlet grille,
  - .5 in each thermostatically controlled zone.

### **3.2 General Requirements**

- .1 Balance systems so that fans operate at lowest possible speed and static pressure consistent with delivery of specified air quantity at most remote terminal point.
- .2 Measure air quantities at each exhaust system inlet and supply system outlet.
- .3 Balance supply fans and associated return fans with their respective outdoor air dampers and exhaust air dampers at their minimum airflow position.
- .4 Be responsible for supply and installation of ductwork test plugs.

### **3.3 Setting Grill and Diffuser Airflow Patterns**

- .1 Adjust the throw and pattern at each supply outlet as shown on drawings. Where a specific pattern is not shown, set the supply outlet grills and diffusers in accordance with the following;
  - .1 for rectangular and circular cone diffusers, set for a uniform 360° dispersion,
  - .2 for rectangular perforated-plate diffusers, set the flow pattern plates for four-direction horizontal dispersion,
  - .3 for rectangular wall-mount grilles with horizontal front blades, set the blades at an approximate 15° upward facing angle,
  - .4 for linear diffusers at exterior windows or walls, set the flow pattern blades for a downward flow towards the floor and parallel to the windows or wall,
  - .5 for linear diffusers in interior spaces within 300 mm (12 in.) of a wall, set the flow pattern blades for horizontal dispersion away from the wall,
  - .6 for linear diffusers in interior spaces other than close to a wall, set the flow pattern blades for bi-directional horizontal dispersion,
  - .7 for light-troffer diffusers, set the flow pattern blades for horizontal dispersion away from the light fixture.

### 3.4 Use of Terminal Unit Flow Stations for Balancing Purposes

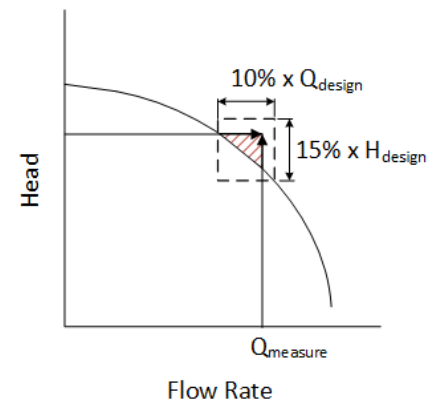
- .1 Where terminal units are equipped with integral air flow stations, do not use these air velocity stations as a proxy for manual duct traverse measurements of the zone airflow.

### 3.5 Transient Operating Conditions Preparation

- .1 Set-up supply fans with sufficient speed to deliver design air flow when filters are loaded to manufacturers recommended maximum pressure drop (dirty filter condition) and condensing coil air-pressure drop is at its wet coil condition;
- .2 Temporarily block portions of filter banks to achieve maximum pressure drop at design air flow, to simulate dirty filters.
  - .1 only apply blanking material to the highest MERV rated filter in the air handling unit. If there is more than one filter bank, test the remaining filter banks in their clean condition.
- .3 Temporarily block portions of cooling coils to achieve rated wet coil pressure drop at design air flow, to simulate summer condensing operation.
- .4 Uniformly distribute blocking media across filter face and coil face to minimize disruption to overall airflow pattern through the filter and coil bank.
- .5 Remove blanking material at completion of system TAB.

### 3.6 Fan Performance Assessment

- .1 Obtain the measured duct leakage for each system prior to balancing the duct systems and record in the TAB report. An additional 5% of terminal outlet design airflow rates may be included for balancing effects on the fan delivered airflow rate.
- .2 Measure air quantity by taking anemometer traverses across a coil or at a filter bank, or by pitot tube traverse in a straight section of duct at fan suction or discharge.
- .3 Measure static pressure difference between fan inlet and discharge, motor amperage and fan rotation speed. Determine motor input power from a curve showing power output as a function of motor amperage for the particular motor.
- .4 Plot results of measurements on fan characteristic curve supplied by fan manufacturer; the measured air volume, static pressure and fan speed lines should form a triangle enclosed by a rectangle having a dimension of not more than 15% of the design static pressure by a dimension of not more than 10% of the design airflow rate. Input power taken from the fan characteristic should be within 10% of the power determined from the motor amperage readings.
- .5 If required precision is not obtained, repeat measurements. If subsequent testing shows that the required precision is unobtainable, then fan manufacturer is to submit written report explaining actual fan performance and provide new characteristic curve showing actual performance for fan "as installed".
- .6 Measure static pressure loss across cooling coils, heating coils and individual filter banks and tabulate readings with manufacturers published pressure loss figures for the actual measured air volume.



### 3.7 Branch Air Quantity Measurement Procedure

- .1 Determine branch air quantities using pitot tube traverses in accordance with the procedures defined in ASHRAE 111 and ANSI/ASHRAE 41.2.

- .2 Take measurements at each riser as it is connected to fan discharge or suction header and at each floor where branches are taken from the riser. Repeat measurement until sum of branch air quantities is within 10% of fan delivery.

### **3.8 Constant Volume System Balancing Procedure**

- .1 Application:
  - .1 single zone systems with constant airflow,
  - .2 constant volume systems using CAV terminal units,
  - .3 constant volume systems with terminal reheat coils,
  - .4 exhaust systems, constant airflow,
- .2 Where a system has CAV units, or a system has a mixture of no units and CAV units, set the CAV units for 100% design airflow at all times.
- .3 Where a system has EAV units, set EAV units to 100% design airflow prior to balancing the supply air system.
- .4 First step - balance the branch ducts:
  - .1 open all supply air terminal outlets and return/exhaust air terminal inlets to 100% full open,
  - .2 starting with the submain duct closest to the fan or the submain duct that has the highest percentage airflow, measure and balance airflow on each branch duct off that submain duct,
  - .3 repeat on other submain ducts in descending order of percent of total airflow, until all branch ducts are balanced,
  - .4 verify supply and return fans are delivering 100% design airflow.
  - .5 acceptance criteria:
    - (a) branch airflow measurement:  $\pm 5\%$  of design flow.
    - (b) fan airflow measurement:  $\pm 5\%$  of design flow.
- .5 Second step - balance airflows at zones:
  - .1 starting at the most remote zone, balance terminal outlets and inlets using duct balancing dampers ahead of the outlet or inlet device. Only use any integral balancing device in the terminal outlet or inlet to adjust the final airflow rate by not more than 10% of design flow,
  - .2 for supply grilles and diffusers, adjust airflow pattern controllers to prevent airflow impinging on adjacent walls.
- .6 Acceptance criteria:
  - .1 total of terminal outlets/inlets airflow measurement in each zone:  $\pm 10\%$  of design flow.

### **3.9 Terminal Unit Balancing Procedure**

- .1 For spaces or zones with ducted return, close the doors to the space and then first balance return/exhaust terminal inlets to design flow rates.
- .2 Balance terminal outlets and inlets downstream of terminal units after the associated terminal units and supply, return and exhaust fans have been balanced.
- .3 Set system to operate with 100% return air, set zone thermostats at indoor design temperature and set fan discharge temperature at design value. Where a ducted return system is used, open any doors to adjacent spaces in the room under test.
- .4 Set thermostat in each zone being balanced to full cooling. Verify terminal unit airflow is supplying 100% design airflow.



- .5 Adjust each terminal outlet grille or diffuser to design airflow rates.
- .6 Repeat for all other terminal unit zones.
- .7 After all terminal unit zones are balanced, check fan performance and adjust fan static pressure controller as required to operate the fans at the minimum static pressure required to achieve terminal unit design airflow rates.

### **3.10 Outdoor Air Adjustment Procedure**

- .1 After balancing of supply fan, return fan, and related exhaust fans systems, adjust the outdoor air dampers position to obtain minimum design fresh air quantity.
- .2 Measure outdoor air values by duct traverse reading across outdoor air intake, recirculation duct, and exhaust air duct.
  - .1 Where there is insufficient duct length to provide reliable traverse readings, determination of outdoor air flow rate may be estimated based on a mixed airflow coil or filter bank traverse and measurement of outdoor air, return air, and mixed air temperature, provided the temperature differential between outdoor and return air is at least 11°C (20°F).
  - .2 Where neither of the above methods can be used, a temporary outdoor air minimum damper position may be set by measuring the pressure drop across the outdoor air damper and estimating the airflow rate based on damper manufacturer pressure drop data. Once outdoor conditions are available, remeasure and reset the outdoor air damper to a minimum position based on mixed air temperature conditions.
  - .3 Where temperature is used to estimate the balanced minimum outdoor air flow rate, include calculations of same in the balancing report.
- .3 After the minimum outdoor air flow rate and damper position have been adjusted, operate the air handling system at 100% outdoor air. Check that supply fan and return fan are operating within 5% of their airflow rate at minimum outdoor air condition.
  - .1 If the supply or return air flow rates at 100% outdoor air exceed their respective airflow rates at minimum outdoor air condition by more than 5%, adjust the maximum outdoor and exhaust air dampers to reduce their percent opening until the airflow variance is less than 5%.
  - .2 If the supply or return airflow rates at 100% outdoor air is less than their respective airflow rates at minimum outdoor air condition by more than 5%;
    - (a) reduce the minimum outdoor damper open position and return damper open position, and increase fan static pressure controller setpoint to re-establish minimum outdoor air flow rate,
    - (b) recheck the supply or return fan airflow rates at 100% outdoor air damper position.
    - (c) repeat above adjustment procedure until supply or return air fan airflow rates at 100% outdoor air is within 5% of their respective airflow rates at the minimum outdoor air damper position.

### **3.11 VFD Setpoint and Fan-Motor Sheave Change**

- .1 For fans with VFD motor controllers, at completion of system balancing, if the maximum VFD control point is more than 15% below the motor rated operating speed (< 50 Hz on a 60 Hz rated motor frequency), replace the drive sheaves and pulleys so that the motor is operating within 10% of motor rated speed at full load operating conditions.

## **4 EXECUTION - HYDRONIC SYSTEMS**

### **4.1 Measurement Parameters**

- .1 The following measurement parameters identify the minimum requirements for inclusion in the TAB process:
  - .1 volume flow rate,

- .2 temperature,
- .3 pressure (gauge),
- .4 equipment related;
  - (a) rotational speed (rpm),
  - (b) electrical power, kW
  - (c) voltage, V
  - (d) current, A,
- .2 Measurement are required at and around equipment to establish fluid side performance of;
  - .1 heat exchangers (primary and secondary sides),
  - .2 coils,
  - .3 refrigeration equipment (water side),
  - .4 boilers,
  - .5 pumps,
  - .6 PRVs,
  - .7 makeup (water) systems,
  - .8 domestic hot water heaters,
  - .9 humidifiers.
- .3 Measurement are required to characterize system performance;
  - .1 at floor branch connections (where measurement devices are installed),

#### **4.2 General Requirements**

- .1 Use calibrated venturi tubes, orifices or other metered fittings and pressure gauges in conjunction with permanent and portable type flow meters to determine flow rates for system balance.
- .2 Effect system balancing with automatic control valves open to heat transfer elements and bypasses closed.
- .3 Check and clean strainers prior to balancing.
- .4 Check expansion tanks are not waterlogged, and record expansion tank pressure before and after system pumps are turned On, and again when the system is at design operating temperatures.
- .5 Base flow balance on (in order of preference):
  - .1 double regulating valves, or globe valves associated with flow measuring elements (flow meters),
  - .2 temporary non-invasive flow meters,
  - .3 differential pressure measurement across heat transfer elements, with flowrate determined from manufacturer's literature, or
  - .4 temperature difference across various heat transfer elements in the system where flow metering devices are not installed. This method may only be used at design heat transfer conditions and at least one flow rate is known.
- .6 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing.
- .7 Perform balancing by measurement of temperature differential in conjunction with air balancing.

- .8 Adjust water distribution systems by means of double regulating valves, globe valves, balancing cocks, valves and fittings. Do not use shut-off valves for balancing unless indexed.
  - .1 Butterfly valves on discharge side of pumps may be used if they are one trade size smaller than system pipe size. Include Cv values and flow vs valve position curve with balancing report.

#### **4.3 Variable Flow Rate Balancing Procedure**

- .1 Obtain from Consultant the expected diversity value or determine the percent diversity by dividing the pump design flow rate by the sum of all connected loads.
- .2 Where available pump capacity is less than total flow requirements of individual system parts, full flow in any part may be simulated by temporary restriction of flow to other parts.
- .3 First step - Balance pipe riser floor branches:
  - .1 applies where floor-branch riser connections are provided with measurable pipe balancing devices,
  - .2 open all load control valves to 100% open,
  - .3 run all system pumps and balance the most remote floor-branch balancing device; floor-branch balancing devices on other floors may be partially closed. Adjust pump static pressure controller to supply the minimum required pressure to obtain required flow rate at the floor.
  - .4 repeat with other floors progressing towards the floor closest to the pump.
  - .5 acceptance criteria:  $\pm 5\%$  of total design flow rate of the branch.
- .4 Second step – Balance loads:
  - .1 balance the most remote load from the branch balancing valve, with other loads on the same branch throttled at the estimated system diversity.
  - .2 repeat with other load valves on the same branch moving towards the floor balancing device.
  - .3 Acceptance criteria:  $\pm 10\%$  of design flow rate at each load.

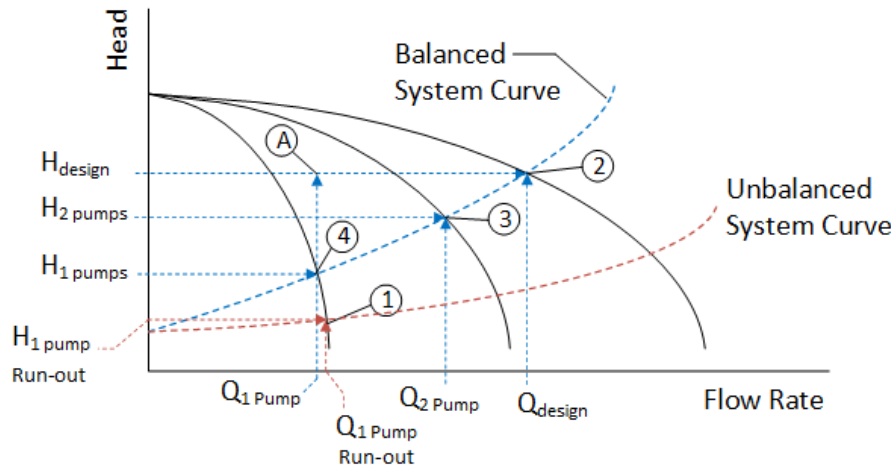
#### **4.4 Pressure-Independent Control Valves Balancing Procedure**

- .1 Where all load connections on a system are equipped with a pressure-independent balancing valve, the preceding balancing procedure may be modified as follows:
  - .1 open all control valves to 100% open and adjust pump speed or balancing valve to limit pump discharge to not exceed the maximum design flow rate,
  - .2 starting at the closest valve to the pump, set the pressure-independent control valve to the required flow rate,
  - .3 proceed with succeeding valves, moving towards away from the pump(s) towards the most remote control valve,
  - .4 if necessary, manually reduce flow rates through some control valves to obtain sufficient flow for the most hydraulically remote pressure-independent valves,
  - .5 after the pressure-independent control valves are set, reduce pump speed or adjust pump discharge balancing valve to provide the lowest differential pressure to achieve required total design flow rate.

#### **4.5 Multiple Pump Systems Balancing Procedure**

- .1 Balance multiple pump systems, which have two (2) or more pumps operating in parallel (not including stand-by pumps), in accordance with the following procedure. In the figure below, the state points are:
  - “A”: individual pump design data.

- “1”: single pump operation at maximum run-out capacity without motor overload  
 “2”: multi-pump operation, balanced system,  
 “3”: N-1 pumps operating at balanced system demand point,  
 “4”: single pump operating at balanced system demand point.



- .2 Step 1 – establish single pump maximum run-out condition (unbalanced system):
  - .1 set all load equipment automatic control valves to 100% open,
  - .2 start one pump separately and open flow through associated source equipment (chiller, boiler, cooling tower, etc.) and run pump to full speed and open discharge valve to maximum open position without causing pump motor to exceed its power rating. This is point 1 on the figure above. Record pump flow rate, head, and motor current. Mark this data on a multi-pump curve as maximum run-out condition.
- .3 Step 2 – balance pump discharge for all pump simultaneous operation:
  - .1 open all load valves 100% open,
  - .2 start-up all pumps which are required for maximum system design capacity along with associated chillers, cooling towers and boilers,
  - .3 concurrently throttle discharge valve at each pump to obtain total system design flow rate (point 3 in the above figure). Record this value as Maximum Rated Capacity (“MRC”),
    - (a) for pumps with VFD controllers, before throttling the pump discharge valve, reduce pump speeds until MRC is reached (point 2). If the resulting pump speed is more than 15% below pump maximum speed (50 Hz on a 60 Hz motor), increase pump speed to 50 Hz and then use pump discharge throttling valve to obtain MRC at point 2.
- .4 Step 3 – check operating points at reduced number of pumps:
  - .1 shut-down one pump and check operating point of remaining pumps on their pump curves. Check that the operating point does not cause any remaining pump from operating in a motor overload condition,
  - .2 repeat by shutting down additional pumps in sequence until one pump remains operating, and record all test values (flow, pressure, RPM and motor kW). Plot operating point on a multi-pump curve.

## **5 EXECUTION - EQUIPMENT TESTING**

### **5.1 Performance Data**

- .1 Submit the following data as a minimum. If contractor's standard forms provide for additional data, also submit such additional data.
- .2 Some equipment tests may need to be performed during the alternate season testing.
- .3 Include nameplate data and as-tested results.
- .4 Water chillers:
  - .1 manufacturer and model,
  - .2 refrigerant type and weight,
  - .3 cooling rating (refrigeration tons),
  - .4 condenser:
    - (a) entering and leaving water temperature,
    - (b) entering and leaving water pressure,
    - (c) flow rate (minimum, maximum),
    - (d) pressure rating (MAWP),
  - .5 evaporator:
    - (a) entering and leaving water temperature,
    - (b) entering and leaving water pressure,
    - (c) flow rate (minimum, maximum),
    - (d) pressure rating (MAWP),
  - .6 motor real power (kW),
  - .7 motor apparent power (kVA) or power factor (PF).
- .5 Hydronic Heating Equipment (Boilers, Heaters, etc.):
  - .1 manufacturer and model,
  - .2 heat output rating (kW),
  - .3 electric power input rating (kW),
  - .4 gas and fuel oil input flow rating,
  - .5 gas and fuel oil input pressure rating (minimum, maximum),
  - .6 gas pressure regulator inlet and outlet pressure,
  - .7 heat performance:
    - (a) entering and leaving water temperature,
    - (b) entering and leaving water pressure,
    - (c) liquid flow rate (minimum, maximum),
    - (d) steam flow rate and pressure,
    - (e) pressure rating (MAWP),
  - .8 pressure relief valve rating (pressure setpoint, heat rating, steam rating).
  - .9 combustion efficiency test at maximum rated capacity; including flue gas analysis corrected to 3% O<sub>2</sub>, for fuel input ratings exceeding 2930 kW (10 MMBtu/h),

- .10 thermal efficiency test at maximum rated capacity, based on ASME PTC 4 for steam boilers with fuel input ratings exceeding 2930 kW (10 MMBtu/h),
- .6 Condenser water cooling towers:
  - .1 manufacturer and type,
  - .2 inlet and outlet air temperature, dry and wet bulb,
  - .3 inlet and outlet water temperature,
  - .4 motor, pump and fan information.
- .7 Motors:
  - .1 manufacturer,
  - .2 model or serial number,
  - .3 amperage and voltage,
  - .4 power rating,
  - .5 service factor,
  - .6 RPM,
  - .7 corrected full load amperage,
  - .8 measured amperage and voltage,
  - .9 calculated BHP (kW).
- .8 Fans:
  - .1 manufacturer,
  - .2 model or serial number,
  - .3 flow rate,
  - .4 static pressures (suction and discharge),
  - .5 RPM,
  - .6 pulley size, type and manufacturer,
  - .7 belt size and quantity.
- .9 Pumps:
  - .1 manufacturer,
  - .2 model or serial number,
  - .3 flow rate,
  - .4 developed pump head,
  - .5 RPM.
- .10 Heat transfer equipment:
  - .1 manufacturer and type,
  - .2 inlet and outlet temperatures,
  - .3 pressure drop,
  - .4 design pressure rating (MAWP),
  - .5 flow rate,

- .6 pressure relief valve rating (pressure setpoint, heat rating).

## **6 EXECUTION - ALTERNATE SEASON TESTING**

- .1 Based on the scope of the Work, it is expected that complete or final testing of some of the HVAC equipment and systems will need to be deferred to an alternate season period after Substantial Performance / date or Ready-for-Takeover of the Work, but before expiry of the warranty period.
- .2 Alternate season testing is required for heating or cooling equipment which cannot be tested at full load conditions due to ambient outdoor conditions at time of TAB work prior to achieving Substantial Performance / Ready-for-Takeover of the Work.
- .3 As the Work nears Substantial Performance, review with Consultant to determine which equipment and systems will require final TAB work to be deferred to the alternate season. For equipment and systems whose TAB work is to be deferred, provide initial balancing of the systems to a sufficient extent to allow general functional testing of associated services including building control systems.
- .4 Requirements for alternate season TAB work:
  - .1 Plan and allow for costs for alternate season TAB work to be performed at night and on weekends.
  - .2 Perform final balancing of deferred equipment and systems. Arrange with Owner's operations staff to operate equipment normally scheduled off during TAB work times.
  - .3 Where the balancing of deferred equipment and systems interfaces or interacts with previously balanced equipment or systems, check operating performance characters of previously balanced and adjusted equipment or systems to verify continued as-balanced condition.
  - .4 Include the measurement and recording of temperatures and pressures at all gauges, as well as outdoor and indoor conditions.
  - .5 Measure and record the motor amperages and drive RPM of all fans and pumps during re-checking.
- .5 Report
  - .1 Provide an addendum report to the original balancing report for all alternate season balancing results.

## **7 EXECUTION – MISCELLANEOUS**

### **7.1 Balance Position Marking**

- .1 Mark the balance position of dampers and valves at the completion of the final testing:
  - .1 ductwork: indicate with arrow using paint or permanent marker,
  - .2 exposed ductwork in public areas: self-adhesive label, placed adjacent to balancing damper, neatly filled in with % open or degree open value.
  - .3 valves: self-adhesive label, placed on piping (insulated or not) adjacent to valve, neatly filled in with either % valve open, or number of valve turns to open.
- .2 Additional requirements for circuit-balancing valves with test ports:
  - .1 remove valve handle or other protective device, and set memory stop to limit valve open travel. Replace valve handle or protective cover.

## **8 EXECUTION - REPORT PRESENTATION AND VERIFICATION**

### **8.1 Required Reports**

- .1 Provide the following reports:
  - .1 Air and water balancing report,

- .2 Alternate season test report.

## **8.2 Record Keeping**

- .1 Keep records of trial and final balance and submit preliminary report as each system is completed.
- .2 Do not submit the final TAB report until all audit verification re-measurements, and any required re-balancing, is completed to the satisfaction of Consultant.

## **8.3 Report Format**

- .1 Reports to incorporate approved standard forms, with values expressed in the same units as shown on Contract Documents.
- .2 Include "as-built" system schematics, marked-up to show as-measured flow quantities and measurement points. Use as-built drawings and ventilating line diagrams for reference.
- .3 Submit an electronic PDF copy of the draft TAB report for review by Consultant. Where a report page length is more than 20 pages, include bookmarks in the PDF document organizes by system number and/or name.
- .4 After any revisions requested by Consultant have been made and final review accepted by Consultant, submit the final TAB report in the following formats:
  - .1 two (2) hard copies of the completed report, each with index tabs and bound in "D" ring binders,
  - .2 electronic file PDF copies by email or drop-box as coordinated with Owner and Consultant.

## **8.4 Completion**

- .1 Continue TAB until reports are approved.
- .2 The Substantial Performance of the Mechanical Work will be considered reached when the initial Start-Up and Performance Testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance.
- .3 The substantial performance of the Work is not dependent upon alternate season testing.
- .4 The total performance of the Work will not be considered reached until the alternate season testing and balancing is completed and the final report submitted has been reviewed by Consultant and accepted by the Owner.

**END OF SECTION**



## **TESTING, ADJUSTING & BALANCING SUPPLEMENT FOR HEALTHCARE**

### **23 05 93.23**

## **1 GENERAL**

### **1.1 Scope**

- .1 Test, adjust, and balance ("TAB") airflows for rooms and spaces in healthcare facilities.
- .2 This section is supplementary to Specification section 23 05 93.13 and is to be read in conjunction with that section.

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 23 05 93.13 Testing, Adjusting & Balancing for HVAC

### **1.3 Definitions and Abbreviations**

- .1 The following definitions apply to this section.
  - .1 **Differential airflow** – means the difference in the aggregate airflow rates of supply terminal outlets in a room or space minus the aggregate airflow rates of return air and exhaust air terminal inlets in the room or space, for design or measured flow rates.
  - .2 **Differential pressure** – means the design or measured air pressure of an enclosed room relative to the adjacent corridor, room or space.
  - .3 **Negative pressure (room)** – means a room where the net airflow movement is from adjacent spaces into the room.
  - .4 **Neutral pressure (room)** – means a room where the net airflow movement into/out from the room is essentially zero but may be have limited airflow into or out from the room.
  - .5 **Positive pressure (room)** – means a room where the net airflow movement is from the room to adjacent spaces,
  - .6 **Specialty Rooms** – means those room types as listed in Schedule A of this Specification section.

## **2 PRODUCTS**

### **2.1 Not Used**

## **3 EXECUTION**

### **3.1 General**

- .1 Balance air systems in accordance with Specification section 23 05 93.13 before performing room differential pressure balancing as specified herein.
- .2 For differential pressure, measure the room air pressure relative to the adjacent connecting corridor or room unless otherwise shown.
- .3 Where a space has dynamic differential pressure control, coordinate with the Division 25 contractor and supply measured data to allow configuration of Division 25 control sequences.

### **3.2 General Room and Space Differential Pressure Balancing Process**

- .1 Application: all rooms and spaces that are not Specialty Rooms or Odour/Vapour Generating rooms specified herein.

- .2 For the purpose of this balancing process, the following definitions apply;
  - .1 A "positive pressure room" is one in which the design supply airflow rate exceeds the design return/exhaust airflow rates by 25 L/s (53 cfm) or more,
  - .2 A "negative pressure room" is one in which the design return/exhaust airflow rate exceeds the design supply air flow rate by 25 L/s (53 cfm) or more,
  - .3 A neutral pressure room is one that where the difference between the design supply airflow rate and the design return/exhaust airflow rate is less than 25 L/s (53 cfm).
- .3 Calculate the design differential airflow rates from design supply and return/exhaust airflow rates as shown on drawings. Record the design differential airflow rates in the TAB report.
- .4 Adjust room pressurization based on differential airflow:
  - .1 for positive and negative pressure rooms, adjust exhaust airflow rate until a balanced differential airflow of not less than 25 L/s (53 cfm), positive or negative as applicable to the room design differential airflow rate, is achieved unless a greater value is calculated or is as otherwise shown,
    - (a) acceptance criteria: measured differential airflow is within -0/+15% of design differential airflow.
  - .2 for neutral pressure rooms, adjust exhaust airflow rate until it is within the lessor of  $\pm 5\%$  or 10 L/s (22 cfm) of the measured supply airflow rate,
- .5 Alternate method for rooms which are fully enclosed and provided with doors: balance room to achieve a differential pressure relative to adjacent connecting corridor or room, measured across the closed door;
  - .1 for positive pressure rooms, adjust exhaust airflow rate until a positive pressure of between +1.5 to +2.5 Pa (+0.006 to +0.01 in.w.c) is achieved and maintained for a time period of one (1) minute,
  - .2 for negative pressure rooms, adjust exhaust airflow rate until a negative pressure of between -1.5 to -2.5 Pa (-0.006 to -0.01 in.w.c) is achieved and maintained for a time period of one (1) minute,
  - .3 for neutral pressure rooms, adjust exhaust airflow rate until a relative pressure between -1.5 and +1.5 Pa (-0.006 and +0.006 in.w.c.) is achieved and maintained for a time period of one (1) minute.

### **3.3 Odour or Vapour Generating Rooms Differential Pressure Balancing Process**

- .1 Application: washrooms, utility rooms, bathing rooms, shower rooms, wash-down rooms, waste storage rooms, and other contaminated storage rooms.
  - .1 Adjust room exhaust airflow rates to achieve a negative room differential pressure of not less than 2.5 Pa (0.03 in.w.c.) and maintained for a time period of two (2) minutes,
- .2 Acceptance criteria: measured differential pressure is within -0/+15% of design differential pressure.

### **3.4 Specialty Room Differential Pressure Balancing Process**

- .1 Application: all rooms with permanent differential pressure sensors used for differential pressure control (directly or indirectly) as listed in Schedule A at the end of this specification section.
- .2 Adjust room airflow rates to achieve the required room differential pressure as listed in Schedule A at the end of this specification section, and which is maintained for a test time period of ten (10) minutes,
  - .1 for positive pressure rooms, adjust the return/exhaust airflow rates,
  - .2 for negative pressure rooms, adjust the return/exhaust airflow rates. If necessary, the supply airflow rate may be reduced by up to 5% of design supply airflow value to achieve the required negative pressure.
- .3 For rooms which have anterooms (vestibules);

- .1 first adjust airflow rates to achieve required differential pressure between the room and the connecting corridor,
- .2 then adjust airflow rates in the anteroom to achieve required differential pressures.
- .4 Acceptance criteria: measured differential pressure is within -0/+15% of design differential pressure.

### **3.5 Site Acceptance Testing**

- .1 After completion of differential pressure balancing, conduct Site Acceptance Testing ("SAT") of the Specialty Rooms in the presence and to the satisfaction of the Owner's representative(s) before equipment is permanently placed into service, for all Specialty Rooms or a subset as selected by the Owner or Consultant.
- .2 SAT to include the following:
  - .1 Continuous measurement and recording of room differential pressure under static conditions, with all doors to the rooms closed for at least 5 minutes prior to the test, and measured for a period of ten (10) minutes,
  - .2 continuous measurement and recording of room differential pressure during an upset condition caused by the opening of a door to the connecting corridor for a period of 30 seconds;
    - (a) record the differential pressure vs time from the start of the door opening until time required after the door has closed for the room to return to 90% of the static differential pressure.

### **3.6 Commissioning Program**

- .1 Comply with the project commissioning requirements in accordance with specification section 20 08 15 and Division 01 requirements.
- .2 The verification and testing requirements specified in this section may be concurrent with, or conducted separate from, the commissioning program, as coordinated with the Contractor and the commissioning authority.

### **3.7 Test and Installation Records**

- .1 Provide the following test records to the Owner and a copy to Consultant.
  - .1 design and measured differential airflow and differential pressures for each room, to be included in the main TAB report,
  - .2 SAT results, to be included in the main TAB report.

### **3.8 Schedules**

- .1 The following equipment schedules form part of this specification section.
  - .1 Schedule A: Specialty Room Differential Pressure Values

### SCHEDULE A – Specialty Room Differential Pressure Values

**Notes for the following table:**

*[1] Open areas with no physically closed interior boundary, or enclosed rooms where doors are frequently open.*

*[2] Unless otherwise stated, room pressure is measured relative to adjacent corridor serving the room.*

Occupancy	Room Type	Measurement Parameter (minimum)	Positive or Negative [Note 2]
Healthcare	Airborne Isolation Rooms (AIR)	7.5 Pa (0.03 in.w.c.)	Negative to corridor
		7.5 Pa (0.03 in.w.c.)	Negative to adjacent (non-communicating) spaces
	AIR anteroom	2.5 Pa (0.01 in.w.c.)	Negative to corridor
			Positive to AIR room

**End of Section**

## **HYDRONIC PIPING – CARBON STEEL**

### **23 21 13.23**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide carbon steel pipe and fittings for HVAC liquid piping systems. Refer to section 23 05 01 for piping system applicability.
- .2 This specification applies to liquid piping systems with design pressures not exceeding 2070 kPa (300 psig) at temperatures not exceeding 121°C (250°F), except as otherwise specified.

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 24 Welding and Brazing
  - .2 23 05 01 HVAC Piping Systems General Requirements
  - .3 23 25 05 HVAC Pipe Cleaning

### **1.3 Applicable Codes and Standards**

- .1 Legislation:
  - .1 Refer to section 23 05 01.
- .2 Installation standards and codes:
  - .1 Refer to section 23 05 01.
- .3 Product standards:
  - .1 ANSI A21.11 Rubber Gasket joints for Ductile-Iron Pressure Pipe and Fittings
  - .2 ANSI B1.20.1 Pipe Threads, General Purpose (inch)
  - .3 ASME B16.1 Cast Iron Pipe Flanges And Flanged Fittings
  - .4 ASME B16.3 Malleable Iron Threaded Fittings.
  - .5 ASME B16.5 Pipe Flanges and Flanged Fittings
  - .6 ASME B16.9 Factory Made Wrought Steel Buttwelding Fittings
  - .7 ASME B36.10 Welded and Seamless Wrought Steel Pipe
  - .8 ASME B16.11 Forged Steel Fittings, Socket-Welding and Threaded
  - .9 ASME B16.20 Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed.
  - .10 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges.
  - .11 ASME B16.39 Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300.
  - .12 ASTM A47 Standard Specification for Ferritic Malleable Iron Castings.
  - .13 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  - .14 ASTM A105 Standard Specification for Carbon Steel Forgings for Piping Applications

- |               |  |
|---------------|--|
| .15 ASTM A106 | Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service                                       |
| .16 ASTM A193 | Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service                |
| .17 ASTM A194 | Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both. |
| .18 ASTM A536 | Standard Specification for Ductile Iron Castings.  |

## **2 PRODUCTS**

### **2.1 Pipe**

- .1 Carbon steel pipe:
  - .1 to ASTM A53 Grade B, seamless or electric resistance welded (type “A53”),
  - .2 to ASTM A106 Grade B (type “A106”),
- .2 Pipe wall thickness:
  - .1 Refer to Schedule A1 appended to the end of this specification section.
  - .2 Select pipe material and wall thickness/schedule (as defined in ASME B36.10), based on pipe size, design temperature and jointing method.
  - .3 Acceptable substitutions:
    - (a) where only type A53 is specified, then A106 may be used,
    - (b) where only type A106 is specified, then piping with dual certification for meeting both ASTM A53 Grade B seamless and ASTM A106 Grade B seamless may be used.

### **2.2 Pipe Joints and Fittings**

- .1 Threaded fittings:
  - .1 End connections: NPT thread to ANSI B1.20.1.
  - .2 Fittings: Class 150 and Class 300, malleable iron to ASME B16.3..
  - .3 Unions: Class 150 and Class 300, malleable iron body with ground joint and bronze face to ASME B16.39.
  - .4 Threaded joint compound: pulverized lead paste or Teflon pipe tape sealant.

#### *Standard of Acceptance*

- Masters Pro-Dope
  - Masters Orange or White Tape.
- .2 Welding fittings:
  - .1 Butt weld fittings:
    - (a) Forged to ASME B16.9,
    - (b) wall thickness to match pipe,
    - (c) long radius elbows.
  - .2 Welding outlet fittings:
    - (a) forged to ASTM A105,

- (b) dimensions and pressure ratings to MSS SP-97, Standard Class for butt welding branch connection and Class 3000 for threaded or socket welded branch connection,
- (c) NPT ends to ASME B1.20.1.
- .3 Socket welded fittings:
  - (a) forged to ASTM A105,
  - (b) dimensions and pressure ratings to ASME B16.11, Class 3000.
- .4 Half couplings:
  - (a) forged carbon steel to ASTM A105,
  - (b) dimensions and pressure rating to ASME B16.11, Class 3000 socket weld or threaded ends,
  - (c) NPT ends to ASME B1.20.1.
- .3 Flanges:
  - .1 Flat-faced cast iron to ANSI B16.1, Class 125.
  - .2 Raised-face forged carbon steel to ASME B16.5, Class 150 and Class 300, weld neck with wall thickness to match pipe, or slip on type.
  - .3 Studs and bolts: to ASTM A193, Grade B7,
  - .4 Nuts: to ASTM A194 Grade 2H or 2HM,
  - .5 Gaskets to ANSI B16.21, ANSI B16.20 or ANSI A21.11.

*Standard of Acceptance*

- Chesterton - fig. 100, 195 and 450
- Beldam

### **3 EXECUTION**

#### **3.1 Piping Installation**

- .1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.
- .2 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:500 (0.2%);
  - .1 branch piping to have greater slope,
  - .2 slope piping up in direction of terminal heating and cooling devices,
  - .3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.
- .3 Use eccentric reducers at pipe size changes arranged flat-on-top to assist venting.
- .4 Cap ends during construction to prevent entry of foreign matter.

#### **3.2 Class Rated Fittings and Flanges Selection**

- .1 Select ASME Class rated fittings and flanges in accordance with the following table for design pressure limits at coincident design temperature limits unless otherwise shown on drawings.

Class	Maximum Design Pressure	Maximum Coincident Design Temperature
125 Note [1]	900 kPa (130 psi)	≤ 65°C (150°F)

Class	Maximum Design Pressure	Maximum Coincident Design Temperature
125 Note [1]	700 kPa (100 psi)	≤ 121°C (250°F)
150	1720 (250 psi)	≤ 38°C (100°F)
150	1400 kPa (200 psi)	≤ 121°C (250°F)
300	3700 kPa (535 psi)	≤ 38°C (100°F)
300	3100 kPa (450 psi)	≤ 121°C (250°F)

**Notes:**

[1] For flanges only.

### 3.3 Pipe Joints and Fittings

- .1 Make pipe joints as follows.
  - .1 Piping NPS 2-1/2 and under:
    - (a) NPT threaded joint to ANSI B1.20.1 and made with Teflon tape or pipe dope, or
    - (b) socket weld joints.
  - .2 Piping NPS 2-1/2 and larger:
    - (a) welded,
    - (b) flanged.
  - .3 For clarity, pipe size of NPS 2-1/2 may be either type of joint specified.
- .2 For flange joints, select gasket materials in accordance with the following table so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

Gasket Temperature Limit	Gasket Pressure Limit	Gasket Material	Gasket Thickness	Chesterton Figure
80°C (180°F)	1720 kPa (250 psig)	Red rubber	1.6 mm (1/6 in)	100
200°C (390°F)	2400 kPa (350 psig)	Synthetic fiber with nitrile binder	1.6 mm (1/6 in)	450
400°C (750°F)	3700 kPa (535 psig)	Synthetic fiber with nitrile binder	1.6 mm (1/6 in)	195

### 3.4 Equipment connections

- .1 Make pipe connections to equipment as follows:
  - .1 NPS 2 and smaller: threaded fittings.
  - .2 NPS 2 ½ and larger:



(a) flanged connections,

- .2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.

### 3.5 Welding

- .1 Comply with section 20 05 24 and as specified herein.

### 3.6 Branch Connections

- .1 Make branch connections to mains in accordance with Table 2a and 2b.
  - .1 These tables are valid for design pressures up to 2070 kPa (300 psig), without adding reinforcement material where branch pipe is directly welded to the main. For welded branch connections at higher design pressures, use butt weld, socket weld, or integrally reinforced outlet fittings only.
  - .2 In these tables, the following abbreviations apply.

**Abbreviations:**

TH	Threaded fitting to ASME B16.3
SW	Socket weld fittings to ASME B16.11
HC	Half coupling to ASME B16.11
BW	Butt weld fitting to ASME B16.9
OF	Reinforced Outlet Fittings to MSS SP-97
DP	Direct welding of Branch Pipe to Main without added reinforcement.

Table 2a – Allowable Branch to Main Connections (NPS 1 to NPS 10)										
Branch NPS	Mains Pipe, NPS									
	1	1-1/4	1-1/2	2	2-1/2	3	4	6	8	10
3/4	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW HC DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/4	---	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/2	---	---	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
2	---	---	---	TH SW	BW SW	BW, OF SW	BW, OF SW DP	BW, OF DP	BW, OF HC DP	BW, OF HC DP
2-1/2	---	---	---	---	BW SW	BW, OF SW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
3	---	---	---	---	---	BW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
4	---	---	---	---	---	---	BW	BW, OF	BW, OF DP	BW, OF DP
6	---	---	---	---	---	---	---	BW	BW, OF	BW, OF DP
8	---	---	---	---	---	---	---	---	BW	BW, OF
10	---	---	---	---	---	---	---	---	---	BW

<b>Table 2b – Allowable Branch to Main Connections (NPS 12 to NPS 30)</b>								
Branch NPS	Mains Pipe, NPS							
	12	14	16	18	20	22	24	30
¾ to 2	OF HC DP	OF HC DP	OF HC	OF HC	OF HC	OF HC	OF HC	OF HC
2-1/2	OF DP	OF DP	OF	OF	OF	OF	OF	OF
3	OF DP	OF DP	OF	OF	OF	OF	OF	OF
4	BW OF DP	OF DP	OF	OF	OF	OF	OF	OF
6	BW OF DP	BW OF DP	BW OF	OF	OF	OF	OF	OF
8	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	OF	OF	OF
10	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
12	BW	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
14	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF	BW OF
16	---	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF
18	---	---	---	BW	BW OF	BW OF	BW OF	BW OF
20	---	---	---	---	BW	BW OF	BW OF	BW OF
22	---	---	---	---	---	BW	BW OF	BW OF
24	---	---	---	---	---	---	BW	BW OF
30	---	---	---	---	---	---	---	BW

- .2 Use of Class 3000 half-couplings as a branch connector ("HC"), and direct welding of branch piping to main piping ("DP"), is permitted in accordance with the following requirements:
- .1 half-coupling or branch pipe sits-on mains pipe, and does not insert into the main pipe,
  - .2 the opening size in the main pipe to closely follow the inside diameter of the half-coupling or branch pipe,
  - .3 half-coupling or branch pipe attachment end is shaped and beveled to closely following the surface of the main pipe, suitable for a pull-penetration weld,

- .4 the half-coupling or direct branch pipe is attached with a groove weld and covered with a smooth finishing fillet weld in accordance with the requirements of the applicable piping code.
- .3 Where integrally reinforced outlet fittings, half-couplings or direct welding of branch pipe is used, hole saw or drill and ream mains pipe to maintain full inside diameter of branch line prior to welding.
- .4 Where multiple branch pipes are to connect to the main pipe in close proximity to each other, provide a minimum separation between the centerlines of adjacent branch pipes equal to or greater than the sum of the OD dimensions of the adjacent branch pipes.
- .5 If threaded fittings have been installed where the specification requires welded fittings, either cut-out and replace the fitting, or fully seal-weld the exposed threads.
- .6 Where saddle type branch welding fittings are used on mains, hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding.

### 3.7 Pressure Testing

- .1 Conduct pressure and leak tests in accordance with section 23 05 01.

### 3.8 Flushing and Cleaning

- .1 After pressure testing, clean piping in accordance with Section 23 25 05.
- .2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:
  - .1 After cutting of threads and de-burring, and before installation of piping, manually clean the interior of the pipe with wire-brush on an extended rod, while washing the inside of the pipe with a solution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear.
  - .2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.
  - .3 After pressure testing, isolate new piping from existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.
  - .4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

### 3.9 Schedules

- .1 The following appended equipment schedules form part of this specification section.
  - .1 Schedule A1 Pipe Wall Thickness.

<b>Schedule A1 – Pipe Wall Thickness</b>				
Pipe Size NPS	Piping Design Temperature	Pipe Joint Method	Pipe Material	Pipe Wall Thickness
≤ 2-1/2	≤ 105°C (220°F)	All	A106, A53	Schedule 40
		Threaded	A106	Schedule 80
	>105°C (220°F)	Welded, flanged	A106, A53	Schedule 40
3 to 10	≤ 121°C	All	A106, A53	Schedule 40

12 to 18	≤ 121°C	All	A106, A53	Standard – 9.5 mm (0.375 in.)
20 to 36	≤ 121°C	All	A106, A53	Schedule 30

**END OF SECTION**

## **HYDRONIC PIPING - COPPER**

### **23 21 13.33**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide copper tube and fittings for HVAC liquid piping systems for aboveground and underground installations for the following applications:
  - .1 (as an alternative to steel piping) final connections not exceeding 1 m (39 in) in length to terminal heating units which have copper tube coils, copper tube heating elements, and copper tube radiant panels,
  - .2 tubing located in slabs or under slab-on-grade floors to connect to terminal heating or cooling units,
  - .3 drain and vent piping for equipment and piping systems,
  - .4 where otherwise shown.
- .2 This specification applies to liquid piping systems with design pressures not exceeding 2000 kPa (290 psig) at temperatures not exceeding 121°C (250°F, except as otherwise specified. Refer to section 23 05 01 for piping system applicability.
- .3 The use of copper tube is limited to nominal tube sizes NPS 3 and under.

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 24 Welding and Brazing
  - .2 23 05 01 Heating and Cooling Piping Systems General Requirements
  - .3 23 25 05 HVAC Pipe Cleaning

### **1.3 Applicable codes and standards**

- .1 Legislation:
  - .1 Refer to section 23 05 01.
- .2 Installation standards and codes:
  - .1 Refer to section 23 05 01.
- .3 Product standards:
  - .1 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
  - .2 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
  - .3 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges
  - .4 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
  - .5 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
  - .6 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
  - .7 ASTM A307 Standard Specification for Carbon Steel Bolts and Studs 60,000PSI Tensile Strength

.8	ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
.9	ASTM B32	Standard Specification for Solder Metal
.10	ASTM B88	Standard Specification for Seamless Copper Water Tube
.11	ASTM B813	Standards Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
.12	ASTM B828	Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
.13	AWS A5.8	Specification for Filler Metals for Brazing and Braze Welding
.14	AWS A5.31	Specification for Fluxes for Brazing and Braze Welding
.15	AWS C3.4	Specification for Torch Brazing
.16	MSS SP-106	Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300

## **2 PRODUCTS**

### **2.1 Tube**

- .1 Aboveground:
  - .1 NPS ½ to 2: to ASTM B88, type "L" hard-drawn copper tube.
  - .2 NPS 2-1/2 to NPS 3: to ASTM B88, type "K" hard-drawn copper tube.
- .2 Underground or in-slab:
  - .1 NPS ½ to NPS 3: to ASTM B88, type "K" hard-drawn or annealed copper tube.
- .3 Copper tube to be marked on the exterior surface in accordance with ASTM B88, to indicate the tube type ("K" or "L") by type designation or by colour strip (green stripe for type "K" and blue stripe for type "L"), along with identification of the manufacturer.

### **2.2 Tube Joints and Fittings**

- .1 Fittings:
  - .1 cast bronze fittings to ASME B16.18,
  - .2 wrought copper and bronze fittings to ASME B16.22,
  - .3 brazed joints only: Wrought copper and copper alloy to ASME B16.50,
  - .4 threaded fittings including unions to ASME B16.15, Class 250.
- .2 Flanges:
  - .1 brass or bronze flanges to ANSI B16.24,
  - .2 gaskets to ANSI B16.21.

#### *Standard of Acceptance*

- Chesterton - fig. 100, 195 and 450
  - Beldam
- .3 Solder:
  - .1 95:5 tin/antimony solder to ASTM B32.
- .4 Braze filler:
  - .1 silver brazing alloy: classification BCuP-5 to AWS A5.8.

### **3 EXECUTION**

#### **3.1 Tubing Installation**

- .1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.
- .2 Maximum tube size: NPS 3.
- .3 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:1000 (1 in in 10 ft).
  - .1 branch piping to have greater slope,
  - .2 slope piping up in direction of terminal heating and cooling devices.
  - .3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.
- .4 Use eccentric reducers at tube size changes arranged flat on bottom to assist venting.
- .5 Where tubing is installed to run inside of concrete slabs, support tubing to maintain tube centerline at the center of the floor slab unless otherwise shown. Where tubing is supported by ferrous metals or where it might come into contact with reinforcing steel bar, provide two layers of Denso Tape around the tubing at the point of contact.
- .6 Use copper tubing for equipment drains (pressure and non-pressure)
- .7 Provide di-electric unions or flanges in accordance with section 23 05 01.

#### **3.2 Tube Joints and Fittings**

- .1 Prepare and install tube and fittings;
  - .1 in accordance with ASTM B828 for solder joints,
  - .2 in accordance with AWS C3.4 and specification section 20 05
- .2 Use of direct butt weld style soldered or brazed joints, including pulled-Tee's, are not permitted.
- .3 Before assembling solder or brazed joints, remove working parts of valves.
- .4 Make tube joint for above-ground piping as follows:
  - .1 NPS 2 and smaller: soldered or brazed joints with socket type fittings.
  - .2 NPS 2-1/2 to NPS 3: brazed joints with socket type fittings.
- .5 Make tube joints for underground and/or in-slab piping as follows:
  - .1 all sizes: brazed joints with sweat fittings,
  - .2 arrange tubing to minimize the number of joints. Use annealed tubing wherever possible, with field-bends made with tube bending dies which provide uniform support of tubing during bending operations.

#### **3.3 Equipment Connections**

- .1 Equipment connections:
  - .1 NPS 2 and smaller: unions and threaded fittings,
  - .2 NPS 2 1/2 to NPS 3: flanged connections.

#### **3.4 Pressure and Leak Testing**

- .1 Conduct pressure and leak tests in accordance with section 20 05 01.



### **3.5 Flushing and cleaning**

- .1 After pressure testing, clean piping in accordance with Section 23 25 05.
- .2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:
  - .1 After cutting of threads and de-burring, and before installation of tubing, manually clean the interior of the tube with wire-brush on an extended rod, while washing the inside of the tube with a solution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear,
  - .2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.
  - .3 After pressure testing, isolate new piping from existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.
  - .4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

**END OF SECTION**

## **HYDRONIC PIPING SPECIALTIES**

### **23 21 16**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide water piping specialty products for hydronic heating and cooling systems.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 23 05 01 HVAC Piping Systems General Requirements.
  - .2 20 05 49.23 Seismic Qualification for Mechanical Equipment
  - .3 25 30 19.16 Building Automation Pressure Independent Control Valves

##### **1.3 Applicable Codes and Standards**

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Product standards:
  - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
  - .2 ASME B16.5 Pipe Flanges and Flanged Fittings
  - .3 CSA B51 Boiler and Pressure Vessel Code

##### **1.4 Submittals**

- .1 Submit manufacturer catalogue cut-sheets for products specified herein.
- .2 Include confirmation of CRN.
- .3 Submit certification test certificate for seismic qualification in accordance with Specification section 20 05 49.

##### **1.5 Quality Control**

- .1 All products are to have Canadian Registration Numbers in accordance with CSA B51.

#### **2 PRODUCTS**

##### **2.1 Pressure Independent Balancing Valve (Automatic Balancing valve)**

- .1 General
  - .1 Combination automatic flow limiting and commissioning pressure independent balancing valve.

##### *Standard of Acceptance*

- Bell & Gossett - Circuit Sentry Model WV Circuit Sentry

- .2 Design conditions:

- .1 Design pressure: NPS 2½ to 6: minimum 1700 kPa (250 psig)
  - .2 Design temperature: -20°C to 111°C (-4°F to 230°F).
  - .3 Flow control characteristics:

- .1 pressure independent flow control over design flow range at an operating differential pressure range of 14 to 414 kPa (2 to 60 psi) across the valve body,
- .2 minimum flow rate: 0.95 l/s (15 gpm)
- .3 maximum allowable pressure drop: •kPa (• Ft)
- .4 accuracy:  $\pm 5\%$  of control flow rate for total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
- .4 Valve body:
  - .1 body construction NPS 2 1/2 to 6:
    - (a) ductile iron body, 304 stainless steel cartridge, EPDM O-ring packing design, reinforced EPDM diaphragm and a stainless steel spring.
    - (b) wafer body style suitable for installation in ANSI Class 125, 150 or 250 flanges.
- .5 Accessories:
  - .1 two (2) 100 mm (4 in) long pressure/temperature ports,
  - .2 identification tag indicating unit size, and balanced flow rate.

## 2.2 Automatic Air Vents

- .1 Float operated with brass or cast iron body;
  - .1 minimum component pressure rating: [1000 kPa (150 psi)][2000 kPa (300 psi)] at 115°C (240°F),

### *Standard of Acceptance*

- Armstrong - fig. AAE-750
- Bell & Gossett – fig. 87
- Maid-O-Mist - fig. 75
- Spirax Sarco - fig. AE30
- Taco - fig. Hy-Vent
- Thrush - fig. 720

## 2.3 Air Separator; In-Line

- .1 Inertial centrifugal (vortex) style air and dirt separator, cast iron or fabricated steel body, with stainless steel mesh strainer,
  - .1 ASME code stamped to ASME BPVC Section VIII,
  - .2 Canadian Registration Number to CSA B51,
  - .3 pipe-ends: NPT threaded NPS 2 and under, ASME Class 150 flanged NPS 2-1/2 and larger,
  - .4 minimum component pressure rating: 1030 kPa (150 psi) at 121°C (250°F).

### *Standard of Acceptance*

- Taco - fig. 4900
- Bell & Gossett – fig. Rolairtrol
- Amtrol - fig. Tangential Air Separator
- Armstrong - fig. Vortex VAS

## 2.4 Pressure Relief Valves

- .1 Bronze or cast iron body pressure relief valve;

- .1 stamped to ASME Section IV;
- .2 EPDM diaphragm and seat,
- .3 minimum component pressure rating: 860 kPa (125 psi) at 121°C (250°C),
- .4 selectable pressure setting range: 200 to 860 kPa (30 to 125 psi),
- .5 capacity rating: not less than associated heating boiler or unfired heat exchanger heat rating,
- .6 operating differential pressure from open to close not more than 20 kPa (3 psi).

*Standard of Acceptance*

- Bell & Gossett - fig. A-434E
- Watts - fig. 174A, 740

## **2.5 Wye-Pattern Strainers**

- .1 NPS 3 and smaller:
  - .1 bronze, cast iron, or ductile iron bodies to ASME B16.1, with threaded cap,
  - .2 minimum component pressure rating:
    - (a) ASME Class 125: 1200 kPa (175 psi) at 93°C (200°F),
    - (b) ASME Class 250: 2270 kPa (330 psi) at 93°C (200°F),
  - .3 pipe end: NPT threaded or ASME flanged,
  - .4 basket: stainless steel, 0.8 mm ( $1/32$  in) diameter perforations.
- .2 NPS 4 to NPS 24:
  - .1 cast steel or stainless steel bodies to ASME B16.5, with bolted flange cover,
    - (a) stainless steel body where installed in stainless steel piping system,
  - .2 minimum component pressure rating:
    - (a) ASME Class 150: 1800 kPa (260 psi) at 93°C (200°F),
    - (b) ASME Class 300: 3400 kPa (500 psi) at 93°C (200°F),
  - .3 pipe end: ASME Class raised face flanged,
  - .4 basket:
    - (a) stainless steel, 3.2 mm ( $1/8$  in) diameter perforations,
    - (b) made from 0.9 mm (0.037 in) stock reinforced with 13 mm x 0.9 mm ( $1/2$  in x 0.037 in) bands of same material spot welded to baskets,
  - .5 blow-down fitting in strainer cap: NPS 3/4 threaded connection with plug.

*Standard of Acceptance*

- Nibco
- Sure Flow
- Watts (Mueller)
- Zurn Wilkins

## **2.6 Basket- Pattern Strainers**

- .1 NPS 2 to 20, simplex basket:
  - .1 in-line, single basket arrangement,
  - .2 cast steel or stainless steel bodies to ASME B16.5,

- (a) stainless steel body where installed in stainless steel piping system.
- .3 cover: same material as body, with quick-opening feature, to ASME Section VIII or ASME B16.5,
- .4 bottom blow-down fitting: NPS 3/4 threaded connection with plug,
- .5 minimum component pressure rating:
  - (a) ASME Class 150: 1800 kPa (260 psi) at 93°C (200°F),
  - (b) ASME Class 300: 3400 kPa (500 psi) at 93°C (200°F),
- .6 pipe ends:
  - (a) NPS 2 to 2-1/2: NPT threaded to ASME B1.20.1,
  - (b) NPS 3 to 20: ASME Class raised face flanged,
- .7 basket screens:
  - (a) perforated T304 stainless steel plate,
  - (b) NPS 2 and 3: 1.15 mm (3/64 in.) perforation, 36% open area,
  - (c) NPS 4 and over: 3.2 mm (1/8 in.) perforation, 40% open area.

*Standard of Acceptance*

- John Brookes (HART)
- Mueller (Watts)
- Spirax Sarco
- Sure Flow

## **2.7 Packaged Coil Valve Kits**

- .1 Packaged installation valve-kits for terminal unit reheat coils, duct mounted reheat coils, and chilled water or dual temperature fan coils.

*Standard of Acceptance*

- Victaulic - fig. 79V Koil-Kit Coil Pac
- Belimo

- .2 Terminal device connection size range: NPS 1/2 to NPS 2.
- .3 Required MCPR for packaged assembly: 2100 kPa (300 psi) at 110°C (230°F).
- .4 Each packaged kit assembly to consist of:
  - .1 as individual components or as multi-function components,
  - .2 supply side:
    - (a) service isolation ball valve, Y-body strainer, valved and capped drain port, test plug port, union pipe-end fitting,
  - .3 return side;
    - (a) service isolation ball valve, pressure-independent electronic automatic control valve, manual air vent/test port, union pipe-end fitting,
    - (b) pressure-independent control valves to conform to Specification section 25 30 19.16.
  - .4 flexible hose connectors:
    - (a) at installation contractors option,
    - (b) for supply and return connections between coil and valve assemblies,
    - (c) maximum length: 300 mm (12 in.)

- (d) to Specification section 20 05 16 of all metal construction, or stainless steel braided guard with Teflon primary hose,
  - i) for clarity, where EPDM primary hose is used, the braided hose connector shall only be provided by the kit package manufacturer.
- .5 Packaging coordination services:
  - .1 shrink wrap each package coil kit, and identify package with an unique reference number and which identifies as a minimum;
    - (a) the applicable room number and floor level,
    - (b) associated equipment identification tag,
    - (c) contractor name, and project name.

## **2.8 Valve Enclosure Box**

- .1 Valve enclosure box complete with access door for valve kits for terminal unit reheat coils, duct mounted reheat coils, and chilled water or dual temperature fan coils.
- .2 Access door:
  - .1 hospital white access door (by diffuser manufacturer) complete with hinged frame & keyed fastener release,
  - .2 suitable for mounting in drywall or T-bar ceiling as required,
  - .3 enclosure supported from structure above with 3/8" hanger rods.
- .3 Enclosure:
  - .1 24" wide x 24" long factory fabricated galvanized sheet metal enclosure or equivalent custom fabricated enclosure
  - .2 12" high minimum or as required to fully enclose all components
- .4 For custom fabricated enclosures, access door shall be permanently affixed to the enclosure and all seams sealed with caulking.

### *Standard of Acceptance*

- Acudor
- Cendrex
- Karp Inc

## **3 EXECUTION**

### **3.1 Equipment Selection Based on Pressure Rating**

- .1 Unless otherwise specified herein or shown, select equipment that has a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 23 05 01.
- .2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select equipment as follows:
  - .1 select equipment with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level.
  - .2 for clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

### **3.2 Pressure Independent Balancing Valve (Automatic Balancing Valve)**

- .1 Manufacturer to select and provide valves to suit flow and differential pressure requirements. Include the information as a schedule in the shop drawing submittal.
- .2 Install balancing valve assembly with shut-off valve on either end of assembly.
- .3 Install balancing valve assembly in accordance with the manufacturer installation instructions. Provide companion flanges, mounting hardware and gaskets. Install in locations to provide five (5) pipe diameters of straight pipe before and two (2) pipe diameters after, which are free of fittings and valves.
- .4 Support balancing valve assembly rigidly from adjacent piping. Support piping within 300 mm (1 ft) of unit and flanges to prevent strain transmitted to assembly.
- .5 Manufacturer to supply a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).

### **3.3 Air Vents Installation**

- .1 Provide air vents at high points in the piping system, including at the top of all pipe risers, and in sections of piping subject to air binding, in both supply and return mains. Allow for additional air vents as directed by Consultant based on site review of installed work.
- .2 Provide isolating valves installed between unit and piping.
- .3 Pipe vent outlets to discharge to drain, over janitors sinks, over floor drains in mechanical rooms and other similar visible locations.

### **3.4 In-Line Air Separator Installation**

- .1 Provide in-line air separators in locations as shown. Provide an automatic air vent on top of the air separator, except where this connection is shown to be connected to a compression tank.
- .2 Provide a valved blow-down drain line from the air separator blow-down fitting, and extend piping to nearest floor drain. Arrange location of blow-down valve so that it is located within 500 to 1800 mm above the floor adjacent to the point of discharge to the floor drain.

### **3.5 Pressure Relief Valves Installation**

- .1 Provide pressure relief valves on hot water boilers, heat exchangers, expansion tanks and other pressure vessels in accordance with relevant codes.
- .2 Select relief valve setpoints to be not greater than the maximum allowable working pressure of the protected equipment (for individual equipment).
- .3 For main pressure relief valves for piping systems, set the pressure relief valve setpoint to the value as shown.
- .4 Pipe relief valve outlets to drain.

### **3.6 Strainers Installation**

- .1 Provide pipeline-size strainers in each of following locations
  - .1 on the inlet side of water meters,
  - .2 on the inlet side of automatic control valves (except at reheat coils with piping connections NPS ¾ or less, radiation, or radiant panels),
  - .3 on the inlet side of pressure reducing valves (except where pressure reducing valve is equipped with an integral strainer),
  - .4 on suction side of water pumps (except where a pump suction guide with integral strainer is used),

- .5 on inlets to heat exchangers (except where heat exchanger is equipped with integral strainers, or where a dedicated pump with strainer is directly supplying the heat exchanger).
- .2 Install wye-pattern strainers in horizontal or vertical-downflow orientation. Install basket strainers only in horizontal piping.
- .3 Install strainers with clearance for removal of basket.
- .4 For strainers NPS 2½ and over, provide NPS 1 valved blowout connection, consisting of ball valve with hose end and chained cap. Pipe valved blowout connections from strainers at pumps to open drain.

### **3.7 Packaged Coil Valve Kits Installation**

- .1 The use of packaged coil valve-kits are at the contractor's option in lieu of providing site assembly of separate valves and fittings.
- .2 Coordinate with the trade contractor under Division 25 for the supply of pressure independent control valves for inclusion in the coil valve kits.
- .3 Create and provide a schedule of valve kits required to the manufacturer/packager, which includes the following information:
  - .1 a designation indicating the location of the applicable HVAC equipment,
  - .2 design flow rates of the applicable HVAC equipment,
  - .3 manufacturer/packager to select and size the pressure-independent control valves in accordance with Specification section 25 30 19.16.
- .4 Arrange piping to HVAC equipment so that flexible connector hoses are not bent to change direction. Flexible connector hoses may be deflected laterally by an amount not exceeding the outside diameter of the connector hose. Where necessary, provide a rigid elbow at the HVAC coil-end connections.

### **3.8 Valve Enclosure Box Installation**

- .1 Valve enclosure box shall house valve kits for terminal unit reheat coils, duct mounted reheat coils, and chilled water or dual temperature fan coils; this requirement applies both site assembly of separate valves and fittings, or for packaged coil valve kits.
- .2 Support enclosure box from structure above with 3/8" hanger rods.
- .3 Provide installation drawings showing locations of all enclosure boxes on architectural reflected ceiling plans for approval prior to installation.

**END OF SECTION**



## **STEAM AND CONDENSATE TUBING – HUMIDIFICATION**

### **23 22 13.29**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide tube and fittings for low-pressure saturated steam and associated gravity condensate with design pressure less than 103 kPa (15 psig), for tubing between packaged steam humidification generators and steam humidifiers.
- .2 Where steam is supplied by an upstream pressure reducing valve, comply with Specification section 23 22 13.26.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 24 Welding and Brazing
  - .2 23 05 01 HVAC Piping Systems General Requirements

##### **1.3 Applicable codes and standards**

- .1 Legislation:
  - .1 Refer to section 23 05 01.
- .2 Installation standards and codes:
  - .1 ASME B31.9 Building Service Piping Code
- .3 Product standards:
  - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
  - .2 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
  - .3 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges
  - .4 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
  - .5 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
  - .6 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
  - .7 ASTM A269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service
  - .8 ASTM A307 Standard Specification for Carbon Steel Bolts and Studs 60,000PSI Tensile Strength
  - .9 ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts
  - .10 ASTM B88 Standard Specification for Seamless Copper Water Tube
  - .11 AWS A5.8 Specification for Filler Metals for Brazing and Braze Welding
  - .12 AWS A5.31 Specification for Fluxes for Brazing and Braze Welding
  - .13 AWS C3.4 Specification for Torch Brazing

## 1.4 Design Criteria

- .1 Piping design criteria:
  - .1 design pressure: 103 kPa (15 psi),
  - .2 design temperature: 121°C (250°F)

## 2 PRODUCTS

### 2.1 Copper Tube and Fittings

- .1 Tube:
  - .1 NPS ¾ to 3: to ASTM B88, type "K" hard-drawn copper tube.
  - .2 copper tube to be marked on the exterior surface in accordance with ASTM B88, to indicate the tube type ("K") by type designation or by colour strip (green stripe for type "K") along with identification of the manufacturer.
- .2 Fittings:
  - .1 wrought copper and copper alloy to ASME B16.50,
  - .2 threaded fittings including unions to ASME B16.15, Class 250,
  - .3 threaded joint compound:

#### *Standard of Acceptance*

- Masters Pro-Dope (only for steam pressures of 1000 kPa (150 psig) or less)
- Masters Orange or White T-Tape.

- .3 Flanges:
  - .1 brass or bronze flanges to ANSI B16.24,
  - .2 pressure class: ASME Class 125,
  - .3 gaskets for flanges:
    - (a) to ANSI B16.21, ANSI B16.20 or ANSI A21.11 of heavy-duty graphite impregnated compressed sheet 1.6 mm (1/16 in) thick.

#### *Standard of Acceptance*

- Chesterton 195

- .4 Joints:
  - .1 braze filler:
    - (a) silver brazing alloy: classification BCuP-5 to AWS A5.8.

### 2.2 Stainless Steel Tube and Fittings

- .1 Tube:
  - .1 size: nominal OD ¾ to OD 3,
  - .2 fully annealed Type 304/304L stainless steel tubing: to ASTM A269.
  - .3 tubing to be suitable for bending and flaring.
  - .4 tube wall thickness:

Stainless Steel Tube Wall Thickness						
NPS	1	1-1/4	1-1/2	2	2-1/2	3
Tube OD, mm	Ø25	Ø32	Ø38	Ø50	Ø63	Ø76
Wall Thickness, mm	1.8	2.0	2.2	3.0	3.0	3.0

.2 Fittings:

- .1 welded fittings specifically manufactured for stainless-steel tubing.
- .2 elbows, reducers and tees: wall thickness not less than that of pipe to which they are connected.
- .3 extended tube ends suitable for automatic orbital TIG welding.

.3 Flanges:

- .1 raised face forged stainless steel to ASTM A182, Class 150 weld neck with wall thickness to match pipe, or slip-on type,
- .2 studs and bolts: to ASTM A193, Grade B8M Class 2,
- .3 nuts: to ASTM A194 Grade B8M Class 2,
- .4 gaskets for flanges:
  - (a) to ANSI B16.21, ANSI B16.20 or ANSI A21.11 of heavy-duty graphite impregnated compressed sheet 1.6 mm (1/16 in) thick.

*Standard of Acceptance*

- Chesterton 195

.4 Joints:

- .1 Butt-welded.

### 3 EXECUTION

#### 3.1 Tubing Installation – General Requirements

- .1 Refer to section 23 05 01 for general requirements for piping installation.
- .2 Maximum tube size: NPS 3.
- .3 Steam tubing:
  - .1 use copper tube or stainless steel tube for steam tubing,
  - .2 install steam tubing to slope back to the steam generator, with a slope of not less than 1:250 (½ in in 10 ft.),
  - .3 install branches with greater slope,
  - .4 provide concentric reducers at pipe size changes in vertical runs,
  - .5 provide eccentric reducers at pipe size changes in horizontal runs, arranged flat-on-bottom,
  - .6 provide eccentric reducers arranged flat-on-bottom at valve inlet and flat-on-top at valve outlet, in horizontal runs at throttling or control valves where pipe connection size is greater than valve size. Pitch tubing on both sides of valve to drain away from the valve.
- .4 Condensate tubing:
  - .1 use stainless steel tubing for condensate tubing which does not exceed a length of 10 m (33 ft.) and which is not concealed. For all other condensate tubing, used stainless steel pipe in accordance with Specification section 23 22 13.26.

- (a) do not use copper for condensate tubing.
- .2 if threaded joints are required, use an adaptor fitting, or use stainless steel pipe in accordance with Specification section 23 22 13.26.
- .3 slope condensate tubing down in the direction of flow 1:160 ( $\frac{3}{4}$  in in 10 ft.) to the steam generator or floor drain, as shown,
- .4 install return branches with greater slope,
- .5 provide concentric reducers at pipe size changes in vertical runs,
- .6 provide eccentric reducers at pipe size changes in horizontal runs, arranged flat-on-bottom.

### **3.2 Tube Joints and Fittings Installation – Copper Tube**

- .1 Prepare and install copper tube and fittings with brazed joints in accordance with AWS C3.4 and specification section 20 05 24, using socket-type fittings.
- .2 Use of soldered joints is not permitted.
- .3 Use of direct butt weld-style brazed joints, including pulled-Tee's, are not permitted.
- .4 Before assembling brazed joints, remove working parts of valves.

### **3.3 Tube Joints and Fittings Installation – Stainless Steel Tube**

- .1 Prepare and install stainless steel tube and fittings with welded-butt joints in accordance with Specification section 20 05 24.
- .2 Use welding procedures which reduce the formation of chromium carbide in the heat affected zone. Acceptance criteria is to achieve a No. 10 colour value in accordance with AWS D18.2, equivalent to 25,000 ppm oxygen content in the internal purge gas/air mix during welding.
- .3 Do not use carbon steel wire brushes for cleaning pipe or tube ends. Do not use stainless-steel wire brushes that have been previously used on carbon steel.
- .4 Weld pipe using manual or automatic orbital tungsten inert gas ("TIG") welding.
- .5 Use removable/inflatable gas dams to continuously purge the inside of pipes/tubes with 100% argon or nitrogen backing gas during welding. Use of argon mixed with carbon dioxide or other gasses is not permitted.
- .6 Use qualified time purging to obtain required oxygen concentration for tube sizes NPS 2 and smaller.
- .7 Use of backing gas is not required where the inside surface of the pipe is accessible for removal of the HAZ weld tint by grinding or manual application of pickling compound to remove the weld tint, while the weld is accessible before installation. This condition would apply to welding of flanges, or welding of branch connections using methods other than the use of butt-weld fittings.

### **3.4 Equipment Connections**

- .1 Equipment connections:
  - .1 NPS 2 and smaller: unions and threaded fittings,
  - .2 NPS 2 ½ to NPS 3: threaded or flanged connections.

### **3.5 Pressure and Leak Testing**

- .1 Conduct pressure and leak tests in accordance with section 20 05 01.

**END OF SECTION**

## **HVAC PIPE CLEANING 23 25 05**

### **1 GENERAL**

#### **1.1 Scope**

- .1 Provide chemicals and instructions for the cleaning of piping systems and equipment.
- .2 This specification only applies to piping systems within Division 23.

#### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 23 25 13 HVAC Water Treatment Systems

#### **1.3 Qualifications of Supplier**

- .1 Equipment, chemicals and services to be provided by specialist firm with an established reputation in field including:
  - .1 a verifiable minimum of five (5) years experience of providing these types of services to both Government and/or private industry customers,
  - .2 the supplier is a member in good standing of the Association of Water Technologies (AWT),
  - .3 supplier's service technicians are either a Certified Water Technologist (CWT) accredited by the AWT, or is a qualified Chemical Water Treatment Services Chemist,
  - .4 certification records or similar proof-of-training for service personnel shall be made available upon request.

##### *Standard of Acceptance*

- Klenzoid
- GE Betz
- D.H. Jutzi Limited
- Nalco Chemical Company
- Ashland

### **2 PRODUCTS**

#### **2.1 Pipe Cleaning Chemicals**

- .1 Boiler internals:
  - .1 Alkaline boil-out compound for chemically cleaning of new boiler internals.
- .2 Piping:
  - .1 Non-foaming, non-chromate, phosphate free, neutral pH chemical cleaner detergent to remove sludge oil and debris.

#### **2.2 Mobile Pipe System Cleaning and Test Stand**

- .1 General:
  - .1 Design and fabricate a mobile pump test stand to be used for flushing and cleaning of steam, condensate, and heating and cooling water systems prior to connection to existing piping installation.

- .2 Select a pump capacity to maintain a minimum circulation rate of at least 1.5 m/s (5 fps) in the largest pipe in the system. The following provides a guide on required flow rates:

<b>Table 1 : Minimum circulation rates</b>			
Pipe Size NPS	Flow Rate Lps (gpm)	Pipe Size NPS	Flow Rate Lps (gpm)
2	3.0 (50)	6	28.0 (450)
3	8.0 (120)	8	50.0 (800)
4	12.5 (200)	10	75.0 (1200)

- .3 Where piping NPS 4 and smaller are included with piping system of NPS 6 and larger, wherever possible clean the piping NPS 4 and smaller separate from the larger piping.
- .2 Fabrication:
- .1 Test stand to include:
- .2 circulating pump: flow rate as shown and at pump head of 90 kPa (30 ft) head,
  - .3 manual motor starter or Adjustable Frequency Drive to suit motor characteristics,
  - .4 suction and discharge valves with hose-end connections,
  - .5 polyethylene chemical tank with chemical metering injection pump,
  - .6 pressure relief valve with setpoint equal to 100% of the piping design pressure,
  - .7 flow indicator on pump suction line,
  - .8 40 litre (10 gallon) diaphragm expansion tank,
  - .9 manual suction and discharge valves with hose end connections,
  - .10 manual flushing drain valve,
  - .11 make-up water connection with reduced pressure backflow preventer, pressure regulating valve and water meter,
  - .12 pressure gauge on pump suction and discharge,
  - .13 piping: ASME A53 Grade B, schedule 40, or schedule 80 PVC.

### **2.3 Temporary Strainer Screens**

- .1 Conical strainer with indicating handle, 1.6 mm (1.16 in) perforations, sized to suit NPS pipe and to be clamped between ASME pipe flanges.

#### *Standard of Acceptance*

- Suyre Flow Equipment Inc

## **3 EXECUTION**

### **3.1 Temporary Services and Equipment**

- .1 Provide all temporary equipment, including pumps, drain and fill connections, hoses, water meters and other miscellaneous equipment necessary to circulate cleaning compounds and to flush piping.

- .2 Where permanent system pumps are to be used for circulating cleaning fluid, provide temporary 1.6 mm (1/16 in) screens in permanent strainer bodies, or provide temporary insertion style strainers of same screen size inserted into a pipe spool section on the suction side of the pump.
- .3 Where permanent system pumps are not available, or where connections are made to an existing piping system, provide temporary circulation pumps to maintain cleaning fluid minimum velocity through piping at 1.5 m/s (5 fps).
- .4 At completion of testing, temporary equipment is to be removed from site and becomes the property of the contractor.

### **3.2 Temporary Work**

- .1 At air handling unit coils and terminal units, do not subject the control valve to the cleaning fluid even if a strainer is installed ahead of the valve. Remove the control valve and provide a spool piece, or where flexible connectors are used at terminal units, cross connect the supply and return piping with these flexible connectors, bypassing the control valve and the terminal unit.
- .2 At major equipment such as boilers and chillers, provide temporary strainer cones installed in a pipe flange ahead of the equipment. Remove strainer after completion of system cleaning.

### **3.3 Cleaning of New Piping in Existing Installations**

- .1 For piping connections to existing systems, provide NPS 1 valved drains on the load side of the new supply and return piping service isolation valve. Blank-off or otherwise isolate connections to existing treated piping systems. Provide temporary bypass piping/hose and circulation pump to permit circulation of cleaning fluid.

### **3.4 Cleaning of Steam and Condensate Piping**

- .1 After completion of piping pressure tests, chemically clean steam and condensate piping followed by flushing piping with clean water.
- .2 Provide temporary bypasses around steam-traps, equipment connections and control valves, and install temporary drain and fill lines.
- .3 Fill piping with clean city water using permanent or temporary water meter to establish system volume. Add cleaning detergent to achieve required concentration as recommended by chemical cleaning manufacturer.
- .4 Circulate solution for minimum of eight hours or as recommended by chemical cleaning manufacturer instructions.
- .5 Flush to drain with clean water until sample tests of flush-water indicate an iron residual of < 1 ppm.
- .6 Check for removal of cleaning compound; samples to be clear, not coloured, and free of foam after agitation.
- .7 At completion of water flushing, remove and clean strainers. If there is visible debris in the strainers, repeat drain, fill and circulation routine until strainers are free of debris.
- .8 Remove temporary equipment and cross-overs and reconnect steam traps. Place traps in-service and condensate pumping system in operation. Allow steam into system and check traps for blow through and service faulty units.
- .9 After system is in operation for at least eight (8) hours, perform a final clean of strainers and service traps.

### **3.5 Cleaning of HVAC Water Piping**

- .1 After completion of piping pressure tests, chemically clean HVAC water piping systems followed by flushing piping with clean water.

- .2 For plate-and-frame heat exchangers, disconnect piping and make temporary cross-connections to bypass heat exchanger unless the heat exchanger is equipped with an integral strainer. Provide a temporary fine mesh strainer screen..
- .3 Fill piping with clean city water using permanent or temporary water meter to establish system volume. Add cleaning detergent to achieve required concentration as recommended by chemical cleaning manufacturer.
- .4 Circulate solution for minimum of seventy-two (72) hours at room temperature or as recommended by chemical cleaning manufacturer instructions.
- .5 Flush to drain with clean water until sample tests of flush-water indicate an iron residual of < 1 ppm.
- .6 Check for removal of cleaning compound; samples to be clear, not coloured, and free of foam after agitation.
- .7 At completion of water flushing, remove and clean strainers. If there is visible debris in the strainers, repeat drain, fill and recirculation routine until strainers are free of debris.
- .8 Refill system with clean water and add water treatment corrosion inhibitors in accordance with the requirements of Section 23 25 13.
- .9 After system is in operation for at least eight (8) hours, perform a final clean of strainers.

### **3.6 Records**

- .1 Provide a cleaning test record and submit to the Consultant and the Owner. Test record to record for each piping system:
  - .1 water volume of system as measured,
  - .2 quantity of cleaner added to the system, by volume or weight,
  - .3 name of cleaner product used,
  - .4 manufacturer's recommended concentration,
  - .5 start and end times/dates of circulation,
  - .6 free-iron residual measured at end of cleaning, and name of person conducting test,

**END OF SECTION**



## **AIR DISTRIBUTION - GENERAL**

### **23 31 01**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide labour, materials and equipment for installation, testing and putting into operation ventilating and air conditioning systems as further specified in other Specification sections of Division 20 to 25.

##### **1.2 Qualified Tradesperson**

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

#### **2 PRODUCTS**

##### **2.1 Not Used**

#### **3 EXECUTION**

##### **3.1 Ductwork**

- .1 Ductwork system routing is shown diagrammatically. Drawings are not to be considered as fabrication or installation drawings.
- .2 Locate mains, risers and runouts to be concealed behind furrings or above ceilings, except in mechanical equipment rooms and access spaces where ductwork is to be exposed.
- .3 Determine areas without ceilings from Architectural drawings and Room Finish Schedules, and in these areas keep ductwork as high as possible.
- .4 Anchor, guide and support vertical and horizontal runs of ductwork to resist dead load and external live loads, and to absorb pressure thrust.

##### **3.2 Air Supply Equipment**

- .1 Install and connect air handling units, air conditioning units, fans and associated equipment, and build casing and plenums.

##### **3.3 Air Exhaust Equipment**

- .1 Install and connect exhaust fans, roof and wall exhausters and dust and fume collectors.

##### **3.4 Terminals Units**

- .1 Locate and install terminal units, registers, diffusers, and grilles. Coordinate with Architectural reflected ceiling plans for position of ceiling mounted elements.

##### **3.5 Life Safety**

- .1 Install fire dampers, smoke dampers, and combination smoke and fire dampers to protect openings in fire separations.
- .2 Provide smoke stopping around unprotected ducts passing through smoke separations.

##### **3.6 Air Balancing**

- .1 Co-operate with air balancing agency; install supplementary dampers, access openings and access doors to facilitate testing and adjustment.

**END OF SECTION**

## METAL DUCTS 23 31 13.13

### 1 GENERAL

#### 1.1 Scope

- .1 Provide metal HVAC ductwork including casings and plenums as shown.

#### 1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 01 Basic Materials and Methods
  - .2 20 05 49 Seismic Restraint
  - .3 23 33 05 Duct Accessories.

#### 1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section and as applicable to related sections.
  - .1 **Casing(s)** – a fabricated metal construct of some combination of walls, roofs, and/or floors for the conveyance of air at relatively low air velocities (typically below 5 m/s (1000 fpm) and which encloses equipment such, as but not limited to, fans, coils, and filters.
  - .2 **Ductwork** – a network of metallic or flexible material distributed through a building or space for the conveyance of air: (a) from an HVAC unit to one or more spaces, or (b) exhausted from those spaces.
  - .3 **Plenums** – a form of ductwork for the conveyance of air at relatively low velocities (typically below 3.5 m/s (700 fpm)).
- .2 In SMACNA 006 - *HVAC Duct Construction Standard – Metal and Flexible*, a reference to requirements for construction of “casings” in chapter 9 applies equally to construction of plenums, except/and as specified herein.

#### 1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
  - .1 NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2 ASHRAE Letter and number designations, shown as “CR3-16” etc., are taken from ASHRAE Duct Fitting Data Base.(DFDB)
  - .3 ANSI/SMACNA 006 HVAC Duct Construction Standards - Metal and Flexible (4th edition)
  - .4 ANS/SMACNA 002 Rectangular Industrial Duct Construction Standards (2<sup>nd</sup> edition)
  - .5 ANSI/SMACNA 016 HVAC Air Duct Leakage Test Manual (2<sup>nd</sup> edition)
- .2 Product standards:
  - .1 ASTM A36 Standard Specification for Carbon Structural Steel
  - .2 ASTM A90 Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
  - .3 ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

- |     |                |  |
|-----|----------------|--|
| .4  | ASTM A283      | Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates   |
| .5  | ASTM A463      | Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process  |
| .6  | ASTM A480      | Specification for General requirements for Flat Rolled Plate, Sheet, and Strip   |
| .7  | ASTM A653      | Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process  |
| .8  | ASTM A924      | Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process  |
| .9  | ASTM A1011     | Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| .10 | ASTM B209      | Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate   |
| .11 | ANSI/MSS SP-58 | Pipe Hangers and Supports  |

**1.5 Qualified Tradesperson**

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

**1.6 Design Criteria**

- .1 Outdoor ductwork, rooftop duct support frames, and weather shields are to be designed to meet the local wind loading in accordance with the building code requirements at the location of the Work.
- .2 Seismic design loading for duct supports to conform to Specification section 20 05 49.

**1.7 Submittals**

- .1 Submit manufacturer's catalogue literature for:
  - .1 proprietary joints.
- .2 Submit fabrication shop drawings for the following ductwork elements:
  - .1 plenums.

**1.8 As-Built Drawings**

- .1 As work progresses, mark-up field drawings as to actual location of ductwork, balancing dampers and other duct accessories and submit as part of record of "As-Built" conditions.

**2 PRODUCTS****2.1 Common Material**

- .1 Galvanized steel:
  - .1 Ducts and connectors: lock forming quality to ASTM A653 or ASTM A924, type Z180 (G60) or Z275(G90) as specified in Part 3 – EXECUTION.
  - .2 Miscellaneous pipe, angles, strips and threaded rod in contact with ductwork: galvanized with a minimum thickness equal to ASTM A653 - Z180 (G60).
- .2 Stainless steel:

- .1 to ASTM A480/ASTM A240, Type 304L and 316L.
- .2 finish: 2B mill, except where otherwise shown.
- .3 Aluminum:
  - .1 To ASTM B209;
    - (a) alloy 3003-H14 or 5052-H32 for sheet material.
    - (b) alloy 6061-T6 for plate material
    - (c) alloy 6061-T4 or T6 for shapes material.
- .4 Plain mild carbon steel:
  - .1 To ASTM A1011, A283, A572 and A36 as applicable.

## 2.2 Joints

- .1 Fabricated joints: to ANSI/SMACNA 006 as applicable to duct pressure class, duct size, duct-wall thickness, and reinforcing requirements.
- .2 Bolted companion flange – rectangular ductwork:
  - .1 formed flanges, corner pieces, integral edge seals, gaskets and cleats.
  - .2 material to match that of ductwork being joined,
  - .3 Neoprene gaskets.

### *Standard of Acceptance*

- Ductmate – fig. System 25/35/45
- Hardcase (Carlisle) – fig. Nexus

- .3 Barrel-rim clamped companion flange – round ductwork:
  - .1 roll-formed companion flanges, field installed, mechanically fastened and sealed to ends of duct,
  - .2 barrel ring clamp with bolted or no-tool cam locking clamp,
  - .3 Neoprene gaskets.

### *Standard of Acceptance*

- Ductmate - fig. Spiralmate
- Nordfab - fig. Quick-Fit Ducting

## 2.3 Sealant and Tape

- .1 To Specification section 23 33 05.

## 2.4 Hangers and Supports

- .1 Upper hanger attachments;
  - .1 in new concrete: manufactured concrete inserts.

### *Standard of Acceptance*

- Myatt Fig. 485

- .2 for steel joist: galvanized joist clamps or steel plate washer.

### *Standard of Acceptance*

- Anvil Fig. 61 or 86

- Anvil Fig. 60 for plate washer

.3 for steel beams: galvanized beam clamps.

*Standard of Acceptance*

- Anvil Fig. 60

.2 Hanger straps:

.1 Galvanized steel strap hangers for indoor use only.

.3 Hanger rod:

.1 Continuous threaded rod:

- (a) carbon steel, USS national course thread,
- (b) tension load ratings to MSS SP-58,

*Standard of Acceptance*

- Anvil - fig. 146
- Taylor – fig. 54

.2 Welded eye rod:

- (a) carbon steel, USS national course thread,
- (b) tension load ratings to MSS SP-58,
- (c) tension load rating to be the same as continuous welded rod.

*Standard of Acceptance*

- Anvil - fig. 278
- Taylor

.4 Seismic supports and restraints to Specification section 20 05 49.

## **2.5 Rooftop Duct Support System**

.1 Prefabricated rooftop duct, HVAC equipment, and conduit supports, supported without penetrations of the roof membrane or flashings:

- .1 to ANSI/MSS SP-58, Type 62, 63 and 64,
- .2 high density polypropylene roof bases, with UV protection,
- .3 roof pads suitable for roof type,
- .4 minimum 2.5 mm (12 ga.) thick formed channel structure
- .5 minimum 1.9 mm (14 ga.) thick supplementary support
- .6 galvanized steel duct support mounting channels,
- .7 modular mounting channels and clips for conduit,
- .8 designed to withstand local wind loading and seismic movement,
- .9 for ductwork 300 x 300 mm (12 in x 12 in) and larger,
- .10 for conduit Ø12 mm to Ø100 mm.

*Standard of Acceptance*

- Portable Pipe Hangers
- Miro (Unistrut)]
- Taylor Pipe Supports

## **2.6 Duct Access Doors**

- .1 To Specification section 23 33 05.

## **3 EXECUTION**

### **3.1 General Fabrication and Installation Requirements**

- .1 Construction details, sheet gauges, reinforcing, and bracing for ductwork, casings, and plenums to be in accordance with SMACNA 006, except/and as otherwise shown.
- .2 Material selection: refer to Schedule A at the end of this section where otherwise shown.
- .3 Rectangular ductwork seams and joints:
  - .1 longitudinal seams: Pittsburgh Lock, with specified sealant applied prior to hammering of joint,
  - .2 transverse joints: to SMACNA HVAC standards based on pressure class and reinforcement used, and for sealing requirements.
- .4 Round ductwork seams and joints, for pressure class 500 Pa (2 in wg) and higher:
  - .1 spiral flat type longitudinal seam, button punched.

### **3.2 Sheet-Metal Plenums**

- .1 Provide sheet metal plenums with dimensions as shown. Construct plenums as follows:
  - .1 single wall construction,
  - .2 constructed of the same material as adjacent duct except as otherwise shown,
  - .3 50 mm (2 in.) flanges or as required to suit ductwork or damper connections.
- .2 Design loading:
  - .1 where a horizontal plenum has an internal vertical dimension greater than 1000 mm (39 in.) and with a concurrent width greater than 600 mm (24 in.) and has access doors to allows entry of an adult person into the plenum, design the plenum and support system to support a live point load of 1.3 kN (300 lbf) over a contact area of 300 x 300 mm<sup>2</sup> (12 x 12 in<sup>2</sup>).
- .3 Additional requirements for outdoor intake air plenums and exhaust air plenums:
  - .1 construct the bottom of the plenum as an integral drain pan as specified herein.
  - .2 drain pan material: same as plenum material

### **3.3 Integral Drain Pans**

- .1 Where shown or specified, construct the bottom portion of a duct, casing or plenum as a watertight drain pan.
- .2 Materials: same material as the associated duct, casing or plenum unless otherwise shown.
- .3 Break the bottom panel in two-directions to allow water to drain to a low-point drain outlet,
- .4 Provide continuous welded joints along bottom of plenum, and extend welds up vertical joints at least 50 mm (2 in.).
  - .1 For galvanized steel materials, touch-up ductwork where galvanization is damaged during welding with zinc-rich paint.

- .2 For stainless steel materials, mechanically grind or chemical pickle to remove the welding tint in the heat affected zone (HAZ).
- .5 Provide a NPS 3/4 x 75 mm (3 in.) long stainless steel drain tube connected to the duct drain pan at the low-point drain outlet.

### 3.4 Balancing Dampers

- .1 Provide splitter dampers where branch connections are taken from supply mains.
- .2 Provide single blade dampers on each branch of supply air systems downstream of terminal boxes.
- .3 Provide Opposed Blade Dampers (OBD) at branch and main connection on exhaust and return air systems.

### 3.5 Finishing, Fastening and Supports

- .1 Hammer edges and slips to leave smooth finished surface inside duct.
- .2 Support vertical ducts with steel angles riveted to duct and bearing on building structure;
  - .1 design and fabricate duct riser supports using supplementary structural steel supports in accordance with SMACNA 006 and Specification section 20 05 01.
  - .2 use plain carbon steel for duct riser supports located indoors,
  - .3 use galvanized carbon steel for duct riser supports located outdoors.
- .3 Duct hangers;
  - .1 for ducts with both dimensions not exceeding 500 mm (20 in):
    - (a) supported with strap hangers of same material as duct but one sheet metal thickness heavier, or on steel angles as specified below.
    - (b) extend strap hangers down duct side and turn under 50 mm (2 in) fastening securely to side and underside of duct.
  - .2 for ducts with any dimension greater than 500 mm (20 in):
    - (a) supported with trapeze hangers constructed from galvanized steel angle with steel rods in accordance with table 1;

Table 1 : Duct Hangers		
Duct size mm (in)	Angle size mm (in)	Rod size mm (in)
up to 750 (up to 30)	25x25x3 (1x1x $\frac{1}{8}$ )	6 ( $\frac{1}{4}$ )
750 to 1050 (30 to 40)	40x40x3 (1 $\frac{1}{2}$ x1 $\frac{1}{2}$ x $\frac{1}{8}$ )	6 ( $\frac{1}{4}$ )
1050 to 1500 (40 to 60)	40x40x3 (1 $\frac{1}{2}$ x1 $\frac{1}{2}$ x $\frac{1}{8}$ )	10 ( $\frac{3}{8}$ )
1500 to 2400 (60 to 90)	50x50x3 (2x2x $\frac{1}{8}$ )	10 ( $\frac{3}{8}$ )
2400 and over (90 and over)	50x50x6 (2x2x $\frac{1}{4}$ )	10 ( $\frac{3}{8}$ )

- .3 maximum hanger spacing: 2.4 m (8 ft) on centre.
- .4 For additional requirements for seismic restraints, refer to Section 20 05 49.



### **3.6 Outdoor Ductwork Installation**

- .1 Construct outdoor ductwork in accordance with the requirements for indoor ductwork, and/except as follows.
- .2 Construct galvanized steel duct using Z275 (G90) sheet metal.
- .3 Support ductwork on a manufactured rooftop duct support framing system, specifically designed and fabricated to suit each outdoor duct.
- .4 Where seismic restraint is required;
  - .1 provide both a bottom support beam and top support brace.
  - .2 provide restraint at both sides at the top of the duct, at the specified restraint spans, with minimum Ø12 mm stainless steel bolt, nuts and washers, fastened to the duct support system post and to a duct mounting bracket. Fasten the mounting brackets to the stop corners of the duct with 2@ #10 sheet-metal screws.
- .5 For uninsulated ductwork;
  - .1 support ducts on a steel angle fastened to the underside of the duct, and bolt the steel angle to the duct support frame bottom crossbar,
  - .2 where fastened to the bottom crossbar, provide slotted bolt holes and oversize washer plates to allow 6 mm (1/4 in) duct axial movement for thermal expansion, and to resist wind and seismic movement.
- .6 For insulated ductwork;
  - .1 support ducts on a steel angle fastened to the underside of the duct, which extend not more than 50 mm (2 in) past each side of the duct. Do not penetrate the duct insulation with the steel angles.
  - .2 support the duct on threaded rods from the support frame bottom crossbar, to provide sufficient space between the underside of the duct and the crossbar to accommodate the required insulation thickness and protective finish cover, plus an additional 25 mm (1 in),
  - .3 insert a section of 25 mm (1 in) thick high-density polystyrene insulation equal to Owners Corning Celfort 300, between the duct insulation and top of the support crossbar,
  - .4 snug down the mounting bolts to provide adequate compression onto the polystyrene insert.

### **3.7 Special-purpose Corrosion-Resistant Exhaust Systems**

- .1 General construction requirements for corrosion-resistant ductwork for special purpose exhaust systems:
  - .1 weld longitudinal and transverse joints,
  - .2 flanges including Vanstone-type flanges may be used to joint sections of ductwork and at connection to equipment.
- .2 Special-purpose exhaust system:
  - .1 application: as indicted in Schedule A at the end of this section,
  - .2 material: in accordance with Schedule A at the end of this section,
  - .3 ductwork limits: extends from connection to exhaust grill in room or spaces to the exhaust termination outside the building.

### **3.8 Pressure Classification and Seal Class**

- .1 Low pressure ductwork construction classification in accordance with Table 2.

<b>Table 2: Duct Pressure Classification</b>			
Pressure class Pa (in wg)	Operating pressure Pa (in wg)	Velocity m/s (fpm)	Leakage Test Pressure Pa (in wg)
125 (½)	up to 125 (½)	10.0 (2000)	125 (½)
250 (1)	125 to 250 (½ to 1)	12.5 (2500)	250 (1)
500 (2)	250 to 500 (1 to 2)	12.5 (2500)	500 (2)
750 (3)	500 to 750 (2 to 3)	15.0 (3000)	750 (3)
Greater than 750 (3)	High Pressure Ductwork		Not less than 1000 (4)

.2 Assemble ductwork seams and joints with joint sealant as shown in table 3.

.3 Sealant application:

- .1 store duct sealant at room temperature for 24 hours before use,
- .2 apply sealant on seams as noted in table 1, and brush or extrude sealant to cover fasteners,
- .3 on bell and spigot style joints apply sealant on male section with caulking gun and spread sealant evenly on mating surface with brush,
  - (a) insert fitting and secure with sheet metal screws
  - (b) brush sealant onto outside of assembled joint in 50 mm (2 in) wide band covering fastener heads,
- .4 allow 40 hours curing time before pressure testing.

**Table 3: Duct System Pressure and Seal Class – Healthcare and Laboratories**

No.	Ductwork System	Static pressure construction class Pa (in.wg.)	Seal class	Sealing requirements (1)(2)(3)(4)
1	Supply air ducts inside of mechanical rooms	+1000 (4)	A	Transverse joints, longitudinal seams, and duct wall penetrations
3	Supply air duct risers in vertical service space (duct shafts).	+1000 (4)	A	
4	Supply air ducts serving operating rooms and associated support spaces	+1000 (4)	A	
5	Return/exhaust air ducts between a Heat Recovery Wheel and suction side of fan.	-1000 (4)	A	
6	Supply, return and exhaust air ducts located outdoors.	All classes as otherwise specified herein	A	

**Table 3: Duct System Pressure and Seal Class – Healthcare and Laboratories**

No.	Ductwork System	Static pressure construction class Pa (in.wg.)	Seal class	Sealing requirements (1)(2)(3)(4)
7	Autopsy exhaust air ducts.	-1000 (4)	A	
8	Process exhaust air ducts between exhaust HEPA filters and suction side of fan.	-1000 (4)	A	
9	Process exhaust air ducts upstream of exhaust air filters, or upstream of exhaust fan if there are no exhaust filters	-750 (3)	A	
10	Chemical fume hood exhaust ductwork on suction side of exhaust fan	-750 (3)	A	
11	Biohazard exhaust ductwork	-750 (3)	A	
12	Perchloric Acid exhaust system on suction side of exhaust fan	-1500 (6)	A	
13	Perchloric Acid exhaust system on discharge side of exhaust fan	+500 (2)	A	
14	Supply air ductwork between vertical riser and inlet to terminal units or reheat coils (excluding any supply air system containing HEPA filters)	500 (2)	B	Transverse joints and longitudinal seams
15	Supply air ducts between supply fan and inlet to HEPA filters/HEPA diffusers (other than operating rooms)	750 (3)	B	
16	Supply air ductwork downstream of terminal units or reheat coil to outlet HEPA filters	+500 (2)	B	
17	Return air and general exhaust air duct risers in mechanical rooms and in vertical service spaces (duct shafts).	-750 (3)	B	
18	Exhaust ductwork on discharge side of fans for: autopsy exhaust, process exhaust, chemical fume hood exhaust, biohazard exhaust	+500 (2)	B	
19	Supply air ductwork downstream of terminal units or reheat coil (no HEPA filters)	250 (1)	C	Transverse joints

**Table 3: Duct System Pressure and Seal Class – Healthcare and Laboratories**

No.	Ductwork System	Static pressure construction class Pa (in.wg.)	Seal class	Sealing requirements (1)(2)(3)(4)
20	Return air and general exhaust air main ducts on suction side of fans <u>other than</u> in mechanical rooms and vertical service spaces.	-250 (1)	C	
21	Relief air ductwork on discharge side of return fan	+250 (1)	C	
22	Fan coil units, suction and discharge.	+250 (1)	C	
23	Washroom and general exhaust branch ducts to individual rooms	125 (1/2)	---	None

**Notes for table 3:**

- (1) *Transverse joints* are connections of two duct or fitting elements oriented perpendicular to flow,
- (2) *Longitudinal seams* are joints oriented in direction of flow,
- (3) *Duct wall penetrations* are openings made by screws, non-self-sealing fasteners, pipe, tubing, rod and wire,
- (4) *Other connections* such as spin-ins taps and other branch fittings inserted into cut openings in duct, access door frames, insertion type control elements and duct joints at equipment are to be treated as *transverse joints*.
- (5) *This pressure class also applies to supply ductwork downstream of a terminal unit or reheat coil which serve diffusers with integral HEPA filters.*

**3.9 Fittings - Rectangular Ductwork**

- .1 Refer to Schedule B at the end of this section for illustrations of referenced fitting types.
- .2 Elbows:
  - .1 Elbows are to be installed as shown, or if not shown, in descending order as listed in table 4.
    - (a) for clarity, elbows types are to be selected based on the highest order number (where 1 is the highest) which will fit the available space.

**Table 4: Rectangular Duct, Elbows**

Order No.	ASHRAE Fitting No.	Description	Throat Radius Ratio R/W	Duct Width Limit mm (in)	Minimum Throat Radius mm (in)	Remarks
1	CR3-1	Smooth radius Un-vented elbow	1.5	≤ 300 (12)	---	Default
			1.0	> 300 (12)	---	
2	CR3-3	Smooth radius Vented elbow	0.75	≤ 900 (36)	150 (6)	One full radius single thickness splitter vane
	CR3-4	Smooth radius Vented elbow	0.75	> 900 (36) ≤ 1500 (60)	150 (6)	Two full radius single thickness splitter vane
	CR3-5	Smooth radius Vented elbow	0.75	> 1500 (60)	150 (6)	Three full radius single thickness splitter vane

<b>Table 4: Rectangular Duct, Elbows</b>						
Order No.	ASHRAE Fitting No.	Description	Throat Radius Ratio R/W	Duct Width Limit mm (in)	Minimum Throat Radius mm (in)	Remarks
3	CR3-15	Square Mitred Vaned elbow	Square throat; Square heel.	--	---	Double thickness turning vanes; 50 (2) heel radius vane; 54 mm (2.125 in) vane spacing.

.2 First elbow on discharge side of fan:

(a) fitting CR3-1, un-vaned elbow with throat radius 1.0 times duct width, with the required upstream effective length  $L_e$  of straight length of duct in accordance with fitting type SR7-5 or SR7-9 as applicable.

.3 Wye and tee branch fittings - Supply air systems:

.1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 5.

<b>Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Supply Air Systems</b>			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
1	For 750 Pa (3 in.wg) pressure class and above: branch take-off from ducts in shafts, and ducts upstream of terminal boxes, filters and reheat coils	Smooth radius wye; diverging	SR5-1
		Dovetail wye	SR5-14
		Divided flow fittings	(SMACNA) 4A or 4B
		45° entry branch diverging	SR5-13
2	Supply ducts downstream of terminal boxes, fan coil units, reheat coils or heat pumps	Tee, rectangular main to round conical tap	SR5-12
		Tee, 45° entry branch diverging	SR5-13
		Smooth radius wye; diverging	SR5-1

.4 Wye and tee branches - Return/Exhaust air systems:

.1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 6.

<b>Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Return/Exhaust Air Systems</b>			
Ref. No.	Return/Exhaust Ductwork System	Fitting Type	ASHRAE Fitting No
1		Smooth radius wye; converging	ER5-1

**Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Return/Exhaust Air Systems**

Ref. No.	Return/Exhaust Ductwork System	Fitting Type	ASHRAE Fitting No
	All pressure classes including branch connections at duct shafts	Dovetail wye	ER5-4
		Divided flow fittings	(SMACNA) 4A or 4B
		45° entry branch diverging, where shown on drawings	ER5-3

.5 Transitions (Rectangular and Round):

.1 converging: maximum 20° angle between duct side and direction of flow,

.2 diverging: maximum 15° angle between duct side and direction of flow.

.6 Fabricate duct offsets using elbows selected in accordance with table 2 and as follows:

.1 single offset in single plane, less than duct height: made up with two 45° elbows,

.2 single offset, of greater displacement, made up with 90° elbows,

.3 double offset in single plane, less than duct height, made up with four 45° elbows,

.4 double offset in single plane, of greater displacement than duct height, made up with 90° elbows.

.7 Obstructions passing through duct:

.1 covered by round nosed streamline enclosure where free area of duct is reduced by less than 15%,

.2 fitted in round nosed streamline enclosure with duct width increase, SMACNA HVAC FIG 2-10, Detail E , with converging and diverging transition angle requirements as specified above.

### 3.10 Fittings - Round Ductwork

.1 Refer to Annex A at the end of this Section for illustrations of referenced fitting types.

.2 Elbows:

.1 Elbows are to be installed as shown, or if not shown, in order of available space as listed in table 6.

**Table 6 : Round Duct, Elbows**

Ref. No.	Description	ASHRAE Fitting No.	Throat Radius Ratio R/W	Duct Width Limit mm (in)	Remarks
1	30° elbow	CD3-3*	1.5	≤ 300 (12)	Die stamped
		CD3-14*	1.5	> 300 (12)	2-Gore
2	45° elbow	CD3-3	1.5	≤ 300 (12)	Die stamped
		CD3-14	1.5	> 300 (12)	3-Gore
3	60° elbow	CD3-3*	1.5	≤ 300 (12)	Die stamped
		CD3-14*	1.5	> 300 (12)	4-Gore

<b>Table 6 : Round Duct, Elbows</b>					
Ref. No.	Description	ASHRAE Fitting No.	Throat Radius Ratio R/W	Duct Width Limit mm (in)	Remarks
4	90° elbow	CD3-1	1.5	≤ 200 (8)	Die stamped
		CD3-9	1.5	>200 (8) and ≤ 350 (14)	5-Gore
		CD3-10	1.5	>350 (14) and ≤ 900 (36)	7-Gore
			2.5	> 900 (36)	7-Gore

.3 Wye branches:

- .1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 7.

<b>Table 7 : Round Duct, Wye and Tee Branch Fittings</b>			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
1	Downstream of supply fan.	Wye branch plus 45° elbow	SD5-2
		Tee, tapering	SD5-12
2	Downstream of terminal boxes.	Wye branch plus 45° elbow	SD5-1
		Tee, tapering	SD5-10
3	Return or exhaust duct branches.	Wye branch plus 45° elbow	ED5-2
4	Return or exhaust duct branches; equal main and branch duct size.	Tee, tapering, with 45° elbow	SD5-2
5	Return or exhaust duct branches; smaller branch size.	Tee, tapering, with 45° elbow	SD5-12

### 3.11 Temporary Protection of Duct Openings

- .1 Cap off ends of unfinished ducts while plastering, drywall and other finishing operations are in progress,
- .2 Cover open ends or registers of active exhaust/return ducts with 25 mm (1 in) thick filter media secured with tape. Maintain media until dust producing finishing operations are completed.

### 3.12 Duct Access Doors

- .1 Provide for inspection and servicing of duct mounted components and cleaning of duct system;
- .1 located such that any section of duct is not more than 15 m (50 ft) from point of access,
- .2 at not more than 6 m (20 ft) intervals on supply air ductwork installed after HEPA filter,
- .3 at base of each accessible duct riser,

- .4 in front of and behind duct mounted coils,
  - .5 at activation side of fire, smoke, and combination fire/smoke dampers,
  - .6 and motorized dampers where damper actuator is located inside of duct or plenum.
- .2 Door size:
- .1 Select access door sizes based on smallest duct dimension in accordance with table 8.

<b>Table 8 : Access Door Sizes</b>			
Smallest Duct Dimension mm (in)	Bottom of duct height above floor m (ft)	Location	Door Size mm (in)
≤ 350 (14)	Any	Side or bottom	300 x 150 (12x6)
>350 and ≤500 (>14 and ≤20)	Any	Side or bottom	450 x 250 (18x10)
>500 (>20)	≤3.6 (12)	Side or bottom	530x350 (21x14)
	>3.6 (12)	Bottom	635x430 (25x17)

### 3.13 Duct Pressure Testing

- .1 Duct pressure testing must be completed to the satisfaction of Consultant before ductwork is insulated or concealed.
- .2 Pressure test air duct systems for leaks at 1.33 times the system, or portion of the system, pressure class specified and as follows;
  - .1 between supply air handling units and terminal units,
  - .2 between supply air handling units and final connection to supply outlets on supply systems without terminal units (excluding flexible ductwork)
  - .3 between inlet grilles and the exhaust/return fan inlet,
  - .4 between the return fan discharge outlet and the mixing plenum on recirculating return systems,
  - .5 between the exhaust fan discharge outlet and the point of discharge before leaving the building, but only for process exhaust systems conveying any materials other than general building exhaust air,
- .3 The following parts of system are exempt from pressure testing;
  - .1 short duct runs of 15 metres (45 feet) or less, operating at 37 Pa (1/8 in) SP or less.
  - .2 ductwork installed downstream of terminal boxes and fan coil units.
- .4 Conduct test in accordance with Associated Air Balance Council (AABC) recommended procedures.
- .5 Where audible air noise is detected during test, remove test, pressure apply sealant to leaking joints and seams, and retest after 48 hours. Continue testing and sealing until leaks are inaudible.

### 3.14 Duct Leakage Testing

- .1 Duct leakage testing must be completed to the satisfaction of Consultant before ductwork is insulated or concealed.



- .2 Conduct duct leakage tests in accordance with SMACNA *HVAC and Duct Leakage Test Manual* and as specified herein.
- .3 For each duct systems, calculate the maximum allowable ductwork airflow leakage rate based on duct surface area, pressure class and duct seal class in accordance with the following:

$$L = F \times D_{SA}$$

$$\text{and } F = K \times C_L \times P^{0.65}$$

where these parameters are unique to each section of duct:

- $L$  is the maximum allowable leakage airflow rate,
- $D_{SA}$  is the duct surface area,
- $F$  is the leakage rate coefficient,
- $C_L$  is the duct leakage class, and is listed in Table 10,
- $P$  is the duct design pressure,
- $K$  is a conversion factor depending on the units of measure and is listed in Table 9.

Table 9: Duct Leakage Measurement Units			
	Parameter	Flow Measurement Units	
		L/s	CFM
L	Allowable leakage units	L/s	CFM
$D_{SA}$	Duct surface area units	m <sup>2</sup>	ft <sup>2</sup>
F	leakage rate coefficient	L/s per m <sup>2</sup>	CFM per 100 ft <sup>2</sup>
$C_L$	Leakage Class Coefficient	Refer to table 10 below	Refer to table 10 below
P	Duct Class pressure units	Pa	in.w.c.
K	unit conversion (multiplier)	$1.4 \times 10^{-3}$	1

Table 10: Leakage Coefficient, $C_L$			
Duct Type	Pressure Class		
	500 (2)	750 (3)	≥1000 (4)
Rectangular metal	16	8	4
Round Metal	8	4	2
Unsealed rectangular metal duct	48	48	48
Unsealed round or oval metal duct	30	30	30

- .4 Conduct duct leakage tests for each duct system at an air pressure equal to the duct system pressure class. Where a duct system has multiple pressure classes for different sections, test each section of the system independently.

- .5 If leakage rate exceeds the calculated maximum allowable value, examine ductwork for excessive leakage, re-seal and then repeat the leak test until the measured leakage rate is less than the calculated maximum allowable value for the section of the system under test.
  - .1 for clarity, where a duct system consists of multiple sections of different pressure classes, the acceptance criteria is based on not exceeding the aggregate of the calculated maximum allowable leakage of all sections in the same duct system.
- .6 Maintain a set of drawings on site, coloured each day during testing to indicate extent of duct satisfying leakage criteria under test.
- .7 Submit a written report, verified by the TAB Agent, identifying each segment of duct system tested, showing calculation of maximum allowable leakage (duct surface area, pressure class, seal class, leakage class "CL" and calculated leakage air flow rate for the section), along with the test pressure and measured leakage airflow rate, and certifying that leakage testing has been satisfactorily completed.
- .8 Submit the report for review by Consultant before duct insulation is installed and branch take-offs are made for terminal units.

### **3.15 Duct Cleaning**

- .1 Cleaning to be performed by agent specializing in this field of work, be a member in good standing with National Air Duct Cleaners Association (NADCA), and to comply with NADCA standards.
- .2 Clean new horizontal and vertical ducts (supply, return, exhaust, transfer), as well as existing supply and return ductwork connected to new fan systems.
- .3 Clean ductwork using high powered vacuum system, hand tools and mechanical brushing systems such that metal surfaces are visibly clean.
- .4 Reset balancing dampers to original settings if moved during work. Have TAB Agent confirm damper settings.
- .5 Maintain set of drawings on site, coloured each day during cleaning to indicate extent of duct cleaning completed.
- .6 Submit a written report, verified by TAB Agent, identifying extent of duct system cleaning and certifying that NADCA standards have been met.

### **3.16 Schedules**

- .1 The following schedules form part of this specification section.
  - .1 Schedule A – Ductwork, Casings and Plenum Materials
  - .2 Schedule B – Illustrations of Referenced Fittings.

<b>Schedule A – Materials for Ductwork, Casings and Plenums</b>					
<p style="text-align: center;"><u>Legend</u></p> <p style="text-align: center;">“Yes” means permitted material                      “---” means not permitted</p> <p style="text-align: center;">Where more than one material is indicate as permitted for a particular application or location, than any of those permitted materials may be used.</p>					
Application or Location	Galvanized Steel Z180 (G60)	Galvanized Steel Z275 (G90)	Stainless Steel 304L or 316L	Aluminum	Notes
Outdoors	---	Yes	Yes	---	[1]
Intake air plenums	---	Yes	Yes	---	[1]
Exhaust air plenums	---	Yes	Yes	---	[1]
Parking garages	---	Yes	Yes	---	[1]
Indoor swimming pools and spas	---	---	316L	Yes	[2]
Shower room supply ducts	---	---	Yes	Yes	
Shower room exhaust ducts	---	---	Yes	Yes	[4]
Indoor painted ductwork	---	Yes	---	---	
Dishwasher exhaust, Tunnel washer exhaust, Cage washer exhaust	---	---	Yes	Yes	[2],[4]
Sterilizer equipment exhaust	---	---	Yes	---	[4]
Owner Process Equipment exhaust	---	---	Yes	---	[2]
Duct-mounted humidifiers	---	---	Yes	---	[4]
Buried ductwork	---	PVC Coated	Yes	---	
Airborne Isolation Rooms (AIR)	---	---	Yes	---	[3],[4]
All other indoor locations	Yes	Yes	---	---	

Notes:

- [1] For both insulated and uninsulated ductwork.
- [2] No. 4 brushed finish for exposed ductwork and hoods, No. 2B mill finish for concealed ductwork.
- [3] Special-purpose exhaust system.
- [4] Welded joints and seams. Flanges, including Vanstone-type flanges, may be used for duct section connections and connections at equipment

Schedule B – Illustration of Referenced Fittings

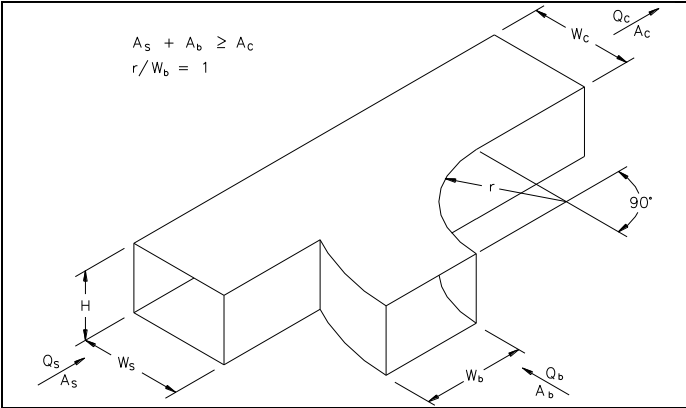
Rectangular Elbows (see Table 4 in Part 3.)

<p><math>C_o = K C_p</math></p> <p>where</p> <p><math>K = \text{angle factor}</math></p> <p><math>W \times H</math></p>	<p>SPLITTER VANE</p> <p>FRONT VIEW</p> <p>SIDE VIEW</p> <p><math>C_o = K C_p</math> <math>R_1 = R/CR</math></p> <p>where</p> <p><math>R = \text{throat radius}</math> <math>R_1 = \text{splitter vane radius}</math> <math>CR = \text{'CURVE RATIO'}</math> <math>K = \text{angle factor}</math></p> <p>CR3-3</p>
<p>SPLITTER VANE #2 SPLITTER VANE #1</p> <p>FRONT VIEW</p> <p>SIDE VIEW</p> <p><math>C_o = K C_p</math> <math>R_1 = R/CR</math> <math>R_2 = R_1/CR = R/CR^2</math></p> <p>where</p> <p><math>R = \text{throat radius}</math> <math>R_1 = \text{splitter vane \#1 radius}</math> <math>R_2 = \text{splitter vane \#2 radius}</math> <math>CR = \text{'CURVE RATIO'}</math> <math>K = \text{angle factor}</math></p> <p>CR3-4</p>	<p>SPLITTER VANE #3 SPLITTER VANE #2 SPLITTER VANE #1</p> <p>FRONT VIEW</p> <p>SIDE VIEW</p> <p><math>C_o = K C_p</math> <math>R_1 = R/CR</math> <math>R_2 = R_1/CR = R/CR^2</math> <math>R_3 = R_2/CR = R/CR^3</math></p> <p>where</p> <p><math>R = \text{throat radius}</math> <math>R_1 = \text{splitter vane \#1 radius}</math> <math>R_2 = \text{splitter vane \#2 radius}</math> <math>R_3 = \text{splitter vane \#3 radius}</math> <math>CR = \text{'CURVE RATIO'}</math> <math>K = \text{angle factor}</math></p> <p>CR3-5</p>
<p><math>r = 2.0 (50), s = 2.125 (60) \text{ in. (mm)}</math></p> <p>CR3-15</p>	

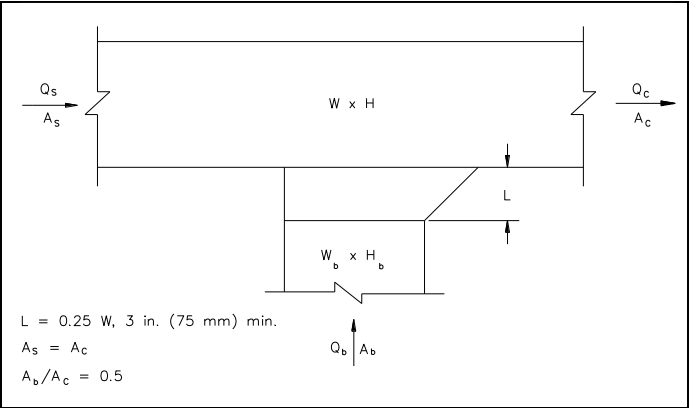
**Rectangular Wyes and Tee's – Supply Ductwork** (see Table 5 in Part 3)

<p> <math>A_s = A_b \geq A_c</math>  <math>r/W_b = 1.0</math> </p>	<p> <math>L = 4\text{in. (100mm)}</math> </p>
<p><b>SR5-1</b></p> <p> <math>L = 0.25W_b, 3 \text{ in. (75mm) min.}</math> </p>	<p><b>SR5-12</b></p> <p> <math>r/W_c = 1.5</math>  <math>Q_{b1}/Q_c = Q_{b2}/Q_c = 0.5</math>  <math>W_{b1} = W_{b2} = W_b</math> </p>
<p><b>SR5-13</b></p> <p> <b>SMACNA Fig. 4A/4B</b> </p>	<p><b>SR5-14</b></p>

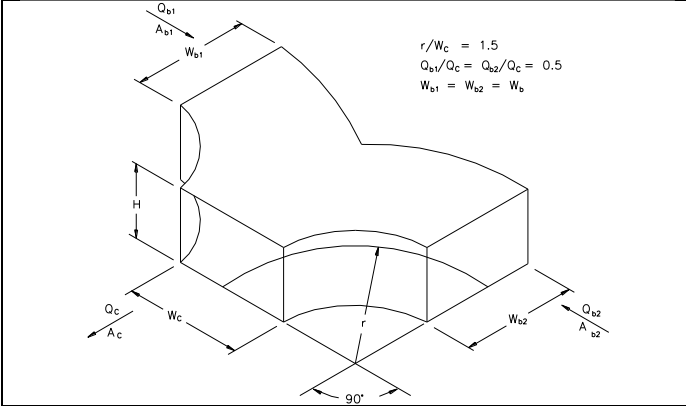
Rectangular Wyes and Tee's – Return/Exhaust Ductwork (see Table 5 in Part 3)



ER5-1

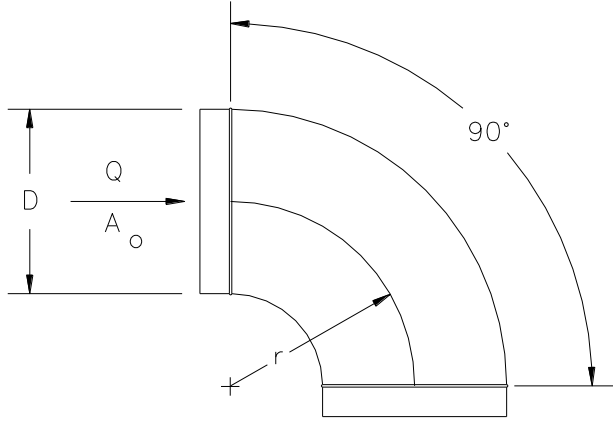
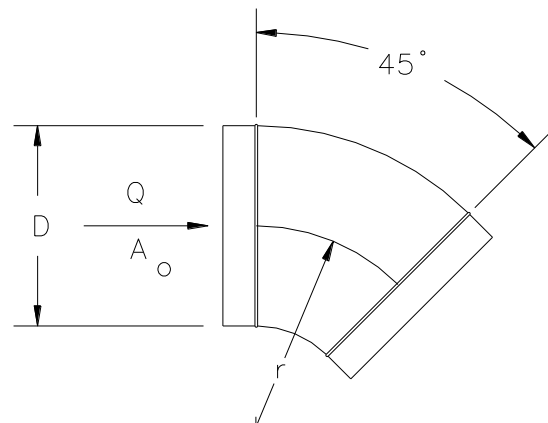
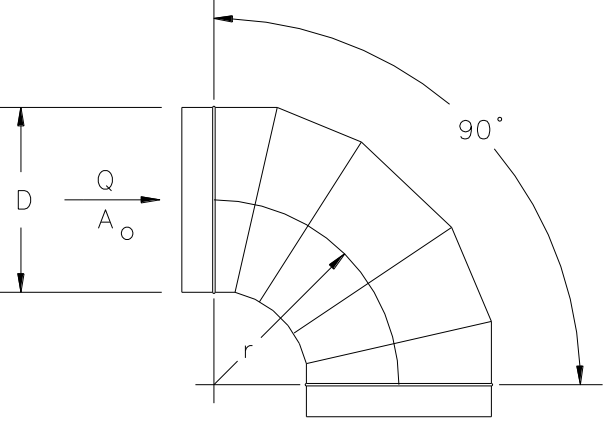
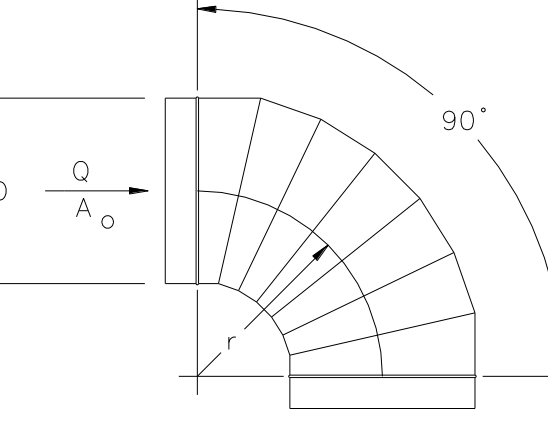
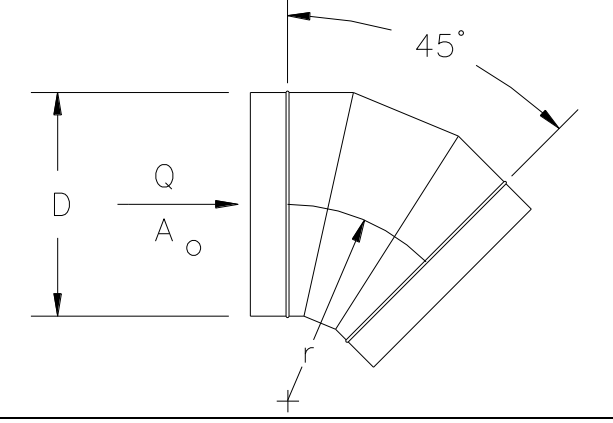


ER5-3

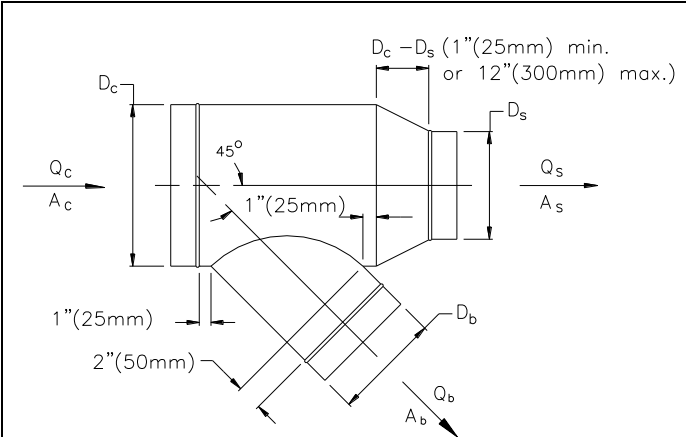


ER5-4

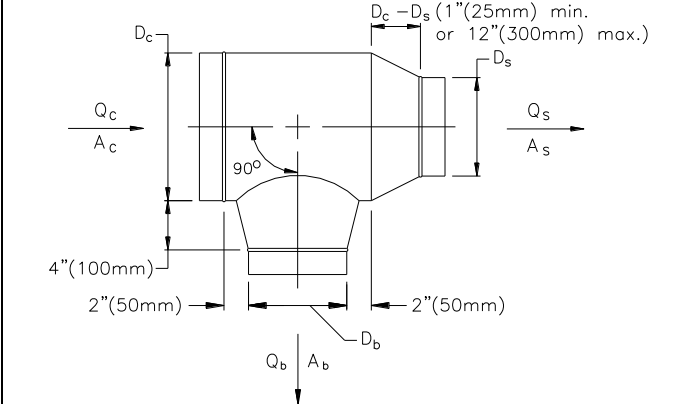
**Round Elbows** (see Table 6 in Part 3)

	
CD3-1	CD3-3
	
CD3-9	CD3-10
	
CD3-14	

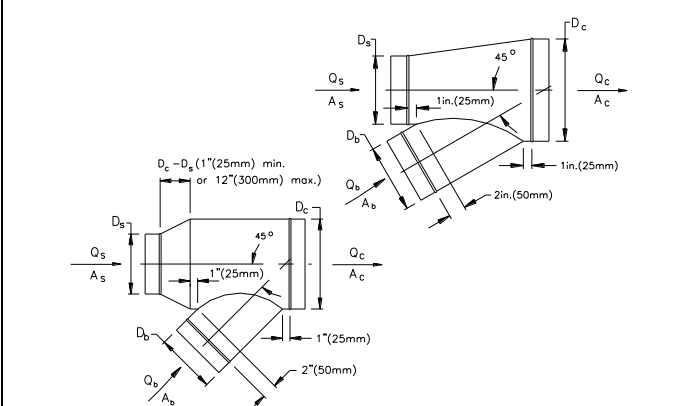
Round Wyes and Tees (see Table 7 in Part 3)



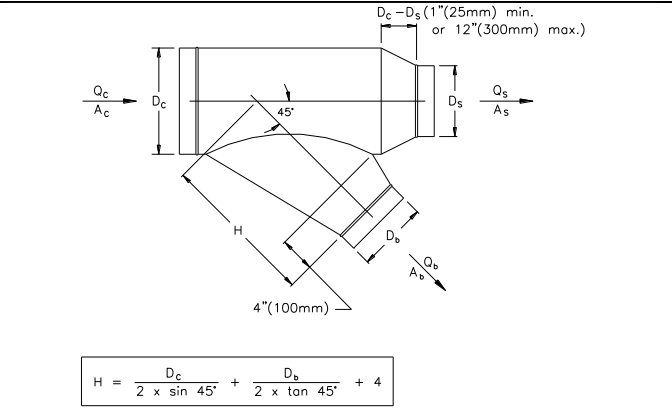
SD5-1



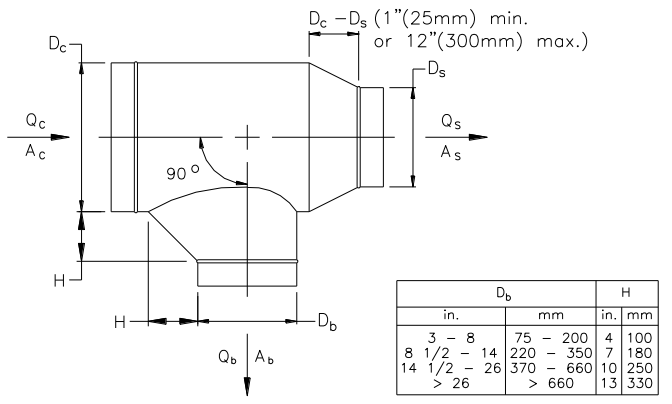
SD5-10



ED5-2



SD5-2



SD5-12

END OF SECTION



## DUCT ACCESSORIES 23 33 05

### 1 GENERAL

#### 1.1 Scope

- .1 Provide duct accessories as shown.

#### 1.2 Applicable Codes and Standards

- .1 Product standards:
  - .1 ULC-S110 Standard Methods of Test for Air Ducts

#### 1.3 Submittals

- .1 Submit product data sheets for:
  - .1 flexible fan connectors,
  - .2 sealants,
  - .3 tapes,
  - .4 duct access doors and hardware,
  - .5 instrument test ports.

### 2 PRODUCTS

#### 2.1 Flexible Fan Connectors

- .1 Neoprene, non-insulated:
  - .1 fabric material: fire resistant, self-extinguishing, neoprene-coated glass fabric, density 0.653 kg/m<sup>2</sup> (0.13 lb./sq. ft),
  - .2 attachment frames: galvanized 0.66 mm (24 ga.) sheet metal frame, with fabric clenched with double locked seams,
  - .3 operating temperature: -40°C to 90°C (-40°F to 194°F),
    - ° Duro-Dyne - fig. Durolon
    - ° Ventfabric - fig. Ventglas
    - ° Elgin - fig. Neoprene
- .2 Vinyl coated, insulated:
  - .1 fabric material: flame resistant, 0.56 mm (0.022 in) thick vinyl coated fabric, encapsulating minimum 25 mm (1 in,) thick, 21 kg/m<sup>3</sup> (1.34 lb./cu ft) fiberglass insulation,
  - .2 attachment frames: galvanized 0.66 mm (24 ga.) sheet metal frame, with fabric clenched with double locked seams,
  - .3 operating temperature: 82°C (180°F) continuous and 93°C (200°F) intermittent,

##### *Standard of Acceptance*

- ° Duro-Dyne - fig. Insulflex
- .3 Silicon rubber, non-insulated:
  - .1 silicon rubber-coated woven fiberglass fabric, density of 0.461 kg/m<sup>2</sup> (0.094 lb./sq. ft),

- .2 attachment frames: galvanized 0.66 mm (24 ga.) sheet metal frame, with fabric clenched with double locked seams,
- .3 operating temperature: up to 260°C (500°F).

*Standard of Acceptance*

- Duro-Dyne - fig. Thermafab

## **2.2 Duct Sealant**

- .1 Water-based polymer emulsion type, flame resistant duct sealing compound.
- .2 Operating temperature range: -29°C to 93°C (-20°F to 200°F).
- .3 Operating pressure: tested to operate at 2.5 kPa (10 in.w.c.) duct static air pressure,
- .4 Meets requirements for SMACNA Class A, B and C duct sealing requirements.
- .5 Listed to ULC-S102 with flame-spread rating of 25 or less and smoke-development classification of 50 or less.
- .6 LEED requirements:
  - .1 meets requirements for LEED BD+C v4 credit for low emitting material – Paints and Coatings.
  - .2 manufacturer to supply documentation demonstrating compliance.

*Standard of Acceptance*

- Bakor - fig. Duck-Seal
- RCD - fig. #6 Mastic
- Childers - fig. CP-146
- McGill Air Seal - fig. United Duct Sealer (Water Based)
- Duro Dyne - fig, DWN (water based)

## **2.3 Tape**

- .1 Polyvinyl treated open weave glass fibre tape, 50mm (2") wide.

## **2.4 Access Doors for Standard-Duty Ducts**

- .1 Application: for general purpose HVAC ductwork.
- .2 Low-pressure access doors:
  - .1 manufactured duct access doors, of same material as associated duct,
  - .2 pressure rating: 500 Pa (2 in.w.c.) positive and negative pressure,
  - .3 door panel:
    - (a) double-wall construction encapsulating 25 mm (1 in.) thick fibreglass insulation,
    - (b) minimum 0.7 mm (24 ga.) sheet thickness for both inner and outer panel,
    - (c) inside face of access door does not protrude into interior space of duct,
  - .4 door frame: minimum 0.7 mm (24 ga.) thick channels, with mounting tabs and neoprene door gasket,
  - .5 door size: 150x150 mm (6 x 6 in.) up to 600x600 mm (24x24 in.)
  - .6 door hardware:
    - (a) hinge: continuous length, galvanized steel piano hinge of same material as door,
    - (b) latch - standard: galvanized steel cam-latch,

- (c) latch – secured: common-key operated latch,
- (d) security chain when only provided with cam-latches.

*Standard of Acceptance*

- Ductmate
- Duro-Dyne

.3 High-pressure access doors – framed style:

- .1 similar construction as for low-pressure framed access doors, except/and as specified below,
- .2 pressure rating: 2500 Pa (10 in.w.c.) positive and negative pressure without measurable leakage under laboratory testing,
- .3 hardware: cam-latch only,
  - (a) one (1) latch per door edge (total of 4) for 150x150 mm (6 x 6 in.) doors,
  - (b) two (2) latches per door edge (total of 8) for larger doors.

*Standard of Acceptance*

- Ductmate
- Duro-Dyne

.4 High-pressure access doors – frameless style:

- .1 manufactured duct access doors, of same material as associated duct, for rectangular, round and flat-oval ducts,
- .2 pressure rating: 2500 Pa (10 in.w.c.) positive and negative pressure without measurable leakage under laboratory testing,
- .3 door panel:
  - (a) inner sandwich double-wall construction, encapsulating 25 mm (1 in.) thick fibreglass insulation, spot-welded seams, with smooth-faced finish where exposed to the airstream,
  - (b) outer pressure panel: stamped reinforced-exterior panel,
  - (c) neoprene gasket applied to inner panel face, positioned for positive or negative pressure applications,
  - (d) inside face of access door does not protrude into interior space of duct,
- .4 door frame: none.
- .5 door size: 200x100 mm (8 x 4 in.) up to 600x450 mm (24 x 18 in.)
- .6 door hardware:
  - (a) two (2) spring-loaded pressure-retaining bolting system, with tool-less polypropylene knobs.

*Standard of Acceptance*

- Ductmate - fig. Sandwich Access Doors

## **2.5 Access Doors for Plenums**

.1 Shop fabricated doors:

- .1 double-wall construction, fully encapsulating 25 mm (1 in.) thick glass-fibre insulation,
- .2 same material as duct, with both inner and outer panels of same thickness as associated plenum wall but not less than 0.6 mm (26ga.) thick,

- .3 door frame: structural angles, galvanized steel minimum 2.0 mm (14 ga.) thickness, with continuous welded joints,
- .4 gasket: automotive-style Neoprene gaskets bonded to door frame,
- .5 door size: 500 mm wide x 1370 mm high (20 in. x 54 in.) except as otherwise shown,
- .6 door swing:
  - (a) inwards for positive pressure plenums,
  - (b) outwards for negative pressure plenums.
- .2 Door hardware:
  - .1 hinges: continuous piano hinge, zinc-plated steel or stainless-steel,
  - .2 handles: two (2) handles operable from both sides.

*Standard of Acceptance*

- ° Duro-Dyne - fig. SP-20 (door handles)

## **2.6 Instrument Test Ports**

- .1 Manufactured test ports:
  - .1 nominal size: Ø25 mm (1 in) minimum inside diameter, length to suit insulation thickness,
  - .2 extended body to accommodate 25 and 50 mm (1 and 2 in.) insulation thickness as applicable to the duct system,
  - .3 1.6 mm (16 ga.) thick steel body zinc plated after manufacture,
  - .4 chain-secured neoprene expansion plug with cam lock handle,
  - .5 Neoprene mounting gasket: flat for rectangular duct and moulded for round duct.

*Standard of Acceptance*

- ° Duro-Dyne - fig. TH1 or IP2

- .2 Sealant for test port: high temperature silicone.

*Standard of Acceptance*

- ° Duro-Dyne - fig. Red High Temperature Silicon

## **3 EXECUTION**

### **3.1 Flexible Fan Connectors**

- .1 Provide flexible fan connectors to isolate air handling equipment and fans from ductwork, and as shown.
  - .1 minimum length: 75 mm (3 in) length of fabric measured in direction of air flow,
  - .2 minimum distance between metal parts when system is in operation: 25 mm (1 in).
- .2 Use insulated type where connected ductwork is insulated.
- .3 Use silicon-rubber type for laboratory exhaust ducting, and other process exhaust ducting conveying chemical vapours and gases.
- .4 Do not install flexible fan connectors on NFPA 96 kitchen grease duct systems.

### 3.2 Sealant and Tape

- .1 Apply sealant to ductwork joints and seams as detailed in other sections.
- .2 Use of tape is limited to low-pressure systems requiring Class C

### 3.3 Access Doors for Standard Ducts

- .1 Provide access doors in HVAC standard ducts in accordance with the following table:

Access Point	Location
Reheat coils	Both sides of coil
Fire dampers - replaceable thermal link type	Either side of damper
Motorized fire dampers, smoke dampers and combination smoke fire	On actuator side of damper
Motorized Dampers	Either side of damper
Duct smoke detectors	Across from or beneath sensor tube
Bottom of duct risers	Bottom of duct riser, or on backside of elbow

- .2 Weld door frames in place for high velocity ductwork having air velocities in excess of 10 m/s (2500 fpm).
- .3 Access door sizes:
  - .1 as large as possible, with 1:1.5 aspect ratio, for duct sides up to and including 360 mm (14 in),
  - .2 300 mm x 380 mm (12 in x 15 in) for duct sides 380 mm (15 in) and larger,
  - .3 1500 mm (60 in) high by 450 mm (18 in) wide in casings and plenums.

### 3.4 Access Doors for Plenums

- .1 Provide access doors to plenums and casing in locations as shown.
- .2 Weld door frames in place for plenums and casings.

### 3.5 Instrument Test Ports

- .1 Install test ports for duct velocity traverse readings and for duct air temperature readings.
- .2 Locate across duct or plenum at right angles to flow, at not more than 250 mm (10 in) intervals for traverses and at not more than 500 mm (20 in) for temperature measurements.
- .3 Install test ports for velocity traverses in the following locations:
  - .1 at ducted inlets to roof and wall exhausters,
  - .2 at inlet to and outlet from other fan systems, and
  - .3 at main and branch ducts where branch serves more than one outlet. Ports in main to be upstream of branch in both diverging and converging flow.
- .4 Install test ports for temperature measurement;
  - .1 at outside air intakes,
  - .2 at inlet and outlet of coils, and
  - .3 downstream of intersection of converging air streams of different temperatures.

**END OF SECTION**

## **MANUAL BALANCING DAMPERS**

### **23 33 13.11**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide manual balancing dampers.

## **2 PRODUCTS**

### **2.1 Splitter Dampers**

- .1 Shop-fabricated, single thickness construction, of same material as duct but one sheet metal gauge thickness heavier where both dimensions of damper blade are less than 300 mm (12 in).
- .2 Double thickness construction, one metal gauge thickness lighter than duct, where either dimension of damper blade is 300 mm (12 in) or larger,
- .3 Height equal to full depth of branch duct, and length 1½ times branch duct width.
- .4 Fitted with piano hinge pivot, control rod, and locking device accessible from outside fitting.

### **2.2 Single Blade Dampers in Rectangular Ductwork**

- .1 Manufactured product.
- .2 Blades and shaft:
  - .1 constructed of same material as the duct, with longitudinal V-grooves,
  - .2 blade thickness: 1.0 mm (20 ga.) minimum,
  - .3 blade length: 915 mm (36 in) maximum.
  - .4 bronze bearings,
  - .5 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
  - .1 channel section of same material as duct, minimum 1.3 mm (18 ga.) thickness,
  - .2 angle blade stop.

#### *Standard of Acceptance*

- Nailor - fig. 1870
- Ruskin
- Greenheck

### **2.3 Multi-Blade Dampers in Rectangular Ductwork**

- .1 Manufactured product.
- .2 Blades and shaft:
  - .1 constructed of same material as the duct, with longitudinal V-grooves,
  - .2 opposed blade configuration, with link assembly located out of airstream,
  - .3 blade thickness: 1.6 mm (16 ga.) minimum,
  - .4 blade height: 150 mm (6 in) maximum,
  - .5 blade length: 1200 mm (48 in) maximum.

- .6 synthetic polymer or bronze bushings,
  - .7 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
- .1 channel section of same material as duct, minimum 1.6 mm (16 ga.) thickness,
  - .2 angle blade stop,

*Standard of Acceptance*

- Nailor - fig. 1820
- Ruskin
- Greenheck

**2.4 Single Blade Dampers in Round Ductwork**

- .1 Manufactured product.
- .2 Blades and shaft:
  - .1 constructed of same material as the duct,
  - .2 blade thickness: 0.86 mm (22 ga.) minimum,
  - .3 blade diameter: Ø100 to 500 mm (4 to 20 in. dia.),
  - .4 bearings: synthetic self-lubricating bushing,
  - .5 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
  - .1 round duct section of same material as duct, minimum 0.86 mm (22 ga.) thickness, with stiffening beads,
  - .2 angle blade stop,
  - .3 stand-off bracket for locking quadrant for insulated ducts.

*Standard of Acceptance*

- Nailor - fig. 1890
- Ruskin
- Greenheck

**2.5 Single Blade Dampers in Round Ductwork with Remote Cable Adjustment**

- .1 Manufactured product.
- .2 Blades and shaft:
  - .1 constructed of same material as the duct,
  - .2 blade thickness: 1.0 mm (20 ga.) minimum with V brake centreline,
  - .3 blade diameter: Ø100 to 500 mm (4 to 20 in. dia.),
  - .4 bearings: synthetic self-lubricating bushing,
  - .5 shaft extension with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
  - .1 round duct section of same material as duct,
  - .2 wall thickness:



- (a) Ø100 to 250 mm (4 to 10 in. dia.): 0.7 mm (24 ga.)
  - (b) Ø300 to 500 mm (12 to 20 in. dia.): 1.0 mm (20 ga.).
- .3 angle blade stop,
- .4 stand-off bracket for insulated ducts.
- .4 Remote cable operator:
  - .1 damper blade gear operator:
    - (a) self-locking worm-gear regulator, suitable for 9.5 mm (3/8 in.) square or Ø13 mm (½ in.) dia damper shaft,
  - .2 flex-shaft cable:
    - (a) Ø6 mm (1/4 in.) multi-core wound cable in flexible non-binding protective sheath,
    - (b) length: standard and custom lengths up to 15 m (50 ft),
    - (c) with brass end caps and threaded end fittings to attached to damper gear operator and adjustment operator,
  - .3 remote cable operator fixture:
    - (a) cable termination end for tool access,
    - (b) termination kit:
      - i) Ø60 mm (2-1/4 in. dia) zinc coated termination access housing, with prime coated cover plate, for self-clamping installation in drywall ceilings,
      - ii) remote cable operator kit for installation in slot diffuser plenum to allow tool access through diffuser slot.

*Standard of Acceptance*

- ° Young Regulators - fig. 5020CC with 270-275 cable operator

### **3 EXECUTION**

#### **3.1 Balancing Damper Locations and Type**

- .1 Provide balancing dampers in the following locations:
  - .1 at floor branches from a duct riser, use a single or multiple blade damper in the branch duct,
    - (a) where a wye-fitting is installed directly after the duct riser take-off, provide a balancing damper in each outlet branch after the wye fitting,
  - .2 for supply branch ducts that do not directly serve outlet grilles or diffusers, use a single or multiple blade damper in the branch duct,
  - .3 for exhaust or return branch ducts that do not directly serve inlet grilles, use a single or multiple blade damper in the branch duct,
  - .4 for branch duct which directly serve three or more grilles or diffusers (supply, return or exhaust), use splitter damper in the take-off fitting, or use a single or multiple blade damper in the branch duct,
  - .5 on the inlet to a supply air terminal unit, use a damper of the style to match the inlet duct connection to the air terminal unit,
  - .6 on the outlet from a return or exhaust air terminal unit, use a single or multiple blade damper in the branch duct.
- .2 Provide other manual dampers as shown.

### **3.2 Access for Adjustment**

- .1 Locate dampers to allow adjustment of blade position and for locking of the quadrant.

### **3.3 Remote Cable Adjustment Station**

- .1 Use round balancing dampers with remote cable operators where:
  - .1 ceiling height is greater than 3.0 m (10 ft),
  - .2 ceiling height is less than 3.0 m (10 ft) and is not accessible, or
  - .3 elsewhere at the Contractor's discretion.
- .2 Review with Consultant approximate location for each group of remote cable operators;
  - .1 exception: Consultant's review is not required when remote cable operator is located in a slot diffuser plenum.
- .3 Group operators together within the limits of the allowable cable length.
- .4 For ceilings up to 3.0 m (10 ft) in height, remote cable operators may be located in the following locations:
  - .1 within slot diffuser plenums, or
  - .2 mounted in or immediate above ceilings, with termination kit which passes through the ceiling to allow adjustment tool access from below ceiling.
- .5 For ceilings greater than 3.0 m (10 ft) in height, group remote operators together in wall chase access in locations agreed by Consultant, positioned between 1200 and 1800 mm (4 and 6 ft) above the floor. Provide a wall mounted access cover with screwdriver door operator and prime coated finish.
- .6 Where a service room, including mechanical rooms, electrical rooms, and janitor closets are available, mount the remote cable operator in those rooms on a wall mounted bracket. A panel enclosure is not required.
- .7 Label each remote cable operator with a unique reference number, and mark-up as-built drawings to include the reference number for each applicable balancing damper.

**END OF SECTION**

## **DAMPERS - OPERATING**

### **23 33 13.13**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide motorized control dampers as shown.

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 23 73 23 Custom Air Handling Units
  - .2 25 30 13 Building Automation Actuators and Operators
  - .3 25 30 23.13 Building Automation Control Dampers

### **1.3 Applicable Codes and Standards**

- .1 Product standards:
  - .1 AMCA 511 Product Rating Manual for Air Control Devices

### **1.4 Submittals**

- .1 Submit product data sheets for materials specified herein and include:
  - .1 performance charts, pressure drop vs approach velocity for range of blade angles from 0 to 90°,
  - .2 torque requirements,
  - .3 construction details.

## **2 PRODUCTS**

### **2.1 Multi-Blade Operatable Control Dampers**

- .1 Performance:
  - .1 control dampers listed to AMCA 511.
  - .2 leakage in closed position: AMCA Class 1A at 250 Pa (1 in.wc.) and Class 1 at 1000 kPa (4 in.w.c.).
  - .3 pressure drop in open position: maximum 12 Pa (0.05 in wg) differential at 5 m/s (1000 fpm).
  - .4 operating temperature range: -40 to 149°C (-40 to 300°F)
- .2 Construction:
  - .1 non-insulated dampers:
    - (a) blades: [extruded aluminum][formed galvanized steel][formed stainless steel] interlocking blades,
    - (b) frame: [extruded aluminum][formed and welded galvanized steel],
  - .2 insulated dampers:
    - (a) blades: extruded aluminum interlocking double thickness insulated blades,
    - (b) frame: extruded aluminum, thermally broken,
  - .3 seals: extruded vinyl seals, and spring stainless steel side seals,

- .4 bearings: [bronze oiltite inner bearing and outer bearing ][Celcon or similar inner bearing with polycarbonate outer bearing],
- .5 maximum blade width: 150 mm (6 in),
- .6 maximum blade length: 1200 mm (4 ft).
- .7 blade linkage: aluminium and zinc-plated steel tie rods, brass pivots and steel brackets, for parallel blade and opposed blade operation as required for damper control operation.

## 2.2 **[[Bubble-Tight Isolation Dampers**

- .1 Single blade type for modulating and two position service.
- .2 Performance:
  - .1 leakage in closed position: maximum 0.01% of rated air flow at 7 kPa (28 in wg) differential across assembly,
  - .2 linear characteristic with 20:1 turndown,
  - .3 sized using Cv numbers in 65% open position for pressure drop of less than 150 Pa (0.6 in wg) differential at 5 m/s (1000 fpm),
- .3 Construction:
  - .1 body: 316L stainless steel,
  - .2 trim: 316L stainless steel,
  - .3 shaft: 316L stainless steel, and Teflon packing glands,
  - .4 seal: silicon blade seal and external adjustable double-packing gland shaft seals,
  - .5 seat: elastomer seat compatible with paraformaldehyde and ethylene gas,
  - .6 flanged gasketed connections for 7 kPa (28 in wg) service,
  - .7 actuator torque requirement: maximum 205 Nm. (150 lb. Ft) to seat and unseat.

### *Standard of Acceptance*

- Ruskin - fig. BT092 (rectangular ducts)
- Ruskin - fig. BTR92 (round duct)]

## 3 **EXECUTION**

### 3.1 **Damper Movement Style Selection**

- .1 Blade movement type (for control function other than recirculating air handling units):
  - .1 parallel blade style for two position operation.
  - .2 opposed blade style for modulating applications.
- .2 Blade movement type for air handling units with recirculating air dampers;
  - .1 select damper type based on AHU function in accordance with the following table.

System Type	AHU Systems	Minimum Outdoor Air	Economizer Outdoor Air	Exhaust Damper	Recirculating Damper
Fixed Outdoor Air	All	Parallel	N/A	Parallel	Parallel
Air Economizer	All	Parallel	Opposed	Opposed	Opposed

### **3.2 Installation**

- .1 Secure dampers within ductwork, air handling units and at air inlets and exhaust outlets.
- .2 Caulk around frames and between multiple damper modules with UL listed silicone-free duct sealant.

### **3.3 Start-Up and Testing**

- .1 Stroke dampers fully open and fully closed ten times. Check for free movement of damper blades. Check dampers full close along blade edge seals and end seals.

**End of Section**

## **DAMPERS - FIRE**

### **23 33 13.16**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide fire dampers.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 13.16 Wiring Requirements for Mechanical Services

##### **1.3 Definitions**

- .1 The following definitions apply for this specification section:
  - .1 **Damper:** means a smoke damper, motorized fire damper or combination smoke/fire damper.
    - (a) **Balancing damper:** : a damper with an electric actuator that is listed for operation as a modulating damper in normal service, to allow setting the damper at a position between open and closed, for system air balancing purposes.
    - (b) **Dynamic damper:** a fire damper rated to close with airflow through damper at specified air velocities and operating pressure.
    - (c) **Modulating damper:** a damper with an electric actuator that is listed for operation as a modulating damper in normal service, to allow modulating control of the damper in response to a normal (non-emergency) process control requirement.
    - (d) **Reopenable damper:** a motorized fire damper or combination smoke/fire damper that can be electrically re-opened by bypassing the primary heat detection device.
    - (e) **Static damper:** a fire damper rated only to close with essentially no airflow through the damper.

##### **1.4 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 NFPA 80 Installation, Testing, and Maintenance of Fire Dampers
- .2 Product standards:
  - .1 AMCA 500-D Laboratory Methods of Testing Dampers for Ratings.
  - .2 ANSI/CAN/UL/ULC 33 Heat Responsive Links for Fire-Protection Services
  - .3 CAN/ULC - S112 Standard Method of Fire Test of Fire Damper Assemblies
  - .4 CAN/ULC - S112.1 Standard for Leakage Rated Dampers for Use in Smoke Control Systems
  - .5 CAN/ULC - S112.2 Standard Method of Fire Test of Ceiling Firestop Flap Assemblies
  - .6 ULC-S505 Standard for Fusible Links for Fire Protection Services
  - .7 CSA C22.2 No. 14 Industrial Control Equipment

##### **1.5 Submittals**

- .1 Submit manufacturer catalogue cut-sheets for the following materials;
  - .1 fire dampers

- .2 When requested by an AHJ for building safety, submit confirmation data that the fusible link is listed to ULC-S505 or ANSI/CAN/UL/ULC 33.

## **2 PRODUCTS**

### **2.1 General**

- .1 Approvals:
- .1 Fire dampers and combination smoke/fire dampers listed to CAN/ULC-S112.
  - .2 Fusible links for fire dampers listed to ULC-S505 or ANSI/CAN/UL/ULC 33.

### **2.2 Fire Dampers - General Requirements**

- .1 Curtain damper styles:
- .1 Type A: blade pack and frames in airstream,
  - .2 Type B: blade pack out of airstream,
  - .3 Type C:
    - (a) blade pack and frame out of airstream,
    - (b) for rectangular, round and flat oval ductwork, and
    - (c) sleeve joints and damper/sleeve joints sealed.
- .2 Fire damper fire-resistance rating:
- .1 Fire separation ratings 2 hr and less: 1-1/2 hrs.
  - .2 Fire separation rating 3 hr or more: 3 hr.
- .3 Installation orientation:
- .1 Dynamic and static dampers suitable for installation in vertical and horizontal separations.
  - .2 Dampers that are only listed for one orientation are not permitted.
- .4 Rating class, dynamic dampers:
- .1 Standard performance;
 

(a) air velocity, maximum	10 m/s (2000 fpm),
(b) operating static pressure, maximum	1000 Pa (4 in.w.c.)
  - .2 Extended performance ("EPxx");
 

(a) air velocity, maximum	15 m/s (3000 fpm),
(b) operating static pressure, maximum	1000 Pa (4 in.w.c.)
  - .3 High velocity performance ("HVxx");
 

(a) air velocity, maximum	20 m/s (4000 fpm),
(b) operating static pressure, maximum	1000 Pa (4 in.w.c.)
- .5 Manufacturers:

#### *Standard of Acceptance*

- Nailor
- EH Price (National Controlled Air)
- Ruskin
- Pottorff

## **2.3 Fire Dampers - Curtain Type**

- .1 Construction:
  - .1 Frame: G60 roll formed galvanized steel frame.
  - .2 Blades: curtain type, interlocking blades, G60 galvanized steel.
  - .3 Sleeve:
    - (a) same material as damper frame, length to suit application with steel enclosure and transition collars, and retaining angles.
    - (b) for type B damper sleeves, top of sleeve is formed closely around top of damper; sleeve construction that leaves the blade pack in the airstream is not permitted.
  - .4 Sleeve type: type A, B, or C as specified in Part 3.
  - .5 Fusible link: 71°C (160°F) unless otherwise shown.
  - .6 Notwithstanding the above, frame, sleeve, and blades to be stainless steel where damper is installed in a duct system which is stainless steel.
  - .7 Dynamic dampers: fitted with stainless steel closure spring, and rated for velocity and operating pressure based on rating class.
  - .8 Static dampers: fitted with stainless steel closure spring.

## **2.4 Fire Dampers - Multiblade Type**

- .1 Construction:
  - .1 Type: dynamic.
  - .2 Frame: G60 galvanized steel hat channel.
  - .3 Blades: airfoil multiblade type, interlocking blades, G60 galvanized steel;
    - (a) Parallel blade for Open-Closed operation,
    - (b) Opposed blade for modulating control or balancing control.
  - .4 Blade linkage: plated steel, concealed in frame (out of airstream).
  - .5 Bearings:
    - (a) On-Off control, and balancing: self-lubricated oil-tight bronze,
    - (b) modulating control: stainless steel.
  - .6 Jackshaft: cadmium plated steel.
  - .7 Internal locking quadrant for balancing maximum opening position.
  - .8 Sleeve: same material as damper frame, length to suit application with steel enclosure and transition collars, and retaining angles.
  - .9 Sleeve type: type A, B, or C as per listing requirements.
  - .10 Notwithstanding the above, the frame, sleeve, and blades to be stainless steel where damper is installed in a duct system that is stainless steel.
- .2 Operator - fusible link:
  - .1 Torsion spring, with 74°C (165°F) fusible link unless otherwise shown.

## **2.5 Special Sleeve Modifications**

- .1 Special sleeve and damper arrangements for:
  - .1 single-sided retention angle installation,



- .2 sleeve mounting tags for air diffusers and grilles directly attached to fire damper sleeve and wall opening. Dampers positioned in sleeve to allow for balancing damper installed on back-side of grille or diffuser.

### 3 EXECUTION

#### 3.1 Installation – General Requirements

- .1 Install fire dampers throughout supply, return and exhaust air systems in fire separations marked as having a fire resistance rating and as shown.
- .2 Install fire dampers in accordance with manufacturer's instructions, with sleeve, duct connections and angle supports to comply with terms and conditions of listing or classification and maintain integrity of fire wall and/or fire separation.
- .3 Install stainless steel dampers in stainless steel duct systems and/or wherever ductwork is specified to be watertight construction.

#### 3.2 Fire Damper Selection

- .1 Select fire damper types as follows:
- .1 "Dynamic" - all locations unless otherwise shown,
- .2 "Static" - restricted to un-ducted transfer air openings.
- .2 Select curtain-type fire damper styles as follows:
- .1 For dynamic and static dampers:
- (a) duct height in the following tables is the duct dimension perpendicular to blade length orientation.

Damper Velocity Class	Duct Height mm	Curtain Damper Style
Standard Performance ( $\leq 10$ m/s)	> 300	A
	$\leq 300$	B
Extended Performance (10 to $\leq 12.5$ m/s)	> 200	B
	$\leq 200$	C
High Velocity Performance ( $> 12.5$ m/s)	Any	C

Damper Velocity Class	Duct Height In.	Curtain Damper Style
Standard Performance ( $\leq 2000$ fpm)	> 12	A
	$\leq 12$	B
Extended Performance (2000 to $\leq 2500$ fpm)	> 8	B
	$\leq 8$	C
High Velocity Performance ( $> 4000$ fpm)	Any	C

### **3.3 Fire Damper Installation**

- .1 Where the duct size exceeds the maximum listing size of a multiple curtain damper assembly, provide multiblade fire dampers.
- .2 Where fire dampers are shown to be motorized, provide multiblade fire damper with electric operator.

### **3.4 Damper Sleeves**

- .1 Provide factory-made damper sleeves in accordance with damper listing requirements, and as described herein.
- .2 For multiblade dampers, smoke dampers, and combination smoke/fire dampers, fabricate sleeve style based on damper size listing requirements.
- .3 Install damper sleeves with retaining angles in accordance with the damper manufacturer instructions.
- .4 Where a diffuser or grille is shown at a fire damper, smoke damper or combination smoke/fire damper, provide sleeves specifically listed for single sided retention angles and which provide brackets for securing of the grille or diffuser to the sleeve.
- .5 Where permitted by the damper manufacturer installation instructions, smoke dampers may be fastened directly to the duct without requiring the use of a sleeve.

### **3.5 Damper Access Doors**

- .1 Provide duct access door at each fire damper to permit visual inspection and replacement of fusible link. Do not locate access doors in a vertical service space (shaft).
- .2 For curtain-type fire dampers in vertical ducts, the preferred access location is from the floor above the damper.
- .3 Install damper actuator assemblies on the room side of a damper isolating the room from a corridor, except where the duct ends at a wall grill.

### **3.6 Testing**

- .1 Conduct installation tests of all fire dampers in accordance with NFPA 80 and NFPA 90A as applicable to damper type and summarized as follows.
- .2 Field test all fire dampers as follows:
  - .1 operate dampers to demonstrate unobstructed operation of the damper from open-to-close-to open state. These tests are to be performed while the fan systems are not in operation (static test),
  - .2 for dynamic dampers, confirm air velocity through the open dampers under normal HVAC system operation, once air balancing is completed. Select dampers to confirm operation for ducts operating within 80% of the maximum air velocity of the damper listing,
  - .3 confirm accessibility to components of fire damper to permit maintenance and testing,
- .3 Record test results as per the attached test form or similar containing the same information, and submit to Owner and Consultant as part of the Operations and Maintenance manual.
- .4 Upon completion of testing, provide labour and resources necessary to conduct a demonstration re-test for up to 10% of curtain-type dampers on each floor as selected and witnessed by Engineer.

### **3.7 Test Form**

- .1 Test form follows at the end of this section.

**Fire, Smoke, and Fire/Smoke Damper Test Record**

<b>Project</b>							<b>System</b>		
<b>Testing Company</b>							<b>Technician Name</b>		
Damper location	Inspection Date YYYY-MM-DD	Damper Type <sup>(1)</sup>	Static Op. Test <sup>(2)</sup>	Dyn Op. Test <sup>(3)</sup>	Access Test <sup>(4)</sup>	Air Flow <sup>(5)</sup>	Confirmed/ Deficiencies	Deficiency Corrected	Damper Audited

(1) Damper Type : FD, MFD, SD, or CSFD  
(2) Static Operating Test without airflow  
(3) Dynamic Operating Test with balanced airflow; multiblade FD, SD and CSFD only.  
(4) Damper and components are accessible for inspection and testing  
(5) Identify which damper air velocity is checked in accordance with the test selection criteria.

**END OF SECTION**

## **FLEXIBLE CONNECTORS**

### **23 33 43**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide flexible connectors between rigid ductwork and air terminal devices, as shown.
- .2 Flexible connectors not to be used where the supply air temperature exceeds 121°C (250°F).

### **1.2 Definitions and Abbreviations**

- .1 The following definitions apply to this section.
  - .1 **Core** – means the element of the flexible connector in direct contact with and containing the transported air.
  - .2 **Flexible connector** – means metallic and non-metallic round ducting that is used to connect rigid ductwork to air distribution terminal devices.
  - .3 **Relative pressure drop coefficient** – means the pressure loss of flexible connectors compared to a reference sheet metal duct pressure drop coefficient of 1.00 for same size duct and airflow rates.
  - .4 **Terminal devices** – means air grilles and diffusers.

### **1.3 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 SMACNA HVAC Duct Construction Standards Metal and Flexible
- .2 Product standards:
  - .1 ULC S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  - .2 ULC S102.2 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
  - .3 ULC S110 Standard Method of Test for Air Ducts
  - .4 ULC 181 Factory Made Air Ducts and Connections.

### **1.4 Submittals**

- .1 Submit manufacturer's data sheets for each product showing;
  - .1 thermal properties,
  - .2 friction loss characteristics,
  - .3 acoustical insertion loss data,
  - .4 leakage rates,
  - .5 fire and smoke ratings,
  - .6 product listings and certifications.

## 2 PRODUCTS

### 2.1 General Requirements for Flexible Connectors

- .1 Flame spread rating not to exceed 25 and smoke developed rating not to exceed 50 when tested in accordance with ULC-S102 or S102.2.
- .2 Maximum manufactured unit length: 4 m (12 ft).
- .3 Listed to ULC-S110 and UL 181 as a Class 0 or Class 1 product.
- .4 Common requirements for metallic (aluminum) connector cores:
  - .1 material: spiral wound, corrugated flexible aluminum alloy with interlocked seams folded flat and rolled,
  - .2 design positive working pressure: 1.5 kPa (6 in. w.g) minimum,
  - .3 design negative working pressure: 0.25 kPa (1 in.w.g.) minimum,
  - .4 rated air velocity: 25 m/s (5000 fpm)
  - .5 minimum bending radius: 0.5 x duct diameter
  - .6 relative pressure drop coefficient: 2.0 maximum
  - .7 core air leakage: zero leakage.

### 2.2 Metallic Bare Flexible Connector

- .1 Core: as specified above for metallic (aluminium) cores.

#### *Standard of Acceptance*

- TCE - fig. S
- Flexmaster - fig. T/L
- Peppertree - fig. TF

### 2.3 Metallic Insulated Flexible Connectors

- .1 Core: as specified above for aluminium cores.
- .2 Insulation layer: factory-applied outer insulation layer of flexible glass-fibre thermal insulation, maximum thermal resistance value of 0.74 m<sup>2</sup>·K/W (4.2 ft<sup>2</sup>·°F·h)/BTU
- .3 Jacket: polyethylene or aluminium foil-skrim vapour barrier.

#### *Standard of Acceptance*

- TCE - fig. SIG, SIA
- Flexmaster - fig. T/L-T, T/L-M
- Peppertree - fig. TFT-M

### 2.4 Flexible Connector Sealing Compound

- .1 Water based duct sealer, adheres to galvanized steel, aluminum and non-metallic flexible connector fabrics.
- .2 Zero VOC content.
- .3 High-solids content, low shrinkage, permanently flexible.
- .4 Listed to ANSI/UL 181A.

#### *Standard of Acceptance*

- Durodyne - fig. EDS-RS
- Ductmate - fig. PROseal
- Transcontinental Equipment - fig. MP

### **3 EXECUTION**

#### **3.1 Restrictions on Use of Flexible Connectors**

- .1 Do not install flexible connectors that would pass through any wall, partition or floor.
- .2 Do not use flexible connectors to connect rigid ductwork to the inlet of terminal units including variable volume or constant volume terminal units, with or without integral fans.
- .3 Do not use flexible connectors on exhaust systems which convey:
  - .1 return or general exhaust air from commercial kitchens,
  - .2 exhaust air serving high humidity spaces including shower rooms, bathing rooms, pools,
  - .3 exhaust air serving cold-rooms with temperatures below 15°C (60°F),
  - .4 return or exhaust air serving medical device processing areas in healthcare facilities,
  - .5 exhaust air from laboratory fume hoods,
  - .6 contaminated exhaust air from process exhaust systems including hoods, exhausted cabinets and exhaust enclosures,
  - .7 exhaust air containing particulates.
- .4 Flexible connectors may be used on connections to return/exhaust grilles only where it is not possible to make a rigid duct connection.

#### **3.2 Flexible Connector Installation**

- .1 Use the type of flexible connectors in accordance with the following:
  - .1 supply duct connections: insulated metallic
  - .2 return and exhaust duct connections: bare metallic.
- .2 Maximum installed flexible connector lengths:
  - .1 supply air: 2 m (6 ft).
  - .2 return/exhaust air: 1 m (39 in.).
- .3 The centre-line radius of bends in flexible connector to be at least equal to one duct diameter or larger.
- .4 Apply sealing compound at connection points between sheet metal and flexible connector. Apply the sealing compound to the sheet metal prior to placing the flexible connector over the sheet metal, to minimize ingress of sealant into the airstream.
- .5 Overlap flexible connectors onto rigid ductwork and diffuser/grill collars by not less than 50 mm (2 in.), and to fully overlap the sheetmetal connector on diffusers and grilles.
- .6 For metallic flexible connectors, secure the core material to the sheet metal with #8 sheet metal screws as follows:
  - .1 for connectors sizes Ø300 mm (12 in.dia.) and smaller, with at least three screws equally spaced around the connector,
  - .2 for connector sizes larger than Ø300 mm (12 in.dia.), at least five screws equally spaced around the connector,
  - .3 the screws installed at least 12 mm (1/2 in.) from the end of the connector,

- .7 Fit insulation and vapour barrier jackets over the core connection and secure with a Panduit-type draw band.

### **3.3 Rigid Duct Collar Construction**

- .1 Provide a rolled external bead on rigid duct connection collars, located at least 25 mm (1 in.) from the end of the collar.

### **3.4 Connections to Exhaust Grills**

- .1 Where a flexible connector is to be connected to an exhaust grill, order the grill with a backing plenum with applicable sized sheet metal connector.
- .2 Where an exhaust grille is not provided with a factory plenum and connector, shop fabricate a plenum that;
  - .1 has the same plan dimensions as the exhaust grille and having a depth of not less than:
    - (a) 75 mm (3 in) for a back-inlet connection,
    - (b) at least 50 mm (2 in) greater than the diameter of the flexible connector for a side-entry connection,
  - .2 has a sheet metal connector of a diameter to suit the flexible connector and having a depth of not less than 50 mm (2 in.).

**END OF SECTION**

## **HVAC FANS**

### **23 34 16**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide centrifugal and axial HVAC fans of type, size and performance as shown.

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
- .1 20 05 01 Basic Materials and Methods
  - .2 20 05 13 Common Motor Requirements for Mechanical Equipment

### **1.3 Applicable Codes and Standards**

- .1 Product standards:
- .1 ABMA 9 Load Ratings and Fatigue Life for Ball Bearings
  - .2 ABMA 11 Load Ratings and Fatigue Life for Roller Bearings
  - .3 AMCA 99 Standards Handbook
  - .4 AMCA 204 Balance Quality and Vibration Levels for Fans
  - .5 AMCA 205 Energy Efficiency Classification for Fans
  - .6 AMCA 210 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
  - .7 AMCA 211 Certified Ratings Program – Product Rating Manual for Fan Air Performance
  - .8 AMCA 300 Reverberant Room Method for Sound Testing of Fans,
  - .9 AMCA 311 Certified Ratings Program – Product Rating Manual for Fan Sound Performance
  - .10 AMCA 320 Laboratory Methods of Sound Testing Fans Using Sound Intensity
  - .11 ASME B117 Standard Practice for Operating Salt Spray (Fog) Apparatus

### **1.4 Design Criteria**

- .1 Fan rating conditions:
- .1 elevation: project site elevation-based.
  - .2 airflow design temperature:

Application	Temperature
Conditions supply air fans	10°C (50°F)
Supply air and make-up air fans (with upstream heating)	21°C (70°F)
Supply air or make-up air fans (no heating or heating is downstream of fan)	-25°C (-13°F)
Conditioned space return air or exhaust air fans	21°C (70°F)
Other fans unless otherwise shown on equipment schedules	21°C (70°F)



## **1.5 Submittals**

- .1 Submit product data sheets for materials specified herein. Submittals to include:
  - .1 Dimensioned standard drawings indicating dimensions, motor mounting details, inlet and outlet connection details, and equipment weight,
  - .2 motor ratings and characteristics,
  - .3 drive arrangements including drive-set details,
  - .4 AMCA certified performance curves for each fan showing airflow, static pressure, efficiency point, fan RPM, and power input as KW (brake horsepower) from shut-off to free delivery through scheduled rating point, and also show fan curves for fan RPM at 15% above and 15% below this curve.
  - .5 certified sound power data for supply, return and exhaust fans.
  - .6 specified accessories.
- .2 Operating and maintenance data:
  - .1 provide operation and maintenance data for incorporation into operating and maintenance manuals,
  - .2 include factory test vibration analysis report for fans with motor power ratings greater than 15 kW (20 hp).

## **1.6 Quality Control**

- .1 Fan performance for airflow rate, fan pressure, fan power, air density, fan RPM and fan efficiency: certified and bear the AMCA seal to AMCA Publication 211 when tested in accordance with AMCA Standards 210.
- .2 Fan acoustic performance: certified and bear the AMCA seal to AMCA Publication 311 when tested in accordance with AMCA Standard 300 or AMCA Standards 320.
- .3 Fan energy efficiency: rated in accordance with AMCA Standard 205.
- .4 Fan vibration: factory vibration tested prior to shipment as a completed assembly, in accordance with AMCA Standard 204 and as follows:
  - .1 tested at the specified fan RPM,
  - .2 vibration signature measured at each fan bearing in the horizontal, vertical and axial directions,
  - .3 maximum allowable fan vibration level: grade G6.3 to AMCA Standard 204, at 3.8 mm/s (0.15 in/sec) peak velocity, filter-in, with the fan rigidly mounted,
  - .4 vibration test records are to be retained by the manufacturer and copies to be made available to the Owner on request.

## **2 PRODUCTS**

### **2.1 General**

- .1 Space allocation, motor sizes, base details, connection arrangements and performance are based on fan equipment by manufacturers as shown in schedules.
- .2 Fans to be of same manufacture for similar applications, but may be chosen from other manufacturers' product lines for other different applications, and are to be selected from manufacturer's catalogued range of standard products.

*Standard of Acceptance)*

- New York Blower (Northern Industrial Supply)
- Barry Blower/Pennbarry
- Chicago Blower
- CML Northern Blower
- Trane
- Greenheck
- Loren Cook
- Twin City
- Industrial Air
- Woods
- Carnes
- Acme

## **2.2 Selection Criteria**

- .1 Select fan size, operating RPM and rating point on stable part of head flow curve with smooth characteristics.
- .2 Except as specified elsewhere in this Section, select fans (excluding motors) so that the fan construction will permit fan operation up to 125% of the design static pressure and airflow rate, individually and concurrently, without requiring modifications to this equipment.

## **2.3 Construction General Requirements**

- .1 Fan class to conform with AMCA 99-2408, Operating Limits for centrifugal fans.
- .2 Operating temperature range: fans to be constructed to be suitable for operation from -40°C (-40°F) up to the temperatures specified under article Design Criteria.
- .3 Fan housing and impeller:
  - .1 statically and dynamically balanced impeller,
  - .2 operating at least 20% below first critical speed when operating at maximum speed for class of construction,
  - .3 continuously welded steel housing, unless other materials are shown, with integral reinforcing bracing, and spun inlet cones,
  - .4 pre-punched flanges for ductwork connections,
  - .5 interior and exterior surfaces factory cleaned and primed with zinc-rich coating, and finished in manufacturers standard top coat,
    - (a) where shown on equipment schedules, coatings for surfaces contacting airstream: Heresite coated for carbon steel materials.
    - (b) coating performance to meet 1000 hour salt spray test in accordance with ASME B117.
- .4 Fan shaft:
  - .1 steel shaft, turned, ground and polished, and protected with a petroleum-based rust preventative coating,
  - .2 sized for first critical speed at a minimum of:
    - (a) 1.25 times maximum speed for fan Class I and II, and
    - (b) 1.40 times maximum speed for fan Class III and IV.
  - .3 key shaft to the wheel hub,
- .5 Fan bearings:

- .1 grease lubricated self-aligning ball or roller type with oil retaining, dust excluding seals,
- .2 cartridge type for shafts less than 37 mm (1 - 7/16 in) diameter,
- .3 shaft adapter sleeves with horizontally split pillow blocks and mechanical flinger type grease valves for shafts 37 mm (1 - 7/16 in) diameter or larger,
- .4 interference fit rather than adapter sleeve type on shafts 56 mm (2 - 3/16 in) and larger
- .5 furnished with drain plugs,
- .6 fitted with extended grease lubricating lines where access is restricted,
- .7 packed with grease at factory,
- .8 chosen for 125% of rotational speed at point of selection, and with an L<sub>10</sub> service life rating of 80,000 hours in accordance with ABMA 9 or ABMA 11.
- .6 Fan configuration (unless shown or noted otherwise):
  - .1 Arrangement #1 or #2 for single inlet, single width, belt driven fans up to and including 915 mm (36 in) wheel diameter.
  - .2 Arrangement #3 for belt driven single inlet fans with wheel diameter larger than 915 mm (36 in) diameter and belt driven double inlet fans.
  - .3 Arrangement #3 for plenum (plug) fans.
  - .4 Arrangement #10 for utility sets.
  - .5 Arrangement #8 for direct connected single inlet centrifugal fans.
  - .6 Arrangement #7 for direct connected double inlet fans.
- .7 Variable volume devices:
  - .1 adjustable inlet vanes,
  - .2 operated from mechanism, with locking device for manual operation, linked to each damper vane, and interconnecting vanes in each inlet of DWDI fans.
- .8 Fan/motor drives and guards:
  - .1 pulleys and drive belts to conform to Section 20 05 01,
  - .2 guards for fan/motor belt-drive and couplings, to conform to Section 20 05 01,
  - .3 guards for fan inlet openings to conform to Section 20 05 01.
- .9 Fan motors:
  - .1 motors to conform to Section 20 05 13, except/and as specified herein,
    - (a) minimum motor power rating: not less than motor kW (horsepower) shown in equipment schedules, and
    - (b) capable of satisfactory operation without motor overload or operation in the motor service factor, over a performance range from shut-off to run-out at 115% of rotational speed at point of selection.
  - .2 motor slide rails to conform to Section 20 05 01,

## **2.4 Centrifugal Fans**

- .1 Arrangement:
  - .1 rotation, discharge and motor position to be as shown,

- .2 unless otherwise shown, fan classification to be selected to permit operation at 125% of rotational speed at point of selection.
- .2 Fan wheels:
  - .1 backward curved or backward inclined blades for fan wheel diameters less than 686 mm (27 in), backward curved air foil blades for fan wheel diameters 686 mm (27 in) and larger.
- .3 Accessories:
  - .1 38 mm (1 - ½ in) casing drains where fans discharge vertically,
  - .2 access doors in scroll casing,
  - .3 stuffing box style shaft seals on single inlet single width fans and utility sets.

## **2.5 Plenum (Plug) Fans**

- .1 Arrangement:
  - .1 rotation, discharge and motor position to be as shown, with motor mounted on frame,
  - .2 unless otherwise shown, fan classification to be selected to permit operation at 125% of rotational speed at point of selection.
- .2 Fan wheels:
  - .1 backward curved air foil blades.
- .3 Accessories
  - .1 outlet cage,
  - .2 inlet collar.

## **3 EXECUTION**

### **3.1 Fan installation**

- .1 Mount fans as shown, with vibration isolation, restraining snubbers, flexible electrical leads, and flexible connections to inlet and discharge ductwork.
- .2 Align shafts, belt drive and motor, and adjust belt static tension based on measured belt deflection test in accordance with drive manufacturer instructions.
- .3 Confirm and check motor rotation before start-up.

### **3.2 Protection**

- .1 Provide temporary enclosures for open drip proof motors.
- .2 Cover fan inlet and discharge openings during construction to prevent ingress of foreign objects into the fan housing.
- .3 Rotate fans, by hand, every month between delivery and acceptance of building.

### **3.3 Start-Up and Testing**

- .1 During system air balancing, adjust sheaves on variable pitch belt drives, adjust blade pitch of axial flow fans, and change pulleys and belts on fixed pitch belt drives, to achieve specified air quantities.

**END OF SECTION**

## HIGH-PLUME EXHAUST FAN SYSTEM 23 35 26

### 1 GENERAL

#### 1.1 Scope

- .1 Provide high-plume exhaust fan systems of type, size and performance as shown.

#### 1.2 Definitions

- .1 The following definitions apply to this section:

**Bypass air** - means outdoor air which blends with process air on the suction side of the fan.

**Induced air** – means outdoor air induced into the discharge air after the fan to cause dilution of the final discharge air and to increase the discharge velocity to increase discharge plume height.

**Metallic fan systems** – means the fan volute, fan wheel, intake plenum and discharge cone are substantially constructed of coated carbon steel and/or stainless steel.

**Non-metallic fan systems** – means the fan volute, intake plenum and discharge cone are constructed on non-metallic materials, but that some internal components such as the fan wheel and fasteners may be metallic.

#### 1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
- .1 20 05 01 Basic Materials and Methods
  - .2 20 05 13 Common Motor Requirements for Mechanical Equipment.

#### 1.4 Applicable Codes and Standards

- .1 Product standards:
- .1 AMCA 99 Standards Handbook
  - .2 AMCA 210 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
  - .3 AMCA 211 Certified Ratings Program – Product Rating Manual for Fan Air Performance
  - .4 AMCA 300 Reverberant Room Method for Sound Testing of Fans,
  - .5 AMCA 311 Certified Ratings Program – Product Rating Manual for Fan Sound Performance
  - .6 ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus

#### 1.5 Design Criteria

- .1 Fan rating conditions:
- .1 elevation: 180 m (590 ft)
  - .2 airflow design temperature:

Application	Temperature
Process exhaust air inlet temperature	21°C (70°F)
Bypass Air / Induced Air temperature	-25°C (-13°F)

## **1.6 Submittals**

- .1 Submit product data sheets for materials specified herein. Submittals to include:
  - .1 dimensioned standard drawings indicating dimensions, motor mounting details, inlet and outlet connection details, and equipment weight,
  - .2 nozzle velocity of exhaust fan, total exhaust flow, and discharge plume rise at specified wind velocity.
  - .3 motor ratings and characteristics,
  - .4 drive arrangements including drive-set details,
  - .5 AMCA certified performance curves for each fan showing airflow, static pressure, efficiency point, fan RPM, and power input as KW (brake horsepower) from shut-off to free delivery through scheduled rating point and also show fan curves for fan RPM at 15% above and 15% below this curve.
  - .6 certified sound power data for exhaust fan set,
  - .7 specified accessories.
- .2 Operating and maintenance data:
  - .1 provide operation and maintenance data for incorporation into operating and maintenance manuals,
  - .2 include factory test vibration analysis report for fans with motor power ratings greater than 15 kW (20 hp).

## **1.7 Quality Control**

- .1 Fan performance for airflow rate, fan pressure, fan power, air density, fan RPM and fan efficiency: certified and bear the AMCA seal to AMCA Publication 211 when tested in accordance with AMCA Standards 210.
- .2 Fan acoustic performance: certified and bear the AMCA seal to AMCA Publication 311 when tested in accordance with AMCA Standard 300 or AMCA Standards 320.
- .3 Fan energy efficiency: rated in accordance with AMCA Standard 205.
- .4 Fan vibration: fans to be factory vibration tested prior to shipment as a completed assembly, in accordance with AMCA Standard 204 and as follows:
  - .1 tested at the specified fan RPM,
  - .2 vibration signature measured at each fan bearing in the horizontal, vertical and axial directions,
  - .3 maximum allowable fan vibration level: grade G6.3 to AMCA Standard 204, at 3.8 mm/s (0.15 in/sec) peak velocity, filter-in, with the fan rigidly mounted,
  - .4 vibration test records are to be retained by the manufacturer and copies to be made available to the Owner on request.

## **2 PRODUCTS**

### **2.1 General**

- .1 Packaged high-plume exhaust system with inlet plenum, exhaust fan and high-induction discharge nozzle and accessories to be the product of and supplied by the fan manufacturer.

- .2 Fan system consisting of intake plenums (where specified), fans and discharge nozzle to be self-supporting for all operating loads as well as wind loads and seismic loads, without requiring the use of guide wires to other external support systems.
- .3 Select fan size, operating RPM and rating point on stable part of head flow curve with smooth characteristics.
- .4 Select fans (excluding motors) so that the fan construction will permit fan operation up to 125% of the design static pressure and airflow rate, individually and concurrently, without requiring modifications to this equipment.
- .5 Fan arrangement: as specified in Schedule A attached to the end of this Specification section.
- .6 Metallic fan systems:

*Standard of Acceptance*

- Greenheck - fig. Vektor series
- Twin City Fans - fig. TVIFE
- Loren Cook - fig. Power-Plume
- Strobic Air Technologies - Tri-Stack
- Penbarry - fig. vPlume, iPlume

## **2.2 System Performance Criteria**

- .1 Fan system performance:
  - .1 process flow and external pressure as shown in equipment schedule drawings.
    - (a) airflow rate as shown is for the process airflow rate only,
    - (b) fan static pressure as shown is for external pressure only, measured at the process exhaust duct connection to the inlet plenum. Manufacturer to add internal pressure losses of all components supplied with the fan system including but not limited to plenum, fan isolation dampers, and discharge stack pressure losses.
  - .2 additional performance criteria as specified in Schedules A located at the end of this Specification section.
- .2 Wind loads: plenum, fan and discharge nozzle designed and manufacturers to withstand wind loads from any direction of 200 km/hr without additional supporting structure.
- .3 Seismic loads: as specified herein but are not required to be concurrent with wind loads.
- .4 Acoustic performance:
  - .1 sound pressure levels tested in accordance with AMCA 300 and 311,
  - .2 sound pressure measured 1.5 m (5 ft) and at 15.2 m (50 ft) from fan nozzle discharge,
  - .3 fan system noise measured at 15 m (50 ft) horizontal from fan not to exceed values specified in Schedule B located at the end of this Specification section.

## **2.3 Common Materials – Metallic Construction**

- .1 Unless otherwise specified, all steel components exposed to the airstream including fans, nozzle, windband and plenum to be either:
  - .1 Type 316 stainless steel with No. 4 finish, or
  - .2 carbon steel with both sides having a factory finished corrosion coating system specified herein.
- .2 Fasteners exposed to corrosive exhaust: 316 stainless steel.

## **2.4 Corrosion Coating Systems for Metallic Components**

- .1 Applies only for metallic components exposed to the air stream.
- .2 Single-component system:
  - .1 Baked phenolic epoxy single coat system: Heresite P-413
  - .2 Total coating finish thickness: minimum 0.025 mm (1 mil).
- .3 Two-component system:
  - .1 Baked epoxy primer coat and electrostatic polyester finish coat corrosion-resistant coating system or similar system.
  - .2 Total coating finish thickness: minimum 0.10 to 0.15 mm (4 - 6 mils),
  - .3 Coatings to be not affected by ultra-violet sunlight exposure,
  - .4 Compatible for exposure to air-fumes of acids, alkali and solvents,
- .4 Exceed 4000-hour salt spray resistance test to ASME B117.

## **2.5 Fan**

- .1 Fan spark resistance construction: AMCA type A or B spark resistant construction unless otherwise as shown.
- .2 Fan housing material: welded-steel
- .3 Fan housing construction – mixed flow wheel fans:
  - .1 fan type: in-line mixed flow centrifugal wheel,
  - .2 fan housing: bifurcated style with airflow separated from motor and serviceable components,
  - .3 outdoor air ports for motor cooling,
- .4 Fan housing construction – centrifugal utility fans:
  - .1 fan type: backward inclined, single width, single-inlet centrifugal fan,
  - .2 integral fan casing drain,
- .5 Fan impeller:
  - .1 aluminium impeller with aluminium rub ring,
  - .2 impellers provided with corrosion coating as specified herein,
  - .3 statically and dynamically balanced,
- .6 Fan shaft bearings:
  - .1 ball or spherical roller type, with minimum L-10 life of 200,000 hours.
  - .2 grease lubricated with extended grease lines.
- .7 Removable or hinged access panels for access to impeller for inspection and service.
- .8 Teflon shaft seals or similar to prevent passage of process exhaust air through the shaft seals to the outdoors.
- .9 Fan flow station:
  - .1 fan inlet cone provided with multiple tap piezometric ring for fan inlet flow rate and provided with flow calibration constants determined in accordance with AMCA 210,
  - .2 factory installed sensing tubing run to common termination point on outside of fan housing,



- .10 Lifting lugs: 316 stainless steel.

## **2.6 Motor and Drive**

- .1 TEFC Inverter-duty rated motor with Class F insulation, continuous duty, conforming to Specification section 20 05 13.
- .2 Drive method: belt-drive conforming to Specification section 20 05 01 with a minimum service factor of 2.0 and with a minimum of two belts.

## **2.7 Discharge Nozzle and Induction Windband**

- .1 Tapered vertical discharge cone to increase discharge air velocity, with no abrupt changes in cross sectional area,
- .2 Materials: fabricated from welded carbon steel,
- .3 Designed for a minimum of 15.2 m/s (3000 fpm) discharge velocity at the discharge air flow rate,
- .4 Where specified, includes air induction windband for induced dilution air,
- .5 integral acoustic silencer designed to not affect discharge velocity, with type 304 stainless steel internal liner.
- .6 Straight sided extension sections between fan discharge and discharge nozzle as required to achieve minimum overall height of fan assembly as specified in Schedule A at the end of this Specification section.

## **2.8 Inlet Air Plenum**

- .1 Plenum construction:
  - .1 double wall insulated construction,
  - .2 plenum wall: welded carbon steel,
  - .3 with internal structural stiffener frame assembly as required,
  - .4 structurally designed for the imposed static and dynamic loads including support of fan and discharge nozzle dead weight, fan operating dynamic load, wind loading and where specified seismic loading.
  - .5 designed and provided with mounting hardpoints on outside of plenum walls to allow attachment of steel channel frames for support of motor controllers and/or disconnect service switches. Design of plenum hardpoints to assume the following design parameters:
    - (a) top of motor controller to be located at 1200 mm (4 ft) above roof level,
    - (b) weight allowance of supported motor controller or disconnect switch to be based on 1.0 kg/HP rating.
- .2 Bypass dampers:
  - .1 control arrangement: opposed blade type,
  - .2 performance:
    - (a) control dampers listed to AMCA 511.
    - (b) leakage in closed position: AMCA Class 1 – 20 L/s/m<sup>2</sup> at 250 Pa (4 CFM/ft<sup>2</sup> at 1 in.w.c.) and Class 1 – 41 l/s/m<sup>2</sup> at 1000 kPa (8 CFM/ft<sup>2</sup> at 4 in.w.c.).
    - (c) pressure drop in open position: maximum 12 Pa (0.05 in wg) differential at 5 m/s (1000 fpm).
    - (d) operating temperature range: -40 to 100°C (-40 to 212°F)
  - .3 damper construction:

- (a) blades: airfoil design, extruded aluminum with Heresite coating, FRP, or formed 316 stainless steel with interlocking blades, with plated steel damper rods,
- (b) frame: extruded aluminum,
- (c) seals: extruded vinyl edge seals and stainless steel sprung side seals,
- (d) bearings: Celcon, stainless steel or similar inner bearing with polycarbonate outer bearing,
- (e) maximum blade width: 150 mm (6 in),
- (f) maximum blade length: 1200 mm (4 ft).
- .4 blade linkage:
  - (a) aluminium and zinc-plated steel tie rods, brass pivots and steel brackets,
  - (b) linkage assembly mounted outside of air stream,
- .5 damper actuator mounting position:
  - (a) actuator jackshaft arranged for actuator to be mounted outside of air stream.
- .3 Fan isolation dampers:
  - .1 same as for bypass dampers except/and as follows,
  - .2 control arrangement: parallel blade type,
  - .3 damper construction:
    - (a) blades: airfoil design, extruded aluminum with Heresite coating, FRP, or formed 316 stainless steel with interlocking blades, with plated steel damper rods,
    - (b) frame: formed and welded T304 stainless steel,
  - .4 damper pressure drop in the fully open position to be included in the fan total internal static pressure drop.
  - .5 damper installed in twin C-channel tracks to allow complete removal of damper from the fan system for servicing without requiring removal of fan.
- .4 Weatherhood:
  - .1 45° air intake hood with stainless steel bird screen,
  - .2 single wall construction, fabricated of same material as inlet plenum,
  - .3 sized for full area of bypass dampers,
- .5 Duct connector:
  - .1 flexible PVC duct connectors,
  - .2 connector including fabric, connection ends and end-overlap constructed for leakage not exceeding 40 l/s/m<sup>2</sup> at 1000 Pa (8 CFM/ft<sup>2</sup> at 4 in.w.c.) pressure differential.

## 2.9 Roof Curb

- .1 Plume fan unit mounted on factory fabricated roof curb provided by the fan manufacturer.
- .2 Construction:
  - .1 designed for the same wind and seismic requirements as for the fan unit, specifically to transmit wind load and seismic loads to the building structure,
  - .2 carbon steel factory fabricated curb, structurally reinforced, welded joints, minimum 12 gauge channel thickness,
  - .3 finished with corrosion coating as specified herein after fabrication,
  - .4 internal insulation: minimum 25 mm (1 in.) thick, 48 kg/m<sup>3</sup> (3 in/ft<sup>3</sup>) density rigid fibreglass board,

- .5 curb height: as shown,

## **2.10 Fan Motor Controller (Starter)**

- .1 Provided under Division 20 of the Work.

## **2.11 Damper Actuators**

- .1 Provided under Division 25 of the Work.
- .2 Actuator for fan isolation dampers:
  - .1 for outdoor installations,
  - .2 operating temperature: -30 to +50°C (-22 to 122°F)
  - .3 Two-position open/close spring-return type, 90 degree rotation, 2 x SPDT position switches, 24 VAC/DC with NEMA 4X housing and weather shield.

### *Standard of Acceptance*

- ° Belimo - fig. AFBUP-S ACT Spring

- .3 Actuator for bypass air dampers:
  - .1 Modulating spring-return type, 90 degree rotation, 24 VAC/DC with 2-10 VDC control signal, with NEMA 4X housing and weather shield.

### *Standard of Acceptance*

- ° Belimo - fig. AFB24-SR ACT-Spring, 2-10 V

## **3 VIBRATION ISOLATION:**

- .1 EPDM continuous strip between fan and inlet plenum.

## **3.2 Fan System Controller**

- .1 Provided under Division 25 of the Work.

## **4 EXECUTION**

### **4.1 Plume Fan Unit Installation**

- .1 Install roof curbs and fasten to roof structure in accordance with plenum fan manufacturer's instructions. Only use mechanical fastening devices as specified by fan manufacturer.
- .2 Install fans in accordance with manufacturer's instructions.
- .3 Mount plume fans on factory manufacturer curbs and fasten to curb with mechanical fasteners as specified by fan manufacturer.
- .4 For SWSI centrifugal fans, provide a NPS ¾ drain hose from the fan drain outlet and pipe to a location clear of the inlet plenum to allow water to drain to the adjacent roof.

### **4.2 Electrical Installation**

- .1 Provide service disconnect switch at plume fan unless otherwise shown to provide combination motor controller and disconnect switch.
- .2 Mount motor disconnect switch /motor controllers with top of device located 1200 mm (4 ft) above finished roof level.

- .3 Mount disconnect switch/motor controller on supplementary support steel fastened to mounting hardpoints on fan plenum. Where such hardpoints are not provided on the fan plenum, provide roof support assembly to support equipment.
- .4 Provide weathertight flexible electrical conduit and conductors from motor disconnect/controller to each fan motor.
- .5 Confirm and check motor rotation before start-up.

#### **4.3 Protection**

- .1 Cover fan inlet and discharge openings during construction to prevent ingress of foreign objects into the fan housing.
- .2 Rotate fans, by hand, every month between delivery and acceptance of building.

#### **4.4 Start-Up and Testing**

- .1 During system air balancing, adjust or replace sheaves and belts for constant speed fans to achieve specified process air flow rates. For fans equipped with VFDs, fan air flow balancing may be performed by adjusting VFD high speed setting by not more than +5% / -10% of motor rated speed.

#### **4.5 Schedules**

- .1 Refer to equipment schedule on drawings for primary performance data for equipment specified herein.
- .2 The following appended equipment schedules form part of this specification section.
  - .1 Schedule A1 High-Plume Fan Performance Criteria
  - .2 Schedule A2 High-Plume Fan Performance Criteria
  - .3 Schedule B1 Acoustic Performance Criteria

*The following Notes apply to each of these Schedules.*

*[1] Refer to equipment schedule drawings and/or equipment cut sheets provided.*

*[2] Effective Plume Rise at cross wind of 10 mph.*

*[3] Effective Stack Height at cross wind of 10 mph.*

*[4] "Independent" means each fan in a group has a dedicated inlet plenum which is independent of all other inlet plenums in the same fan group.*

*[5] Minimum overall height if measured from the bottom of the roof curb to top of discharge nozzle.*

Schedule A1 – High-Plume Fan Performance Criteria				
Parameter	Units	Fan Group		
		F-20	-	-
Construction Features				
Fan Style	---	Mixed flow		
Inlet plenum style (note 4)	---	Independent		
Minimum Overall Height (note 5)	In	122		
Performance Criteria				
Process Airflow Rate (at plenum inlet)	CFM	(note 1)		
Plenum Bypass Airflow Rate	CFM	0		
Induced Airflow Rate	CFM	0		
Nozzle Discharge Airflow Rate	CFM	Equal to Process Airflow Rate		
Nozzle Discharge / Process Airflow Dilution Ratio	%	0%		
Nozzle Discharge Velocity	fpm	5500		
Effective Plume Rise (note 2)	ft	18		
Effective Stack Height (note 3)	ft	15		
Number of Redundant Fans in Group	---	0		
Intake Plenum Height	ft	N/A		
Bypass Air Damper Size	in x in	N/A		

<b>Schedule B – Acoustic Performance Criteria</b>								
Fan Group	Octave Band Center Frequency, Hz							
	63	125	250	500	1L	2L	4K	8K
	Sound Pressure Level at 15 m (50 ft) Horizontal, dB							
F-20	90	88	(not provided by manufacturer)	80	76	74	75	71

**END OF SECTION**

## **GRILLES, REGISTERS AND DIFFUSERS**

### **23 37 13**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide grilles, registers, and diffusers as shown.

##### **1.2 Applicable Codes and Standards**

- .1 Product standards:
  - .1 ASHRAE 70 Method of Testing the Performance of Air Outlets and Air Inlets
  - .2 ASTM D610 Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
  - .3 ASTM D714 Test Method for Evaluating Degree of Blistering of Paints
  - .4 ASTM D1308 Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
  - .5 ASTM D1654 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
  - .6 ASTM D4752 Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub

##### **1.3 Submittals**

- .1 Submit manufacturer's data sheets with product data including:
  - .1 equipment model numbers, configuration, dimensions, support requirements, general assembly and materials,
  - .2 catalog performance ratings that indicate air flow, static pressure, throw distance at air velocity, and noise criteria (NC) data.

##### **1.4 Samples**

- .1 Submit examples of each type and style of register, diffuser and grille with sample finishes when requested by Consultant or the Owner.

#### **2 PRODUCTS**

##### **2.1 General Requirements**

- .1 Grilles, registers and diffusers:
  - .1 product of one manufacturer where same model or type identification is used,
  - .2 performance data determined in accordance with ASHRAE 70,
  - .3 standard catalogue products selected to meet capacity, throw, and noise level,
  - .4 frames with full perimeter gaskets, plaster stops where set into plaster or gypsum board, and concealed fasteners.
- .2 Type designations:
  - .1 floor plans indicate a diffuser, register or grille type that is referenced on equipment schedules; this unit type includes model numbers taken from listed manufacturer catalogues and which represents the basis-of- design selection.

- .2 the listed manufacturer model (basis-of-design) reference establishes the esthetic (visual) appearance of the equipment and other quality requirements not otherwise specified herein. Products from other manufacturers listed herein may be used where they meet these aesthetic requirements as determined by Consultant.
- .3 Painted finishes:
  - .1 baked-on powder coat finish, minimum build thickness of 0.05 mm (2.0 mils), with a finished hardness of 2H.
  - .2 paint finishes to demonstrate no degradation when tested in accordance with ASTM D1308 and ASTM D4752,
  - .3 paint finish to withstand a minimum salt-spray exposure of 500 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering when tested in accordance with ASTM D610 and ASTM D714.
  - .4 finish colour: as shown or as selected by Consultant.
- .4 Manufacturers:

*Standard of Acceptance*

- Carnes
- Hart & Cooley
- MetalAire
- Nailor
- Price Industries
- Titus

## **2.2 Square Plaque Diffuser (ref. "SPD")**

- .1 Application: supply air.
- .2 Style: square plaque-type with single outlet opening;
  - .1 backpan: one piece die-formed construction with smooth aerodynamically designed surfaces and no corner joints, with integral inlet collar,
  - .2 plaque face panel: removable plate, protruding not more than 6 mm (1/4 in.) below the ceiling plane, with smooth edges and rounded corners,
  - .3 designed to provide a 360° radial direction horizontal airflow pattern, for VAV operation.
  - .4 beaded extended neck, minimum depth of 65 mm (2-1/2 in.),
  - .5 suitable for lay-in to T-bar with drop frame,
- .3 Frame: none.
- .4 Material: aluminum
- .5 Damper: none

## **2.3 Louvred Grille (type "LG")**

- .1 Application: supply, return and exhaust air.
- .2 Style: rectangular louvred with frame;
  - .1 fixed single-deflection louvres,
  - .2 louvres and frame materials: aluminum unless otherwise shown.
  - .3 blade spacing: 13 mm (1/2 in.) unless otherwise shown,
  - .4 deflection: 45°,



- .5 blade orientation: horizontal for vertical grilles, parallel to the long dimension for horizontal grilles,
- .6 border: nominal 32 mm (1-1/4 in.) flat face for surface mount, unless otherwise shown,
- .3 Frame: none
- .4 Fasteners: countersunk holes
- .5 Finish: painted, standard white unless show except dampers are to be painted black,
- .6 Damper: opposed blade damper with manual operator.
- .7 Specials: as shown.

## **2.4 Adjustable Louvred Grille (type "LG-A")**

- .1 Application: supply air only.
- .2 Style: rectangular louvred with frame;
  - .1 adjustable double-deflection louvres, horizontal in rear position, vertical in front position,
  - .2 louvres and frame materials: aluminum unless otherwise shown.
  - .3 blade spacing: 13 mm (1/2 in.) unless otherwise shown,
  - .4 blade orientation: horizontal for vertical grilles, parallel to the long dimension for horizontal grilles,
  - .5 border: nominal 32 mm (1-1/4 in.) flat face for surface mount, unless otherwise shown,
- .3 Frame: none
- .4 Fasteners: countersunk holes
- .5 Finish: painted, standard white unless show except dampers are to be painted black,
- .6 Damper: opposed blade damper with manual operator.
- .7 Specials: as shown.

## **2.5 Hospital-Grade Louvred Grille (type "LG-H")**

- .1 Application: supply, return and exhaust air.
- .2 Style: rectangular louvred with frame and removable core;
  - .1 removable louver and border assembly with quick-release fasteners,
  - .2 fixed single-deflection louvres,
  - .3 louvres and frame materials: stainless steel,
  - .4 blade spacing: 13 mm (1/2 in.) unless otherwise shown,
  - .5 deflection: 45°.
  - .6 blade orientation: horizontal for vertical grilles, parallel to the long dimension for horizontal grilles,
  - .7 border: nominal 32 mm (1-1/4 in.) flat face for surface mount, unless otherwise shown,
- .3 Frame: 9mm (3/8 in.) flat border.
- .4 Fasteners: retained quick-release type.
- .5 Finish:
  - .1 blades: No. 2B finish
  - .2 frames: No. 4 finish
- .6 Damper:
  - .1 supply air: opposed blade damper, stainless-steel with mill finish, with manual operator.

.2 Return air and exhaust air: none.

.7 Specials: as shown.

## **2.6 Low-Level Exhaust Grilles (ref. "LG-LL")**

.1 Application: return and exhaust air, wall-mounted near floor.

.2 Style: rectangular louvred with frame;

.1 fixed single-deflection louvres,

.2 louvres and frame materials: aluminum unless otherwise shown,

.3 blade spacing: 13 mm (1/2 in.) unless otherwise shown,

.4 deflection: 45°,

.5 blade orientation: horizontal for vertical grilles.

.6 border: nominal 32 mm (1-1/4 in.) flat face for surface mount, unless otherwise shown,

.3 Frame: 9 mm (3/8 in.) flat border.

.4 Fasteners: concealed mounting

.5 Finish: painted, standard white unless show except dampers are to be painted black,

.6 Damper: opposed blade damper with manual operator.

.7 Specials: with filter frame and ¼-turn quick release fasteners (filter not included).

## **2.7 Linear Bar Grilles (type "BG")**

.1 Application: supply, return and exhaust air, for sidewall, sill, ceiling and floor installation.

.2 Style: extruded aluminium linear bar grille;

.1 extruded aluminium bar cores, style as shown,

.2 bar-core and frame materials: aluminium,

.3 bar style: as shown.

.4 bar spacing: 6 mm (1/4 in.) unless otherwise shown,

.5 bar deflection:

(a) supply air: 30° unless otherwise shown,

(b) return/exhaust air: 0°.

.6 blade orientation: parallel to long-dimension of grille,

.3 Frame:

.1 drywall installation: concealed plaster frame,

.2 miscellaneous:

(a) butt-flanged for mating to adjacent grilles, with alignment plates,

(b) flat mitered corner sections,

(c) inside and outside mitred corner sections,

(d) end borders with mitred corners.

.4 Fasteners: concealed mounting.

.5 Finish: factory painted with colour as selected by Consultant

.6 Damper: none

.7 Specials: as shown.

## **2.8 Eggcrate Grilles (type "ECG")**

.1 Application: return and exhaust air.

.2 Style: square-grid bladed grille;

.1 louvres and frame materials: aluminum,

.2 blade spacing: 25 mm x 25 mm square by 25 mm deep (1 in. x 1 in. x 1 in.),

.3 deflection: 0°.

.4 blade orientation: not applicable,

.5 border:

(a) lay-in tile ceilings: none

(b) gypsum board ceilings: nominal 32 mm (1-1/4 in.) flat face, suitable for ducted connections.

.3 Frame: none.

.4 Fasteners: countersunk holes

.5 Finish: painted, standard white unless otherwise shown,

.6 Damper:

.1 ceiling plenum return: none

.2 ducted return: opposed blade damper with manual operator.

.7 Specials: as shown.

## **3 EXECUTION**

### **3.1 Layout**

.1 Drawings showing position of air distribution outlets are essentially diagrammatic. Coordinate exact location of diffusers with other elements in ceiling and shown on Architect's reflected ceiling drawings and select trim to suit ceiling materials listed in the Architectural drawings room finish schedules.

### **3.2 Installation of Grilles and Diffusers**

.1 For duct-mounted grilles installed in ceiling or walls constructed of gypsum board, coordinate and arrange with general trades to provide channel framing around ceiling/wall opening to provide backing-blocking for attachment of the grille or diffuser.

.2 Install grilles and diffusers with oval head cadmium plated screws in countersunk holes where fastenings are visible. Use colour-matching screws.

.3 Install diffusers with concealed fastenings.

.4 Provide round, square and rectangular diffusers with equalizing deflectors, mounted in the connecting duct neck, accessible from diffuser face, with blades oriented at right angles to direction from which air is flowing.

.5 Except for last diffuser on branch, where diffusers are installed directly underneath a supply duct provide an extract volume control damper at the duct diffuser-branch connection.

.6 Where a supply air diffuser includes an air pattern controller, provide labour and services to adjust the pattern controller in conjunction with the TAB contractor during system balancing.

### **3.3 Special installations**

- .1 Grilles, registers and diffusers penetrating fire walls and fire partitions, to have steel sleeves secured to structure in accordance with NFPA 90A-1985.
- .2 For grilles and diffusers exceeding 5 kg (12 lbs) weight, mechanically fasten grille/diffuser to ceiling or wall structure, independent of ductwork connection or support.

**END OF SECTION**

## **CRITICAL ENVIRONMENT DIFFUSERS AND GRILLES**

### **23 37 13.16**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide specific-duty diffusers and grilles for critical environment spaces including:
  - .1 patient isolation rooms,
  - .2 and as shown.
- .2 Standard diffusers and grilles to conform to Specification section 23 37 13.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 23 37 13 Grilles, Registers and Diffusers

##### **1.3 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 ASHRAE Fundamentals Handbook
- .2 Product standards:
  - .1 ASHRAE 70 Method of Testing the Performance of Air Outlets and Air Inlets
  - .2 ASTM D610 Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
  - .3 ASTM D714 Test Method for Evaluating Degree of Blistering of Paints
  - .4 ASTM D1308 Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
  - .5 ASTM D1654 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
  - .6 ASTM D4752 Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub

##### **1.4 Submittals**

- .1 Submit manufacturer's data sheets with product data including:
  - .1 equipment model numbers, configuration, dimensions, support requirements, general assembly and materials,
  - .2 catalog performance ratings that indicate air flow, static pressure, throw distance at air velocity, and noise criteria (NC) data.

##### **1.5 Samples**

- .1 Submit examples of each type and style of clean room diffuser with sample finishes when requested by Consultant or the Owner.

## **2 PRODUCTS**

### **2.1 General Requirements**

- .1 Grilles and diffusers:
  - .1 product of one manufacturer where same model or type identification is used,
  - .2 performance data determined in accordance with ASHRAE 70,
  - .3 standard catalogue products selected to meet capacity, throw, and noise level,
  - .4 frames with full perimeter gaskets, plaster stops where set into plaster or gypsum board, and concealed fasteners.
- .2 Type designations:
  - .1 floor plans indicate a diffuser, register or grille type that is referenced on equipment schedules; this unit type includes model numbers taken from listed manufacturer catalogues and which represents the basis-of- design selection.
  - .2 the listed manufacturer model (basis-of-design) reference establishes the esthetic (visual) appearance of the equipment and other quality requirements not otherwise specified herein. Products from other manufacturers listed herein may be used where they meet these aesthetic requirements as determined by Consultant.
- .3 Painted finishes:
  - .1 baked-on enamel paint,
  - .2 paint finishes to demonstrate no degradation when tested in accordance with ASTM D1308 and ASTM D4752,
  - .3 paint finish to withstand a minimum salt-spray exposure of 500 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering when tested in accordance with ASTM D310 and ASTM D714.
  - .4 finish colour: as shown.
- .4 Manufacturers:

#### *Standard of Acceptance*

- Carnes
- Hart & Cooley
- MetalAire
- Nailor
- Price Industries
- Titus

### **2.2 Laminar Flow Diffusers (ref “CEVD”)**

- .1 Application: supply air.
- .2 Style: laminar flow diffuser of the non-aspirating, unidirectional type, providing a uniform projection of air at controlled low velocities and minimal entrainment of room air, as defined in ASHRAE Fundamentals Group E low-velocity diffuser.
- .3 Plenum box:
  - .1 materials: aluminum,
  - .2 continuous welded joints and seams, with [top inlet connection,][secondary plenum with side inlet connection],

- .3 separated into upper and lower chambers and equipped with a pressure equalizing baffle to promote uniform face velocity,
- .4 dimensions:
  - (a) plan: dimensions as shown,
  - (b) maximum plenum height: 120 mm (4.75 in.) excluding duct collar.
- .5 hardware:
  - (a) minimum four (4) hanger tabs to support diffuser independently from ductwork and ceiling structure,
  - (b) corner alignment brackets for connecting to adjacent units.
- .6 secondary plenum box:
  - (a) secondary plenum box welded to top of the primary plenum box, with oval side-entry duct connection,
  - (b) maximum secondary plenum height: 200 mm ([8] in.).
- .4 Faceplate:
  - .1 materials: aluminum,
  - .2 perforated distribution plate with minimum 13% free area,
  - .3 frame: welded-mitred corners, and welded to perforated faceplate,
  - .4 hardware:
    - (a) two (2) stainless steel hinges on one long-dimension side,
    - (b) two (2) quick-release captured ¼-turn fasteners on opposite side,
    - (c) two (2) stainless steel restraint cables.
- .5 Mounting: suitable for lay-in to nominal 13 mm (1/2 in.) wide ceiling flange or for gypsum board ceiling.
- .6 Finishes:
  - .1 aluminium materials: painted finish, standard white colour,
  - .2 stainless steel materials: No. 4 brushed finish on exposed surfaces.
- .7 Damper:
  - .1 internal butterfly damper with white baked-on power coated finish,
  - .2 operating cable for balancing access from room-side of diffuser.
- .8 Insulation:
  - .1 13 mm (1/2 in.) thick aluminum foil-backed fibreglass insulation factory applied to back of plenum box.
- .9 Accessories:
  - .1 diffuser face and inlet covered with temporary protective film to be removed at time of installation.

### **3 EXECUTION**

#### **3.1 Layout**

- .1 Drawings showing position of air distribution outlets are essentially diagrammatic. Coordinate exact location of diffusers with other elements in ceiling and shown on Architect's reflected ceiling drawings and select trim to suit ceiling materials listed in the Architectural drawings room finish schedules.

### **3.2 Installation**

- .1 Install diffusers in accordance with manufacturer instructions. Where HEPA filters are shipped loose, store and protect filters until spaces are ready for final clean and then install HEPA filters into diffusers.
- .2 Support laminar flow diffusers from building structure with stainless steel cable. Do not allow diffuser weight to be supported by the ceiling T-bar frame system.

### **3.3 Start-Up and Testing**

- .1 At time of balancing the ventilation system, after the diffusers have been balanced, perform an air velocity travers across the face of each laminar flow diffuser, with a traverse pattern on 150 mm centers both ways with first measurement at 75 mm (3 in.) from edge of filter (i.e. 4 x 8 measurements for a 600 x 1200 mm (24 x 48 in.) nominal filter. Make adjustments to the baffle and/or balancing damper so that air velocity variation does not exceed +/- 10% of the mean value at any measured location.

### **3.4 Reporting**

- .1 Submit a report to the Owner and Consultant for review and approval of diffuser face velocity tests.

**END OF SECTION**



## **PARTICULATE AIR FILTERS**

### **23 41 11**

#### **1 GENERAL**

##### **1.1 Scope**

.1 Provide particulate filters as shown, including:

- .1 particulate air filters,
- .2 filter holding frames,
- .3 side-access filter housing,
- .4 filter gauges.

##### **1.2 Definitions**

.1 Abbreviations

- .1 **MERV**: minimum efficiency reporting value in accordance with ASHRAE 52.2
- .2 **HEPA**: High Efficiency Particulate Air
- .3 **ULPA**: Ultra Low Particulate Air

##### **1.3 Applicable Codes and Standards**

.1 Product standards:

- |    |               |   |
|----|---------------|---|
| .1 | ASHRAE 52.2   | Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size. |
| .2 | CAN/ULC-S111  | Standard Method of Fire Tests for Air Filter Units.   |
| .3 | IENT-RC-CC001 | HEPA and ULP Filters  |
| .4 | IENT-RC-CC021 | Testing HEPA and ULPA Filter Media  |
| .5 | IENT-RC-CC034 | HEPA and ULPA Filter Leak Tests   |

##### **1.4 Submittals**

.1 Submit manufacturer's catalogue literature for filters showing:

- .1 pressure drop vs air flow rate,
- .2 filter efficiency rating,
- .3 media area in each cell,
- .4 filter dimensions,
- .5 maximum recommended pressure drop at filter change,
- .6 product test report including all details as prescribed in ASHRAE 52.2,
- .7 product test report confirming filters are rated as MERV-A when tested in accordance with Appendix J of ASHRAE 52.2, at the same specified MERV rating value.

.2 In addition, for HEPA and ULPA filters, submit test certification reports.

## 2 PRODUCTS

### 2.1 General Requirements

- .1 Filter efficiency performance (except HEPA and ULPA filters): certified to conform to ASHRAE 52.2 for MERV ratings and with equal MERV-A ratings as tested in accordance with Appendix J of ASHRAE 52.2.
- .2 Filters listed as a Class 2 product to CAN/ULC-S111.
- .3 Filters to be suitable for continuous exposure to air at the following conditions as applicable:

Filter Position	Minimum Air Temperature °C (°F)	Relative Humidity %RH
Before first heating coil	-25 (-13)	90%
After cooling coil	+3°C (37°F)	100%
All other locations	+3°C to 50°C (37°F to 122°F)	10% to 95%

- .1 maximum air temperature: 50°C (122°F).
- .4 Filter sizes: as shown on equipment schedules or as specified in specification sections for air handling equipment.

#### *Standard of Acceptance*

- AAF
- Camfil
- Airgaud (Parker)

### 2.2 MERV 8 – Panel Filter

- .1 Performance:
  - .1 filter style: Panel, disposable
  - .2 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
  - .3 filter depth: 100 mm (4 inch) , nominal
  - .4 efficiency: MERV 8 at 2.5 m/s (492 fpm)
  - .5 initial air resistance: 75 Pa (0.30 in.w.c.), maximum
  - .6 final air resistance: 250 Pa (1 in.w.c.), minimum at change out
- .2 Construction:
  - .1 media; synthetic
  - .2 frame: fibre board with moisture inhibitors
  - .3 face gasket: none.

#### *Standard of Acceptance*

- Camfil - Farr 30/30 or Aeropleat III
- AAF - fig. VP-MERV8 SC

## 2.3 MERV 11 to 14 – Rigid Box

### .1 Performance:

- .1 filter style: Rigid-Box, disposable
- .2 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
- .3 filter depth: 300 mm (12 inch) , nominal
- .4 efficiency and initial air resistance:

MERV	11	13	14
Initial air resistance Pa (in.w.c.)	90 (0.36)	135 (0.54)	160 (0.64)

- .5 final air resistance: 375 Pa (1.5 in.w.c.), minimum at change out

### .2 Construction:

- .1 media; glass fibre
- .2 frame: galvanized steel
- .3 face gasket: Neoprene

#### *Standard of Acceptance*

- Camfil - fig. Riga-Flo
- AAF - fig. Varicel

## 2.4 MERV 11 to 14 – Rigid V-Bank

### .1 Performance:

- .1 filter style: Rigid V-Bank, disposable
- .2 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
- .3 filter depth: 300 mm (12 inch) , nominal
- .4 efficiency and initial air resistance:

MERV	11	13	14
Initial air resistance Pa (in.w.c.)	75 (0.30)	110 (0.45)	140 (0.56)

- .5 final air resistance: 375 Pa (1.5 in.w.c.), minimum at change out

### .2 Construction:

- .1 filters to be cable of being fully incinerated.
- .2 media; glass fibre
- .3 frame: plastic
- .4 face gasket: Neoprene

#### *Standard of Acceptance*

- Camfil - fig. Durafil 2V, Durafil ES2
- AAF - fig. Varicel VXL

## 2.5 MERV 11 to 15 – Bag

### .1 Performance:

- .1 filter style: Bag, disposable
- .2 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
- .3 filter depth: 550 mm (22 inch) , nominal
- .4 efficiency and initial air resistance (based on filter depth specified):

MERV	11	13	14	15
Initial air resistance Pa (in.w.c.)	65 (0.26)	125 (0.50)	125 (0.50)	175 (0.70)

- .5 final air resistance: 375 Pa (1.5 in.w.c.), minimum at change out

### .2 Construction:

- .1 media; glass fibre
- .2 frame: plastic or galvanized steel
- .3 face gasket: Neoprene or EPDM

#### *Standard of Acceptance*

- Camfil - fig. Hi-Flo ES
- AAF - fig. DriPak / DriPak NX / DriPak 2000

## 2.6 MERV 16 – Rigid V-Bank

### .1 Performance:

- .1 filter style: Rigid V-bank, disposable
- .2 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
- .3 filter depth: 300 mm (12 inch) , nominal
- .4 efficiency: MERV 16 at 2.5 m/s (492 fpm)
- .5 initial air resistance: 160 Pa (0.65 in.w.c.), maximum
- .6 final air resistance: 375 Pa (1.5 in.w.c.), minimum at change out

### .2 Construction:

- .1 media; glass fibre
- .2 frame: plastic
- .3 face gasket: Neoprene or locking-metal

#### *Standard of Acceptance*

- Camfil - fig. Durafil ES2

## **2.7 Filter Holding Frames**

### **.1 Construction:**

- .1 modular framing system,
- .2 minimum 1.27 mm (18 ga) thick galvanized steel with 20 mm (3/4 in) wide filter sealing flange, pre-drilled for frame-frame fastener attachments,
- .3 replaceable Neoprene gasket on frame face for filters not provided with integral gaskets,
- .4 gasketing between adjacent frames and between frames and plenum walls,
- .5 high-tensile spring clips filter-fasteners.

#### *Standard of Acceptance*

- AAF - fig. PF-1 Pureframe, Universal Holding Frames and Latches
- Camfil - fig. FastFrame (upstream filter loading)
- Camfil - fig. Type 8 Frame (downstream filter loading)

## **2.8 Side Access Housings**

### **.1 Construction:**

- .1 1.6 mm (16 ga) galvanized steel frame with Z-channel support members, with inlet and outlet mounting flanges for connection to ductwork or plenums,
- .2 filter tracks: aluminium, with lever locking to full face of frame,
- .3 doors: galvanized steel door, continuous or two point hinges, locking knobs, sealed with full perimeter neoprene gaskets, and seals the filter side facing the door,
- .4 tracks and doors fully gasketed,
- .5 50 mm (2 in) thick, double wall, insulated construction,
- .6 capable of holding pre-filter and final filters, or separate racks for each filter bank,
- .7 filter depth:
  - (a) 50 mm to 100 mm (2 to 4 in) for panel filters,
  - (b) 150 mm to 915 mm (6 to 26 in) for all filters

#### *Standard of Acceptance*

- AAF - fig. SureSeal (two-stage), SurePlea (panel filters)

## **2.9 Air Filter Gauges**

### **.1 Pneumatic magnehelic gauge:**

- .1 cast aluminium housing, with acrylic cover, 100 mm (4 in) diameter dial face,
- .2 connections: NPS 1/8 NPT,
- .3 dual scale Pa, and inch water column,
- .4 0-250 Pa (0-1 in wg) range for panel filters,
- .5 0-750 Pa (0-3 in wg) range for other filter banks,
- .6 installation kit with static pressure tips and isolation valves.

#### *Standard of Acceptance*

- Dwyer - fig. 2001D, 2003D

### **3 EXECUTION**

#### **3.1 Filter Banks**

- .1 Install in plenums, ducts, and air intakes in filter racks or filter housings as shown, where not provided as an integral part of an air handling unit.
- .2 Made up using one size of cell throughout. Mixed cells are not permitted.

#### **3.2 Filter Gauges**

- .1 Provide filter gauges at the following filter banks:
  - .1 each bank of filters over 1900 l/s (4000 cfm) capacity
- .2 Provide separate gauges for each filter bank.
- .3 Install and pipe static pressure taps and isolating valves to allow calibration of pressure gauges.

#### **3.3 Filter Protection and Replacement**

- .1 Provide temporary roughing filters ahead of filter banks during initial operation of air handling systems.
- .2 When building is turned over to the Owner;
  - .1 remove temporary filters and ensure that filter banks are fitted with full sets of filters.
  - .2 install new, full sets of filters for any air filter banks used during construction and loaded to more than 125% of initial clean pressure drop.

#### **3.4 Inspection and Testing**

- .1 Immediately prior to hand-over to the Owner,
  - .1 visually inspect the filters and filter frames to ensure there are no visible gaps in frame gaskets and blanking plates, that filters are set square and level in their frames, and retention clips are in place.
  - .2 with the air handling system operating at normal conditions, check and record the pressure drop across each filter bank, and submit a test report with the date of the test to the Owner and include in the operations and maintenance data.

**END OF SECTION**

## **AIR-TO-AIR ENERGY RECOVERY EQUIPMENT**

### **23 72 13**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide air-to-air heat reclaim devices as part of air handling equipment or as a separate component as shown.

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 12 Common Electrical Requirements for Mechanical Services
  - .2 20 05 13 Common Motor Requirements for Mechanical Equipment
  - .3 20 05 14.13 Variable Frequency Drive Motor Controllers

### **1.3 Definitions and Abbreviations**

- .1 The following definitions apply to this section.
  - .1 **Exhaust air transfer ratio (EATR)** – has the meaning as defined in AHRI 1060.
  - .2 **Cross-contamination percent** - is the percent concentration of a test gas introduced into the return air stream that transfers to the supply air stream via the heat reclaim device; it is calculated in the same manner as EATR but applies to percent values which are lower than the AHRI 1060 minimum reporting limit of 0.1%.

### **1.4 Applicable Codes and Standards**

- .1 Product standards:
  - .1 ASHRAE 84:20 Method of Testing Air-to-Air Heat/Energy Exchangers
  - .2 ASTM E84 Standard Test Method for Surface Burning
  - .3 CAN/ULC S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

### **1.5 Submittals**

- .1 Submit product data sheets for equipment and materials specified herein and include:
  - .1 unit dimension and weight data,
  - .2 thermal performance data at maximum rated capacity for both sensible effectiveness and (where applicable) latent effectiveness,
  - .3 for rotary heat exchangers: thermal performance data for sensible and (where applicable) latent effectiveness at 10%, 20%, 40%, 60%, and 80% of maximum normal wheel speeds,
  - .4 power requirements,
  - .5 product certification listing file number and testing organization name,
  - .6 a copy of the AHRI listing report identifying all test performance results for each heat reclaim device type and size,
  - .7 for rotary heat exchangers: verification from heat wheel desiccant manufacturer confirming that internal pore diameter distribution in desiccant limits absorption to materials with critical

diameters less than or equal to that of water molecules (2.8 angstrom units). In the case of ion exchange, submit written verification that co-absorption and transfer of non-water vapour is limited.

- .8 3<sup>rd</sup> party testing laboratory test report verifying cross-contamination performance not exceeding 0.04%.

## 1.6 Warranty

- .1 In addition to the warranty provisions of Division 01, provide a written warranty for parts and labour to repair or replace any part of the equipment which may fail due to defective material or workmanship within a period of five (5) years from date of acceptance by the Owner.

## 2 PRODUCTS

### 2.1 Rotary Type Heat Exchanger (heat wheel)

- .1 Packaged rotary total energy (enthalpy) heat wheel, with fabricated casing, variable speed drive system, in a shop fabricated and tested assembly.
- .2 Performance certified in accordance with ASHRAE 84 and listed to AHRI 1060.

#### *Standard of Acceptance*

- Seibu Giken / SG America
- Thermotech
- DRI (Desiccant Rotors International);
- FlaktGroup Semco
- innenergy tech

#### .3 Wheel media:

- .1 fabricated of alternating smooth and corrugated aluminum interleaved in a winding to form the wheel,
- .2 treated for corrosion resistance and bacteriostatic agent capable of inhibiting growth,
- .3 coating for selective adsorption and transfer of water vapour of either:
  - (a) non-migrating 3 Angstrom molecular sieve hygroscopic solid desiccant coating for selective adsorption of water vapour or
  - (b) low co-adsorption ion exchange resin media.
- .4 wheel surfaces ground and polished smooth for long seal life and prevent annular cross contamination between air streams,
- .5 air flow passages able to pass dry particles of at least 800 microns diameter and smaller,
- .6 flame-spread rating of 25 or less and smoke-developed rating of 50 or less in accordance with CAN/ULC-S102 or ASTM 84,
- .7 media cleanable with low temperature steam, hot water or light detergent, vacuum cleaner and/or compressed air, without degradation of latent recovery,

#### .4 Media support system:

- .1 structural hub, spoke and rim system material: extruded aluminum,
- .2 smooth-faced wheel perimeter flange to minimize wheel-seal contact,
- .3 wheel frame designed and constructed to limit wheel-face deflection not to exceed 0.9 mm (0.035 in.) at wheel perimeter while operating at 100% wheel speed and under design airflow through the wheel, by either:



- (a) inherent stiffness of the wheel assembly and wheel-bearings, or
  - (b) use of perimeter ball-bearing rollers acting on the wheel rim face.
- .4 media supported in segmented fashion that allows field erection or replacement of sections without side access or disassembly of entire wheel structure.
- .5 Purge sector:
  - .1 purge sector plate to flush wheel media with outdoor air immediately prior to wheel-media passing into the supply stream side of the heat wheel,
  - .2 factory set based on design supply air/exhaust air pressure differential, field adjustable in maximum 1° increments up to 10°,
  - .3 designed to limit cross-contamination to less than 0.04% of exhaust air stream test gas contaminant concentration;
    - (a) cross-contamination performance to be verified by 3rd party testing laboratory and copy of test report included with submittals,
    - (b) cross-contamination test to be performed at the lessor of design differential pressure or 250 Pa (1 in.wc.) between outdoor air and exhaust air flow streams, with air leakage from outdoor to exhaust air streams.
- .6 Wheel seals:
  - .1 wheel radial (media face) seal:
    - (a) non-contact multi-pass type with not less than four labyrinth stages,
    - (b) secured with stainless steel bolts,
    - (c) adjusted to a clearance of not more than 0.8 mm (0.03 in.) measured with no-airflow through the wheel,
  - .2 wheel-rim seal:
    - (a) non-contact multi-pass type with not less than four labyrinth stages,
    - (b) secured with stainless steel bolts,
    - (c) adjusted to a clearance of not more than 2.0 mm (0.08 in.) with no-airflow through the wheel, but may be installed in contact with the wheel rim flange.
- .7 Unit housing:
  - .1 galvanized or epoxy coated tubular welded steel structural framework,
  - .2 galvanizes steel casing walls on both sides of the wheel, reinforced to provide a uniform surface for mounting of rim and radial seals,
- .8 Wheel bearings:
  - .1 two flange-block or pillow-block style tapered roller bearings supporting wheel,
  - .2 bearings sized and selected for an L-10 minimum life of 1,000,000 operating hours,
  - .3 arranged to allow maintenance or replacement without removal of wheel from casing or media from support system,
  - .4 wheel shaft machined to eliminate lateral movement of the wheel due to bearing loads,
  - .5 bearing grease fittings to be easily accessible.
- .9 Drive system:
  - .1 self-adjusting dual belt or chain-drive arrangement,
  - .2 drive motor:
    - (a) conform to specification section 20 05 13 except/and as specified herein,

- (b) inverter duty rated AC induction motor,
- (c) selected to operate under full load at input voltage frequency up to 120 Hz, with constant voltage/frequency ratio at 60 Hz and lower, and reducing V/F ratio between 60 and 120 Hz to a minimum of 50% of baseline V/F ratio at 60 Hz
- (d) suitable for operating the wheel at a speed turndown ratio of 80:1 (20 rpm to 1/4 rpm),
- (e) power supply: as shown on equipment schedules,
- .3 gear reducer (if used): permanently lubricated gear reducer with L-10 minimum life of 90,000 hours,
- .10 Variable frequency drive (VFD):
  - .1 heat wheel to be supplied with VFD which conforms to Specification section 20 05 14.13.
- .11 Rotation detector:
  - .1 factory-mounted rotation detector to monitor wheel rotation direction,
  - .2 control unit:
    - (a) NEMA 1 enclosure,
    - (b) local visual alarm indication, with output alarm relay with Form C contacts,
    - (c) power supply: 120 VAC, 60 Hz, 1 ph.
    - (d) supplied for field installation,

## **2.2 Counterflow Air-to-Air Heat Exchanger**

- .1 Fixed air-to-air plate sensible heat recovery exchanger in counterflow configuration.
- .2 Performance certified in accordance with ASHRAE 84 and listed to AHRI 1060.
- .3 Construction:
  - .1 matrix to be made up with aluminum plates 0.125 mm (0.005 in) thick with positive and negative stampings to maintain spacing.
  - .2 plate edges sealed with mechanical lock-formed and epoxy seals, with no cross-contamination,
  - .3 corners of matrix to be cast and sealed into aluminum extrusions with permanently elastic epoxy resin,
  - .4 side walls of galvanized steel, bolted to corner extrusions,
  - .5 maximum hot side inlet temperature of 80°C (176°F)
  - .6 differential pressure rating between adjacent plates: 2500 Pa (10 in.wc.),

### *Standard of Acceptance*

- Hoval
- Klingenburg
- Engineered Air
- Temp-EffHeat

## **3 EXECUTION**

### **3.1 Storage and Protection**

- .1 Inspect faces of heat reclaim devices for damage to media or fins at time of receipt of equipment at site. If damage is found, immediately notify manufacturer and have damaged components repaired or replaced.

- .2 Protect faces of heat reclaim devices from damage while work is ongoing adjacent to the reclaim equipment.
- .3 Reinspect faces of heat reclaim devices for damage to media or fins prior to start of testing. If damage is found, repair or replace damaged components.

### **3.2 Installation**

- .1 Supply heat reclaim devices for field or factory assembly into air handling units or plenums.
- .2 For field assembly of heat wheels, arrange and pay for supervision of equipment manufacturer to supervise and inspect such equipment during assembly and installation.
- .3 Where condensing heat reclaim devices are installed in plenums which are not part of an air handling unit, provide drain pans under the heat recovery device constructed as follows:
  - .1 drain pan materials: 1.6 mm (16 ga.) type 304/304L to ASTM B209, with continuous welded seams and joints;
    - (a) caulking of drain pan seams is not permitted,
  - .2 drain-pan width: equal to the external width of the heat recovery device,
  - .3 drain-pan length: commencing at the inlet face of the device and extending downstream of the leaving face of the device not less than 450 mm (18 in.),
  - .4 minimum pan depth: 50 mm (2 in.),
  - .5 bottom of pan cross-broken and double sloped to recessed bottom or side drain, with a minimum slope of 2% from all points on the pan to the drain outlet connection.
- .4 Protect faces of heat reclaim devices from damage while work is ongoing adjacent to the reclaim equipment. Inspect

### **3.3 Electrical Services**

- .1 Provide control wiring between control devices and instrumentation to controlled equipment in accordance with Specification section 20 05 12.
- .2 Provide motor or equipment power wiring between remote motor controller and controlled equipment in accordance with Specification section 20 05 12.

### **3.4 Controls and Instrumentation**

- .1 Provide instrumentation for measurement of air parameters and wheel rotation monitoring;
  - .1 install temperature sensors in the outdoor air, supply air, return air and exhaust air streams.
  - .2 Install relative humidity sensors in the return air and exhaust air stream.

### **3.5 Cleaning**

- .1 Prior to testing and commissioning, and again immediately prior to hand-over of equipment to Owner, clean surfaces and interior air passages of heat reclaim devices in accordance with manufacturers written cleaning instructions.

### **3.6 Programming and Configuration**

- .1 Program and configure operating sequences in packaged control systems supplied with heat wheel.

### **3.7 Start-up and Testing**

- .1 Arrange for manufacturers representative to inspect and adjust units before startup Check seals for proper seal clearance between supply and exhaust air streams per manufacturer's instructions in static and operating conditions.

**3.8 Commissioning Program**

- .1 Comply with the project commissioning requirements in accordance with specification section 20 08 15.
- .2 The verification and testing requirements specified in this section may be concurrent with, or conducted separately from, the commissioning program, as coordinated with the Contractor and the commissioning agent.
- .3 Contractor and manufacturer to provide field service personnel to participate in the system integration commissioning of the equipment and/or system including:
  - .1 review of equipment and system commissioning procedures provided by Owner in addition to the manufacturers own testing procedures.
  - .2 to have control and provide operation of equipment during testing;
  - .3 adjusting of equipment controls as required to simulate load and/or fault conditions; and
  - .4 assist with record keeping of test results,
  - .5 as further identified in specification section 20 08 15.

**3.9 Demonstration and Training**

- .1 Demonstrate the operation of, and provide training on, the equipment and system, as applicable, in accordance with section 20 05 01.

**3.10 Test and Installation Records**

- .1 Provide a completed manufacturer installation checklist record for the following elements of the work and submit the original to the Owner and a copy to Consultant. Provide an additional copy when required or requested by the Authority-having-Jurisdiction.
  - .1 rotary heat reclaim exchangers.

**END OF SECTION**

## **PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS**

### **23 74 13**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide roof top packaged units as shown.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 01 Basic Materials and Methods
  - .2 23 24 16 HVAC Fans
  - .3 23 72 13 Air-to-Air Energy Recovery Equipment

##### **1.3 Applicable Codes and Standards**

- .1 Product standards:
  - .1 AHRI 270 Sound Performance Rating of Outdoor Unitary Equipment
  - .2 AMCA 99 Standards Handbook
  - .3 AMCA 210 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
  - .4 AMCA 300 Reverberant Room Methods for Sound Testing of Fans
  - .5 AMCA 301 Method for Calculating Fan Sound Ratings from Laboratory Test Data
  - .6 ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus

##### **1.4 Submittals**

- .1 Submit shop drawings for each roof top package unit with;
  - .1 equipment model number,
  - .2 outline dimensions,
  - .3 enclosure details,
  - .4 space requirements for service and maintenance,
  - .5 support arrangements.
- .2 Provide rating information showing capacity and power input requirements for heating and cooling at full load.
- .3 Provide diagrams showing;
  - .1 requirements for field assembly with air flows, connection pipe sizes and external pressure drop at rated air flow,
  - .2 unit internal and external electrical power and control wiring with motors, starters, relays and interlocks identified, and with terminal and wire numbers marked.
- .4 Submit sound power data for supply, relief, or return fans rated at more than 2.0 m<sup>3</sup>/s (4000 cfm) and for condenser section where unit capacity exceeds 40 kW (11.4 tons).

##### **1.5 Warranty**

- .1 Compressors to be warranted against failure for three (3) years parts only.

## **2 PRODUCTS**

### **2.1 General**

- .1 Performance as shown.
- .2 Hermetic reciprocating or scroll compressor, evaporator, air cooled condenser, condenser fans, evaporator fan, electric heater section, filter box, economizer section, power exhaust fans, motor starters, and controls,
- .3 For installation on structural steel platform.
- .4 Factory assembled and tested with refrigeration piping, refrigerant and oil charge.
- .5 Ready for connection to ductwork and electric power source.
- .6 Sound ratings to AMCA 301 when tested to AMCA 300 and soundproofing to ARI 270.
- .7 Fans to AMCA 99 and fan ratings to AMCA 210.
- .8 Weatherproofing to AGA rain test standards when tested to ASTM B117.
- .9 Units larger than 40 KW (11.4 tons) to conform to ARI 210.

#### *Standard of Acceptance*

- McQuay
- Trane
- Carrier
- York
- Lennox
- Reznor
- Rheem
- Daikin

### **2.2 Cabinet**

- .1 Construction:
  - .1 assembled on galvanized steel base with lifting lugs and curb flashings,
  - .2 constructed with angle or folded plate frame of galvanized steel, minimum 22 mm (14 ga), and panels of minimum 1.0 mm (20 ga),
  - .3 configured for bottom or side air supply and return connections
  - .4 weathertight casing with removable gasketed panels for access to motorized equipment, electrical control panel and filter changing,
  - .5 primed and enameled to withstand 1000 hr salt spray test.
- .2 Insulation:
  - .1 insulation on panel surfaces in contact with conditioned air: 13 mm (½ in), 24 kg/m<sup>3</sup> (1.5 lb/ft<sup>3</sup>) density foil faced or neoprene coated glass fibre.

### **2.3 Evaporator**

- .1 Direct expansion type, arranged with counter flow between air and refrigerant,
  - .1 minimum of two circuits for units with capacities of 6 tons or larger,
  - .2 aluminum fins on copper tubes mounted in zinc coated steel casing,
  - .3 maximum face velocity of 2.6 m/s (500 fpm), minimum 3 rows,

- .2 Condensate pan:
  - .1 stainless steel welded condensate pan draining to 20 mm (¾ in) side outlet connection.

## **2.4 Evaporator Fan**

- .1 Double width, double inlet centrifugal type;
  - .1 statically and dynamically balanced,
  - .2 arrangement 3 belt driven, with adjustable pitch sheave and belt tensioning arrangement, sized for 150% of fan motor horsepower for units with capacities of 6 tons or larger.
  - .3 multi-speed direct driven, with fan mounted on motor shaft for units with capacities of 5 tons or smaller,
  - .4 mounted with motor on isolation base separated from unit casing with flexible connections and rubber in shear isolators.

## **2.5 Air Filters**

- .1 50 mm (2 in) thick MERV8 throwaway filters, and
- .2 100 mm (4 in) thick MERV14 throwaway filters.
- .3 Mounted ahead of evaporator coil, in filter box with access panel.

## **2.6 Refrigeration Compressors**

- .1 Direct driven reciprocating or scroll hermetic compressors operating at 1750 rpm each with;
  - .1 thermal overloads,
  - .2 oil sight glass,
  - .3 oil pump for forced feed lubrication,
  - .4 crank case heater,
  - .5 solid state motor protection including phase failure and under/over voltage.
- .2 Mounted on pad type vibration isolators.
- .3 Located in separate compartment isolated from air stream.

## **2.7 Refrigerant Circuit**

- .1 Piping, valves, fittings and related parts to CSA B52 with;
  - .1 thermal expansion valve or capillary refrigerant metering device
  - .2 combination filter/dryer,
  - .3 liquid sight glass with moisture indicator,
  - .4 high side pressure relief device, and
  - .5 charging valve.
- .2 Insulation:
  - .1 19 mm (¾ in) thick flexible elastomeric insulation on suction line.

## **2.8 Condenser Section**

- .1 Fans:
  - .1 direct drive, slow speed, multiple propeller fans,
  - .2 variable speed, ball bearing, permanently lubricated fan motors, fitted with electronic head pressure control, for stable operation down to outside temperature of -29°C (-20°F)

- .2 Condenser coil:
  - .1 aluminum fins on copper tube, integral subcooling circuits,
  - .2 separate refrigeration circuits for each compressor,
  - .3 sized for outdoor air entering temperature of 38 C (100 F).

## **2.9 Refrigeration Controls**

- .1 Microprocessor based DDC control system with;
  - .1 external unit stop switch,
  - .2 recycling pump down control,
  - .3 high and low refrigerant pressure switches,
  - .4 oil pressure safety switch,

## **2.10 Electric Heat Section**

- .1 SCR control.
- .2 Sized for outdoor air entering temperature of -20F, mixed with recirculating air at 33% outdoor air.

## **2.11 Economizer Section**

- .1 Motorized fresh air and recirculation dampers,
- .2 Gravity relief dampers with direct drive propeller type power exhaust fans

## **2.12 Energy Recovery Section**

- .1 Refer to Section 23 72 13 - Air-to-Air Energy Recovery Equipment.
- .2 Dedicated 50 mm (2 in) MERV8 filters, one set for outdoor air intake, and one for exhaust air intake.

## **2.13 Temperature Control System**

- .1 Microprocessor based, Direct Digital Control (DDC) processor, BACnet.
- .2 Electronic thermostat and DDC control module to operate heating, economizer dampers and power exhaust fans, and cooling in sequence in response to thermostat sensed temperature.
- .3 Remote status panel with indicating lights showing heat mode, cool mode, compressor operation, no heat, filter and touch sensitive key pad to allow hour/day operating program and adjustment of thermostat set point.
- .4 Connection to BAS shall be over BACnet MS/TP.

## **2.14 Electrical Control Panel**

- .1 Single point power supply with;
  - .1 power connection,
  - .2 control interlock terminals,
  - .3 unit control system located in sheet metal weatherproof enclosure.
- .2 Circuit protection for;
  - .1 compressors and starters,
  - .2 fans and control circuit,



- .3 solid state sequence timer,
- .4 compressor motor overload protection with current sensing in three passes,
- .5 control transformer.

### **3 EXECUTION**

#### **3.1 Installation**

- .1 Install roof curb and place unit on curb with adequate clearance for service and maintenance.
- .2 Connect ductwork, and gas piping.
- .3 Provide un-fused weatherproof disconnect on or adjacent unit and run electric power and control wiring.

#### **3.2 Start-up Service**

- .1 Arrange for manufacturers' field representative to supervise installation, start-up unit and instruct Owners operations and maintenance personnel.

**END OF SECTION**

## **SPLIT-SYSTEM AIR-CONDITIONERS**

### **23 81 26**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide ductless or ducted split-system air-conditioning units and heat pump units, of the air-source and/or air-sink type, as shown.
- .2 Products covered by this specification section are limited to a cooling capacity of 5 tons or less or heating capacity of 18 kW or less.

##### **1.2 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 CSA B52 Mechanical Refrigeration Code
- .2 Product standards:
  - .1 AHRI 210/240 Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
  - .2 CSA C656 Performance Standard for Split-System and Single-Package Air Conditioners and Heat Pumps
  - .3 UL/CSA C22.2 No. 60335-2-40 Household and Similar Electrical Appliances – Safety – Part 2-40: Particular Requirements for electrical Heat Pumps, Air-Conditioners and Dehumidifiers

##### **1.3 Submittals**

- .1 Submit shop drawings for each condensing unit and evaporator with;
  - .1 equipment model number,
  - .2 outline dimensions,
  - .3 enclosure details,
  - .4 space requirements for service and maintenance,
  - .5 support arrangements.
  - .6 rating information showing capacity and power input requirements for heating and cooling at full load.
  - .7 diagrams showing;
    - (a) requirements for field assembly with air flows, connection pipe sizes and rated air flow,
    - (b) unit internal and external electrical power and control wiring with motors, starters, relays and interlocks identified, and with terminal and wire numbers marked.

##### **1.4 Warranty**

- .1 Components to be warranted against manufacturer defects for minimum of five (5) years parts only.
- .2 Complete system to be warranted due to any failure of the system for a minimum of two (2) years for parts, labour, refrigerant and other materials used in correcting the defect, including cleaning, dehydrating and charging the refrigeration system.
- .3 The warranty period is to commence on the date the equipment is turned over to the Owner for use.

## **2 PRODUCTS**

### **2.1 General**

- .1 Package system, factory assembled and tested with pre-charged refrigeration piping, refrigerant and oil charge.
- .2 Single indoor unit for each outdoor unit type.
- .3 Refrigerant type: R-32, R-410A
- .4 Listed to UL/CSA C22.2 No. 60335-2-40
- .5 Listed to CSA C656 or AHRI 210/240 for energy performance.
- .6 Cooling/heating performance: as shown.
- .7 Energy efficiency rating: conform to requirements of ASHRAE 90.1:2016, Table X
- .8 Ready for connection of electric power at evaporator unit and condensing unit and control wiring between units.

#### *Standard of Acceptance*

- Trane
- Daikin
- York
- LG
- Mitsubishi

### **2.2 Indoor Unit**

- .1 Style: exposed indoor evaporator unit.
- .2 Components:
  - .1 refrigeration: Pre-charged direct expansion type cooling coil, arranged with counter flow between air and refrigerant, switching valve for heat-pump units,
  - .2 indoor fan: four speed motors, statically and dynamically balanced, ECM or PSC type.
  - .3 automatic swinging discharge louvres,
  - .4 filters: disposable filters for particulate and odour control,
  - .5 condensate pan draining to 20 mm (¾ in) side outlet connection.
- .3 Casing:
  - .1 exposed units: plastic enclosure with removable panels for servicing,
  - .2 concealed units: enamel sheet metal enclosure with access doors and concealed fasteners,
  - .3 concealed suspension brackets.
- .4 Performance:
  - .1 operating sound level: not to exceed 45 dB(A) at high speed and 30 dBA at low speed measured at 1.0 m (40 in.) from front of unit.
- .5 Power supply: 120 VAC, 60 Hz, 1 phase.

### **2.3 Outdoor Unit**

- .1 Style: outdoor, air-sink for cooling and/or air-source for heat pump.
- .2 Outdoor operating air temperature range:

- .1 cooling: -20 to 45°C (-4 to 100°F)
- .2 heating: -15 to 18°C (5 to 65°F)
- .3 Refrigeration systems:
  - .1 variable-speed hermetic refrigeration compressor and inverter-duty motor with ECM or PSC motor, with vibration isolation,
  - .2 refrigeration coil: copper tube with aluminium fins,
  - .3 for heat pump units:
    - (a) refrigerant liquid heater,
    - (b) automatic defroster control system,
  - .4 condenser fans with ECM or PSC motor, motor controllers and head-pressure control.
- .4 Enclosure:
  - .1 sheet metal enclosure with mounting lugs and fan safety grille primed and enameled to withstand 1000 hr salt spray test.
  - .2 low ambient operation to -22°C (-7°F)
- .5 Performance:
  - .1 operating sound level: not to exceed 50 dB(A) measured at 1.0 m (40 in.) from front of unit.
- .6 Power supply: 208/230 VAC, 60 Hz, 1 phase.

## **2.4 Refrigerant Piping**

- .1 Piping, valves, fittings and related parts to CSA B52.
- .2 Pre-charged copper tube liquid and gas piping,
- .3 Pipe insulation: factory insulated, 19 mm (¾ in) thick flexible elastomeric insulation on suction line.

## **2.5 Temperature Control System**

- .1 Hard wired electronic thermostat and control module to operate heating, and cooling in sequence in response to thermostat sensed temperature, with indication for;
  - .1 operating mode (heat/cool),
  - .2 compressor operation,
  - .3 no heat,
  - .4 touch sensitive keypad to allow hour/day operating program and adjustment of thermostat set point,
  - .5 programmable operating time schedule,

# **3 EXECUTION**

## **3.1 Installation**

- .1 Install packaged split-system air-conditioner and/or heat pump system in accordance with manufacturer instructions.
- .2 Install indoor unit and route condensate drain piping as shown.
- .3 Install outdoor unit with adequate clearance for service and maintenance; strictly adhere to the minimum ventilation clearance as stated in the manufacturer's instructions.
- .4 Run refrigeration suction and liquid piping as shown in accordance with manufacturer's instructions with respect to horizontal and vertical length limitations.

- .5 Charge systems with refrigerant and conduct leakage test in accordance with manufacturer's instructions.
- .6 Provide sheet-metal wind-baffle shield on condenser as required by manufacturer's instructions for low ambient operation.

### **3.2 Electrical**

- .1 Provide un-fused weatherproof disconnect within 3 m (10 ft.) to the outdoor unit.
- .2 Provide a recessed single-pole, motor-rated unfused disconnect toggle-switch with white cover plate for the indoor unit. Locate the disconnect switch immediately to the side of the indoor unit, with top of switch level with top of indoor unit enclosure.
- .3 Unless otherwise shown in the manufacturer literature, run power and control wiring from the outdoor unit to the indoor unit; for clarity, the indoor unit power is to have power sub-fed from the outdoor unit.

### **3.3 Start-up, Testing and Records**

- .1 Start-up and test the complete installation in accordance with the manufacturer's instructions.
- .2 Create and maintain a written start-up and test report demonstrating compliance with all installation and testing required by the equipment manufacturer, including any requirements necessary to validate the warranty. Include records of measured test results as necessary to validate conformity to those start-up requirements.
- .3 Submit the start-up and test record with the operating and maintenance manuals.

**END OF SECTION**

## **HYDRONIC DUCT-MOUNTED AIR COILS**

### **23 82 16**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide hydronic duct-mounted heat transfer coils (reheat coils) and accessories as shown.
- .2 This section applies to:
  - .1 duct-run mounted reheat coils.

### **1.2 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code
- .2 Product standards:
  - .1 AHRI 410 Forced-Circulation Air-Handling and Air-Conditioning Coils
  - .2 ASME B1.20.1 Pipe Threads, General Purpose, Inch
  - .3 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

### **1.3 Design Criteria**

- .1 Coils to have a Canadian Registration Number ("CRN") in accordance with CSA B51.

### **1.4 Submittals**

- .1 Submit manufacturers product sheets with performance data for products specified herein.
- .2 Coil shop drawing data to include:
  - .1 coil size: face area, tube length, tube face, number of rows, circuiting arrangement,
  - .2 construction: tube material and size, fin material and spacing, header material and connection sizes, casing and tube support material,
  - .3 heat transfer fluid performance: working pressure, fluid flow rate, entering and leaving fluid temperatures, entering steam pressure and leaving condensate pressure, tube fluid velocity, and fluid pressure drop,
  - .4 air side performance: air flow rate, entering air dry-bulb and wet-bulb temperatures, leaving air dry-bulb and wet-bulb temperatures, and air side pressure drop.
  - .5 AHRI certified performance.

## **2 PRODUCTS**

### **2.1 Water Reheat (Booster) Coils**

- .1 General:
  - .1 coil performance certified to AHRI 410 where the water supply temperature is greater than 49°C (120°F).
  - .2 coil design criteria to be in accordance with the following table except as otherwise shown on equipment schedules or drawings:

Parameter	Value SI	Value IP
Minimum design pressure	1720 kPa	(250 psig)
Airside face velocity, maximum	2.5 m/s	(500 FPM)
Airside pressure drop, maximum	50 Pa	(0.2 in.w.c)
Fluid tube velocity, maximum	2.5 m/s	(8.3 fps)
Fluid side pressure drop - water	15 kPa	(5 ft)

**.2 Construction:**

- .1 tubes: copper, minimum 0.5mm (0.020 in) wall thickness, serpentine circuited,
- .2 fins: aluminum,
- .3 fin density: not more than 640 fins/m (16 fins/in),
- .4 maximum tube length: 750 mm (2 ft-6in).
- .5 factory leak tested with air under water between 120 and 150% of design pressure.
- .6 coil connections:
  - (a) NPS 2 and smaller: threaded to ASME B1.20.1.
- .7 Casings and tube supports:
  - (a) 1.6 mm (16 ga) thick galvanized sheet steel with out-of-face flange for bolting to ductwork or equipment, or with slip and drive connections.

*Standard of Acceptance*

- Aerofin
- Cancoil
- Carrier
- Coil Company
- Daikin
- RAE Coils
- Engineered Air
- Heatcraft
- Marlo Heat Transfer Solutions
- McQuay
- RefPlus
- Trane
- USA Coil & Air
- Ventrol
- York

**3 EXECUTION****3.1 Coil Installation**

- .1 Install coils in accordance with manufacturer's instructions, with specific attention given to air inlet flow direction.
- .2 Support reheat coils located in ductwork independently of the ductwork with use of threaded rod at each corner of the reheat coil;
  - .1 for factory mounted terminal unit reheat coils, coils are supported as part of the terminal unit.
  - .2 for venturi valves, support reheat coils in accordance with requirements for duct mounted coils.

### **3.2 Ductwork Installation**

- .1 Where coils have flange duct connections, provide neoprene gasket between coil flange and duct flange.
- .2 Make connections to reheat coils with gradual transitions;
  - .1 inlet transition angel: maximum 30°,
  - .2 outlet transition angle: maximum 30°,
  - .3 where reheat coil height exceeds duct height, arrange reheat coil to maintain a constant centerline between coil and ducts;
    - (a) where clearance above duct does not permit maintaining a constant centerline, elevate the coil as high as possible to minimize centerline offset.
- .3 For terminal unit reheat coils, make duct connections to coil at full size of coil connections.
- .4 Provide access doors on both sides of reheat coil;
  - .1 size: 300 x 300 mm (12 in x 12 in),
  - .2 where duct width/height dimension is less than 350 mm (14 in), access door dimension is to be duct width/height less 50 mm (2 in).
  - .3 install access doors on bottom of duct (preferred position); access doors may be installed on side of duct where bottom access is obstructed.

### **3.3 Piping Installation**

- .1 Make piping connections to reheat coils as follows:
  - .1 supply piping: provide manual shut-off valve, strainer, union, and flexible connector,
  - .2 return piping: provide manual shut-off valve, pressure independent control valve, union and flexible connector,
  - .3 make supply connections to lower coil connection,
  - .4 provide unions between the flexible connector and pipeline, unless flexible connector is provided with an integral union joint.
- .2 Flexible connector installation:
  - .1 locate flexible connectors between the coil connections and valves and strainers,
  - .2 arrange flexible connectors to remain in a single plane, with the maximum offset in any direction not exceeding 25 mm (1 in.).
  - .3 do not bend flexible connectors; provide an elbow fitting on coil connection.
- .3 Provide coil drain on supply side piping.
- .4 Provide screwdriver air vents on both supply and return piping between valves and flexible connectors.
- .5 Refer to Section 23 21 16 for Valve Enclosure Box requirements.

**END OF SECTION**



## STEAM HUMIDIFIERS 23 84 13.23

### 1 GENERAL

#### 1.1 Scope

- .1 Provide steam humidifiers as shown including:
  - .1 atmospheric steam humidifiers,

#### 1.2 Related Section

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 23 84 29 Humidification Steam Generator

#### 1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
  - .1 CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code
- .2 Product standards:
  - .1 AHRI 640 Performance Rating of Commercial and Industrial Humidifiers

#### 1.4 Definitions

- .1 The following definitions apply to this section:
  - .1 **Atmospheric** (humidifier): a steam humidifier operating at a nominal steam pressure of 0-1250 Pa (0 to 5 in.w.c.).
  - .2 **Maximum absorption distance**: the maximum distance downstream of the humidifier, in which the humidification fluid will be fully absorbed by the air stream, and beyond which distance there shall be no water accumulation on the interior surface of the duct or plenum and the equipment contained therein.
  - .3 **Pressurized** (humidifier): a steam humidifier operating at steam pressures of 35 kPa (5 psig) and higher.

#### 1.5 Design Criteria

- .1 Manufacturer to design, select, and construct the humidifier taking into due consideration the location of the humidifier and related conditions that may affect the installation and performance of the humidifier.

#### 1.6 Submittals

- .1 Submit manufacturer's data sheets, and piping and wiring diagrams, showing:
  - .1 capacities and absorption distances,
  - .2 steam supply pressure and total flow rate requirements, including estimated condensate losses based on specified conditions,
  - .3 recommended installation methods,
- .2 Submit manufacturers test data substantiating absorption distances with air entering the humidifier at 13°C (55°F) and 65%RH at the design air velocity.

## **2 PRODUCTS**

### **2.1 Atmospheric Steam Dispersion Tubes**

- .1 General:
  - .1 atmospheric steam humidifier, single steam distribution tube,
  - .2 application: air handling units, and duct mounted.
  - .3 steam source: local steam generator to section 23 84 29.
- .2 Performance:
  - .1 capacity: as shown on drawings.
  - .2 inlet operating pressure: 0-1.25 kPa (0 - 5 in.w.c.),
  - .3 maximum absorption distance:
    - (a) air handling units: 1000 mm (39 in) at 2.5 m/s (500 fpm)
    - (b) ductwork: 1000 mm (39 in) at 7.5 m/s (1500 fpm)
- .3 Construction:
  - .1 single tube with equally spaced steam dispersion openings,
  - .2 materials: type 304/304L stainless steel for all wetted components and components exposed to the air stream,
  - .3 steam and condensate connections on same end of header, designed for positive condensate drainage,
  - .4 distribution tube length coverage: not less than 80% of the duct width,

## **3 EXECUTION**

### **3.1 Installation - General**

- .1 Mount and fit humidifiers in accordance with manufacturer's instructions.

### **3.2 Installation – Atmospheric Steam Humidifiers**

- .1 Provide steam supply piping in accordance with specification section 23 84 29.
- .2 Provide condensate drainage piping as follows:
  - .1 where the humidifier drain outlet is located above the top of the local steam generator, drain the humidifier condensate to the steam generator, and include a pigtail steam trap having a minimum diameter of 150 mm (6 in),
  - .2 where the humidifier drain outlet is located so that it cannot be drained by gravity to the steam generator, provide a S-trap in accordance with the manufacturer's instructions, or in their absence as follows:
    - (a) top of S-trap: at least 150 mm (6 in) below the humidifier drain outlet,
    - (b) depth of S-trap: at least 200 mm (\* in),
    - (c) discharge the outlet of the S-trap over a floor drain with a minimum 25 mm (1 in) airgap.
  - .3 Slope condensate drainage piping downward in direction of flow at a slope of 4% (1 in 25).

### **3.3 Supervision and Start-up**

- .1 Where humidifiers require field assembly of components, including placement in ductwork, arrange and pay for services of a trained manufacturer's service representative to inspect the installation prior to

start-up. Make any corrections to deficiencies identified by this inspection or as identified by the Consultant.

### **3.4 Commissioning Program**

- .1 Where a commissioning program is used, the SAT shall be performed as part of the commissioning test program, and not separately, unless the commissioning program requires separate tests.
- .2 During commissioning, the contractor shall
  - .1 have control and operation of equipment during testing;
  - .2 make adjustments to the equipment controls as required to simulate load and/or fault conditions; and
  - .3 assist with record keeping of test results.

**END OF SECTION**

## HUMIDIFICATION STEAM GENERATORS 23 84 29

### 1 GENERAL

#### 1.1 Scope

- .1 Provide steam generators to supply steam to atmospheric humidifiers as shown including:
  - .1 electric steam generators

#### 1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 23 22 13.29 Steam and Condensate Tubing - Humidification
  - .2 23 84 13.23 Steam Humidifiers

#### 1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
  - .1 CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code
- .2 Product standards:
  - .1 AHRI 640 Performance Rating of Commercial and Industrial Humidifiers
  - .2 UL 998/  
CSA C22.2 No. 104 Humidifiers
  - .3 ULC-S636 Standard for Type BH Gas Venting Systems

#### 1.4 Definitions

- .1 The following definitions apply to this section.
  - .1 **Atmospheric** (humidifier): a steam humidifier operating at a nominal steam pressure of 0-1250 Pa (0 to 5 in.w.c.).

#### 1.5 Design Criteria

- .1 Potable water quality:
  - .1 water source: City of Toronto
  - .2 total cold water hardness: 130 mg/L
  - .3 average total dissolved solids (TDS): 210 ppm
  - .4 conductivity: 328  $\mu$ S/cm
  - .5 free residual chlorine: 3 mg/L
  - .6 supply water pressure: 240 kPa (35 psi)
  - .7 minimum city supply water temperature: 4°C (40°F)

#### 1.6 Submittals

- .1 Submit manufacturer's data sheets, and piping and wiring diagrams, showing:
  - .1 capacities
  - .2 minimum/maximum water quality and water pressure requirements,
  - .3 recommended installation methods,

- .4 power, control signal, and control wiring, clearly indicating factory installed wiring versus field installed wiring requirements.

## **2 PRODUCTS**

### **2.1 Electrode Humidification Steam Generator**

#### **.1 General:**

- .1 disposable cylinder-type electrode steam generator for production of steam at atmospheric pressure, for indoor use.
- .2 application: ductwork
- .3 maximum design pressure: 70 kPa (10 psi).
- .4 listed to CSA C22.2 No. 104.

#### *Standard of Acceptance*

- Condair (Nortec) - fig. EL series
- Armstrong - fig. EHU series
- Dri-Steam - fig. XT series
- Carnes

#### **.2 Performance:**

- .1 humidification generation capacity application rating to conform to AHRI 640, Group II.
- .2 thermal efficiency: not less than 98% over cylinder life-time,
- .3 capacity turndown range: 20 – 100%
- .4 feedwater conductivity range: 125 to 1250  $\mu\text{S/cm}$

#### **.3 Unit:**

- .1 wall mounted steel cabinet with powder coated finish, with key locked access doors,
- .2 ventilated air gap between heated section and electrical section,
- .3 solenoid make-up valve with strainer and flow regulating device,
- .4 blow-down quench water solenoid valve,
- .5 integral fill cup with 25 mm (1 in) air gap, sized to allow steam pressure of 1.25 kPa (5 in.w.c)

#### **.4 Cylinders:**

- .1 disposable cylinders with integral electrodes,

#### **.5 Controller:**

- .1 microprocessor controller with embedded web interface,
- .2 proportional/integral modulating control,
- .3 touchscreen TFT LCD display, for operating data and operator adjustment of control setpoints,
- .4 building automation system integration: BACnet MSTP and Modbus RTU,
- .5 two analog inputs for remote demand control and relative humidity transmitter input
- .6 operating and alarm lights on front of cabinet,

#### **.6 Control functions:**

- .1 automatic water level control in response to scaling of electrodes,
- .2 automatic blow-down/drain to regulate water conductivity,

- .3 automatic drain water temperature control of quench cooling water to limit drain water outlet temperature to not exceed 60°C (140°F),
- .4 full cylinder indication (replacement) with pre-notification alert for pending shut-down,
- .5 automatic cleaning of drain solenoid valve,
- .6 automatic shut-down and cylinder drain when there has been no call for steam demand for adjustable time period (days).
- .7 proof-of-airflow start/run permissive interlock,

## **2.2 Accessories**

- .1 Airflow pressure differential switch to establish airflow before energizing generator,
- .2 Floor stand
- .3 Inline 5 micron water filter.

## **2.3 Steam and Condensate Distribution Hose**

- .1 As supplied by steam generator manufacturer.
- .2 For connection between generator and steam humidifier, and may be used to connect generator and humidifier to hard-piped steam lines.
- .3 Steam hose:
  - .1 maximum hose length: 3 m (10 ft)
  - .2 size:
    - (a) Ø22mm (7/8 in.) I.D. for steam load up to 15 kg/hr (33 lb/hr),
    - (b) Ø45mm (1-3/4 in) I.D. for higher steam capacity,
  - .3 Include steam trap tees for draining of low points.
- .4 Condensate hose:
  - .1 size: Ø9.5mm (3/8 in) I.D.

## **2.4 Atmospheric Steam Humidifier**

- .1 To Section 23 84 13.23

# **3 EXECUTION**

## **3.1 Installation**

- .1 Mount and fit units in accordance with manufacturer's instructions. Install with required clearance for service and maintenance.
- .2 Provide potable cold water or treated water piping to steam generator, and provide isolating valve. Install the pre-filter after the isolation valve, complete with unions on each side of the pre-filter.
- .3 Provide interconnecting hose and/or piping between the steam generator and the humidifier. Where the length of the steam piping is greater than 3 m (10 ft), use rigid piping except for final 300 mm (12 in) at the steam generator and humidifier, where steam hose can be used.
- .4 Provide drainage piping from drain outlets of the steam generator equipment and extend to the nearest floor or hub drain.
- .5 Provide power and control wiring to steam generator. Coordinate with the building automation system (BAS) contractor for termination of control input and monitoring points.
- .6 Locate steam generator close to and below humidifiers.

### **3.2 Piping and Tubing**

- .1 Provide rigid steam and condensate piping in accordance with Specification section 23 22 13.29.

### **3.3 Supervision and Start-up**

- .1 Arrange and pay for services of a trained manufacturer's service representative to inspect the installation prior to start-up. Make any corrections to deficiencies identified by this inspection or as identified by the Consultant.
- .2 Start-up and test the equipment and associated supporting services, all in accordance with the applicable equipment manufacturer instructions.

### **3.4 Commissioning Program**

- .1 Where a commissioning program is used, testing of the steam generator shall be performed as part of the commissioning test program, and not separately, unless the commissioning program requires separate tests.
- .2 During commissioning, the contractor shall
  - .1 have control and operation of equipment during testing;
  - .2 make adjustments to the equipment controls as required to simulate load and/or fault conditions; and
  - .3 assist with record keeping of test results.

### **3.5 Demonstration and Training**

- .1 Demonstrate the operation of, and provide training on, the system in accordance with section 20 05 01.

**END OF SECTION**

## **BUILDING AUTOMATION COMMON WORK RESULTS**

### **25 05 01**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide a building automation system ("BAS") for control and supervisory management of facility mechanical and electrical equipment systems.
- .2 The BAS is to be a direct digital control ("DDC") system with digital/electric instrumentation and electric operation.
- .3 The BAS is to integrate with:
  - .1 other building services subsystems including [lighting control systems, access control systems and fire alarm systems,
  - .2 facility equipment other than equipment and systems under Divisions 20 to 28.
- .4 During the tender period, the contractor must perform a site inspection of the place of work and surroundings as well as areas where access would be considered reasonable and make a thorough investigation of as-built conditions to determine the scope of work required relating to existing controls equipment and main trunk locations, prior to submitting their tender price.
- .5 Controls Contractor must use previously agreed "Open Book Pricing" for this Project. Consultant will request confirmation of this.
- .6 Extend/modify existing hospital Building Automation System (BAS) with Direct Digital Control (DDC), and Energy Management for new mechanical systems and interface with other microprocessor based building subsystems.
  - .1 Controls contractor is to include for all upgrades required to the existing system (including software/hardware/controllers/licenses/etc.) as required to interface all new points and controllers into BAS.
  - .2 Provide programming and decommissioning for demolition of existing BAS headend including graphics, trends, and schedule.
  - .3 Products (including control devices, controllers, instrumentation, thermostats, etc.), controls strategies, and labelling scheme shall match base building standards.
- .7 Power and data will be terminated by Division 26. A new control panel shall be installed in these locations only and all new controls taken to/from this location.
- .8 Sequence of operations are documented on drawings and in the specifications.
- .9 Refer to spec Section 20 05 02 for spare control points to be included in contract.

##### **1.2 Dependent Sections**

- .1 The BAS Work is further defined in the following specification sections:

25 05 02	Building Automation Alternate and Separate Prices
25 05 06	Work on Existing Building Automation
25 05 11	Building Automation Control Panels and Wiring
25 30 13	Building Automation Actuators and Operators
25 30 16.13	Building Automation Instrumentation
25 30 16.16	Building Automation Room Pressure Monitoring
25 30 19.13	Building Automation Control Valves
25 30 19.16	Building Automation PICV and Energy Valves



25 30 23.13	Building Automation Control Dampers
25 90 01	Building Automation Control Sequences

### 1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the BAS system is further described in the following the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 12 Common Electrical Requirements for Mechanical Services
  - .2 20 08 11 Testing of Mechanical Life Safety and Fire Protection Requirements

### 1.4 Equipment Supplied for Installation under Other Sections

- .1 Supply the following equipment for installation under other Sections of Division 20;
  - .1 automatic control valves and pressure independent control valves,
  - .2 instrumentation including pressure sensors, flow meters and energy meters to be installed in piping systems,
  - .3 temperature wells for controllers and sensors provided under this Section, for installation in piping systems,
  - .4 instrumentation including air flow stations to be installed in ductwork systems,
  - .5 motorized dampers, except:
    - (a) where provided as part of factory built air handling units,
    - (b) motorized fire dampers, smoke dampers and/or combination fire/smoke dampers,

### 1.5 Equipment Provided under Other Divisions

- .1 The following equipment is provided under other Sections of Division 20;
  - .1 steam humidifiers with automatic control valves,
  - .2 unit heater and cabinet unit heater line voltage thermostats,
  - .3 manual dampers, non-motorized fire dampers, and gravity dampers,
  - .4 motorized fire dampers, smoke dampers and combination smoke/fire dampers, including damper actuators,

### 1.6 Definitions and Abbreviations

- .1 The following definitions, abbreviations, and acronyms apply to this Division of the Work:
  - .1 AI Analog Input: continuously variable value, usually a sensor, referenced to a controller
  - .2 AO Analog Output: continuously variable value, usually a control signal to an actuator device, referenced to a controller.
  - .3 ASC Application Specific Controller
  - .4 DI Digital Input: a two-state (On-Off) value, usually associated with a switch or state, referenced to a controller.
  - .5 DO Digital Output: a two-state (On-Off) value, usually associated with starting or stopping equipment or generating an alarm, referenced to a controller.
  - .6 FC Fail Close (valve or damper action on failure of the controller)
  - .7 FO Fail Open (valve or damper action on failure of the controller)

- .8 FAS Fire Alarm System
- .9 GUI Graphic User Interface: an LED, LCD or monitor display
- .10 I/O Input/Output
- .11 LAN Local Area Network
- .12 NC Normally Closed: position of device in a de-energized state.
- .13 NO Normally Open: position of device in a de-energized state.
- .14 NSC Network Supervisory Controller
- .15 OEM Original Equipment Manufacturer
- .16 OWS Operator workstation: a PC based server or computer
- .17 Tier 1 Building level network providing communication between NSCs and workstations.
- .18 Tier 2 Field level network providing communications between ASCs and NSCs
- .19 WAN Wide Area Network

### **1.7 Applicable Codes and Standards**

- .1 Product standards:
  - .1 ANSI/ASHRAE 135 BACnet – A Data Communication Protocol for Building Automation and Control Networks
  - .2 ANSI/CEA 709.1 Control Network Protocol Specification (Lonworks)
- .2 Interfacing Standard:
  - .1 Input/output devices to use ASCII (American Standard for Communication and Information Interchange) code and standard EI (Electronic Industry Association) interfaces.
    - (a) CSA T530 Commercial Building Standard for Telecommunications Pathways and Spaces
    - (b) IEEE 802.3 Ethernet

### **1.8 Qualified Tradesperson**

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.
- .2 BAS to be provided by an organization that:
  - .1 specializes in design, installation, commissioning and service of BAS systems,
  - .2 has completed five (5) projects of similar size and complexity within the preceding five (5) years,
  - .3 employs licensed journeymen experienced in this type of work,
  - .4 Work to be performed by Johnson Controls Inc. using tradespersons holding applicable certificates of competency.

*Standard of Acceptance*(no alternates)

- Johnson Controls (Metasys NAE)

### **1.9 Design Services**

- .1 Provide engineering services for the design of the BAS including product selection, wiring details, and all installation details to meet the prescribed and performance requirements described in the specifications sections of Division 25. Issued design documents are to be sealed by a professional engineer licensed in the province of the Work.

- .2 Prior to preparation of shop drawings for the BAS, provide a design assist to review Consultant's sequence of operation and provide feedback on any recommendation that may improve the installation or ease of operation, while remaining within the hardware scope as originally designed and specified herein.

#### **1.10 Licences and Ownership**

- .1 Ownership of, and licences for, hardware and software supplied or used for this project or for ongoing system operation, maintenance and modification to be registered, without restrictions, in Owner's name.
- .2 This is applicable to System Software, Workstation Application Editors, and Controller Software.
- .3 Licensing to permit an unlimited number of users to access system without additional fees.
- .4 At the time of substantial performance of the Work, upgrade the BAS software to the most current release version at that time, at no additional cost to the Owner.
- .5 Project-developed software and resulting documentation to be treated as part of system and subject to these same requirements for ownership and licensing. This material includes;
  - .1 project graphic images,
  - .2 CAD generated record drawings,
  - .3 project database,
  - .4 project-specific application programming code and documentation.

#### **1.11 Submittals**

- .1 Submit one (1) completely engineered and coordinated shop drawing package. Partial or incomplete submission of data and/or drawings will be returned without review.
- .2 Submit shop drawings for designed elements;
  - .1 list of materials of equipment to be used indicating manufacturer, model number, and other relevant technical data,
  - .2 BAS riser diagram showing system controllers, operator workstations, network devices, and network wiring,
  - .3 control panel internal wiring diagrams, .
  - .4 single-line schematics and system flow diagrams showing location of control devices,
  - .5 wiring diagrams identifying interface hard-wire terminations to controlled equipment OEM control panels,
  - .6 points list for each system controller, including: Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Panel, Reference Drawing, and Cable Number,
    - (a) points to be named by function, and list to include software points such as programmable set-points, range limits, time delays, and so forth,
  - .7 detailed analysis of each Sequence of Operation from Consultant's design documents, ready for development of actual programming code,
  - .8 written Sequence of Operations to cover normal operation and operation under various alarm conditions applicable to that system.
- .3 Submit shop drawing schedules for;
  - .1 control dampers: spreadsheet type, to include separate line for each damper and columns for damper attributes.

- .2 control valve: spreadsheet type, to include separate line for each valve and separate columns for valve attributes.
- .4 Submit catalogue cut-sheets for;
  - .1 manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for equipment and hardware items as follows;
    - (a) controllers (NSC's and ASC's),
    - (b) instrumentation, including
      - i) accuracy data, range and scale information,
      - ii) one sheet for each device marked with applicable options. Where several devices of same type are to be used, submit one sheet for each device, individually marked.
    - (c) actuators,
    - (d) valves and dampers,
    - (e) relays/switches,
    - (f) control panel enclosures,
    - (g) power supplies,
    - (h) batteries,
    - (i) GUI operator interfaces,
    - (j) wiring and wiring accessories.
- .5 Submit supporting documentation:
  - .1 representative examples of graphics for GUI to include;
    - (a) BAS network schematics,
    - (b) typical terminal unit floor plan graphic that shows conditions on occupied floor,
    - (c) typical equipment room floor plan graphic,
    - (d) typical graphics for each system and terminal unit at least one sample graphic for each type of equipment,
    - (e) one sample graphic for chilled water system,
    - (f) one sample graphic for hot water system,
    - (g) description of techniques used for dynamic display of information on graphics and method of how building operator drills down to secondary information and affects control of equipment.
  - .2 Protocol Implementation Conformance (PIC) statement for BACnet devices,
  - .3 where interfaces occur with control or wiring diagrams of other sections, obtain reproducible copies of those diagrams and revise to show terminal numbers at interface and include diagrams as part of interconnection schematic shop drawings.

## **1.12 Quality Control**

- .1 Continuity of staff and subcontractors:
  - .1 Controls contractor's project manager is to be nominated at time of shop drawing submission and is to remain involved with the project, from shop drawing preparation through to project acceptance, unless a request for change of personnel is submitted to and approved by Owner.
  - .2 Subcontractors listed in preliminary design submission are to execute the Work defined as sublet in preliminary design document, unless request for change is submitted to and approved by Owner.
  - .3 Requests for changes in staff, subcontractors, or extent of work subcontracted are to be submitted for approval by Owner and such approval is not to be unreasonably withheld.
- .2 Identification of non-conforming materials and equipment:

- .1 Submit documentation at time of bid, identifying nature and extent of non-conformance and variances from specifications or referenced standards.
- .2 Failure to submit this documentation at time of bid will be interpreted as confirmation that materials, workmanship, hardware and software will be in strict accordance with specifications and standards.
- .3 All products that are connected to a piping system that is subject to registration under applicable boiler and pressure vessel legislation are to have current Canadian Registration Numbers in accordance with CSA B51.
- .4 Site Acceptance Testing
  - .1 Manufacturer to provide services of manufacturer's authorized service personnel in accordance with the requirements of Part 3 of this specification.

### **1.13 Warranty**

- .1 At completion of Work, submit written guarantee undertaking to remedy defects in work for period of two (2) years from date of acceptance, which includes:
  - .1 rectification of control system failures attributable to defects in workmanship, materials, hardware, and software,
  - .2 service technician to arrive on site within 24 hours of warranty service request, to install and debug software patches, to replace defective parts, materials or equipment, and to provide incidental supplies, and labour for remedial work,
  - .3 technician to remain in attendance until system is returned to operating condition.
- .2 Submit similar guarantee for any part of the Work accepted by Owner, before completion of whole work.

## **2 PRODUCTS**

### **2.1 General**

- .1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges unless otherwise specified in other specification sections of Division 25:
  - .1 temperature: 0°C to 40°C (32°F to 104°F)
  - .2 relative humidity 10% to 90% non-condensing
  - .3 electrical power service of single phase, 120 VAC +/- 10%, 60 Hz nominal.
- .2 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.

### **2.2 Equipment Standard**

- .1 Products and software: manufacturer/developer/supplier's catalogued current stock.
- .2 This installation is not to be used as test site for newly developed product or software, without explicit written approval by Owner.
- .3 Equipment and systems installed to meet;
  - .1 performance specifications when subjected to VHF, UHF, FM, AM or background RFI as generated by commercial or private, portable or fixed transmitters that meet regulatory codes,
  - .2 Federal Communication Commission (FCC) Rules and Regulations, Part 15, Subpart J for computing devices.

## **2.3 BAS General Functional Requirements**

- .1 Control mechanical and electrical equipment as specified in control sequences, shown on control schematics, detailed in Points Lists, and described in equipment schedules.
- .2 Scalable system architecture to be modular, permitting stepped expansion of application software, system peripherals, and field hardware.
- .3 Control system:
  - .1 high-speed, peer-to-peer network of microprocessor based Direct Digital Control (DDC) controllers with web-based operator interface,
  - .2 each mechanical system, building floor plan, and control device to be displayed through point-and-click graphics,
  - .3 Web server with network interface card to gather data from this system and generate web pages that can be accessed through conventional web browser on any PC connected to network,
  - .4 operators to access this system through web browser on connected PC's, wireless tablet PCs and smart phones to perform normal operator functions,
  - .5 scalable, modular, automatic process and optimized workflows, with automatic data acquisition and energy performance analytics,
- .4 Each controller;
  - .1 operates with local closed loop programming, independent from server, able to continue functional control if peer-to-peer communication is interrupted;
  - .2 performs resident control routines;
    - (a) receiving information from field mounted sensors and switches and
    - (b) transmitting instructions to actuators to perform control sequences.
  - .3 manages local hardware and software alarms;
    - (a) to collect historical data,
    - (b) to facilitate operator input and output,
    - (c) to communicate with Central BAS web server and GUI.
- .5 Central BAS Web server;
  - .1 performs global application programs and data consolidation;
    - (a) communicating with controllers,
    - (b) obtaining data from field devices for central monitoring of building systems, and
    - (c) transmitting instructions to controllers.
  - .2 has software routines for;
    - (a) BAS Server operation,
    - (b) database creation and data storage,
    - (c) web based GUI with graphics generation and display,
    - (d) report formulation, printing, and presentation,
    - (e) alarm detection, management and reporting,
    - (f) event initiated programming.

## **2.4 Network Integration Functional Requirements**

- .1 Open protocol:
  - .1 Provide an integrated, open protocol building automation system using BACnet to ANSI/ASHRAE Standard 135, with native integration with:

- (a) Lonworks,
  - (b) Modbus,
  - (c) OPC (OLE for process control).
  - (d) ONVIF,
  - (e) DALI.
- .2 Integral systems integration functionality:
  - .1 provide hardware and software to allow bi-directional digital communications between BAS and facility control subsystems including:
    - (a) HVAC,
    - (b) fire safety including fire alarm systems,
    - (c) security systems,
    - (d) power control and monitoring systems,
    - (e) lighting control systems,
    - (f) 3<sup>rd</sup> party integration with other facility systems.
- .3 OEM Controller integration:
  - .1 provide hardware and software to allow bi-directional digital communications between BAS and 3<sup>rd</sup> party manufacturers' equipment control panels including but not limited to;
    - (a) boilers,
    - (b) chillers,
    - (c) variable frequency drives,
    - (d) packaged HVAC equipment,
    - (e) power monitoring equipment,
    - (f) medical gas equipment.
  - .2 integrate real-time data from these systems.

## **2.5 BMS Network Architecture**

- .1 Refer to specification section 25 05 06 for work required on existing BAS networks.

## **2.6 Performance**

- .1 General:
  - .1 information transmission and display times are based upon network connections,
  - .2 test systems using manufacturer's recommended hardware and software for operator interface.
- .2 Performance criteria:
  - .1 Graphic Display;
    - (a) display graphic with 50 dynamic points with current data within 10 seconds.
  - .2 Graphic Refresh;
    - (a) update graphic with 50 dynamic points with current data within 10 seconds and
    - (b) automatically refresh every 15 seconds.
  - .3 Configuration and Tuning Screens;
    - (a) special screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic to refresh every 5 seconds.
  - .4 Object Command response;

- (a) time between command of binary object at GUI and onset of reaction by device to be less than 5 seconds,
- (b) time between command of analog object at GUI and start of adjustment to be less than 5 seconds.

.5 Alarm Response Time;

- (a) time between when an object goes into alarm and when it is annunciated at GUI to be less than 15 seconds.

.6 Program Execution Frequency;

- (a) execution repeat frequency to be selected in manner consistent with process under control,
- (b) custom and standard applications to be capable of executing as often as once every 5 seconds.
- (c) programmable controllers to be able to perform PID control loop routines at selectable frequency, adjustable at GUI down to once every second.
- (d) workstations connected to network to receive alarms with not more than 5 seconds spread between first and last annunciation.

## **2.7 Capacity for Future Expansion**

.1 Tier 1 network;

- .1 network backbone to have capacity for future 50 routers or building controller/routers in addition to connected devices at time of acceptance of the Work,
- .2 each router or building controller/router on network backbone to have routing capacity for 50 controllers.

## **2.8 Wiring and Conduit**

- .1 Wire and conduit for power wiring, control wiring, and communication wiring to conform to specification section 20 05 12.

# **3 EXECUTION**

## **3.1 Examination**

- .1 Inspect site and thoroughly examine documents to establish locations for control devices and equipment and report discrepancies, conflicts, or omissions for resolution before starting rough-in work.
- .2 Be responsible for correction of defects caused through neglect of inspections and examinations or failure to report and resolve discrepancies.

## **3.2 Protection**

- .1 Protect work and material against damage during construction and be responsible for work and equipment until inspected, tested, and accepted.
- .2 Protect material not immediately installed and seal connector terminations with temporary covers or plugs during storage and construction to prevent entry of foreign objects.
- .3 Protect electronic equipment from elements during construction.

## **3.3 Coordination**

- .1 Coordinate and schedule BAS work with other work in same area to ensure orderly progress.
- .2 Testing and balancing:



- .1 Supply sets of tools of sufficient quantity for Testing and Balancing Technicians to interface to control system, train these technicians in use of tools, and provide qualified Control Technician to assist with testing and balancing the first 10 terminal units.
- .2 Tools to be turned over to Owners on completion of testing and balancing.
- .3 Controls work by others:
  - .1 Integrate and coordinate this control work with controls and control devices provided or installed by others.
  - .2 Each supplier of control product to configure, program, start up, and test that product to satisfy requirements of Sequence of Operation regardless of where within contract documents product is specified or described.
  - .3 Resolve compatibility issues between control products provided under this Division and those provided under other Divisions of the Work.

### **3.4 General Workmanship**

- .1 Installation to be performed by skilled and certified technicians.
- .2 Install equipment, piping, and wiring or raceways horizontally, vertically, and parallel to building lines.
- .3 Provide sufficient slack and flexibility in connections to allow for vibration isolation between conduit, raceways, piping and equipment.
- .4 Install instrumentation and devices in locations providing adequate ambient conditions.
- .5 Protect components placed in areas of potentially high humidity.

### **3.5 Wiring for Power, Control and Communications**

- .1 Provide wire and raceways (conduit) for power wiring, control wiring, and communications wiring for BAS controllers and associated instrumentation and actuation devices, at voltages of 120 V and under, in accordance with specification section 20 05 12 and, for greater clarity, Schedule A appended to that specification section.
- .2 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

### **3.6 Cleaning**

- .1 Clean up debris, remove packaging material, collect waste and place in designated location, on a daily basis.
- .2 Keep work areas free from dust, dirt, and debris.
- .3 On completion of work, check finish of equipment provided under this section for damage and repair damaged factory-finished paint, replace deformed cabinets and enclosures with new material, and repaint to match original.
- .4 Prior to hand-over to the Owner, clean the inside of control panels;
  - .1 remove debris and vacuum clean internal components,
  - .2 the use of low-pressure dry nitrogen or inert compressed gases may be used to blow dust and debris out of panels where the use of such pressurized gases will not damage equipment or loosen wiring terminations,
  - .3 after cleaning, apply a label to the exterior side of the panel to identify the date the panel was cleaned and the initial of the person who cleaned the panel.

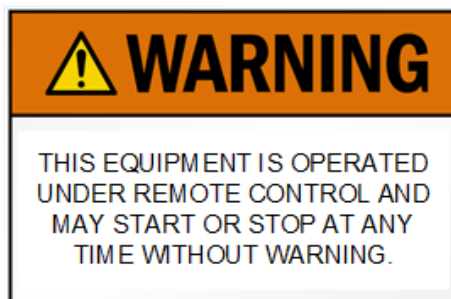
### **3.7 Field Quality Control**

- .1 Ensure work, materials, and equipment comply with this specification and reviewed shop drawings.

- .2 Monitor field installation for applicable safety and building code compliance and workmanship quality.
- .3 Arrange and pay for inspections by local or provincial authorities having jurisdiction over the work.

### 3.8 Identification of Equipment

- .1 Manufacturers' nameplates and product certification labels to be visible and legible after equipment is installed.
- .2 Identify discrete items of equipment with plastic nameplates or plasticized labels, identifying equipment and function. Identification plates are in addition to manufacturers nameplates.
- .3 Identification plates:
  - .1 provided for equipment identified with number designations in schedules and equipment shop drawings.
  - .2 marked with equipment type, number and service following wording and numbering used in contract documents and shop drawings,
  - .3 plastic laminated labels,
  - .4 white face and black background field,
  - .5 minimum size 75 mm x 40 mm x 3 mm (3 in x 1½ in x 1/8 in),
  - .6 engraved or printed with 6.5 mm (1/4 in) high lettering.
  - .7 securely attached to equipment with brass chains.
- .4 Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 50 mm (2 in) of termination.
- .5 Label pneumatic tubing at each end within 50 mm (2 in) of termination with descriptive identifier.
- .6 Permanently label or code each point of field terminal strips to show instrument or item served.
- .7 Label each control component with permanent label. Label plug-in components so that label remains stationary during component replacement.
- .8 Label room sensors related to terminal boxes or valves with nameplates. Place labels on back of sensors.
- .9 Identify motor controllers that are remotely controlled by the BAS with self-adhesive labels, black letters on white background with a red border and electric shock warning icon, with wording as follows;



### 3.9 Checkout and Testing

- .1 Provide schedule for start-up and testing.
- .2 Calibrate and prepare for service equipment, instruments, controls, and accessories.
- .3 Start-up testing to verify completion of control system before system demonstrations begin;
  - .1 verify that control wiring is connected and free of shorts and ground faults. Verify that terminations are tight,

- .2 enable control systems and verify input device calibration,
  - .3 verify that binary output devices operate and that normal positions are correct,
  - .4 verify failure positions of dampers and control valves are correct when power/compressed air is deenergized to the device,
  - .5 verify that analog output devices are functional, that start and span are correct, and that direction and normal positions are correct,
  - .6 check control valves and automatic dampers for proper action and closure and adjust valve stroke/rotation and damper blade travel,
  - .7 verify that damper and control valve feedback signals are correct when device is stroked fully open and closed (two position) and at any opening position between zero and fully open (modulating devices),
  - .8 verify that system operates according to Sequences of Operation. Simulate changes in variables by overriding and varying inputs and schedules and observe and record each operational mode response.,
  - .9 tune PID loops and control routines to provide stabile operation and to minimize valve and damper hunting,
  - .10 check each alarm with an appropriate signal at value that will trip alarm,
  - .11 trip interlocks using field contacts to check logic and to ensure that actuators fail in proper direction,
  - .12 test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.
- .4 Prepare and submit test log documenting start-up testing of each input and output device and each control routine, with technician's initials certifying each device and each routine is functioning correctly and sensors have been calibrated. Include list of deficiencies and a workplan schedule setting out rectification program with time lines.

### **3.10 Testing of Integrated Life Safety and Fire Protection Systems**

- .1 Comply with the requirements of specification section 20 08 11 for the testing of the integration of controls and communications between the BAS and life safety and fire protection systems.

### **3.11 Control System Demonstration**

- .1 Obtain approval of start-up testing log and rectification program before scheduling demonstrations.
- .2 Provide notification to Owner and Consultant not less than 10 business days before system demonstration begins.
- .3 Demonstration to follow previously submitted and approved procedures;
  - .1 submit checklists and report forms for each system as part of demonstration,
  - .2 lists and forms to have initials of technicians conducting demonstrations,
  - .3 date of each demonstration and signatures of Owner's representatives witnessing each demonstration section.
- .4 Prior to acceptance, perform the following operating tests in the presence of the Owner or Owner's representative and Consultant to demonstrate system operation and compliance with specification after and in addition to tests specified above in article Checkout and Testing.
- .5 Demonstrate field operation of;
  - .1 each Sequence of Operation,
  - .2 Operator Interface,

- .3 control loop response with graphical trend data output showing;
  - (a) each control loop response to set point change producing an actuator position change of at least 25% of full range.
  - (b) trend sampling rate to be from 10 seconds to 3 minutes, depending on loop speed,
  - (c) loop trend data to show set point, actuator position, and controlled variable values,
  - (d) documentation of further tuning of any loop that displays significantly under- or over-damped control
- .4 demand limiting routine with trend data output showing demand-limiting algorithm action;
  - (a) trend data to document action sampled each minute over at least 30-minute period and to show building kW, demand-limiting set point, and status of set-points and other affected equipment parameters.
- .5 control integration with life safety and fire protection systems,
- .6 trend logs for system points as selected by the Owner with;
  - (a) trend data to indicate set-points, operating points, valve positions, and other data as specified in points list provided with each Sequence of Operation,
  - (b) each log to cover three 48-hour periods and to have sample frequency not less than 10 minutes, except where a Control Sequence specifies other time intervals,
  - (c) show that trend logs are accessible through operator interface and can be retrieved for use in other software programs.
- .7 substantiate calibration and response of any input and output points requested,
- .8 provide at least two technicians equipped with two-way communication,
- .9 provide and operate test equipment to establish calibration and prove system operation.
- .6 Tests that fail to demonstrate system operation are to be repeated after repairs and/or revisions to hardware or software is completed.

### **3.12 Training**

- .1 Materials:
  - .1 provide course outline and materials for each class at least four (4) weeks before first class,
  - .2 provide training through instructor-led sessions, with computer-based, or web-based techniques,
  - .3 instructors to be factory-trained and experienced in presenting this material,
  - .4 perform classroom training using network of working controllers representative of installed hardware.
- .2 Operating staff training:
  - .1 provide training for Owners operating staff using abovementioned training materials in self-paced mode, web-based or computer-based mode, classroom mode, or combination of these methods,
  - .2 allow for 2 repeat sessions for each category to cover operator shift rotation.
- .3 Training to enable students to accomplish following objectives:
  - .1 Group 1:
    - (a) proficiently operate system,
    - (b) understand control system architecture and configuration,
    - (c) understand BAS system components,
    - (d) understand system operation, including BAS system control and optimizing routines (algorithms),
    - (e) understand Sequence of Operations,

- (f) operate workstation and peripherals,
  - (g) log on and off system,
  - (h) access graphics, point reports, and logs,
  - (i) adjust and change system set-points, time schedules, and holiday schedules,
  - (j) recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools,
  - (k) understand system drawings and Operation and Maintenance manual,
  - (l) understand project layout and location of control components,
  - (m) access data from BAS controllers,
  - (n) set-up trend logs,
  - (o) operate portable operator's terminals
- .2 Group 2:
- (a) create and change system graphics,
  - (b) create, delete, and modify alarms, including configuring alarm reactions,
  - (c) create, delete, and modify point trend logs (graphs) and multi-point trend graphs,
  - (d) configure and run reports,
  - (e) add, remove, and modify system's physical points,
  - (f) create, modify, and delete application programming,
  - (g) add and configure GUIs,
  - (h) add new controller to system,
  - (i) download firmware and advanced applications programming to controller,
  - (j) configure and calibrate I/O points.
- .3 Group 3:
- (a) maintain software and prepare backups,
  - (b) interface with job-specific, third-party operator software,
  - (c) add new users and understand password security procedures.
- .4 Divide presentation of objectives into three sessions:
- .1 Group 1: Day-to-day Operators,
  - .2 Group 2: Advanced Operators,
  - .3 Group 3: System Managers and Administrator,
  - .4 participants will attend one or more sessions, depending on knowledge and expertise level required,
  - .5 provide each student with one copy of training material.

### **3.13 Record Submittals**

- .1 Submit record documents to the Owner.
- .2 Document language: [English][French][English and French],
- .3 Submit three copies of project record documents and obtain approval during acceptance procedures.
- .4 Submit AHJ inspection certificates.
- .5 Provide as-built drawings;

- .1 as-built interconnection wiring diagrams, or wire lists of field installed system with identified, ordering number of each system component and service,
- .2 floor plans with accurate depiction of location of system devices, controllers, and trunk wiring. Drawings to be constructed using Architectural backgrounds provided,
- .3 provide copies of as-built drawings on two (2) removable storage devices,
- .4 provide five (5) full size hard copies of floor plan drawings.
- .6 Operation and Maintenance (O&M) Manuals:
  - .1 provide two (2) paper copies of material and copies on five (5) removable storage devices in portable document format.
  - .2 describe operation, maintenance and servicing requirements of system and associated equipment,
  - .3 provide the following information in separate sections, each with an index:
    - (a) Service and parts;
      - i) names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems,
      - ii) list of recommended spare parts with part numbers and suppliers.
    - (b) System description;
      - i) outline of BAS system and system architecture,
      - ii) as-built versions of shop drawing product data,
      - iii) reduced size (11 in x 17 in) copies of record drawings,
      - iv) graphic files, programs, and database on magnetic or optical media,
      - v) licenses, guarantees, and warranty documents for equipment and systems.
    - (c) Technical literature for equipment, including;
      - i) catalogue sheets,
      - ii) calibration, adjustments and operation instructions,
      - iii) installation instructions,
      - iv) hardware and software manuals, with information supplied by original product developer, on application programs and on computers and controllers supplied,
      - v) Operator's manual with procedures for operating control systems; logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set-points and variables,
      - vi) engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware,
      - vii) original-issue documentation with installation and maintenance information for third-party hardware including computer equipment and sensors,
      - viii) recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions,
      - ix) programming manual or set of manuals with description of programming language and syntax, explanation of statements for algorithms and calculations used, procedures for point database creation and modification, documentation of techniques for program creation and modification, and instructions for use of editor,
      - x) documentation of programs created using custom programming language including set-points, tuning parameters, and object database. Electronic copies of programs to modify

and create control logic, set-points, tuning parameters, and objects that can be viewed using programming tools.

- .7 Original Software:
  - .1 Furnish one original set of application and system software on original media. Disks to bear manufacturer's label. Field copies are not acceptable.
  - .2 Original-issue copies of software to include operating systems, custom programming language, application generation, graphic support, maintenance support, operator workstation or web server software, and other utilities provided in support of installed system.
- .8 On-line record documentation:
  - .1 After completion of testing and adjustment, install the following additional information on the server OWS.
    - (a) as-built record drawing files,
    - (b) detailed catalog data on all installed system components, with supplier contact information for purchasing and factory authorized repair service.

### **3.14 Acceptance**

- .1 Application for substantial performance of the Work requires as a prerequisite the completion of the BAS including testing, demonstration, and submittal of required documentation, except where the Owner agrees to differ any work to a later date.
- .2 In support of an application for substantial performance, submit a signed declaration to the Owner certifying that:
  - .1 the BAS is complete and operating in accordance with the contract documents,
  - .2 control system checkout and testing is completed,
  - .3 control system demonstration is completed,
  - .4 training is completed,
  - .5 as-built documentation is completed and turned-over to the owner.
- .3 Certification document may identify tests that cannot be performed due to extenuating circumstances such as weather conditions, where previously agreed to be deferred to a later date by the Owner. Append a program for completion of deferred work to the certification document for rectification and completing these tests during warranty period.

### **3.15 Correction After Completion**

- .1 After start-up, testing, and commissioning phase has been completed and satisfactory and reliable operation of equipment and systems has been demonstrated, acceptance of the system is to be given by Owner. Warranty period to begin on date established on certificate of acceptance.
- .2 Provide updates and patches to resolve software deficiencies in operator workstation or web server software, project-specific software, graphic software, database software, and firmware during warranty period.
- .3 Provide upgrades that improve routines and procedures of operator workstation software, web server software, project-specific software, graphic software, or database software, free of charge, during warranty period.
- .4 Provide details of proposed changes and obtain written authorization from Owner before installation of updates, patches, or upgrades.
- .5 Include preventative maintenance, with allowance for spare parts, labour, and emergency (24 hour) service for system and equipment during warranty period.

- .6 Equipment manufacturers to submit written undertakings to make circuit board repairs and provide spare parts, software support and patches, and technical assistance for at least five years after acceptance is certified.

**End of Section**



## **WORK ON EXISTING BUILDING AUTOMATION**

### **25 05 06**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Modifications to existing building control systems including:
  - .1 connection to of new BAS networks to the existing building BAS networks,
  - .2 connection of new control devices to existing BAS networks,
  - .3 selective demolition of existing building controls,
  - .4 modifications and upgrades of existing BAS.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 26 Pipeline Hot-Tapping and Line Stopping
  - .2 25 05 01 Building Automation Common Work Results

##### **1.3 Definitions and Abbreviations**

- .1 Refer to specification section 25 05 01.

##### **1.4 Designated Controls Contractor**

- .1 BAS work shall be performed by Johnson Controls Inc. as the base building controls contractor authorized by the Owner to perform such Work.

##### **1.5 Design Criteria**

- .1 Existing BAS networks:
  - .1 Tier 1: hosted on facility IT network.
  - .2 Tier 2: BACnet MSTP

##### **1.6 Submittals**

- .1 Shop drawings:
  - .1 In addition to the requirements of section 25 05 01, submit the following information as a shop drawing:
    - (a) documentation of existing sequence of operations for applicable equipment and systems affected by the Work.

#### **2 PRODUCTS**

##### **2.1 General**

- .1 Conform to specification section 25 05 01 and other sections of Division 01 except as specified herein.

#### **3 EXECUTION**

##### **3.1 Existing Equipment**

- .1 Reuse of control components:

- .1 reuse existing equipment and components as listed below where condition and conformance with this specification permits;
  - (a) valves and operators,
  - (b) dampers and operators,
  - (c) compressed air system,
  - (d) thermocouple wells,
  - (e) freezestats,
  - (f) firestats,
  - (g) limit, end, or level switches and air or liquid flow switches,
  - (h) static pressure sensors and controllers,
  - (i) wiring and conduit for safety controls and I/O points,
  - (j) relays,
  - (k) cabinets,
  - (l) other items specifically noted as existing, to be re-used.
- .2 Remove and replace existing temperature and humidity sensors with new units, throughout the installation,
- .3 Check and re-calibrate existing indicator gauges,
  - .1 under no circumstances are existing gauges or thermometers be removed.
- .4 Re-calibrate valves and dampers as part of installation of this system.
- .5 Existing thermowells for conventional control system may be reused for new sensors,
  - .1 repack temperature wells, both new and reused, with heat conductive grease.

### **3.2 Existing Programming and Configuration**

- .1 Document existing control device programming, configuration, and setpoint values at the start of the work, prior to any demolition or other work on existing control equipment.
- .2 For each NSC or ASC being replaced, review the existing control programming and/or configuration settings, and prepare a written sequence of operation in laymen terms that describes the operating control of each control device. Where multiple control devices of the same type exist (e.g. terminal units), review at least three (3) randomly selected controllers to verify the same control functions; a single written control sequence for each type controller is sufficient.
- .3 Provide a copy of these documentation to the Owner.
- .4 Except where otherwise specified for new sequence of operations, program and/or configure software for replacement NSC and ASC to achieve the same control functionality and sequence of operation of the pre-existing NSC and ASC controllers, and configure setpoints to match pre-existing controller values.

### **3.3 Existing Condition Survey**

- .1 Conduct a condition survey of existing control devices:
  - .1 test, inspect and report on existing devices which are to be incorporated into the BAS, for satisfactory operation within 30 days of award of contract and prior to installation of any new devices,

- .2 for those items found in unacceptable condition, provide with report test data, original specification sheets or written functional requirements to confirm conclusion,
- .3 Owner to arrange for repair or replacement of those existing items judged defective, but shown to be re-used in BAS and control system,
- .4 items thus repaired or replaced by Owner will be returned to site and handed over to Contractor under this Section for storage, installation, testing, and commissioning.,
- .5 warrant reused devices that have been rebuilt or repaired. Demonstrate satisfactory operating condition of reused devices at time of acceptance,
- .6 responsibility for existing control devices that have been reused is to terminate at end of warranty period.

### **3.4 Demolition and Removals**

- .1 Unless specifically noted or shown otherwise, remove existing control components made redundant:
  - .1 room thermostats, controllers, auxiliary electronic devices, pneumatic controllers and relays, control valves, electronic sensors, and transmitters: to be removed and placed in storage as directed by Owner.
  - .2 local control panels: removed and placed in storage as directed by Owner.
- .2 Remove and dispose of existing conduits, wiring and tubing in all areas (including above accessible ceilings) as they become redundant;
  - .1 remove existing control compressed air systems and, where applicable, connect to new control air system;
  - .2 existing hardwired interlocks to remain installed in systems.
- .3 In existing areas not otherwise involved in renovations, arrange and pay for holes and marks left by decommissioning and removal of control components, wiring, conduit, and tubing to be patched and refinished to match existing.

### **3.5 Maintaining Existing System Operation**

- .1 Mechanical systems to remain in operation and to maintain space conditions between hours of 6 a.m. and 9 p.m., Monday through Friday.
- .2 In these periods mechanical control system shut downs of up to 15 minutes may be permitted, after obtaining written agreement from Owner.
- .3 When time required for cut-over of controls will not meet these constraints, perform work outside of operating hours after making application; outlining areas affected; and likely length of interruption, and obtain written agreement from Owner. .
- .4 Maintain fan scheduling using existing or temporary time clocks or control systems throughout period of control system installation.
- .5 Modify existing motor controllers to incorporate new local operator control switches for motors to be controlled through BAS system.

### **3.6 Installation of New Thermowells**

- .1 Existing piping services to remain in service during installation of thermowells.
- .2 Coordinate with the trade contractor under Division 23 to install thermowells for new temperature sensors mounted on steel piping by hot-tapping in accordance with specification section 20 05 26.

### **3.7 Interfacing Between New and Existing Control Systems**

- .1 Certain building systems are to operate in event of building power failure or fire alarm. Under no circumstances should interfacing of equipment or controls modify these existing sequences of operation.
- .2 Where tying new system into existing control equipment, show on shop drawings;
  - .1 signal levels,
  - .2 wire type,
  - .3 wire numbers, and
  - .4 terminal numbers.
- .3 Before attempting replacement of existing control systems, install new field panels, controllers and associated devices loose-ended ready for system changeover.
- .4 Submit written request to Owner setting out proposed starting time for changeover, duration of system down time, and establishing extent of interruption to operation of existing control system.
- .5 Do not proceed with work until Owner's written approval of time for, duration of, and extent of interruption is received.
- .6 Subsequent decommissioning and removal of control components to be carried out without interfering with normal operations or creating an interruption in service of any building systems except through an approval process similar to that noted above.

**End of Section**

## **BUILDING AUTOMATION CONTROL PANELS AND WIRING**

### **25 05 12**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide building automation control panels for mounting and securing building automation control equipment and devices.

##### **1.2 Related Sections0**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 05 12 Common Electrical Requirements for Mechanical Services
  - .2 20 05 49.23 Seismic Qualification for Mechanical Equipment
  - .3 25 30 16 Building Automation Instrumentation

##### **1.3 Definitions and Abbreviations**

- .1 The following definitions apply to this section.
  - .1 **Control wiring** – has the meaning as defined in specification section 20 05 12.
  - .2 **Extra-low voltage** – any voltage not exceeding 30 V (has the same meaning as per CSA C22.1)
  - .3 **GUI** means “graphic user interface”, to display system data to the user and to allow the user to enter operating commands and data selection.
  - .4 **Power wiring** - has the meaning as defined in specification section 20 05 12.

##### **1.4 Applicable Codes and Standards**

- .1 Product standards:
  - .1 CSA C22.2 No. 0.3 Test Methods for Electrical Wires and Cables
  - .2 CSA C22.2 No. 14 Industrial Control Equipment
  - CSA C33.3 No. 18.5/UL 1565  
Positioning Devices
  - .3 CSA C22.2 No. 66.2 Low Voltage Transformers – Part 2: General Purpose Transformers
  - CSA C22.2 No. 66.3 / UL 5085-3  
Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers
  - .4 CSA C22.2 No. 72 Heater Elements
  - .5 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
  - .6 CSA C22.2 No. 223 Power Supplies with Extra-Low-Voltage Class 2 Outputs.

##### **1.5 Qualified Tradesperson**

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

## 1.6 Registration and Inspection

- .1 Where control panels are not listed in accordance with CSA C22.2 No. 14, arrange and pay for field inspection by the AHJ for electrical safety.

## 1.7 Seismic Qualification

- .1 Seismically qualify (certify) the following equipment specified herein:
  - .1 Building automation system control panels including microprocessor control units and all other internal devices.
- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 20 05 49.23 for the following seismic qualification level and certification method:
  - .1 Functional seismic qualification (Level III) for electrical control equipment: by shake table testing,
- .3 The following equipment specific seismic force parameters are to be used:

C <sub>p</sub>	A <sub>r</sub>	R <sub>p</sub>	h <sub>x</sub> /h <sub>n</sub>
1.00	1.00	1.25	1.0

## 1.8 Submittals

- .1 Shop drawings:
  - .1 submit product data sheets for materials specified herein.
  - .2 submit shop drawings for control panels including wiring diagrams and panel layout details.

# 2 PRODUCTS

## 2.1 General

- .1 Provide custom factory-made building automation control panels including all factory-installed devices and equipment required for operation of associated building equipment or systems including but not limited to DDC controllers, GUI, power supplies, transducers, solenoid air valves, relays and accessories.
- .2 Comply with the requirements of specification section 20 05 12 for products not otherwise specified herein.
- .3 Provide equipment which functions and meets detailed performance criteria when operating under the following conditions:
  - .1 ambient temperature:
    - (a) indoors: 4°C to 40°C (39°F to 104°F)
    - (b) outdoors: -30°C to + 40°C (-22°F to 104°F)]
  - .2 ambient relative humidity: 10% to 90% non -condensing,
  - .3 electrical power service: 120 VAC +/- 10%, 1 phase, 60 Hz nominal.

## 2.2 Control Panels

- .1 Panel enclosure:
  - .1 indoors: type 2 with sprinkler shield, 3R or 4 to CSA C22.2 No. 94.1 (NEMA 2, 3R, or 4),
  - .2 material: galvanized steel,
  - .3 with hinged door and lock,

- .4 integral cooling fans and vents with power supplies, wiring and circuit protection,
- .5 mounting backplate and/or DIN rails for mounting of wiring devices, controllers, sensors, transducers, and relays,
- .6 conduit openings and adapters in sufficient quantities and sizes to accommodate wiring terminating within enclosure,
- .7 document holder inside panel, to include one set of as built, plasticized control Shop Drawings for equipment served by that panel permanently affixed to cabinet frame,
- .8 enclosure finish: vendors standard colour,
- .2 GUI display:
  - .1 surface mounted on or semi-recessed in panel front door where GUI is required by other specification sections of Division 25.
  - .2 where GUI is mounted on the controller inside the panel, provide panel door cut-out with viewing glass to allow viewing only of GUI with panel door closed.
- .3 Control panel layout and construction:
  - .1 enclosures to be of sufficient size to house control components including controllers and associated transformers, control relays, wiring, conduits and other auxiliary equipment, so as to allow access for maintenance and replacement of components without requiring removal of other components.
  - .2 permanent engraved labels with black lettering on white background indicating:
    - (a) stating applicable building system name and reference number.
    - (b) function of each panel door mounted device.
  - .3 mount air pressure gauges on front of panel door to allow viewing from outside the panel,
  - .4 support wiring in cable ducts; arrange cable ducting and install wiring in a neat and workmanlike manner,
  - .5 provide numbered terminal strips for field wiring terminations; do not terminate field wiring directly on control devices or controllers. Arrange terminal strips in a common location adjacent to minimize routing and quantity of field wiring inside of panel.
  - .6 label both ends of internal wiring with label markers using name of cable function, or to identify wire number as shown on panel shop drawings,
  - .7 layout circuit fuses to facilitate location and replacement; provide labels at each fuse holder identifying fuse number and replacement fuse type and size,
- .4 Control devices mounted on panel door-front:
  - .1 Key-lock operated main panel power ON-OFF switch,
  - .2 alarm buzzer silence pushbutton (where applicable),
  - .3 alarm reset pushbutton (where applicable),
  - .4 indicating lights:
    - (a) main panel power ON (white),
    - (b) summary alarm (red),
    - (c) other indicating lights as specified by control sequences.
- .5 Panel mounted alarm devices:
  - .1 alarm buzzer (where applicable).
- .6 Cable Ducts
  - .1 non-metallic cable ducting with removable cover, slotted access cable restraints,

- .2 ambient temperature rating: -40 to +60°C (-40 to +140°F)
- .3 listed to CSA C33.3 No. 18.5/UL 1565.
- .7 Terminal strips:
  - .1 NEMA finger-safe terminal blocks, spring-clamp or screw fastened,
  - .2 directly fastened to panel backplane or DIN rail mounted.

## **2.3 Power Supplies and Line Filtering**

- .1 For control panels and for field installed devices.
- .2 Transformers and Power Supplies:
  - .1 industrial control transformers to be listed to CSA C22.2 No. 66-2, and temperature rated for 40°C,
  - .2 control transformers to be listed to CSA C22.2 No. 66-3,
  - .3 AC/DC power supplies to be listed to CSA C22.2 No. 223,
  - .4 provide over-current protection in primary and secondary circuits,
  - .5 limit connected loads to 80% of rated capacity.
- .3 DC power supplies:
  - .1 output to match equipment current and voltage requirements,
  - .2 units to be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation to be 1.0% line and load combined, with 100-microsecond response time for 50% load changes,
  - .3 units to have built-in over-voltage and over-current protection and to be able to withstand 150% current overload for at least three seconds without trip-out or failure,
  - .4 units to operate between 0°C and 50°C (32°F and 120°F).
  - .5 EM/RF to meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
- .4 Power Line Filtering:
  - .1 provide internal or external transient voltage and surge suppression for workstations and control modules,
  - .2 surge protection:
    - (a) dielectric strength of 1000 V minimum,
    - (b) response time of 10 nanoseconds or less,
    - (c) transverse mode noise attenuation of 65 dB or greater,
    - (d) common mode noise attenuation of 150 dB or greater at 40-100 Hz.

## **2.4 Miscellaneous Electrical Control Devices**

- .1 Control Relays:
  - .1 plug-in type, UL listed, with dust cover and LED "energized" indicator.
  - .2 contact rating, configuration, and coil voltage suitable for application.
  - .3 NEMA 1 enclosure for relays not installed in local control panels.
- .2 Time Delay Relays:
  - .1 solid-state plug-in type, UL listed, with adjustable time delay adjustable  $\pm 100\%$  from set point shown.
  - .2 contact rating, configuration, and coil voltage suitable for application.
  - .3 NEMA 1 enclosure for relays not installed in local control panels.



- .3 Override Timers:
  - .1 spring-wound line voltage, UL Listed, with contact rating and configuration by application unless implemented in control software.
  - .2 0-6 hour calibrated dial.
  - .3 flush mounted on local control panel face.
- .4 Electronic signal isolation transducers:
  - .1 provided whenever;
    - (a) an analog output signal from BAS is connected to an external control system as an input (such as chiller control panel) or
    - (b) BAS is to receive an analog input signal from an external remote system.
  - .2 designed for ground plane isolation between systems.

## **2.5 Electro-Pneumatic (E/P) Transducers**

- .1 To convert 4-20 mA, 0-5 Vdc, or 0-10 Vdc analog control input signal to a 20-100 kPa (3-15 psig) output signal;
  - .1 separate span and zero adjustments,
  - .2 manual output adjustments,
  - .3 output pressure gauge assembly,
  - .4 feedback loop control,
  - .5 mid-range air consumption of 0.05 NL/s (0.1 SCFM).

## **2.6 Pressure-Electric (P/E) Switches**

- .1 To convert pressure signal to activate electric switch;
  - .1 diaphragm operated SPDT. snap acting contacts with electrical rating suitable for application,
  - .2 designed to withstand up to 170 kPa (25 psi) input pressure,
  - .3 adjustable cut-in and cut-out settings between 25 and 140 kPa ([3 and 20 psi).

## **2.7 Additional Requirements for Outdoor Panels**

- .1 The following additional requirements apply where control panels are installed outdoors, or indoors in unheated spaces.
- .2 Enclosure: type 4, 4X or 12 to CSA C22.2 No. 94.1 (NEMA 4, 4X or 12),
- .3 Thermally insulated on all interior surfaces
  - .1 minimum thickness: 25 mm (1 in) at a maximum thermal conductivity of 0.0365 W/mK (0.0211 Btuh/ft<sup>2</sup>F) , or equivalent minimum RSI= 0.68 m<sup>2</sup>K/W (R = 3.86 ft<sup>2</sup>F/BTUH).
- .4 Mount GUI and other front-mount devices on inner front panel behind main panel door.
- .5 Electric resistance panel heater:
  - .1 electric resistant heaters listed to CAN/CSA C22.2 No. 72,
  - .2 sized to maintain panel interior temperature at not less than 4.5°C (40°F), at the ambient design temperature.
  - .3 integral or line mounted thermostat control, set with a temperature deadband of ON at 4.5°C (50°F) and OFF at 12°C (55°F).

## **2.8 Wiring and Raceways**

- .1 Electrical materials, equipment and installation procedures to conform to the electrical safety code applicable to the location of the Work, in accordance with the requirements of specification section 20 05 12, and as specified herein.
  - .1 conductors for digital functions: 18 AWG minimum, twisted and shielded,
  - .2 conductors for analog functions: 18 AWG minimum, twisted and shielded, 2 or 3 wire to match analog function hardware.
  - .3 conductors for transformer current wiring: 16 AWG minimum,
  - .4 conductors for sensor wiring: 22 AWG minimum, twisted and shielded, 2 or 3 wire to match analog function hardware. Provide additional conductors as to support supplemental features of sensor (i.e. set-point adjustment, override, etc.).
- .2 Non-continuous cable supports:
  - .1 Sling strap:
    - (a) Galvanized steel support bracket with adjustable polyethylene support sling.

### *Standard of Acceptance*

- nVent – fig. Caddy Cable 425

## **3 EXECUTION**

### **3.1 Control Panel Installation**

- .1 Install transmitters, transducers, controllers, solenoid air valves and relays in control panels.
- .2 Mount control panels to poured concrete or concrete block walls on mounting channels; do not fasten directly to the wall.
- .3 Where control panels are located away from concrete walls, provide a fabricated floor-mounted galvanized-steel channel support frame to mount control panels. Design support frame to withstand applicable seismic loads.
- .4 Install control panels with user interface devices on the panel door so that the centerline of the principle interface device is between 1500 and 1600 mm (60 to 64 in) above floor level.
- .5 Install other panels so that the top of the panel is located between 1800 and 1900 mm (72 to 76 in) above the floor.
- .6 Trim-back or neatly collect excess field wiring inside of control panels.

### **3.2 Field Wiring Installation**

- .1 Provide power wiring and control wiring as needed to support operation of the building automation system. Refer to Section 20 05 12 for description of division of work and responsibility.
- .2 Installation of field wiring for power wiring and control wiring to conform to specification section 20 05 12 except/and as specified herein.
- .3 During installation follow cable manufacturer's specified cable pulling tension, and recommended minimum bend radius.
- .4 Verify entire network's integrity following cable installation using appropriate tests for each cable.
- .5 Install lightning arrester according to manufacturer's recommendations between cable and ground wherever cable enters or exits the building.
- .6 Each run of communication wiring to be continuous length without splices.

- .7 Label communication wiring to indicate origin and destination.
- .8 Ground coaxial cable according to Division 26 requirements.
- .9 Fiber optic cable installation:
  - .1 do not exceed pulling tensions specified by cable manufacturer. Post-installation residual cable tension to be in accordance with cable manufacturer's specifications,
  - .2 do not exceed minimum cable and unfaceted fiber bend radii specified by cable manufacturer.[]

### **3.3 Conduit and Raceways**

- .1 Run power wiring and control wiring in conduit except where otherwise specified herein.
- .2 Extra-low voltage control wiring located in horizontal service spaces above dropped ceilings may be run exposed (without conduit) provided that wiring is;
  - .1 installed neatly and parallel to building lines,
  - .2 supported from J-hooks at intervals not exceeding 1200 mm (4 ft),
  - .3 have a FT6 rating in accordance with CSA C22.2 NO. 0.3 when installed in a supply or return air ceiling plenum
- .3 Do not run any BAS wiring in IT infrastructure cable trays.
- .4 Run conduit and raceways parallel to building lines and be secured to building structure.
- .5 Where conduit leaves heated areas and enters unheated areas, seal conduit with weather-tight sealant at the first junction box in the unheated space.

### **3.4 Power Conversion and Control Relays**

- .1 Provide interposing and motor control relays at local item of equipment or at associated MCC as applicable.
- .2 Provide control transformers and power supplies for system components requiring power supply that do not have integral control transformers.
- .3 Where point schematics and specifications indicate auxiliary contact provision, provide instrumentation, wiring, conduit, power supplies and services as to integrate these points into BAS.
- .4 Mount transformers in enclosures adjacent to equipment served.

### **3.5 Cleaning**

- .1 Prior to handover to the Owner, remove all debris from and vacuum clean inside of control panels. Clean exterior surfaces of panels including GUI displays.

**End of Section**

## **BUILDING AUTOMATION APPLICATION SPECIFIC CONTROLLERS 25 14 16**

### **1 GENERAL**

#### **1.1 Scope**

- .1 Provide application specific controller for equipment other than terminal units ("ASC").
- .2 ASC controllers for terminal units are to conform to specification section 24 14 17.

#### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 25 05 01 Building Automation Common Work Results
  - .2 25 05 12 Building Automation Control Panels and Wiring

#### **1.3 Applicable Codes and Standards**

- .1 Product standards:
  - .1 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
  - .2 CSA C22.2 No. 205 Signal Equipment
  - .3 CAN/CSA-E60730-2-14 Automatic Electrical Controls - Part 2: Particular Requirements for Electric Actuators
  - .4 UL 864 Standard for Control Units and Accessories for Fire Alarm Systems

#### **1.4 Network Integration Requirements**

- .1 Controller Tier 2 network communications:
  - .1 BACnet MSTP native device.

#### **1.5 Submittals**

- .1 Shop drawings:
  - .1 Submit product data sheets for materials specified herein,
  - .2 Clearly mark each version type along with the applicable control sequence reference.

### **2 PRODUCTS**

#### **2.1 Environmental Conditions**

- .1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges:
  - .1 temperature: - 0°C to 32.2°C (32°F to 90°F)
  - .2 relative humidity: 10% to 90% non -condensing
  - .3 electrical service: single phase, 120 VAC +/- 10%, 60 Hz nominal,
  - .4 operating voltage: operate at 90% to 110% of nominal voltage rating and to perform an orderly shutdown below 80% nominal voltage,
  - .5 electrical noise: operation to be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

- .2 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.

## **2.2 Application Specific Controllers (ASC) – General Requirements**

- .1 ASCs separated into two types: Programmable, and Configurable.
- .2 General:
  - .1 stand-alone, multi-tasking, multi-user, real time digital processors with hardware, software, and communications interfaces, power supplies, and input/output modular devices,
  - .2 listed to CAN/CSA-E60730-2-14 or CSA C22.2. No. 205,
  - .3 listed to UL864 for smoke control and smoke venting applications,
  - .4 BTL or LonMark certified as an Application Specific Controller (as applicable to network integration requirements),
  - .5 native BACnet or Lonworks firmware (as applicable to network integration requirements),
  - .6 removable (hot swappable ) without disconnection of terminals and wiring,
  - .7 have access to data within network to accomplish global control strategies,
  - .8 support firmware upgrades without need to replace hardware,
  - .9 both firmware and controller database can be loadable over the BAS network or by local service port,
  - .10 continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure to assume predetermined failure mode.
  - .11 monitor status of overrides and inform operator if automatic control has been inhibited, and allow operator to manually override automatic or centrally executed inhibit command.
- .3 Memory:
  - .1 sufficient non-volatile memory to support its own BIOS and programming information in the event of loss of power.
- .4 GUI:
  - .1 face mounted LED type annunciation to display operational mode, and power and communication status.
- .5 Time clock:
  - .1 controllers that perform scheduling operations to have on board real-time clock.
  - .2 in network application, time clock synced to associated Network Supervisory Controller.
- .6 BACnet devices, Tier 2 Network;
  - .1 Conformance Class 3,
  - .2 support the BACnet functional groups for
    - (a) Change-of-Value (COV) Event Initiation,
    - (b) Change-of-Value (COV) Event Response,
    - (c) Event Initiation,
    - (d) Event Response,
  - .3 support the BACnet standard application services of;
    - (a) Read Property,
    - (b) Write Property.

- .4 support the standard BACnet object types of;
  - (a) Device,
  - (b) Analog Input,
  - (c) Analog Output,
  - (d) Analog Value,
  - (e) Binary Input,
  - (f) Binary Output and Binary Value,
  - (g) Loop,
  - (h) Multi-State Input,
  - (i) Multi-State Output,
  - (j) Notification Class at a minimum.
- .5 The described functionality provides reading and writing of all analog or digital inputs and outputs between BACnet devices on the network and provides for change-of-value initiation and reporting.
- .7 Communications:
  - .1 communication port (RS-232 DB-9, RJ-11 or RJ-45) for connection to laptop computer or operator interface device to allow memory downloads and other commissioning and troubleshooting operations.
  - .2 ASCs reside on BAS Tier 2 network for network communications.
  - .3 communication services over BAS networks to support operator interface performance, and value passing as follows;
    - (a) connection of an operator interface device to any one controller on network to allow operator to interface with other controllers as if that interface were directly connected to those other controllers.
    - (b) data, status information, control algorithms, inputs, outputs, etc., from any controller on network is to be available for viewing and editing through operator interface device that is connected to any controller on network.
    - (c) links to execute control strategies to be programmed and tested so that an operator with appropriate password privileges is able to edit these links either by typing in standard object addresses, or by using simple point and click commands.
    - (d) daily routine automatically synchronize time clocks in controllers. An operator initiated change to master time clock setting to be automatically broadcast to other controllers on network.
    - (e) minimum baud rate for peer-to-peer communication between controllers in system LAN to be at 10 Mbps and communication with low level controllers, to be at 76 Kbps.
- .8 Input/Output isolation:
  - .1 I/O protected such that shorting of point to itself, shorting of point to another point, or shorting of point to ground will not damage controller.
  - .2 I/O protected such that voltage spikes of up to 24 V, of any duration, and any polarity will not damage controller.
- .9 Input/Output capacity:
  - .1 I/O capacity as required to suit control sequence plus specified spare I/O.
  - .2 Analog Inputs:
    - (a) for monitoring of variable measurement properties,
    - (b) field selectable for 0-10 VDC, 4-20 mA, or resistance values for thermistors or RTD.

- .3 Analog Outputs:
  - (a) for control of modulating control devices,
  - (b) modulating electronic signal, either 0 -10VDC or 4 -20mA.
- .4 Digital Inputs:
  - (a) for monitoring of on/off signals from remote devices,
  - (b) provide wetting current of at least 12 ma and to be compatible with commonly available control devices.
- .5 Digital Outputs:
  - (a) for On/Off. Open/Close control operation, or pulsed low voltage signal for pulse width modulation control,
  - (b) relays contacts: minimum 0.5 A @ 24 Volts AC or DC maximum,
  - (c) each relay to be configured as normally open or normally closed, and either dry contact or bussed.
- .6 Universal Inputs:
  - (a) field configurable for analog or digital inputs,
  - (b) thermistor, dry contacts, or 0-5VDC with 0-10K Ohm input impedance.
- .7 Spare I/O capacity, each ASC:
  - (a) minimum of two (2) spare I/O point capacity for each point type, which may be met by two (2) only universal type,
  - (b) future use of spare capacity to involve provision of field device, field wiring, point database definition, and custom software,
  - (c) these spare points to be configurable without additional controller boards or point modules,
  - (d) wiring connections to be made field-removable, by use of modular terminal strips or termination cards connected by ribbon cable.
- .10 Power/communications interruption:
  - .1 controller continue to provide control functions in event of network communication failures,
  - .2 incorporate sufficient non-volatile memory to store critical configuration data in event of loss of normal power, and sufficient battery backup to support real time clock and volatile memory for minimum of 72 hours,
  - .3 after loss of power and then subsequent return of mains power, controller to;
    - (a) automatically reboot and return to service,
    - (b) zero output values prior to reinitiating controls sequence,
    - (c) restart control sequence at "Normal Operation" unless a supervisory controller provides a command to operate in a different mode of operation.
  - .4 where ASCs are used as part of a smoke control or smoke venting system, on loss of communication, controller to operate in a default standalone smoke venting control mode as defined in the sequence of operations.

## **2.3 Configurable ASCs**

- .1 General:
  - .1 purpose-built for specific application to which they are applied, including;
    - (a) unit heaters,
    - (b) fan coils,

- (c) rooftop unit
  - (d) heat pumps
  - (e) local reheat zones
  - (f) perimeter heating control
  - (g) free-standing fans
- .2 Optically isolated from other controllers on communication loop.
- .3 Memory: maintain all BIOS and programming information in the event of a power loss for at least 90 days.
- .2 Local zone control:
  - .1 wired to wall mounted temperature sensor with jack-style communications wiring.

## **2.4 Application Specific Controller Software**

- .1 Software for ASC to conform to specification section 25 15 16 except/and as specified herein.

# **3 EXECUTION**

## **3.1 Installation**

- .1 Provide ASC's of type and I/O capacity to suit control and instrumentation strategies as detailed in sequence of operation, and as shown.
- .2 Install equipment in accordance with manufacturer's recommendations.
- .3 Install ASC in control panels in accordance with specification section 25 05 12.

## **3.2 Power and Wiring**

- .1 Provide control power transformer and overcurrent protection to suit controller requirements.
- .2 Provide control wiring in accordance with specification section 25 05 12 for field installed instrumentation and control devices.

## **3.3 Tier 2 LAN Device Density**

- .1 Total number of devices on each Tier 2 LAN not to exceed 80% of maximum device limitations (with the use of repeater devices).

## **3.4 Programming**

- .1 Provide custom programming to meet the control strategies as called for in the sequence of operation sections.

## **3.5 ASC Database**

- .1 Provide a configuration database for each ASC. Data to include as a minimum:
  - .1 room number,
  - .2 device number,
  - .3 system name and ID,
  - .4 building equipment type, name and ID,
  - .5 equipment primary capacity (airflow, water flow).
- .2 Database to also include current measured values:
  - .1 current measured flow, temperature and pressure parameters,



.2 current measured power consumption and demand.

**END OF SECTION**

## **BUILDING AUTOMATION ACTUATORS AND OPERATORS**

### **25 30 13**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide actuators and operators for building systems automation.
- .2 Provide actuators for operating control dampers provided as part of factory built air handling units.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 25 05 01 Building Automation Common Work Results
  - .2 25 30 23 Building Automation PICV and Energy Valves
  - .3 25 30 26 Building Automation Control Valves
  - .4 25 30 33 Building Automation Control Dampers

##### **1.3 Definitions**

- .1 The following definitions apply to this section.
  - .1 **Emergency equipment** means engine-driven electrical generators and diesel-engine driven fire pumps.
  - .2 **Valves** means a water, glycol, or steam control valve in accordance with specification sections 25 30 23 or 25 30 26.

##### **1.4 Applicable Codes and Standards**

- .1 Product standards:
  - .1 CSA C22.2 No. 24 Temperature-Indicating and -Regulating Equipment
  - .2 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
  - .3 CAN/CSA-E60730-1 Automatic Electrical Controls for Household and Similar Use – Part 1: General Requirements

#### **2 PRODUCTS**

##### **2.1 General**

- .1 Provide equipment which functions and meets detailed performance criteria when operating in the following minimum ambient condition ranges except where otherwise specified:
  - .1 ambient temperature:

Actuator Location	Service Temperature Range	Notes
Indoor	4°C to 40°C (39°F to 104°F)	(a)
Outdoor	-30°C to + 40°C (-22°F to 104°F)	
[Intake and exhaust air plenums	-30°C to + 40°C (-22°F to 104°F)]	

**Notes:**

- (a) *Unheated spaces to be treated as outdoor spaces.*

- .2 Ambient relative humidity 10% to 90% non -condensing
- .2 Components installed within motor controllers to be designed to operate with transient electrical fields occurring within these devices.

## **2.2 Damper Actuators - General Purpose Electric/Electronic**

- .1 General purpose damper actuators for air handling unit dampers and plenum/duct mounted dampers.
- .2 Listed to CAN/CSA-E60730-1.
- .3 Control action:
  - .1 electric/electronic operation for two position (OPEN-CLOSE) and proportional-modulating operation as shown,
    - (a) floating-point modulation not acceptable.
- .4 Enclosure:
  - .1 Type 2 to CSA C22.2 No. 94.1, or NEMA 2, for indoor applications,
  - .2 Type 4 or 12 to CSA C22.2 No. 94.1 or NEMA 4 or 12, for outdoor use and where dampers are exposed to the airstream inside an air intake plenum.
  - .3 ☐ integral heating element for low temperature operation, 24 VAC.]
- .5 Construction:
  - .1 gear type mechanism with spring-return to failed position, or electronically fail-safe,
  - .2 adjustable motor rotation direction,
  - .3 mechanical position indicator,
  - .4 directly mounted to damper shaft,
    - (a) remote mounted with connecting linkage and with fastening clamp assembly are permitted only where there is insufficient space for mounting actuator directly onto damper shaft.
  - .5 electronic overload or digital rotation sensing circuitry to protect damper operator through entire range of rotation,
  - .6 angle of rotation adjustable between 0° to 90°,
  - .7 input control signals:
    - (a) proportional-modulation service: 0 - 10V, 2-10 V, or 0 - 20mA,
    - (b) two position service: power On-Off
  - .8 feedback signals:
    - (a) proportional-modulating service: 2 - 10 V position feedback signal.
    - (b) two position service: two (2) x SPDT auxiliary switches for end stop position indication (open and closed), 3 A resistive @ 250 VAC
  - .9 power supply:
    - (a) modulating service: 24 VAC/VDC, 50/60 Hz.
    - (b) two position service: 120 VAC or 24 VAC.
- .6 Selection:
  - .1 sized and selected in accordance with manufacturer's instructions,
  - .2 minimum torque rating for dampers: sufficient to operate damper to provide smooth response up to fan dead-head pressure plus 15%,

## **2.3 Valve Actuators - General Purpose Electric/Electronic**

- .1 General purpose valve actuators for liquid and steam control valves for ball valves and globe valves.
- .2 Listed to CAN/CSA-E60730-2-14 or CSA C22.2 No. 24.
- .3 Control action:
  - .1 electric/electronic operation for two position (OPEN-CLOSE) and proportional-modulating operation as shown,
    - (a) floating-point modulation not acceptable,
  - .2 rotary or linear acting to suit valve action.
- .4 Enclosure:
  - .1 Type 2 to CSA C22.2 No. 94.1, or NEMA 2, for indoor applications,
  - .2 Type 4 or 12 to CSA C22.2 No. 94.1 or NEMA 4 or 12, for outdoor use and where dampers are exposed to the airstream inside an air intake plenum.
- .5 Construction:
  - .1 high alloy gear type mechanism with spring-return to failed position, or electronically fail-safe,
  - .2 adjustable motor rotation direction,
  - .3 mechanical position indicator,
  - .4 directly mounted to valve shaft, or with linear linkage drive assembly,
  - .5 compatible for installation on ISO 5211 mounting pad,
  - .6 electronic overload or digital rotation sensing circuitry to protect actuator through entire range of rotation,
  - .7 running time: < 160 seconds, independent of load,
  - .8 input control signals:
    - (a) proportional-modulation service: 0 - 10V, 2-10 V, or 0 - 20mA,
    - (b) two position service: power On-Off
  - .9 feedback signals:
    - (a) proportional-modulating service: 2 - 10 V position feedback signal.
    - (b) two position service: two (2) x SPDT auxiliary switches for end stop position indication (open and closed), 3 A resistive @ 250 VAC
  - .10 power supply:
    - (a) modulating service: 24 VAC/VDC, 50/60 Hz.
    - (b) two position service: 120 VAC or 24 VAC.
- .6 Selection:
  - .1 sized and selected in accordance with valve manufacturer's instructions,
  - .2 minimum torque ratings for valves: sufficient to suit valve opening or closing requirements against a fluid differential pressure on:
    - (a) closed loop piping system of not less than 280 kPa (40 psig), plus 15%.
    - (b) open loop piping systems of not less than 700 kPa (100 psig), plus 15%.
  - .3 actuators may be supplied as multiple units to achieve required torque.

### **3 EXECUTION**

#### **3.1 Application**

- .1 Use electric/electronic actuators for damper and actuators.

#### **3.2 Installation**

- .1 General:
  - .1 Mount actuators and provide adapters according to manufacturer's recommendations.
- .2 Electric and Electronic Damper Actuators:
  - .1 Mount damper actuators directly on damper shaft or jackshaft; linkages may be used only where there is insufficient space to install and remove the actuator directly on the damper shaft.
  - .2 Mount valve actuator directly on shaft or with linkages according to manufacturer's recommendations.
  - .3 For low-leakage dampers with seals, mount actuator with minimum 5° travel available for damper seal tightening.
  - .4 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close damper, then tighten linkage.
  - .5 Provide mounting hardware and linkages for actuator installation.

#### **3.3 Power and Control Wiring**

- .1 Provide power and control wiring to each electric/electronic operator in accordance with the manufacturer requirements and in accordance with specification section 25 05 13.
- .2 Where required by actuator manufacturer instructions for parallel actuator installation, provide power isolation relays to isolate forward and reverse motor windings.

#### **3.4 Testing**

- .1 Test each actuator by applying appropriate control signal and inspect for smooth operation while operating under normal load conditions.
- .2 Alternatively, where there are more than ten (10) actuators serving the same application, a timed cycle test may be used for all valves in each application:
  - .1 randomly select ten samples for each application, and measure open and closed timing of the sample valve set, and then estimate the average time of the set.
  - .2 Using the BAS, cycle open and then closed and record the time duration for each half cycle for each actuator. Test acceptance criteria is where each damper opens and closes within 90% of the tested average time.

**End of Section**

## **BUILDING AUTOMATION INSTRUMENTATION**

### **25 30 16.13**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide measurement switches, sensors, and transmitter instrumentation for building automation.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 20 01 13 Definitions and Abbreviations – Mechanical
  - .2 20 05 26 Pipeline Hot-Tapping and Line Stopping
  - .3 25 05 01 Building Automation Common Work Results

##### **1.3 Definitions**

- .1 The following definitions apply to this section.
  - .1 **Finished rooms/spaces** means a room or space that is not a service room.
  - .2 **Instrumentation** means products covered by this specification section.
  - .3 **Service rooms** has the meaning as defined in specification section 20 01 13.

##### **1.4 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 CSA B51 Boilers, Pressure Vessels, and Pressure Piping Code
- .2 Product standards:
  - .1 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations.

##### **1.5 Design Criteria**

- .1 Pressure rating of instrumentation connected to pressure piping to be equal to or greater than the design pressure at the design temperature of the associated piping system.

##### **1.6 Submittals**

- .1 Submit manufacturer product data sheets in accordance with the requirements of Division 01.
- .2 Include Canadian Registration Numbers for applicable products.

##### **1.7 Quality Control**

- .1 Products that are in contact with the process fluid of a piping system that is subject to registration under applicable boiler and pressure vessel legislation are to have Canadian Registration Numbers in accordance with CSA B51.

#### **2 PRODUCTS**

##### **2.1 General**

- .1 Provide equipment which functions and meets detailed performance criteria when operating in the following minimum ambient condition ranges except where otherwise specified:
  - .1 ambient temperature:

Instrument Location	Service Temperature Range	Notes
Indoor	4°C to 40°C (39°F to 104°F)	(a)
Outdoor	-30°C to + 40°C (-22°F to 104°F)	
Intake and exhaust air plenums	-30°C to + 40°C (-22°F to 104°F)	

**Notes:**

(a) *Unheated spaces to be treated as outdoor spaces.*

- .2 Ambient relative humidity 10% to 90% non -condensing
- .2 Components installed within motor controllers to be designed to operate with transient electrical fields occurring within these devices.

## 2.2 Temperature Switches

- .1 Low temperature limit temperature switch:
  - .1 6m (20 ft) of sensing capillary sensitive to freezing air over any 400mm (15 in) section,
  - .2 automatic reset with fixed differential temperature,
  - .3 installed in multiples with one unit serving not more than 5 m<sup>2</sup> (40 sq. ft) of duct area.
  - .4 single pole double throw (SPDT) contacts,
  - .5 operating temperature range: 1.7°C to 7.2°C (35°F to 45°F),
  - .6 adjustable set point within specified range,
  - .7 protective enclosure.
- .2 Temperature switches:
  - .1 sensing element of liquid, vapour or bimetallic type,
  - .2 adjustable set-point and differential of at least 0.22°C to 1.7°C ( 0.4°F to 3.0°F),
  - .3 snap action type rated at 120 volts, 15 amps or 24 volts DC,
  - .4 automatic in-operation and automatically reset when condition returns to normal,
  - .5 type:
    - (a) suitable for wall mounting on standard electrical box with protective guard, or suitable for insertion into air ducts with insertion length of 450 mm (18 in), or
    - (b) thermowell type with compression fitting for 20 mm (0.8 in) NPT well, mounting length of 100 mm ( 4 in), and immersion wells of type 316 stainless steel, or
- .3 Strap-on-type temperature switch with helical screw stainless steel clamps:
  - .1 operating temperature range: 23°C to 57°C (75°F to 138°F) [38°C to 71°C (100°F to 160°F)],
  - .2 adjustable set point within specified range,
  - .3 single pole double throw (SPDT) contacts,
  - .4 protective enclosure.

## 2.3 Temperature Sensors – General Requirements

- .1 Sensor element types:
  - .1 Resistance temperature device (RTD) of precision thin film platinum element type;
    - (a) linear characteristics over sensor range,

- (b) reference resistance: 1000 ohm, [ $\pm 20$  ohms (2%)] [ $\pm 2$  ohms (0.2%)] at 0°C (32°F),
- (c) temperature resistance coefficient: 0.0385 ohms/ohm/°C (0.0212 ohms/ohm/°F),
- (d) accuracy:  $\pm 0.36^\circ\text{C}$  at 21°C ( $\pm 0.65^\circ\text{F}$  at 70°F) accuracy [[ to Din IEC 751]
- .2 Resistance temperature device (RTD) of precision thin film nickel element type;
  - (a) linear characteristics over sensor range,
  - (b) reference resistance: 1000 ohm, [ $\pm 20$  ohms (2%)] [ $\pm 2$  ohms (0.2%)] at 21°C (70°F),
  - (c) temperature resistance coefficient: 5.4 ohm/°C (3.0 ohm/°F)
  - (d) accuracy:  $\pm 0.18^\circ\text{C}$  at 21°C ( $\pm 0.34^\circ\text{F}$  at 70°F)
- .3 Thermistor;
  - (a) non-linear negative temperature coefficient of resistance,
  - (b) reference resistance: 10,000 ohms at 25°C (77°F),
  - (c) accuracy: curve matched to  $\pm 0.2^\circ\text{C}$  ( $\pm 0.36^\circ\text{F}$ ) over 0°C to 70°C (32°F to 158°F),
  - (d) long term stability: 0.025°C (0.045°F) drift per year
- .2 Sensor construction general requirements:
  - .1 2 integral anchored lead wires,
  - .2 waterproof sensor to sheath seal,
  - .3 strain minimizing construction,
  - .4 standard conduit box termination with cover,
  - .5 pig-tail wire leads with wire nuts or screwed terminal connector block,
  - .6 factory calibrated and capable of end to end (sensing element to BAS) accuracy of  $\pm 0.25^\circ\text{C}$  ( $\pm 0.5^\circ\text{F}$ ) over full range of measured variable,
  - .7 transducing circuit to convert output to signal compatible with equipment controller.

## **2.4 Temperature Sensors – for Ducts and Piping**

- .1 For installation in duct and piping systems.
- .2 Averaging element type temperature sensors:
  - .1 averaging style element sensors, with minimum of four (4) encapsulated platinum 1 kohm RTD sensors per length,
  - .2 bendable aluminium or copper tubing construction,
  - .3 sensor operating temperature range from  $-40^\circ\text{C}$  to  $121^\circ\text{C}$  ( $-40^\circ\text{F}$  to  $250^\circ\text{F}$ ).
  - .4 ambient relative humidity: 5 to 95% RH non-condensing,
  - .5 minimum immersion length: 1800 mm (6 feet).
  - .6 probe field-formable to minimum radius of 100mm (4 in) at any point along probe length, other than with 200 mm (8 in) of connector box, without degradation of specified performance,
  - .7 galvanized steel or polycarbonate junction box,
  - .8 provided as multiple RTD sensors where single averaging element cannot be located to provide proper duct or plenum temperature sampling.
- .3 Duct mount probe type temperature sensors:
  - .1 provided for ducts of cross section less than 0.4 m<sup>2</sup> (4 sq. ft),
  - .2 sensor operating temperature range from  $-40^\circ\text{C}$  to  $121^\circ\text{C}$  ( $-40^\circ\text{F}$  to  $250^\circ\text{F}$ ),
  - .3 copper or brass or stainless steel sheathed construction,



- .4 ambient relative humidity: 5 to 95% RH non-condensing,
  - .5 metal mounting plate,
  - .6 probe length such that sensing element is between 35 and 70% of duct width or diameter,
  - .7 provided as multiple sensors where single element cannot be located to provide proper duct or plenum temperature sampling.
- .4 Pipe thermowell-mounted temperature sensors:
- .1 for measurement of fluid temperatures in piping,
  - .2 insertion elements for measurement of fluid temperatures with stainless steel sheath,
  - .3 sensor operating temperature range:  $-40^{\circ}\text{C}$  to  $121^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$  to  $250^{\circ}\text{F}$ ),
  - .4 spring loaded construction with compression fitting for 20mm (NPS  $\frac{3}{4}$ ) well mounting,
  - .5 length suitable for application,
  - .6 stainless steel or chrome plated brass thermowells of size and material to suit relevant sensor, pipe and service.
- .5 Outside air temperature sensors:
- .1 insertion type for through-the-wall installation with stainless steel sheath,
  - .2 sensor operating temperature range:  $-25^{\circ}\text{C}$  to  $60^{\circ}\text{C}$  ( $-13^{\circ}\text{F}$  to  $140^{\circ}\text{F}$ ),
  - .3 waterproof seal at wall,
  - .4 ambient relative humidity: 5 to 95% RH non-condensing,
  - .5 total active probe length: 100 mm to 150 mm (4 in to 6 in),
  - .6 non-corroding outdoor shield to minimize solar heating effect,
  - .7 inert section passing through wall to allow precise measurement of outdoor temperature.

## **2.5 Temperature Sensors – General Purpose Space Sensors**

- .1 For general use space/room temperature measurement.
- .2 General purpose space temperature sensors – no display (type TS):
  - .1 hard-wired sensor only, no display,
  - .2 sensor operating temperature range:  $4^{\circ}\text{C}$  to  $60^{\circ}\text{C}$  ( $40^{\circ}\text{F}$  to  $140^{\circ}\text{F}$ ),
  - .3 enclosure: surface mounted, blank (no interface) plastic mono-chromatic guard with surface mounting plate and wall anchors,
  - .4 guard secured to mounting plate by screws or snaps.
- .3 Space temperature sensors with display (type TSD):
  - .1 BAS network sensor with user interface display,
  - .2 user interface:
    - (a) LCD display, for measured values and setpoint values,
    - (b) temperature display resolution:  $0.1^{\circ}\text{C}$  ( $0.2^{\circ}\text{F}$ )
    - (c) physical or virtual buttons for user adjustment of setpoints and selection of measured values.
  - .3 Programmable user input selection (buttons):
    - (a) physical or touchscreen buttons,
    - (b) sensor reading selection,
    - (c) sensor setpoint adjustment (temperature only),

- .4 ambient relative humidity: 5 to 95% RH non condensing,
- .5 temperature sensor: 10 kOhm,
- .6 temperature sensor accuracy:  $\pm 0.2^{\circ}\text{C}$  ( $\pm 0.36^{\circ}\text{F}$ )
- .7 adjustable setpoint range (programmed default is  $20^{\circ}\text{C}$  to  $25^{\circ}\text{C}$  ( $68^{\circ}\text{F}$  to  $78^{\circ}\text{F}$ )),
- .8 BAS field-bus connector to allow local access to sensor and BAS controller and network,
- .9 temperature setpoint remotely resettable from BAS,
- .10 minimum/maximum limit set point values adjustable locally and remote from BAS,
- .11 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors,
- .12 network connection: BACnet MSTP.
- .13 guard secured to mounting plate by screws or snaps.

## **2.6 Humidity Sensors – General Purpose**

- .1 Sensor construction general requirements:
  - .1 measurement operating ranges of 10 to 100% R.H.
  - .2 sensor operating temperature range from  $-40^{\circ}\text{C}$  to  $121^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$  to  $250^{\circ}\text{F}$ )
  - .3 solid state sensing element,
  - .4 accuracy of  $\pm 3\%$  RH reading over range of 5 to 95% R.H.,
  - .5 independent, non-interactive span and zero adjustments,
  - .6 0-100% linear proportional output signal indicating relative humidity, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
  - .7 strain minimizing construction,
  - .8 screwed terminal connector block.
- .2 Duct mount probe type humidity sensors:
  - .1 metal mounting plate,
  - .2 constructed with 304 stainless steel element enclosure,
  - .3 length such that sensing element is between 35% and 70% of duct width or diameter from duct wall.
- .3 Outside air type humidity sensors:
  - .1 weatherproof enclosure with cover,
  - .2 waterproof seal.

## **2.7 Duct Type Combination Temperature and Humidity Sensors – General Purpose**

- .1 Where both temperature and humidity are shown to be measured at same location or in same airstream, use of single measuring unit is permitted provided that features and performance of both the temperature sensor and the humidity sensor are in accordance with requirements of this specification.

## **2.8 Outdoor Combination Temperature and Humidity Transmitter (type THT-OUT)**

- .1 For building reference outdoor conditions.
- .2 Exterior wall mounted humidity and temperature transmitter;
  - .1 traceable calibration certificate, to NIST, ISO 9001 or ISO 17025,
  - .2 on-site field calibration by PC or service tool through service port connection,

.3 user selectable humidity parameters – relative humidity, dew point, enthalpy, wet bulb temperature.

.3 Humidity sensor:

- .1 sensor: HUMICAP 180R
- .2 measurement range: 0 - 100% RH,
- .3 accuracy:

Temperature Range	Humidity Range	Accuracy
-40 to -20°C (-40 to -4°F)	0 – 100% RH	±4% RH
-20 to +10°C (-4 to +50°F)	0 – 90%	±3% RH
	90 – 100%	±4% RH
+10 to +30°C (+50 to +86°F)	0 – 90%	±2% RH
	90 – 100%	±3% RH
+30 to +60°C (+86 to +140°F)	0 – 90%	±3% RH
	90 – 100%	±4% RH

.4 stability: ±0.5% RH/year

.4 Temperature sensor:

- .1 sensor type: Pt1000 RTD,
- .2 measurement range: -40 to +60°C (-40 to +140°F)
- .3 accuracy: ±0.2°C at +20°C (±0.36°F at +68°F).

.5 Calculated parameters:

- .1 Built-in math processor calculates other air properties based on measured temperature and relative humidity.
  - (a) alternate properties selected by configuration settings.

Calculated Parameter	Range	Accuracy (at 20°C and 80% RH)
Dewpoint	-40 to +60°C (-40 to +140°F),	±0.7°C (±1.2°F)
Wet Bulb	-40 to +60°C (-40 to +140°F),	±0.5°C (±0.9°F)
Enthalpy	-40 to +460 kJ/kg (-10 to +190 BTU/lb)	±1.6 kJ/kg (±0.7 BTU/lb)

.6 Ambient operating conditions:

- .1 temperature: -40 to +60°C (-40 to +140°F),
- .2 humidity 0- - 100% RH.
- .3 maximum wind speed: 30 m/s (67 mph).

- .7 Service port: RS 485 for temporary connection for service.
- .8 Output: 2 @ 4-20 mA, one each for temperature and relative humidity,
- .9 Comm port: RS 485 (for network models only),
- .10 Housing:
  - .1 glass-reinforced polycarbonate, with rain shrouds and sun-shield,
  - .2 stainless steel wall mounting bracket with backing plate and hardware.
- .11 Outputs:
  - .1 2 @ 4-20 mA, loop powered transmitter.
- .12 Power: 24 VAC/VDC

*Standard of Acceptance*

- Vaisala - fig. HMS110

## **2.9 Pressure Switches**

- .1 General:
  - .1 device pressure ratings – water, compressed gases and vapours: not less than the design pressure of the applicable piping system specification.
  - .2 device pressure rating – ventilation ducts: minimum 14 kPa (2 psi).
- .2 Differential pressure switches:
  - .1 spring loaded diaphragm type,
  - .2 suitable for use with air, inert gas, water, glycol, steam,
  - .3 adjustable set-point and differential,
  - .4 snap acting SPDT contacts rated at 120 volts, 15 amps AC or 24 volts DC,
  - .5 switch mounted with diaphragm in vertical plane,
  - .6 automatic in operation and automatically reset when condition returns to normal,
  - .7 operating temperature range: 0°C to 60°C (35°F to 140°F),
  - .8 operating humidity: 10 to 90% RH non-condensing,
  - .9 high and low pressure ports, brass hose barbed pressure fittings suitable for Ø8 mm (¼ in) tubing,
  - .10 mounting bracket suitable for duct mounting,
  - .11 dust proof enclosure,
  - .12 screw terminal block.
- .3 Pressure switches:
  - .1 bourdon tube, bellows or diaphragm type,
  - .2 suitable for use with air, inert gas, water, glycol, steam, ammonia or non-corrosive refrigerants,
  - .3 selected with span of not greater than twice maximum set pressure,
  - .4 adjustable set-point,
  - .5 snap acting SPDT contacts rated at 120 volts, 15 amps AC or 24 volts DC,
  - .6 automatic in operation and automatically reset when condition returns to normal,
  - .7 dust proof enclosure,
  - .8 screw terminal block.

## **2.10 Pressure Sensors/Transmitters**

- .1 General:
  - .1 device pressure ratings – water, compressed gases and vapours: not less than the design pressure of the applicable piping system specification.
  - .2 device pressure rating – ventilation ducts: minimum 14 kPa (2 psi).
- .2 Duct static pressure sensors:
  - .1 for static and differential static pressure measurement of duct airflow,
  - .2 type: diaphragm driven, capacitance change type, 0-100% linear proportional output signal indicating static pressure or differential pressure at station,
  - .3 selected with span of not greater than twice the maximum static pressure and not less than twice differential pressure at shut-off.
  - .4 output: 4-20 mA, 0-5 Vdc or 0-10 VDC,
  - .5 power supply: 24 VAC/VDC,
  - .6 stainless steel duct probe, with length equal to between 35% and 70% of duct width or diameter,
- .3 Piping static pressure and differential pressure sensors:
  - .1 for static and differential static pressure measurement for liquids, gases and vapours,
  - .2 type: diaphragm driven, capacitance change type, 0-100% linear proportional output signal indicating static pressure or differential pressure at station,
  - .3 stainless steel wetted parts,
  - .4 output: 4-20 mA, 0-5 Vdc or 0-10 VDC,
  - .5 power supply: 24 VAC/VDC,
- .4 Piping static pressure and differential pressure transmitters:
  - .1 for static and differential static pressure measurement for liquids, gases and vapours,
  - .2 type:
    - (a) type 316L stainless steel diaphragm driven, capacitance change type,
    - (b) signal conditioning electronics for 0-100% linear proportional output signal,
  - .3 operator interface: LCD display of measured process value, with selectable units.
  - .4 wetted parts: type 316L stainless steel,
  - .5 process connections:
    - (a) type 316L stainless steel threaded fitting,
    - (b) NPT to ASME B1.20.1,
  - .6 output: 4-20 mA
  - .7 field adjustable zero and span,
  - .8 selected with span of not greater than twice maximum static pressure and not less than twice differential pressure at shut-off.
  - .9 accuracy, including non-linearity, hysteresis and non-repeatability:  $\pm 0.05\%$  full scale,
  - .10 operating temperature range;  $-40^{\circ}\text{C}$  to  $80^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$  to  $185^{\circ}\text{F}$ ),
  - .11 operating humidity range; 0 to 100% relative humidity,
  - .12 mounting bracket, suitable for pipe mounting,
  - .13 enclosure;

- (a) cast aluminium,
- (b) Type 4X to CSA C22.2 No. 94.1 or NEMA,
- (c) polyurethane finish paint,
- (d) screw terminal connector block.

.5 Differential pressure transmitters for terminal units:

- .1 suitable for use in air with pressure independent terminal units (constant volume, variable volume or fan powered),
- .2 capacitive sensor technology,
- .3 pressure range: 0 to 373 Pa (0 to 15 in.w.g.),
- .4 linear output proportional to velocity pressure of unit inlet air stream, and suitable as analog input to terminal unit controller,
- .5 accuracy including non-linearity, hysteresis, and non-repeatability:  $\pm 1\%$  full scale
- .6 operating temperature range:  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$  ( $32^{\circ}\text{F}$  to  $122^{\circ}\text{F}$ )
- .7 operating humidity range: 10 to 90% non-condensing
- .8 high and low pressure ports, barbed pressure fittings suitable for  $\varnothing 8$  mm ( $\frac{1}{4}$  in) tubing for connection to air flow pick up device provided with terminal box,
- .9 mounting kit, suitable for installation within terminal unit controller enclosure,
- .10 coded screw terminals .

## 2.11 Air Flow Measuring Devices

.1 Multiple head pitot tube type stations:

- .1 diamond shape cross-section averaging Pitot tube-style sensor with multiple tube structure, averaging chambers and bidirectional flow sensing capability,
- .2 sheet metal duct collars,
- .3 selected for operating flow range, duct size and air temperature,
- .4 integral differential pressure sensor with analog output signal proportional to differential pressure across sensor, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
- .5 accuracy:  $\pm 1\%$  of actual value,
- .6 repeatability:  $\pm 0.1\%$  of actual value,
- .7 flow turndown: greater than 10:1,
- .8 differential pressure range: 0 to 1250 Pa (0 to 5 in wg),
- .9 operating pressure: up to 34.3 kPa (5 psig),
- .10 operating temperature rating:  $-4^{\circ}\text{C}$  to  $95^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$  to  $200^{\circ}\text{F}$ ),
- .11 operating pressure rating: 1725 kPa (250 psig)

.2 Thermal anemometer probe type airflow measuring stations:

- .1 sensors mounted in sheet metal duct collars of [aluminum][ stainless steel],
- .2 each thermistor mounted in solid thermoplastic housing,
- .3 probe length equal to greater of two inside dimensions of rectangular and oval ducts and equal to duct diameter for round ducts,
- .4 minimum two sensing points per probe,
- .5 independent averaging of multiple sensing points,
- .6 averaging amplifier with adjustable offset and span for multiple probe applications,

- .7 temperature compensated linear analog output signal indicating average velocity at station, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
  - .8 velocity accuracy:  $\pm 2\%$  of reading,
  - .9 temperature accuracy:  $0.10^{\circ}\text{C}$  ( $0.18^{\circ}\text{F}$ ),
  - .10 resolution: 0.4% of scale,
  - .11 repeatability:  $\pm 0.2\%$  of reading,
  - .12 velocity range: 0 to 25m/s (0 to 5000 fpm),
  - .13 maximum allowable pressure drop: 1.2 Pa at 10m/s (0.005 in wg at 2000 fpm),
  - .14 flow station operating temperature range:  $[0^{\circ}\text{C to } 70^{\circ}\text{C} (30^{\circ}\text{F to } 160^{\circ}\text{F})][ -29^{\circ}\text{C to } 71^{\circ}\text{C} (-20^{\circ}\text{F to } 160^{\circ}\text{F})]$ ,
  - .15 electronics operating temperature range:  $0^{\circ}\text{C to } 70^{\circ}\text{C} (30^{\circ}\text{F to } 160^{\circ}\text{F})$ ,
  - .16 flow station operating humidity range: 0 to 99% RH non-condensing,
  - .17 dedicated electronic, solid state digital processing control panel with general purpose NEMA 2 enclosure,
  - .18 provided with upstream and/or downstream flow conditioning.
- .3 Thermal anemometer type airflow measuring stations for installation at fan inlets:
- .1 fan inlet bell mouth mounted with adjustable steel strut and mounting feet,
  - .2 minimum of two flow sensing thermistors and temperature sensors per station, two stations for DWDI fans,
  - .3 sensors mounted in aluminum casing and recessed within strut,
  - .4 independent averaging of multiple sensing points,
  - .5 temperature compensated linear analog output signal indicating average velocity at station, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
  - .6 velocity accuracy:  $\pm 2\%$  of reading,
  - .7 temperature accuracy:  $\pm 0.2^{\circ}\text{C}$  ( $0.36^{\circ}\text{F}$ ),
  - .8 resolution: 0.4% of scale,
  - .9 repeatability:  $\pm 0.2\%$  of reading,
  - .10 velocity range: 0 to 25m/s (0 to 5000 fpm),
  - .11 maximum allowable pressure drop: 1.2 Pa at 10m/s (0.005 in.w.c. at 2000 fpm),
  - .12 flow station operating temperature range:  $0^{\circ}\text{C to } 71^{\circ}\text{C} (30^{\circ}\text{F to } 160^{\circ}\text{F})$ ,
  - .13 electronic operating temperature range:  $0^{\circ}\text{C to } 71^{\circ}\text{C} (30^{\circ}\text{F to } 160^{\circ}\text{F})$ ,
  - .14 flow station operating humidity range: 0 to 99% RH non-condensing,
  - .15 dedicated electronic, solid state digital processing control panel with general purpose dustproof enclosure.
- .4 Provide mounting hardware for installation of airflow measuring stations by sheet metal contractor.

## **2.12 Air Flow Switches**

- .1 For indication of air flow within duct.
- .2 Differential pressure activated, diaphragm type,
  - .1 snap-action SPDT switch, 10 A @ 120 VAC,
  - .2 field adjustable set point,

- .3 minimum air velocity: 1 m/s (200 fpm),
- .4 maximum air velocity: 10.2 m/s (2000 fpm),
- .5 operating ambient temperature range: 0°C to 40°C (32°F to 104°F),
- .6 dustproof enclosure with mounting plate and gasket seal.

### **2.13 Liquid Flow Switches**

- .1 For indication of fluid flow in piping systems.
- .2 Suitable for use with water, ethylene or propylene glycol, chlorinated or treated water
  - .1 snap-action SPDT switch, 10 A @ 120 VAC,
  - .2 operating ambient temperature range; [0°C to 82°C (32°F to 180°F)][-34°C to 82°C (-30°F to 180°F)]
  - .3 operating liquid temperature range: [0°C to 121°C (32°F to 250°F)][-29°C to 121°C (-29°F to 250°F)]
  - .4 general purpose dust proof enclosure for use indoors with fluids at temperature greater than 0°C (32°F)
  - .5 NEMA 3R vapour tight enclosure for use indoors or outdoors with fluids at temperatures below 0°C (32°F).

### **2.14 Electric Power Instrumentation**

- .1 Current sensing relays:
  - .1 metering transformer ranged to match load being metered,
  - .2 plug in base and shorting shunt to protect current transformer when relay is removed from socket,
  - .3 current transformer for single or three phase metering connected into single relay,
  - .4 adjustable latch level, adjustable delay on latch and minimum differential of 10% of latch setting between latch level and release level,
  - .5 discrimination between phases in three phase applications to allow worst case selection,
  - .6 mounted in motor starter enclosure and fed from starter control transformer,
  - .7 relay contacts capable of handling 10 amps at 240 volts.
- .2 Current switches:
  - .1 self-powered, solid-state type with adjustable trip current,
  - .2 integral current transformers and relays to indicate motor status,
  - .3 SPDT output relay suitable for use as digital input to the BAS,
  - .4 field adjustable output relay trip setting, over 0-100% of range. Deadband adjustment to maximum of 10% of range,
  - .5 integral zero-leakage LED's indicating sensor power and switch status,
  - .6 long term setting drift of current transformer and relay combination not more than 5% full range over 6 months,
  - .7 over current and over voltage protection for current transformer and relay,
  - .8 operating temperature range; -10°C to 50°C (14°F to 122°F),
  - .9 operating humidity range; 5% to 90% RH non condensing.
- .3 Current transducer:
  - .1 output signal proportional to measured line current,



- .2 output signal in one of following ranges; 4-20 mA, 0-5 Vdc or 0-10 Vdc
- .4 AC Current Transmitters:
  - .1 self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output,
  - .2 full-scale unit ranges of 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment,
  - .3 accuracy:  $\pm 1\%$  full-scale at 500 ohm maximum burden.
  - .4 UL/CSA listed and meet or exceed ANSI/ISSA 50.1 requirements.
- .5 AC Voltage Transmitters:
  - .1 self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
  - .2 adjustable full-scale unit ranges; 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac.
  - .3 Accuracy:  $\pm 1\%$  full-scale at 500 ohm maximum burden.
  - .4 UL/CSA listed, 600 Vac rated and conforming to ANSI/ISSA 50.1.
- .6 Power Monitors:
  - .1 three-phase type with three-phase disconnect and shorting switch assembly,
  - .2 UL listed voltage transformers, and
  - .3 UL listed split-core current transformers.
  - .4 selectable output either rate pulse for kWh reading or 4-20 mA for kW reading.
  - .5 maximum error of  $\pm 2\%$  at 1.0 power factor or  $\pm 2.5\%$  at 0.5 power factor.

### **3 EXECUTION**

#### **3.1 Instrumentation Installation – General Requirements**

- .1 Mount instrumentation;
  - .1 in clean areas wherever possible,
  - .2 to be accessible to allow for replacement and servicing without interfering with access for adjacent equipment and personnel traffic in surrounding space,
- .2 Provide access doors where instrumentation is concealed behind solid surfaces.
- .3 In finished spaces and rooms, install room instrumentation on concealed junction boxes;
  - .1 fully recessed in gypsum board, wood, or similar construction,
  - .2 fully recessed in new concrete block construction, with conduit run block void spaces,
  - .3 fully recessed in new poured concrete construction, with conduit and outlet box roughed-in before concrete pour.
  - .4 surface mounted with exposed conduit on existing concrete block walls and existing poured concrete walls.
- .4 In service rooms, loading docks, and parking garages, install room instrumentation on surface mounted junction boxes with exposed surface-mounted conduit.
- .5 Rigidly support field mounted instrumentation on pipe stands or channel brackets.
- .6 Rigidly support duct mounted instrumentation to side of duct, in a location that will allow full removal of the instrumentation including duct probes.

- .7 Orient instrumentation sensing elements to correctly sense measured variable and to be isolated from vibrations and environmental conditions that could affect measurement or calibration.
- .8 Identify each cable and wire at every termination point.
- .9 Air seal wires attached to sensors at entry into junction box.

### **3.2 Power and Control Wiring**

- .1 Provide power and control wiring to each instrument in accordance with the manufacturer requirements and in accordance with specification section 25 05 13.

### **3.3 Temperature and Humidity Instrumentation**

- .1 Averaging duct temperature sensors:
  - .1 Use averaging sensors in the following locations:
    - (a) mixing plenums in front of the first downstream component,
    - (b) ducts with cross sectional area greater than 1.5 m<sup>2</sup> (16 sq. ft),
    - (c) downstream of the supply air leaving side of a thermal heat wheel, located approximately 200 mm (8 in) from leaving face of wheel.
  - .2 Install averaging sensors in serpentine manner vertically across duct. Support each bend with capillary clip. Provide sensor element length of 3 m per m<sup>2</sup> (1 ft per ft<sup>2</sup>) of plenum/duct cross sectional area.
- .2 Low-temperature switch:
  - .1 Install mixing plenum low-limit temperature switches in serpentine manner horizontally across duct. Support each bend with capillary clip. Provide sensor element length of 3 m per 1 m<sup>2</sup> (1 ft per 1 sq. ft) of coil area.
- .3 Pipe mounted temperature sensors:
  - .1 Thermowells to be installed by the trade contractor under the applicable Division of the Work for each piping system. Supply the thermowells to the trade contractor and coordinate with them as to installation location and orientation.
  - .2 For existing steel piping systems, coordinate with the piping trade contractor to install the thermowells by hot-tapping in accordance with specification section 20 05 26 except where the Owner permits draining of the piping system.
  - .3 Install pipe-mounted liquid temperature sensors in thermowells with heat-conducting material.
  - .4 Orientate thermowells and transmitters to be located from the side of the pipe or top of pipe for horizontal piping.
  - .5 Cut and recover piping insulation to 300 mm (12 in) either side for installation of strap-on temperature sensors. Provide removable insulation box over sensor and patch insulation to match existing.
- .4 Space temperature and humidity sensors:
  - .1 Mount space temperature or combination temperature/humidity sensors / transmitters at 1200 mm (4 ft) above finished floor.
- .5 Humidity sensors:
  - .1 Locate humidity sensors adjacent to temperature sensors except as follows.
  - .2 Locate humidity sensors in the supply air downstream of a thermal heat wheel in a location that represents the average relative humidity when hand-measured at the upstream face of the next component in the air handling unit.
- .6 Outdoor temperature and humidity transmitters:

- .1 Install outdoor air combination humidity and temperature transmitters on north facing wall, in a location readily accessible for maintenance access.

### 3.4 Space Temperature Sensor Selection

- .1 Select general purpose space temperature sensor types in accordance with the following table unless otherwise shown on drawings or in control sequences:

Space Types	Temperature Sensor Type
Private offices	TSD
Open plan offices	TSD
Meeting rooms	TSD
Service rooms, corridors, distributed electrical and data rooms, janitorial rooms, storage rooms	TS
Building entrances, lobbies, elevator lobbies, stairwells	TS
Kitchens, laundry rooms	TSD
Non-specific process spaces	TS
Healthcare treatment rooms and procedure rooms	TSD
All other spaces not identified above	TS TSD

### 3.5 Differential Air Static Pressure Sensors

- .1 Install duct static pressure sensors rigidly to side of duct to ensure duct probe is at 90° to the direction of airflow.
- .2 Supply duct static pressure;
  - .1 pipe high-pressure tap to duct using pitot tube,
  - .2 make pressure tap connections according to manufacturer's recommendations.
- .3 Return duct static pressure;
  - .1 pipe high-pressure tap to duct using pitot tube,
  - .2 make pressure tap connections according to manufacturer's recommendations.
- .4 Building static pressure;
  - .1 pipe pressure sensor's low-pressure port to static pressure port located on outside of building through high-volume accumulator,
  - .2 pipe high-pressure port to location behind thermostat cover.
- .5 Piping to air pressure transducer pressure taps to contain capped test port adjacent to transducer.
- .6 Install duct differential pressure sensors across fans, filters and other devices as shown.
- .7 Trim impulse lines to use the shortest length while maintaining adequate bending radius without kinking impulse tubes.
- .8 Locate air pressure transducers, except those controlling terminal unit boxes;

- .1 in control panels, not on monitored equipment or on ductwork,
- .2 mount transducers in vibration-free location accessible for service without use of ladders or special equipment.

### **3.6 Airflow Measuring Stations**

- .1 Provide transducers, relays, and interconnection wiring to perform Sequences of Operations as detailed and Monitoring in accordance with Controls Schematics.

### **3.7 Fluid Pressure Switch**

- .1 Mount pressure switch tees adjacent to fluid pressure gauge taps. Install shut-off valves before tee for water gauges.
- .2 Install pressure snubbers on pressure switches at;
  - .1 suction and discharge sides of oil pumps, and positive displacement pumps,
  - .2 for compressed air at compressors, dryers and receivers.
- .3 Install coil syphons on steam and condensate pressure switches.

### **3.8 Fluid Pressure Sensors and Transmitters**

- .1 Provide isolation valve and snubber between pressure sensor/transmitter and pressure source.
- .2 Install coil syphons on steam and condensate pressure sensors/transmitters.
- .3 Provide two pressure transducers with software calculation at controller for differential pressure measurements in fluid piping systems.

### **3.9 Flow Switch Installation**

- .1 Fit correct length paddle for diameter of pipe.
- .2 Adjust switch for specified flow condition in accordance with manufacturer's instructions

### **3.10 Safety Controls**

- .1 Unless otherwise shown, safety devices including smoke detectors, freezestats, low- and high-pressure cut-offs, and other safety switches and controls, are to be hard-wired to de-energize equipment as described in Sequence of Operation.
- .2 Provide contacts that allow BAS software to monitor safety control status.

**End of Section**

## **BUILDING AUTOMATION ROOM PRESSURE MONITORING**

### **25 30 16.16**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide room differential pressure measurement and GUI monitoring devices, and remote GUI monitoring device.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 25 05 12 Building Automation Control Panels and Wiring

##### **1.3 Definitions and Abbreviations**

- .1 The following definitions apply to this section.
  - .1 **power supply** means a 120 V/24 VAC transformer or 120 V to 24 VDC power rectifier supply unit.

##### **1.4 Applicable Codes and Standards**

- .1 Product standards:
  - .1 CSA C22.2 No. 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use
  - .2 IEC 60529 Degrees of Protection Provided by Enclosures (IP Code)

##### **1.5 Submittals**

- .1 Shop drawings:
  - .1 Submit product data sheets for materials specified herein.

#### **2 PRODUCTS**

##### **2.1 Multiroom Differential Pressure Monitor ("MRM")**

- .1 General:
  - .1 listed to CSA C22.2 No. 61010-1,
  - .2 microprocessor based, differential pressure monitor with GUI display,
  - .3 measure room differential pressure for three (3) rooms simultaneously,
  - .4 visual alarm: change in background colour for condition status,
  - .5 audible alarm: buzzer,
  - .6 flush-mounted, for installation in multi-gang electrical junction boxes,
  - .7 BACnet device: BACnet MS/TP Application Specific Controller,
  - .8 device configuration can be cloned to other similar MRMs,
  - .9 device can be configured remotely over BACnet,
  - .10 power input: 24 VAC.
- .2 GUI display:

- .1 minimum 110 mm (4.3 in.) projected capacitive touchscreen colour LCD, minimum 800x480 resolution, suitable for user input while wearing medical gloves,
- .2 enclosure rating: IP65 to IEC 60529,
- .3 exposed surfaces chemically resistant to common chemical cleaning products and vapourized hydrogen peroxide, formaldehyde, chlorine dioxide, perchloric acid, sodium hypochlorite 3-6% (bleach),
- .4 simultaneous graphic/text display of all room measured parameters,
- .5 language display: selectable English or French,
- .6 two line display for user definable space description (e.g. room name, room number),
- .7 user defined brightness (dimnable), with configuration for blacked-out operation until the screen is touched,
- .8 continuously display room pressure measured value,
- .9 display other room parameters simultaneously:
  - (a) minimum of six parameters: differential pressure, temperature, humidity, room air change rate, plus two (2) user defined parameters.
  - (b) parameter data provided by direct connected analog inputs or over BACnet from other devices.
- .10 four background colour banner for high visibility condition status:
  - (a) green: normal – rooms is within alarm deadband limits,
  - (b) yellow: warning - door is open, space remains within alarm deadband limits,
  - (c) red: alarm – room is outside of alarm deadband limits and door time delay has expired,
  - (d) blue or grey: standby - room not in use, alarms are suspended.
- .3 I/O:
  - .1 Inputs:
    - (a) three (3) universal inputs for -0-5 VDV, 0-10 VDC or 4-20 mA, configurable for analog or digital input signals.
    - (b) one (1) analog input for primary room differential pressure sensor,
  - .2 Outputs:
    - (a) one (1) alarm relay: 24 VDC, SPDT, 2.0 A @ 30 VDC.
    - (b) one (1) analogue: selectable 0-5 VDC, 0-10 VDC, or 4-20 mA, assignable to any room parameter (default primary room differential pressure).
  - .3 BAS integration:
    - (a) BACnet MSTP over RS485.
- .4 Differential pressure sensor:
  - .1 industrial grade bi-directional differential pressure transducer;
    - (a) dead-ended – no airflow passing through the sensor,
    - (b) stainless steel diaphragm capacitance-type differential pressure sensor,
    - (c) NIST-traceable calibration certificate for the sensing element,
    - (d) sensors manufactured for remote installation,
    - (e) sensor total combined accuracy (root-sum-square):  $\pm 0.25\%$  of full range.
    - (f) overpressure rating: minimum  $\pm 3500$  Pa ( $\pm 15$  in.w.c.).

- .2 selectable operating range at time of ordering; refer to Part 3 for sensor range selection by room type:
  - (a)  $\pm 12.5$  Pa
  - (b)  $\pm 25$  Pa
  - (c)  $\pm 50$  Pa
  - (d)  $\pm 100$  Pa
  - (e)  $\pm 250$  Pa.
- .5 Software/programming:
  - .1 user input for room operating mode:
    - (a) for healthcare facilities: only In-Use, Unoccupied, and Cleaning
    - (b) for all other applications: In-Use, Unoccupied, Cleaning, Neutral
  - .2 alarm management:
    - (a) In-Use: general alarm delay 30 seconds; alarm suspended while door is open,
    - (b) Unoccupied: all alarms suspended,
    - (c) Cleaning: all alarms suspended,
    - (d) Neutral: all alarms suspended.
  - .3 user input to set differential pressure alarm set point for each room operating mode,
  - .4 user definable time delay to suppress alarms based on door contact status,
  - .5 one-touch user input to acknowledge alarms,
  - .6 maximum two-touch user input to change room mode,
  - .7 room mode can be modified over BACnet,
  - .8 two levels of password security.

*Standard of Acceptance*

- Setra - fig. FLEX
- Antec Controls - fig. PMT
- Phoenix Controls - fig. Vista

## **2.2 Dual-Room Differential Pressure Monitor (RM2)**

- .1 General:
  - .1 listed to CSA C22.2 No. 61010-1,
  - .2 microprocessor based, differential pressure monitor with GUI display,
  - .3 measure room differential pressure for two (2) rooms simultaneously,
  - .4 visual alarm: change in background colour for condition status,
  - .5 audible alarm: buzzer,
  - .6 flush-mounted, for installation in multi-gang electrical junction boxes,
  - .7 BACnet device: BACnet MS/TP Application Specific Controller,
  - .8 device can be configured remotely over BACnet,
  - .9 power input: 24 VAC.
- .2 GUI display:
  - .1 nominal 110 mm (4.3 in.) LCD TFT resistive colour touchscreen, minimum 480x272 resolution, suitable for user input while wearing medical gloves,

- .2 enclosure rating: IP54 to IEC 60529,
- .3 exposed surfaces chemically resistant to common chemical cleaning products and vapourized hydrogen peroxide, formaldehyde, chlorine dioxide, perchloric acid, sodium hypochlorite 3-6% (bleach),
- .4 simultaneous graphic/text display of all room measured parameters,
- .5 language display: selectable English or French,
- .6 graphical and text display,
- .7 user definable space description (e.g. room name, room number),
- .8 user defined brightness (dimmable),
- .9 continuously display room pressure measured value,
- .10 display other room parameters simultaneously:
  - (a) minimum of three parameters: differential pressure, temperature, humidity,
  - (b) parameter data provided by direct connected analog inputs or over BACnet from other devices.
- .11 four background colour banner for high visibility condition status:
  - (a) green: normal – rooms is within alarm deadband limits,
  - (b) yellow: warning - door is open, space remains within alarm deadband limits,
  - (c) red: alarm – room is outside of alarm deadband limits and door time delay has expired,
  - (d) blue or grey: standby - room not in use, alarms are suspended.
- .3 I/O:
  - .1 Inputs:
    - (a) one (1) digital: door contact closure,
    - (b) two (2) analog: selectable 0-5 VDV, 0-10 VDC or 4-20 mA (in addition to onboard DP sensor).
  - .2 Outputs:
    - (a) one (1) alarm relay: 24 VDC, SPDT, 2.0 A @ 30 VDC.
    - (b) one (1) analog: selectable 0-5 VDC, 0-10 VDC, or 4-20 mA, assignable to any room parameter (default primary room differential pressure).
  - .3 BAS integration:
    - (a) BACnet MSTP over RS485.
- .4 Differential pressure sensor:
  - .1 industrial grade bi-directional differential pressure transducer;
    - (a) dead-ended – no airflow passing through the sensor,
    - (b) stainless steel diaphragm capacitance-type differential pressure sensor,
    - (c) NIST-traceable calibration certificate for the sensing element,
    - (d) sensors manufactured for remote installation,
    - (e) sensor total combined accuracy (root-sum-square):  $\pm 0.25\%$  of full range.
    - (f) overpressure rating: minimum  $\pm 3500$  Pa ( $\pm 15$  in.w.c.).
  - .2 selectable operating range at time of ordering; refer to Part 3 for sensor range selection by room type:
    - (a)  $\pm 12.5$  Pa
    - (b)  $\pm 25$  Pa



- (c)  $\pm 50$  Pa
- (d)  $\pm 100$  Pa
- (e)  $\pm 250$  Pa.

.5 Software/programming:

- .1 user input for room operating mode:
  - (a) for healthcare facilities: only In-Use, Unoccupied, and Cleaning
  - (b) for all other applications: In-Use, Unoccupied, Cleaning, Neutral
- .2 alarm management:
  - (a) In-Use: general alarm delay 30 seconds; alarm suspended while door is open,
  - (b) Unoccupied: all alarms suspended,
  - (c) Cleaning: all alarms suspended,
  - (d) Neutral: all alarms suspended.
- .3 user input to set differential pressure alarm set point for each room operating mode,
- .4 user definable time delay to suppress alarms based on door contact status,
- .5 one-touch user input to acknowledge alarms,
- .6 maximum two-touch user input to change room mode,
- .7 room mode can be modified over BACnet,
- .8 two levels of password security.

*Standard of Acceptance*

- Setra - fig. SRCM
- Antec Controls - fig. PMT
- Phoenix Controls – fig. APM2

**2.3 Single Room Differential Pressure Monitor (“RM1”)**

- .1 General:
  - .1 listed to CSA C22.2 No. 61010-1,
  - .2 microprocessor based, differential pressure monitor with GUI display,
  - .3 measure room differential pressure for one (1) room,
  - .4 visual alarm: change in perimeter lighted ring or background colour for condition status,
  - .5 audible alarm: buzzer,
  - .6 flush-mounted, for installation in a single electrical junction boxes,
  - .7 power input: 24 VAC.
- .2 GUI display:
  - .1 LCD TFT resistive colour touchscreen, suitable for user input while wearing medical gloves,
  - .2 enclosure rating: IP20 to IEC 60529 (NEMA 1),
  - .3 language display: English
  - .4 digital display data: room differential pressure, negative or positive,
  - .5 visual alarm: display changes colour or individual alarm lights:
    - (a) green: normal – room is within alarm deadband limits,
    - (b) red: alarm – room is outside of alarm deadband limits and door time delay has expired,

- .3 I/O:
  - .1 Inputs:
    - (a) one (1) discrete: door contact switch,
  - .2 Outputs:
    - (a) one (1) analog: 0-10 V or 4-20 mA, 2 wire, for room differential pressure.
    - (b) one (1) alarm: SPDT relay, 1A @ 24 VDC or 1A @ 120 VAC.
  - .3 BAS integration:
    - (a) none.
- .4 Differential pressure sensor:
  - .1 industrial grade bi-directional differential pressure transducer;
    - (a) dead-ended – no airflow passing through the sensor,
    - (b) stainless steel diaphragm capacitance-type differential pressure sensor,
    - (c) NIST-traceable calibration certificate for the sensing element,
    - (d) sensors manufactured for remote installation,
    - (e) sensor total combined accuracy (root-sum-square):  $\pm 0.50\%$  of full range.
  - .2 selectable operating range at time of ordering; refer to Part 3 for sensor range selection by room type:
    - (a)  $\pm 25$  Pa
    - (b)  $\pm 50$  Pa
- .5 Software/programming:
  - .1 user input to set differential pressure alarm set point,
  - .2 user definable time delay to suppress alarms,
  - .3 user input to acknowledge alarms,
  - .4 alarms suppressed while door(s) are open,

*Standard of Acceptance*

- Setra - fig. SRPM
- Antec Controls - fig. PM
- Phoenix Controls - fig. APM2

## **2.4 Remote Multiroom Monitor (“REMM”)**

- .1 Microprocessor based master room monitor with LCD touchscreen display,
  - .1 listed to CSA C22.2 No. 61010-1,
  - .2 BACnet device: BACnet MS/TP Application Specific Controller,
  - .3 power input: 24 VAC.
- .2 GUI display:
  - .1 minimum 80 mm (3.2 in) LCD TFT resistive colour touchscreen, suitable for user input while wearing medical gloves,
  - .2 enclosure rating: IP54 to IEC 60529,
  - .3 exposed surfaces chemically resistant to common chemical cleaning products and vapourized hydrogen peroxide, formaldehyde, chlorine dioxide, perchloric acid, sodium hypochlorite 3-6% (bleach),

- .4 minimum number of rooms simultaneously monitored and displayed: four (4)
- .5 primary page information display:
  - (a) colour coded display information for each room,
  - (b) room number and DP status condition,
  - (c) green background: normal
  - (d) yellow background: warning
  - (e) red background: alarm.
- .6 secondary page information display:
  - (a) room number,
  - (b) all room parameters reported by the associated MRM, RM2 or RM1 units,
- .7 language display: selectable English or French,
- .8 password access for menu access,
- .3 I/O:
  - .1 BAS integration:
    - (a) BACnet MSTP over RS485.

*Standard of Acceptance*

- Setra - fig. MRMS
- Antec Controls - fig. MVM
- Phoenix Controls – fig. View Monitor

## **2.5 Space Differential Pressure Sensor**

- .1 Industrial grade bi-directional differential pressure transducer;
  - .1 dead-ended – no airflow passing through the sensor,
  - .2 stainless steel diaphragm capacitance-type differential pressure sensor,
  - .3 NIST-traceable calibration certificate for the sensing element,
  - .4 sensors manufactured for remote installation,
  - .5 sensor total combined accuracy (root-sum-square):  $\pm 0.25\%$  of full range.
  - .6 overpressure rating: minimum  $\pm 3500$  Pa ( $\pm 15$  in.w.c.).
  - .7 enclosure rating: IP20 to IEC 60529 (NEMA 1),
- .2 Selectable operating range at time of ordering; refer to Part 3 for sensor range selection by room type:
  - .1  $\pm 12.5$  Pa
  - .2  $\pm 25$  Pa
  - .3  $\pm 50$  Pa
  - .4  $\pm 100$  Pa
  - .5  $\pm 250$  Pa.

*Standard of Acceptance*

- Sentra - fig. 264

## **2.6 Accessories**

- .1 Pressure sample snubber wall plate:

- .1 Stainless steel wall plate with pressure taps suitable for mounting on standard electrical outlet box.

*Standard of Acceptance*

- Setra - fig. RPS
- Air Monitor – fig. SAP/B

- .2 Pressure sensing tubing:

- .1 for all spaces (except biohazard CL 3 rooms) where concealed in walls:
- (a) platinum-cured silicon tubing, of ID/OD as specified by DPRM installation instructions.
- .2 for biohazard CL3 rooms, and for all spaces where sensing tubing is exposed:
- (a) ASTM A269, T304 stainless steel tubing, 1/4" OD,
  - (b) double ferrule compression fittings.

*Standard of Acceptance*

- Swagelock
- Bi-Lok

- .3 Door contact switch:

- .1 magnetic reed door switch, SPDT contacts,
- .2 ABS enclosure, grey in colour,
- .3 recessed mount for new door construction, surface mounted for modification to existing doors,
- .4 12 mm air gap.

- .4 HEPA Filter for sensing tubes:

- .1 bi-directional HEPA-vent filter, depth filter design
- .2 efficiency: 99/97% at 0.3 micron
- .3 stepped 6 mm to 9.5 mm (1/4" to 3/8") barb fittings.

*Standard of Acceptance*

- GE Healthcare Life Sciences - model HEPA-VENT 50mm DISC

- .5 Laboratory Room Audible Visual Alarm:

- .1 Combination alarm light and horn
- .2 NEMA 4X surface mount enclosure
- .3 Red indicating light
- .4 Horn: 100 dB, single stage
- .5 120 VAC, 60 Hz.

*Standard of Acceptance*

- Allan Bradley - Model 855H

### **3 EXECUTION**

#### **3.1 General**

- .1 Installation of laboratory room monitoring systems to section 25 05 12 and related sections.

### **3.2 Monitor Type and Pressure Range Selection**

- .1 Select monitor types for each served space in accordance with Schedule 1 at the end of this specification section.
- .2 Order differential pressure sensors with a bi-directional range for each room type in accordance with Schedule 2 at the end of this specification section.

### **3.3 Monitor Installation**

- .1 Install room pressure differential monitors (MRM, RM2, RM1) in accordance with manufacturer's instructions.
  - .1 install monitors on single or multi-gang galvanized steel electrical junction boxes.
  - .2 install monitors in the room or in the reference space as shown in Schedule 1 at the end of this specification section, unless otherwise shown.
  - .3 install monitors level, with the top of monitor approximately 1675-1700 mm above the floor, unless shown otherwise on architectural drawings. All monitors to be installed at the same height unless otherwise shown.
- .2 Install room pressure snubber/probes which are separate from the monitor:
  - .1 above the door to the room, centered horizontally on the door and vertically between door frame and ceiling,
  - .2 mount the pressure snubber/probes in an electrical galvanized steel junction box.
- .3 Install pressure sensors that are separate from the monitor in the ceiling space;
  - .1 immediately above one of the associated pressure snubber/probes,
  - .2 so as to minimize the run of sensing tubing, and
  - .3 to be accessible from the adjacent corridor or anteroom for service.

### **3.4 Remote Display Installation**

- .1 Install remote monitoring units (REMM) in accordance with manufacturer's instructions. Install monitors on single or multi-gang galvanized steel electrical junction boxes.
- .2 Where more than one REMM is to be mounted at the same supervised location, install the monitors with a clearance of at 25 – 50 mm (1 – 2 in) between adjacent units.
- .3 Mount the units with the top of unit at a height of 1670 – 1700 mm from the floor, unless otherwise shown on architectural drawings.

### **3.5 Wiring and Power Supplies**

- .1 Provide power supplies for room differential pressure monitors, in accordance with specification section 25 05 13.
- .2 Provide a separate power supply for each monitored space. The power supply for room monitors may be fed from the same power supply used for the associated room terminal units if of the same voltage characteristics.
- .3 Where a dedicated power supply is provided for a room (but which does not supply power for a terminal unit), install the power supply in a dedicated electrical NEMA 1 metal enclosure, installed above the corridor ceiling in close proximity to the entry door or room monitor.
- .4 Provide control and power wiring between the room monitor and associated pressure sensors and door contact switches.
- .5 For BACnet ASC devices, connect the room monitor via BACnet MSTP to the building automation system network.

- .6 For monitoring devices that do not have BACnet connectivity, wire the analog output from the monitor for each monitored pressure, to the associated room terminal unit as an accessory AI to the terminal unit controller.

### **3.6 Door Switches**

- .1 Provide door switches on each door serving the monitored room. Install the door switches on the frame head.
- .2 Where a monitored room has an anteroom, provide a door switch on both doors (corridor-anteroom door, and anteroom door to monitored space).
- .3 Where shown that two or more doors are to be monitored for any one monitor, wire the door contacts in series so that opening any door will create the door open notification condition.

### **3.7 Sample Tubing**

- .1 Connect room pressure snubbers to room monitoring unit;
  - .1 use stainless steel tubing:
    - (a) for biohazard Class 3 or 4 rooms, or
    - (b) where tubing is exposed,
  - .2 use stainless steel tubing or silicon tubing in all other locations.
- .2 For stainless steel tubing, make joints with double ferrule fittings. Tubing may be bent for change of directions following manufacturer's minimum turning radius.
- .3 Make final connection to pressure taps on the room monitoring unit with silicone tubing.

### **3.8 Programming and Configuration**

- .1 Configure each monitor for required differential pressure alarms, door open alarm suppression, general alarm time delay of 15 seconds, and room name and number.
- .2 Configure MRM monitors to include display differential pressures for connected pressure sensors. Configure device to display other room parameter data provided by the BAS network over BACnet:
  - .1 measured space temperature,
  - .2 measured space relative humidity (if applicable), and
  - .3 calculated room air change rate based on terminal unit air flow station and room volume parameters.
- .3 Configure RM2 monitors to include display differential pressures for connected pressure sensors. Configure device to display other room parameter data provided by the BAS network over BACnet:
  - .1 measured space temperature, and
  - .2 measured space relative humidity (if applicable).
- .4 Configure RM1 monitors to include display differential pressures for connected pressure sensor.

### **3.9 Cleaning**

- .1 Clean surfaces of each monitor prior to hand-over of the Work, to remove all dirt, oil, and surface films.

### **3.10 Start-Up and Testing**

- .1 Place the monitors into service in accordance with manufacturer instructions.
- .2 All configuration and testing of monitoring devices to be performed after completion of air balancing.
- .3 Conduct testing of alarm delays.

- .1 Test 1: With the system in the Occupied mode,
  - (a) using the BAS, adjust the airflow rate to cause a change in the room differential pressure to result in a room pressure that is outside of the alarm deadband. Confirm alarms are initiated.
  - (b) conduct five entrance walks into and out of the monitored room at random walking paces. Check that alarms are suppressed during all events.
  - (c) open the door to the monitored room for a duration longer than the door open alarm suppression period and general alarm delay period. Confirm that monitor goes into alarm.
  - (d) repeat for all other monitored doors.
- .2 Test 2: With the system in the Unoccupied mode:
  - (a) using the BAS, adjust the airflow rate to cause a change in the room differential pressure to result in a room pressure that is outside of the alarm deadband. Confirm alarms are suppressed.
  - (b) Open the doors for a time period sufficient to active the alarm. Check that alarms are suppressed while door is open.
  - (c) using the BAS, adjust the airflow rate to cause a change in the room differential pressure to result in a room pressure that is outside of the alarm deadband. Confirm alarms are suppressed.
- .3 Repeat Test 2 for Cleaning mode.
- .4 For each monitored space, verify the measured room differential pressure under steady-state operating conditions. Compare reported values against a portable field testing device of the same differential pressure range and accuracy.

### **3.11 Commissioning Program**

- .1 Provide field service personnel to participate in the system integration commissioning of the equipment and/or system including:
  - .1 review of equipment and system commissioning procedures provided by Owner in addition to the manufacturers own testing procedures.
  - .2 to have control of and operation of equipment during testing;
  - .3 adjusting of equipment controls as required to simulate load and/or fault conditions; and
  - .4 assist with record keeping of test results.

### **3.12 Demonstration and Training**

- .1 Demonstrate the operation of, and providing training on, the system in accordance with section 20 05 01.
- .2 Provide training to Owner's staff on use and maintenance of monitoring equipment. Provide training to two groups: users, and facility operators.

### **3.13 Test Records**

- .1 Prepare a test report of test results and include in the operations and maintenance manuals. Test record to include for each monitored room:
  - .1 steady-states pressure measurement: monitor measured, and separate field measured values,
  - .2 alarm delay durations: setpoint and actual,
  - .3 door open suppression: suppression confirmation,
  - .4 alarm acknowledge/reset functioning,
  - .5 room mode selection functioning.

### **3.14 Schedules**

- .1 The following schedules form part of this section.
- .2 Schedule 1: Differential Pressure Monitors by Space Type:
  - .1 refer to drawings to applicable rooms and locations of monitors,
  - .2 for monitor types specified in Schedule 1
    - (a) if RM1 is required, an RM2 or MRM can also be used.
    - (b) If RM2 is required, an MRM can also be used.
    - (c) If MRM is required, only provide an MRM.
- .3 Schedule 2: Differential Pressure Sensor Selection and Setting by Space Type.



<b>Schedule 1: Differential Pressure Monitor Type by Space Type</b>					
Space Type	Monitor Type	1 <sup>st</sup> DP sensor: Space/ (reference)	2 <sup>nd</sup> DP sensor: Space/ (reference)	3 <sup>rd</sup> DP sensor: Space/ (reference)	Monitor Location
<b>Healthcare:</b> Negative Isolation (AIR) patient room	RM2	Patient Room/ (corridor)	Anteroom/ (corridor)	---	Corridor

End of Schedule 1

**Schedule 2: Differential Pressure Sensor Selection and Setting by Space Type**

Space Type	Monitored Space	Differential Pressures Sensor Range	Minimum Operating Differential Pressure	Default Alarm Setpoint	Reference Room
<b>Healthcare:</b> Negative Isolation (AIR) patient room	Room	± 25 Pa	-10 Pa	-2.5 Pa	Corridor
	Anteroom	± 25 Pa	-5.0 Pa	0.0 Pa	Corridor
	Vestibule	± 25 Pa	-10 Pa	-2.5 Pa	Corridor
	Anteroom	± 12.5 Pa	+10 Pa	+2.5 Pa	Corridor

End of Schedule 2

**End of Section**

## **BUILDING AUTOMATION CONTROL VALVES**

### **25 30 19.13**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide automatic control valves, other than those valves specified in section 25 30 19.16.
- .2 Provide valve actuators in accordance with specification section 25 30 13.

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 25 30 13 Building Automation Actuators and Operators
  - .2 25 30 19.16 Building Automation Pressure Independent Control Valves

### **1.3 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 CSA B51 Boilers, Pressure Vessels, and Pressure Piping Code.
- .2 Product standards:
  - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
  - .2 ASME B16.5 Pipe Flanges and Flanged Fittings

### **1.4 Design Criteria**

- .1 Refer to applicable piping specification sections for piping system design pressure and design temperature.

### **1.5 Quality Control**

- .1 Valves to have current Canadian Registration Numbers in accordance with CSA B51.

### **1.6 Submittals**

- .1 Shop drawings:
  - .1 submit product data sheets for materials specified herein,
  - .2 submit a schedule of control valves, identifying at a minimum the control valve tag, flow rate, pressure drop, Kv (Cv) values, valve body type, valve body pressure rating at design temperature, and CRN number.

## **2 PRODUCTS**

### **2.1 Control Valves General Requirements**

- .1 Body and trim materials selected in accordance with specification for globe valves, ball valves, or high performance butterfly valves in applicable piping system valve specifications, and in accordance with manufacturer's recommendations for design conditions and service.
- .2 Control valve type selections are shown on drawings, schematics and schedules.
- .3 Pipe end connections:
  - .1 NPS ½ to NPS 2: NPT to ASME B1.20.1.

- .2 NPS 2-1/2 and larger: flanged to ASME B16.5, or grooved to CSA.

## **2.2 Water Solenoid Valves**

- .1 Refer to piping specification sections for specific-duty solenoid valves.
- .2 General duty solenoid valves, NPS 1 and smaller:
  - .1 Two-port, two position operation,
  - .2 body: bronze, brass or stainless steel valve with EPDM seals and disc,
  - .3 for normally closed or normally open operation as shown,
  - .4 pilot operated electric solenoid with general purpose enclosure and conduit hub,
  - .5 minimum allowable working pressure: 1035 kPa (150 psig),
  - .6 minimum operating differential pressure: 820 kPa (120 psi)
  - .7 minimum design temperature: 93°C (200°F)
  - .8 manual override operator for normally-closed valves,
  - .9 pipe ends: ASME B1.20.1 NPT threaded ends,
  - .10 listed to CSA C22.2 No. 139,
  - .11 power supply: 24 VAC, 24 VDC or 120 VAC
- .3 Valve size: pipeline size.

## **2.3 Water and Glycol Valves – Two Position, Two- and Three-Way**

- .1 Valves for two-position service
  - .1 ON-OFF for two-way valve,
  - .2 Open port A - Open port B for three-way valve (non-isolation of ports simultaneously).
- .2 Valve pattern:
  - .1 two-way: straight through type, single seated, with replaceable ball, seats and/or disc.
  - .2 three-way: dual seated for globe valves, three way flow pattern for ball valves,
- .3 Valve size: pipeline size.
- .4 Valve type selection:
  - .1 full port ball valves, sizes NPS 2 and smaller,
  - .2 butterfly valves, sizes NPS 2 and larger.
- .5 Valve flow characteristic:
  - .1 quick opening or linear flow characteristics.

## **2.4 Water and Glycol Valves – Modulating Two-Way**

- .1 Valves for two-way modulating service.
- .2 Valve pattern: straight through two port type, single seated, with replaceable disc or ball.
- .3 Valve type:
  - .1 globe valves for all flow rates.
  - .2 characterized ball valves for flow coefficient  $K_v = 35$  ( $C_v = 40$ ) and smaller,
  - .3 butterfly valves for flow coefficient greater than  $K_v = 35$  ( $C_v = 40$ ), based on flow coefficient rating at 70° rotation

- .4 Valve size:
  - .1 size valves based on design flow rates at a pressure drop not greater than the design pressure drop as shown, and not less than 90% of that design pressure drop.
  - .2 where valve pressure drops are not shown, size valve pressure drop (at design flow) to be the greatest of;
    - (a) 200% of pressure drop through heat exchanger,
    - (b) 100% of pressure drop through coil, or
    - (c) 35 kPa (5 psi).
  - .3 for terminal box units and duct mounted reheat coils, size valves on a pressure drop of between 20 to 35 kPa (3 to 5 psi).
- .5 Valve flow characteristic:
  - .1 equal percentage flow characteristics for heat transfer coils and heat exchangers,
  - .2 linear flow characteristic for tank filling operation (water flow discharges to atmosphere).

## **2.5 Water and Glycol Valve Actuators**

- .1 Conform to section 25 30 01 and as specified herein.
- .2 Actuator and valve trim selected for close-off pressure ratings:
  - .1 two-way modulating or two position service: 150% of pump shut off head.
  - .2 three-way modulating service; 300% of pressure differential between ports A and B at design flow or 100% of pump shut off head.
  - .3 shut off head to be based on maximum pump RPM when pump is controlled with a VFD.
- .3 Valve failed position on isolation from control signal:
  - .1 spring-return or electronically fail safe,
  - .2 heating terminal/zone valves: normally open,
  - .3 heating coil valves in AHU; normally open,
  - .4 heating differential pressure by-pass control valves; normally closed,
  - .5 chilled water terminal, zone and AHU coil valves; normally closed,
  - .6 chilled water valves serving process loads: normally open,
  - .7 chilled water differential pressure by-pass control valves: normally open,

## **3 EXECUTION**

### **3.1 General**

- .1 Select control valves for the applicable flow rates and pressure drops.

### **3.2 Installation**

- .1 Supply control valves to the applicable trades contractor for installation. Provide instruction to the trades contractor as to:
  - .1 any required straight pipe lengths upstream and downstream of the valve,
  - .2 correct installation orientation including requirements for valve actuator,
  - .3 for steam systems, location of steam trap drips ahead of the valve on horizontal piping.

### **3.3 Cleaning**

- .1 Coordinate with the applicable installation trades contractor to provide protection of the control valve during pipeline cleaning. Ensure control valves are 100% open during pipeline cleaning.
- .2 After completion of pipeline cleaning, clean strainers located ahead of control valves.

### **3.4 Start-Up and Testing**

- .1 Confirm control valves stroke fully open and fully closed under applied control signal.
- .2 Conduct tests at part load < 30% to check for control loop instability; adjust control parameters to eliminate valve hunting under steady part load conditions.

**End of Section**

## **BUILDING AUTOMATION PRESSURE INDEPENDENT CONTROL VALVES**

### **25 30 19.16**

#### **1 GENERAL**

##### **1.1 Scope**

- .1 Provide pressure independent control valves ("PICV") for modulating control of water or glycol for the following equipment:
  - .1 duct mounted reheat coils
- .2 Refer to specification section 20 05 19 for all other control valves.

##### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 25 30 13 Building Automation Actuators and Operators
  - .2 25 30 19 Building Automation Control Valves

##### **1.3 Definitions and Abbreviations**

- .1 The following definitions apply to this section.
  - .1 **Energy valves** means a PICV that includes two temperature sensors and has control functionality to manage the energy (power) output of the control valve.
  - .2 **PICV valve** means a control valve that will maintain stable flow rates under varying inlet water pressure.

##### **1.4 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 CSA B51 Boilers, Pressure Vessels, and Pressure Piping Code.
- .2 Product standards:
  - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
  - .2 ASME B16.5 Pipe Flanges and Flanged Fittings

##### **1.5 Design Criteria**

- .1 Refer to applicable piping specification sections for piping system design pressure and design temperature.

##### **1.6 Quality Control**

- .1 Valves to have current Canadian Registration Numbers in accordance with CSA B51.

##### **1.7 Submittals**

- .1 Shop drawings:
  - .1 submit product data sheets for materials specified herein,
  - .2 submit a schedule of control valves, identifying at a minimum the control valve tag, flow rate, pressure drop, Kv (Cv) values, valve body type, valve body pressure rating at design temperature, and CRN number.

## 2 PRODUCTS

### 2.1 Pressure Independent Control Valve

#### .1 General

- .1 two-way, pressure independent control valve assembly including valves, actuator, and means of differential pressure regulation, manufactured as a single package.
- .2 pressure test ports on inlet and outlet of valve,
- .3 100% valve authority across full operating range,
- .4 minimum differential-pressure control range for pressure-independence: 35 to 350 kPa (5 to 50 psi)
- .5 selected for valve operating differential pressure of 35 kPa (5 psi) at design flow rate, unless otherwise shown,
- .6 minimum close-off differential pressure: 700 kPa (100 psig),
- .7 combination of control valve and controller to provide valve control characteristic of:
  - (a) equal percentage flow regulation for valves serving hydronic coils, heat exchangers, and source equipment,
  - (b) linear flow regulation for hydronic system bypass valves.
- .8 user adjustable maximum flow within valve control range,

#### *Standard of Acceptance*

- Belimo - fig. PIQCV, ePIV
- Bell & Gosset - fig. Ultra Setter
- Danfoss - fig. AB-QM
- Griswold Controls - fig. PIC-V, MVP,
- Honeywell - fig. VRW
- Johnson Controls - fig. VP140
- Siemens - fig. PICV
- Victaulic - fig. TA 7MP

#### .2 Differential pressure regulation:

- .1 maintain flow accuracy of +/-5% or better regardless of system pressure fluctuations using either:
  - (a) a wet calibrated ultrasonic or electromagnetic flow meter providing dynamic feedback to adjust valve position, or
  - (b) integral mechanical differential pressure regulator maintaining constant pressure drop across valve seat to decouple valve flow from system pressure changes.

#### .3 Control valve:

- .1 valve type:
  - (a) characterized ball, or
  - (b) globe-style with characterized guide cage.
- .2 body material:
  - (a) NPS ½ to NPS 2: DZR brass, bronze, or cast iron.
  - (b) NPS 2-1/2 to NPS 6: cast iron or ductile iron.



- .3 pressure rating at 121°C (250°F):
    - (a) NPS ½ to NPS 2: minimum 1580 kPa (230 psi),
    - (b) NPS 2-1/2 to NPS 6:
      - i) ANSI Class 125 for piping system design pressures up to 1100 kPa (160 psig),
      - ii) ANSI Class 250 for piping system design pressures up to 2400 kPa (350 psig).
  - .4 end connections:
    - (a) NPS ½ to NPS 2: NPT to ASME B1.20.1.
    - (b) NPS 2-1/2 to NPS 6: flanged to ASME B16.5
  - .5 valve internals: nickel-plated brass or stainless steel,
  - .6 stem: nickel-plated brass or stainless steel,
  - .7 seat seals: EPDM or PTFE,
  - .8 O-Rings: EPDM.
- .4 Actuator:
- .1 to specification section 25 30 13 and/except as specified herein,
  - .2 modulating proportional control with 4-20 mA or 0-10 VDC modulating input signal,
  - .3 power supply: 24 VDC or 24 VAC.
  - .4 manually override function,
  - .5 spring-return or electronically fail-safe:
    - (a) fail closed for cooling applications (coil, heat exchanger and chiller),
    - (b) fail open for heating applications (coil, heat exchanger and boilers).
  - .6 fail in last command position for system bypass control valves,
  - .7 stroke range: 100% of valve stroke range.

### 3 EXECUTION

#### 3.1 General

- .1 Select control valves for the applicable flow rates at a valve differential pressure of 35 kPa (5 psig) unless otherwise shown.
- .2 Supply control valves to the applicable trades contractor for installation. Provide instruction to the trades contractor as to:
  - .1 any required straight pipe lengths upstream and downstream of the valve,
  - .2 correct installation orientation including requirements for valve actuator.
- .3 Provide PICV and Energy valves in accordance with the following table unless otherwise shown on drawings.

Service	Application	PICV	Energy Valve
Duct mounted reheat coils	All	●	

#### 3.2 Installation

- .1 Install PICV/Energy valves in accordance with manufacturer instructions.

- .2 Provide straight length of pipe upstream of valve of at least five (5) pipeline diameters, unless manufacturer instructions required longer straight lengths.
- .3 Install an isolation valve and strainer on the upstream side of the PICV/Energy valve.
- .4 As applicable and unless otherwise factory set,
  - .1 set the control valve mechanical limiting device to the required design flow rate, or
  - .2 program the actuator controller to the required design flow rate.
- .5 Program the valve controller to provide control characteristics of:
  - .1 equal percentage flow regulation for valves serving hydronic coils and heat exchangers,
  - .2 linear flow regulation for hydronic system bypass valves, and source equipment.

### **3.3 Power and Control Wiring**

- .1 Provide power and control wiring to each PICV and Energy valve in accordance with the manufacturer requirements and in accordance with specification section 25 05 13.

### **3.4 Cleaning**

- .1 Coordinate with the applicable installation trades contractor to provide protection of the control valve during pipeline cleaning. Ensure control valves are 100% open during pipeline cleaning.
- .2 After completion of pipeline cleaning, clean strainers located ahead of PICV and Energy valves.

### **3.5 Start-Up and Testing – PICV**

- .1 Confirm control valves stroke fully open and fully closed under applied control signal and maximum system dead-head differential pressure.
- .2 Conduct PICV valve controllability performance test for representative valves:
  - .1 one reheat coil,
- .3 Test 1: Establish varying system supply pressures to demonstrate pressure independence at 100% design flow over an inlet pressure range of +30% to -10% of nominal inlet pressure at system full load condition.
- .4 Test 2: While operating within the allowable differential pressure control range, test coil power output vs valve position, at equipment part load conditions between 10% and 100% design load, at 10% load increments.
- .5 Provide a test report for each applicable coil, including a graph depicting valve position vs coil power output over the entire operating range of the coil.

### **3.6 Follow-Up Testing and Configuration**

- .1 After start-up and testing, conduct additional testing and tuning of the valves after the valves have been in service for at least four (4) weeks.

### **3.7 Training**

- .1 Provide training to Owners operations staff on control functions of PICV and Energy valves. Include instruction on how to analyze flow and energy performance data and to refine flow rate settings based on actual in-service flow and energy demand.

**End of Section**

## **BUILDING AUTOMATION CONTROL DAMPERS**

### **25 30 23.13**

## **1 GENERAL**

### **1.1 Scope**

- .1 Provide HVAC air control dampers for building systems automation.
- .2 The following control dampers are supplied as part of factory-built air handling units:
  - .1 [modular air handling units to specification section 23 73 13.]
  - .2 [custom air handling units to specification section 23 73 23.]

### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 23 33 13.13 Dampers - Operating
  - .2 [23 73 13 Modular Air Handling Units]
  - .3 [23 73 23 Custom Air Handling Units]
  - .4 25 30 13 Building Automation Actuators and Operators

### **1.3 Submittals**

- .1 Submit product data sheets for materials specified herein.

## **2 PRODUCTS**

### **2.1 Motorized Control Dampers**

- .1 Construction:
  - .1 conform with section 23 33 13.13.
- .2 Actuators:
  - .1 conform with section 25 30 13.

## **3 EXECUTION**

### **3.1 Coordination**

- .1 Coordinate with the trade contractor under Division 23 to confirm control damper quantity, sizes, blade orientation, actuator position, and damper linkage.  
Supply control dampers to the trade contractor under Division 23 for installation by that trade.

### **3.2 Selection**

- .1 Select control damper type (parallel blade, opposed blade) in accordance with section 23 33 13.13.

**End of Section**

## **BUILDING AUTOMATION CONTROL SEQUENCES**

### **25 90 01**

## **1 GENERAL**

### **1.1 Scope**

- .1 This section describes the control sequences and monitoring requirements for building services and other facility equipment or services.

### **1.2 Definitions**

- .1 The following definitions apply to this section:
  - .1 **Auto (alarm reset)**: an alarm that automatically resets once the exit hysteresis conditions have been met.
  - .2 **Exit hysteresis**: the conditions which must be met before an alarm can be reset or cleared.
  - .3 **Latch (alarm reset)**: an alarm that must be manually reset by the Operator through the BAS, even if the exit hysteresis conditions have been met.
  - .4 **Post-exit suppression**: the time duration after an alarm has been reset/cleared before the same alarm (in the same system) can be annunciated by the BAS.
- .2 The following group headings are used in the control sequences:
  - .1 **Reference**: the drawing which includes the control schematic.
  - .2 **Applicable System**: the systems for which the control sequence applies; may include multiple instances of the equipment or system.
  - .3 **General**: (if included) general background information concerning the system.
  - .4 **OEM Control**: (if included) a general description of control functions included in equipment OEM control panel – provided to clarify control functionality that is not directly controlled by the BAS.
  - .5 **System Start**: actions required at system start-up under schedule control or on re-start after power failure.
  - .6 **Normal Operation**: normal control sequence after initial start-up requirements are satisfied.
  - .7 **System Overrides**: control functions that automatically, or by user input, disable or change the control sequence for a defined period of time.
  - .8 **Unoccupied Mode Override**: a user input command to enable a control system during times when the system is disabled by an operating schedule.
  - .9 **Demand Limiting**: special operation parameters during normal utility power outages (emergency generator operation)
  - .10 **System Stop**: shut-down of system under schedule control and fail-safe position of system in event of loss of normal power.
  - .11 **Integrated FPLS Function**: control functions which are integrated with other fire protection and/or life safety systems.
    - (a) **Fire Alarm**: action required in the event of a signal from the fire alarm system (FA).
    - (b) **Smoke Control**: action required where the system functions as part of a smoke control or smoke venting system.
  - .12 **Network Integration**: control points (hardware or software) which are communicated over a serial network.
  - .13 **Monitoring**: control point data which is collected and included in graphical displays but are not used as part of a control loop.

- .14 **Schedule**: scheduled operation of system.
- .15 **Alarm**: alarm points required.
  - (a) **Level 1**: alarms which affect life safety,
  - (b) **Level 2**: alarms which affect critical equipment,
  - (c) **Level 3**: alarms which require urgent notification to the operator, and which affect non-critical equipment,
  - (d) **Level 4**: alarms which are non-urgent, affect non-critical components, and generally relate to pending maintenance.
- .16 **Control Power Type**: control system elements to be fed from the designated source of power.

## **2 PRODUCTS**

- .1 Not applicable.

## **3 EXECUTION**

### **3.1 Sequence of Operation and Control Drawings**

- .1 Control sequences that follow describe and detail method of control of systems.
- .2 Control drawings listed for each control sequence illustrate required inputs and outputs for the control and monitoring of systems.
- .3 Review sequence of operation described for each system and allow for additional input and output points to achieve method of control described. Review documents to determine quantity of each piece of equipment or system.

### **3.2 Rebooting of BAS Controllers on Resumption of Power**

- .1 Except where a BAS controller is supported on UPS power, upon resumption of power to a BAS controller after a power interruption program each controller so that;
  - .1 once the controller has rebooted, wait 30 seconds before attempting to automatically restart the associated equipment except as follows:
    - (a) cooling towers not equipped with VFDs: 60 second time delay,
    - (b) centrifugal chillers: 120 second time delay,
    - (c) heating and steam boilers: 120 second time delay.
  - .2 the controlled equipment restarts from a System Start condition.

### **3.3 Restart of Major Equipment on Return to Utility Power Supply**

- .1 Where a BAS controller and associated controlled equipment are supported on site-generated power, use a "pre-transfer to utility" signal from the site-generated power control system to cause the following equipment to shut-down (but associated pumps may continue to operate) before transfer to utility power is implemented:
  - .1 refrigeration equipment,
  - .2 heating boilers,
  - .3 steam boilers.

### **3.4 VFD Minimum Speed Setpoints**

- .1 The BAS is to maintain a software setpoint for each VFD based on the requirements for each sequence of operation. Every 60 minutes, the BAS is to read the VFD's internal minimum speed

setpoint. If a mismatch exists between the VFD internal minimum speed setpoint and the BAS software setpoint, the BAS is to overwrite the VFD internal setpoint via network integration.

### **3.5 VFD Power Failure Configuration**

- .1 Unless otherwise specified in a control sequence, program VFD's for flying restart after restoration of power following a power failure event.
- .2 Where a VFD includes a kinetic recovery function, program the VFD for kinetic recovery to keep the VFD controller DC voltage bus energized by using momentum of driven equipment during a short term power interruption of the mains AC bus.

### **3.6 VFD Trip Resets**

- .1 Unless otherwise specified in a control sequence, the BAS is automatically attempt not more than three reset attempts. If the VFD trips after the 3<sup>rd</sup> restart attempt, the VFD is to be disabled and an alarm notification sent to the operator of the original trip event(s) and restart attempts.
  - .1 Exception: does not apply to overcurrent or overload trips (if uniquely alarmed).
- .2 Where the same VFD trip condition occurs more than two times in any sliding 60 minute window, an alarm notification is to be sent to the operator of the recurring trip event.

### **3.7 Operator Adjustable Setpoints**

- .1 Where setpoint values are indicated in square brackets [ ] this means the setpoint is adjustable by the facility operator with appropriate security access rights.

### **3.8 Power Supply to Controls**

- .1 Provide the type of power supply to the applicable controller as shown in the control sequence.

### **3.9 Alarm Management**

- .1 Unless otherwise shown in a control sequence,
  - .1 Level 1 and Level 2 alarms are Latch reset,
  - .2 Level 3 and Level 4 alarms are Auto reset.
- .2 Alarm exit hysteresis conditions are as shown for each alarm:
  - .1 for analog inputs alarms, the conditions are listed in the format "X% / Y time";
    - (a) X%: the percent change of alarm setpoint value in the direction of the normal condition value,
    - (b) Y time: the time duration in seconds or minutes in which the percent change value must exist before the reset can occur.
  - .2 for discrete input alarms for measurement instruments, the conditions are listed in the format " $\Delta$ X / Y time";
    - (a)  $\Delta$ X: the absolute change in units of the alarm setpoint value in the direction of normal condition values,
    - (b) Y time: the time duration in seconds or minutes in which the change value must exist before the reset can occur.
  - .3 for discrete input alarms for equipment status, the conditions are listed in the format "COS/ Y time";
    - (a) COS: change of state
    - (b) Y time: the time duration in seconds or minutes in which the change value must exist before the reset can occur.

.3 Post-exit suppression times:

- .1 Unless otherwise shown, suppress the recurrence of the same alarm after exiting from the previous alarm state:

- (a) Level 1 – Life Safety: 0 minutes,
- (b) Level 2 – Critical Equipment: 5 minutes,
- (c) Level 3 – Urgent Message: 1 hour,
- (d) Level 4 – Normal Message: 1 day.

.4 Suppression of contingent alarms:

- .1 Program an automatic hierarchical suppression scheme, to suppress alarm notifications of a fault alarm condition at a load component, which is contingent (caused by) the impact of a related fault alarm condition at a source component that serves the load
- .2 Exceptions: alarms at load components are not suppressed where:
  - (a) a fault alarm at a source component in a redundant component arrangement does not affect the ability of the source system from supplying resources to the load component.
- .3 Alarm suppression applies to audible and visual alarm notifications to Operator interfaces, including email notifications. Load alarms are still to be registered in the alarm database.

.5 Suppression of time-based alarms:

- .1 Program an automatic suppression of alarms using time delays following a change in setpoint as follows:
  - (a) for thermal zone temperature alarms: 18 minutes per 1°C change, but not to exceed 120 minutes.
  - (b) for thermal zone temperature cooling requests: 9 minutes per 1°C change, but not to exceed 30 minutes.
  - (c) for thermal zone temperature heating requests: 9 minutes per 1°C change, but not to exceed 30 minutes.

.6 Suppression of alarms due to change in operating modes:

- .1 Suppress alarms for 15 minutes as a result of change of setpoint.
- .2 Unless otherwise shown, suppress alarms when a system is in Unoccupied mode, Warmup mode, or Cooldown mode.

### 3.10 Schedules

- .1 The following schedules form part of this specification.
  - .1 Schedule A: List of Control Sequences of Operation

Schedule A: Control Sequences of Operation		
Control Sequence Number	Title	Revision Date
CS100	Air Handling Unit	
CS109	Airbourne Isolation Room Pressure Monitoring	
CS119	Isolation Room Exhaust Fans & Monitoring	
CS171	Terminal Units with Reheat (Healthcare)	
CS179	Duct Mounted Reheat Coils	
CS185	Variable Refrigerant Flow AC System	
CS308	Monitoring of Heat Tracing Systems	

**END OF SECTION**



## **CS100 – Air Handling Unit**

Reference: Detail 2/M-002B

Applicable System: Packaged recirculating air handling unit (AHU) AHU-01 containing supply fan and return fan, and energy recovery wheel, steam humidifier, and DX Coil with condensing unit integral to the AHU. Steam Generator supplied separately to feed the humidifier.

General: Serves K3E North Patient Rooms including one (1) Airbourne Isolation Room supply and patient areas supply and return.

OEM Control:

### ***Packaged Air Handling Unit***

Packaged AHU with OEM control. OEM controller shall include all control, monitoring, and alarm details described below.

### ***DX Coil***

Condensing unit, DX combined heating/cooling coil, and refrigerant loop integral to unit controlled by AHU.

### ***Enthalpy Wheel (EW)***

Controlled by AHU, c/w VFD.

### ***Humidifier***

Steam Generator and humidifier loop utilizes OEM control from Generator.

System

Start: System initialized by BAS schedule, or operator command at BAS, or locally.

System start by OEM controls.

Confirm associated terminal units are at least at minimum flow position before fans are started.

DX Coil is enabled whenever system fans are operating. Humidifier is enabled when outdoor air temperature  $\leq 50^{\circ}\text{F}$  ( $10^{\circ}\text{C}$ ).

Dampers D1 through D6 are enabled.

Return fan ES2 is enabled. Damper open limit switch on each damper is monitored. When exhaust damper D2 or mixed air damper D3 are proved 80% open, return fan is allowed to run.

Supply fan ES1 is enabled and allowed to run once return fan ES2 is proved operating for 15 seconds.

Normal

Operation: ***Fans:***

Fans modulate speed to maintain system static pressure as determined during balancing.

Issued For Tender

***Minimum Outdoor Air Setpoint:***

Minimum setpoint on outdoor air damper D1 during normal operating is 33% of total airflow (to be confirmed during final balancing).

***Supply Air Temperature Control, Heating Mode:***

When Outdoor Air Temperature T0 is below Supply Air Temperature setpoint T5 of 55°F (12.8°C) (adjustable), Outdoor Air Damper D1, Exhaust Air Damper D2 and Return Air Damper D3 modulate to maintain Mixed Air Temperature T1 at setpoint of 55°F (12.8°C) (adjustable).

On further decrease in Outdoor Air Temperature T0, Enthalpy Wheel to modulate to maintain the Supply Air Temperature T5 setpoint.

On further decrease in Outdoor Air Temperature T0, DX Coil modulates to maintain the Supply Air Temperature T5 setpoint.

When DX Coil is operating at maximum heating capacity and Return Air Temperature T6 is below 70°F (21.1°C), electric reheat coil shall modulate to maintain Supply Air Temperature T5 setpoint.

***Enthalpy Wheel Frost Control:***

As the temperature leaving the Enthalpy Wheel T7 falls below the set point temperature of 28°F (-2.2°C) adjustable, the AHU shall utilize internal dampers to bypass the Enthalpy Wheel. As Temperature T7 rises above 28°F (-2.2°C), the bypass can be closed, and the Wheel utilized.

By analyzing Return Air humidity level H2 and Mixed Air Temperature T1, the internal bypass dampers shall modulate to prevent frosting of the Enthalpy Wheel.

***Supply Air Temperature Control, Free Cooling Mode:***

When Outdoor Air Temperature T0 is equal to Supply Air Temperature setpoint T5 of 55°F (12.8°C) (adjustable), Mixed Air Damper D3 fully closes. Outdoor Air Damper D1 and Exhaust Air Damper D2 fully open. DX Coil modulates off, internal AHU Enthalpy Wheel bypass dampers modulate open, and Humidifier modulates to maintain return air humidity setpoint H2 (see Humidifier Control below).

***Supply Air Temperature Control, Cooling Mode:***

When Outdoor Air Temperature T0 is above Supply Air Temperature setpoint T5 of 55°F (12.8°C) (adjustable), Outdoor Air Damper D1, Exhaust Air Damper D2 and Return Air Damper D3 modulate to maintain Mixed Air Temperature T1 at setpoint of 55°F (12.8°C) (adjustable).

On further increase in Outdoor Air Temperature T0, Enthalpy Wheel to modulate to maintain the Supply Air Temperature T5 setpoint.

On further decrease in Outdoor Air Temperature T0, DX Coil modulates to maintain the Supply Air Temperature T5 setpoint.

***Supply Air Temperature Reset:***

Continually reset Supply Air Temperature setpoint T5 higher until the first occurrence of an associated hydronic reheat coil control valve at 10% open (all other hydronic reheat coils valves at more than 10% open), or Return Air Humidity H2 exceeds 60%.

Hold current value setpoint until the first associated reheat coil is fully off, then begin resetting Supply Air Temperature T5 setpoint lower. Continually reset Supply Air Temperature T5 setpoint lower until all associated reheat coils are operating at least at 20% open.

Maximum rate of Supply Air Temperature T5 setpoint change is 0.5°C /15 minutes (adjustable) increase or decrease.

***Humidifier Control:***

Humidifier modulates to maintain Return Air Humidity H2 setpoint. Return Air Humidity H2 setpoint to be scheduled in accordance with Outdoor Air Temperature T0 as follows:

	Outdoor Air Temp -10°F (-23.3°C)	Outdoor Air Temperature +50°F (+10°C)
Maximum Return Air Humidity H2 Setpoint % RH	30	50

Supply Air Humidity H1 sensor overrides Return Air Humidity H2 signal to limit Humidifier to limit Supply Air Humidity H1 of 80% RH. When Outdoor Air Temperature T0 is above 50°F (10°C) (adjustable), Humidifier disabled.

***Pressure and Flow Control:***

Supply air static pressure P1 (average of two (2) sensors) modulates supply fan variable frequency drive (VFD) maintain constant system pressure and demand air volume.

Static Pressure Sensor P2 overrides control of supply fan VFD to maintain pressure below the limit setpoint.

Return air static pressure P3 modulates return fan VFD to maintain constant system pressure and demand air volume.

Static Pressure Sensor P5 overrides control of return fan VFD to maintain pressure below the limit setpoint.

***Freeze Protection Trip***

Automatic-resetting low temperature alarms TLA1 trip on plenum temperature below 35°F (+1.7°C). Provide 30 second (adjustable) debounce timer. Automatic reset will occur based on rise above fixed temperature differential.

On first trip, OEM controls to reset system and record alarm event. Bypass TLA1 for 30 seconds to allow airflow to increase temperature at sensor.

On second trip, OEM controls to initiate a second restart.

On third trip, OEM controls to lock out unit and generate a priority alarm.

All alarms to be transmitted to the BAS.

VFD Fault  
Reset:

***Loss of Power:***

On loss of power detection through VFD under-voltage trip, on resumption of line power the variable frequency drives will automatically attempt after a 60 second delay one (1) restart in a 30 second period. If the drive fails to reset the fault, the building operator will manually initiate an external reset through the BAS, the OEM control panel, or locally at the drive control panel.

***Any Other Fault Condition:***

For any other fault condition, the drive will not automatically reset. The building operator will manually initiate an external reset through the BAS, the OEM control panel, or locally at the drive control panel.

System  
Stop:

System shut down is initialized by BAS schedule, or operator command at BAS, or locally.

System shut down by OEM controls.

Upon signal to stop system, Return Fan ES2 and Supply Fan ES1 stop. Outdoor Air Dampers D1 and Exhaust Air Damper D2 close and are disabled. Return and supply dampers D5 and D6 close fully and are disabled. DX Coil and Humidifier close and are disabled.

When Outdoor Air Temperature T0 is below 38°F (3.3°C), DX Coil modulates to maintain AHU plenum Temperature T1 at 6°C.

**Integrated**

FPLS Function: Upon fire alarm, air handling unit to operate at 100% outdoor air. DX Coil and electric heating coil to maintain supply air temperature.

In the event smoke detectors installed in supply duct is activated, associated fan ES1 shall shutdown.

In the event static pressure sensor P1 exceeds the static pressure corresponding to the supply fan's maximum capability (adjustable) (measured at time of balancing), the supply fan shall shutdown.

In the event static pressure sensor P2 exceeds the static pressure corresponding to the return fan's maximum capability (adjustable) (measured at time of balancing), the return fan shall shutdown.

**Network**

Integration: Integrate OEM controllers via BACnet MSTP. See above for list of OEM controllers.

Provide network communications to VFD's.

Schedule: Continuous 24/7/365

Monitoring: Monitor the following inputs and include in graphics display:

- DO-ES-1 Supply Fan Status from current sensor
- DO-ES-2 Return Fan Status from current sensor
- AI-F-1 Supply Fan airflow
- AI-F-2 Return Fan airflow

**Alarms:**

Point	Alarm Description	Initiating Condition	Exit Condition	Alarm Level
AI-T-5	Supply temperature low	10.5C	COS	L3
AI-T-5	Supply temperature high	18.5C	COS	L3
AI-H-1	Supply air humidity high	80% RH	COS	L3
DI-TLA-1	Freeze protection	<=35°F (+1.7°C)	>36°F (+2.2°C)	L2
DI-ET-1	Fan fault (current switch)	COS For 30 secs	Not COS / 30 secs	L3
DI-ET-2	Fan fault (current switch)	COS For 30 secs	Not COS / 30 secs	L3

Point	Alarm Description	Initiating Condition	Exit Condition	Alarm Level
AI-T-5	Supply temperature low	10.5C	COS	L3
AI-T-5	Supply temperature high	18.5C	COS	L3
AI-H-1	Supply air humidity high	80% RH	COS	L3
DI-TLA-1	Freeze protection	<=35°F (+1.7°C)	>36°F (+2.2°C)	L2
DI-EA-1	Fan fault (VFD summary fault)	COS For 30 secs	Not COS / 30 secs	L3
DI-EA-2	Fan fault (VFD summary fault)	COS For 30 secs	Not COS / 30 secs	L3
DI-EA	Equipment fault (OEM summary fault) – DX Coil / Condensing Unit	COS For 30 secs	Not COS / 30 secs	L3
DI-EA	Equipment fault (OEM summary fault) – Humidifier / Steam Generator	COS For 30 secs	Not COS / 30 secs	L3
DI-PDHA-1	Filter pressure differential High alarm	>250 Pa for 10 min	<100 Pa / 5 min	L4
DI-PDHA-2	Filter pressure differential High alarm	>375 Pa for 10 min	<100 Pa / 5 min	L4

Controller Power  
Type:

☐ Normal  
☐ Vital

☒ Life-Safety  
☐ Delayed-Vital

☐ Standby  
☐ UPS

**End of Control Sequence**

## **CS109 – Airbourne Isolation Room Pressurization Monitoring**

Reference: Refer to floor plan.

Applicable  
System: As shown.

General: An alarm panel is to be located outside the room with buzzer and status lights for Isolation Room Caution Mode, and Isolation Room Alarm Mode. Adjacent to the alarm panel shall be a room pressure display panel.  
BAS is to monitor Isolation room pressurization.

Normal  
Operation: ***Airbourne Isolation Room Pressure Monitoring & Alarm***  
Isolation room monitoring panel located outside isolation room indicates room pressure through Pressure Differential Sensors PDHA1 and PDHA2. Sensors reads negative pressure setpoint between anteroom & corridor and between anteroom & isolation room.  
Exhaust air dampers and supply air terminal boxes are to be set during air balancing to main-tain negative pressure of 7.5 Pa in Isolation room (field determined and adjustable) with re-spect to corridor.  
If room pressure is <5.5 Pa (field determined and adjustable) less than corridor pressure, a notification is generated on the BAS and the Isolation Caution light will be illuminated on the alarm panel.  
If room pressure is <4.0 Pa (field determined and adjustable) less than corridor pressure, an alarm is generated on the BAS, the Isolation room Alarm light will be illuminated on the alarm panel and the buzzer will sound (in the corridor and at the nurses' station).  
Delay pressure alarm for 15 seconds to allow for closing of doors

### ***Space Temperature Control***

Supply terminal boxes are setup as "constant volume" and room temperature is maintained through reheat coil.

Space temperature setpoint (adjustable) as follows:

Daytime: 24°C ± 2°C

Night Time: 24°C ± 2°C

System  
Stop: On shutdown of associated fan system, supply air damper of terminal unit boxes shall remain open in final position.

Integrated  
FPLS Function: Supply air damper of terminal unit boxes shall remain open in final position.  
Issued For Tender

**Network**

Integration: Integrate OEM controllers via BACnet MSTP. See above for list of OEM controllers.  
Provide network communications to VFD's.

Schedule: Continuous 24/7/365

Monitoring: Monitor the following inputs and include in graphics display:

- AI-EA-1 Isolation Room to Corridor Differential Pressure

**Alarms:**

Point	Alarm Description	Initiating Condition	Exit Condition	Alarm Level
AI-EA-1	Isolation Mode Alarm	Room Pressure < Corridor Pressure by 4.0 Pa	< 4.5 Pa / 5 min	L2
AI-EA-1	Isolation Mode Caution	Room Pressure < Corridor Pressure by 5.0 Pa	< 6.0 Pa / 5 min	L3

**Controller Power Type:**

☐ Normal  
☐ Vital

☒ Life-Safety  
☐ Delayed-Vital

☐ Standby  
☐ UPS

**End of Control Sequence**

## CS119 – Isolation Room Exhaust

Reference: Detail 04/M-002B

Applicable  
System: F-20

System  
Start: System start is initiated by operator command at BAS, by AHU schedule, or locally at fan.

Upon signal to start exhaust fan ES-3, exhaust fan isolation damper D7 opens. When fan isolation dampers are proved open, end switch hard-wired to exhaust fan starters permits exhaust fan to start. When exhaust fan is proved running and after 15 seconds time delay, the supply AHU systems are enabled.

Terminal box modulates to provide constant air supply.

*NOTE: Exhaust damper is hardwire controlled by the motor controller.*

*NOTE: Provide damper position switch to prove damper is open and hardwire to the motor controller as a Start and Run permissive.*

Normal  
Operation: Exhaust fan runs continuously.

### **Negative Pressurization**

Duct static pressure sensor P (located at approximately 2/3 of the longest duct run from fan) resets exhaust fan speed through the exhaust fan variable frequency drive (EV3) to maintain constant system pressure of 500 Pa (to be field determined).

System  
Stop: System stop is initiated by schedule, by operator override command in the BAS, or locally at fan.  
Upon signal to stop exhaust fan (ES-3), exhaust fan stops first and then the exhaust air damper closes.

Integrated  
FPLS  
Function: Not applicable. Fan continues to operate during fire alarm.

Schedule: Operates continuously 24/7/365. Allow for owner to add schedule at a later date.

Alarms:

Point	Alarm Description	Initiating Condition	Exit Condition	Alarm Level
DI-ET-x	Exhaust fan run fault from current switch or VFD fault relay.	COS for 1 minute	COS / 30 sec	L3
DI-EA-x	Exhaust fan isolation damper fail to open	COS for 1 minute	COS / 30 sec	L3
AI-P-x	Exhaust static pressure low/high	+/- 10% (adjustable)	30 sec	L4



**Reset:      *Loss of Power***

On loss of power detection through VFD under-voltage trip, on resumption of line power, the variable frequency drive will automatically attempt after a 60 second delay one (1) re-start in a 30 second period. If the drive fails to reset the fault, the operator will manually initiate an external reset through the BAS (ER) or locally at the drive control panel.

***Any Other Fault Condition***

For any other fault condition, the drive will not automatically reset. The operator will manually initiate an external reset through the BAS (ER) or locally at the drive control panel.

**Controller Power****Type:**☐ Normal☐ Vital☒ Life-Safety☐ Delayed-Vital☐ Standby☐ UPS

**Notes:**            None.

**End of Control Sequence**

## CS171 – Terminal Units with Reheat

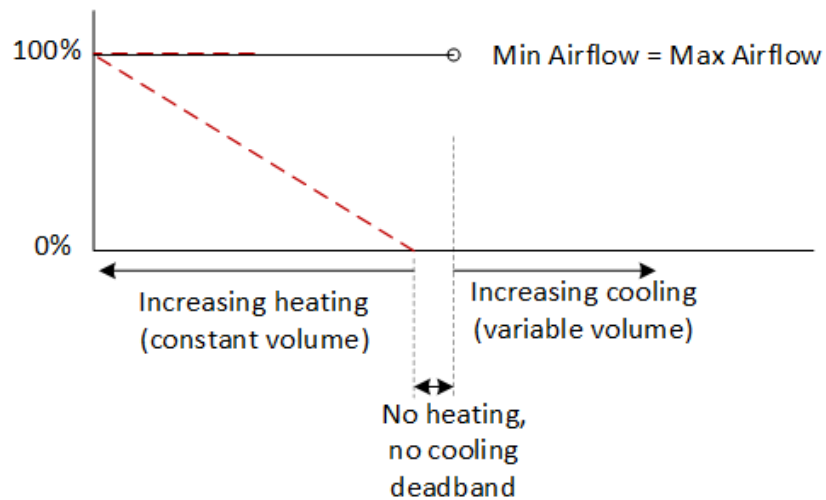
Reference: Drawing M-002C

Applicable  
System: Terminal units with reheat coils.

System  
Start: Terminal boxes are enabled when associated AHU system is commanded to start.

General: Terminal units are setup as constant volume in heating and cooling mode of operation.

Maximum Airflow = Minimum Airflow  
(Constant Volume – Heating and Cooling)



Normal  
Operation:

### ***Airflow Control***

Supply terminal unit airflow sensor (F) modulates terminal unit damper (D) in response to changes in inlet system static pressure (pressure independent control) to supply the required airflow rate.

### ***Space Temperature Control – $Q_{max} = Q_{min}$***

Space temperature sensor (T1) modulates reheat valve (V) to maintain space temperature setpoint.

### ***Space Temperature Setpoint and User Adjustment***

In accordance with control sequence CS001.

System

Stop: On shut-down of associated AHU for any reason other than occupancy schedule or life-safety requirements, terminal unit damper (D) goes to fully closed, and reheat valve V1 goes to fully closed.

Issued For Tender

Integrated  
FPLS  
Function:

**Fire Alarm Response**

Not applicable

Schedule:

24/7

Monitoring: Monitor the following inputs and include in the graphics display:

- AI-F Terminal unit airflow
- AI-H Space humidity (where applicable)

Alarms:

Point	Alarm Description	Initiating Condition	Exit Hysteresis	Alarm Level
AI-T1	Space Temperature Low	2°C < SP for 10 min	10% / 5 min	L4
AI-T1	Space Temperature Low-Low	3°C < SP for 10 min	10% / 5 min	L3
AI-F	Airflow Low during occupied mode	<85% Qmin for 10 min	10% / 5 min	L3

Controller Power  
Type:

- |  |  |                                  |
|--|--|----------------------------------|
| <input checked="" type="checkbox"/> Normal | <input type="checkbox"/> Life-Safety   | <input type="checkbox"/> Standby |
| <input type="checkbox"/> Vital             | <input type="checkbox"/> Delayed-Vital | <input type="checkbox"/> UPS     |

Notes:

[1] Where the terminal unit minimum airflow rate is the same as the maximum airflow rate, the terminal unit is constant volume under all loads.

**End of Control Sequence**

## CS179 – Duct Mounted Reheat Coils

Reference: Detail 1/M-002C; Drawing M-225 & M-226

Applicable  
System: Duct mounted reheat coils.

System  
Start: Reheat coils control valves (V) are enabled when associated AHU system is commanded to start.

Normal  
Operation:

### ***Space Temperature Control***

Space temperature (T) sensor modulates hot water reheat coil control valve (V) to maintain space temperature setpoint.

Where there are two (2) space temperature sensors associated with a single reheat coil, maintain space temperature setpoint based on an average of the two (2) sensors.

### ***Space Temperature Setpoint and User Adjustment***

When outdoor air temperature is below 50°F (10°C): 70°F (21.1°C) (adjustable)

When outdoor air temperature is above 50°F (10°C): 72°F (22.2°C) (adjustable)

User adjustment shall not be provided.

System  
Stop: When associated AHU system is shut-down, reheat valve (V) is closed.

Integrated  
FPLS  
Function: Not applicable.

Schedule: As per associated AHU schedule.

Monitoring: The following points shall be monitored at the BAS:  
• AI-T1,2 space temperature

Alarms:

Point	Alarm Description	Initiating Condition	Exit Condition	Alarm Level
AI-T1	Space Temperature Low	2°C < SP for 10 min	10% / 5 min	L4
AI-T1	Space Temperature Low-Low	3°C < SP for 10 min	10% / 5 min	L3
AI-T2	Space Temperature Low	2°C < SP for 10 min	10% / 5 min	L4
AI-T2	Space Temperature Low-Low	3°C < SP for 10 min	10% / 5 min	L3

Controller Power

Type:

☒ Normal

☐ Vital

☐ Life-Safety

☐ Delayed-Vital

☐ Standby

☐ UPS

Notes: Not applicable.

**End of Control Sequence**

## CS185 – Variable Refrigerant Flow AC System

Reference: Detail 9/M-002C; Drawing M-126, M-226, M-229

Applicable System: Variable refrigerant flow cooling and heating system including:  
CU-1, AC-1A, AC-1B.  
Variable refrigerant flow cooling including:  
CU-4, AC-1C,  
CU-5, AC-1D.

System Start: System is enabled at BAS. OEM controller starts equipment.

Normal Operation: OEM control to maintain space temperatures at setpoint.  
Setpoint to be adjustable at each thermostat.  
OEM control to initiate heating or cooling mode at CU-1, CU-4, or CU-5 based on calls for heating or cooling in individual rooms.  
AC-1A and AC-1B shall operate in heating or cooling mode as required. AC-1C and AC-1D shall operating in cooling mode as required.

System Stop: System is disabled at BAS. OEM controller stops equipment.

Integrated FPLS Function: Not applicable.

Schedule: 24/7.

Monitoring: Monitor the following inputs at the BAS:

- AI-T-1,2

Alarms:

Point	Alarm Description	Initiating Condition	Exit Condition	Alarm Level
AI-T1,2	Space Temperature Low	2°C < SP for 10 min	10% / 5 min	L4
AI-T1,2	Space Temperature Low-Low	3°C < SP for 10 min	10% / 5 min	L3
AI-T1,2	Space Temperature High	2°C > SP for 10 min	10% / 5 min	L4

AI-T1,2	Space Temperature High-High	3°C > SP for 10 min	10% / 5 min	L3
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Controller Power  
Type:

- ☒ Normal
- ☐ Life-Safety
- ☐ Standby
- ☐ Vital
- ☐ Delayed-Vital
- ☐ UPS

Notes:  
1. Serial communications over BACnet MSTP connection.

**End of Control Sequence**

## **CS308 – Monitoring of Heat Tracing Systems**

Reference: Domestic cold water to Steam Generator Heat Tracing System

Connect to heat tracing controller and pick up the following alarms to BAS

- (a) Low and high temperature
- (b) Low current
- (c) Ground fault
- (d) RTD failure
- (e) Loss of programmed values
- (f) EMR failure



**Electrical  
Specifications**

FOR

**Phase 1: SHSC GIM Decant (K-2-E)**

**Phase 2: SHSC Renovation of C2 Decant (K-3-E)**

**Sunnybrook Health Sciences Centre**

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**LIST OF SECTIONS**  
**26 00 01**

**DIVISION 26**

26 05 01 - ELECTRICAL GENERAL REQUIREMENTS  
26 05 05 - PROJECT PHASING `  
26 05 10 - FIRE STOPPING & SMOKE SEALS  
26 05 19 - WIRES & CABLES 0-1000 VOLTS  
26 05 27 - GROUNDING SECONDARY  
26 05 29 - FASTENINGS AND SUPPORTS  
26 05 32 - SPLITTERS, JUNCTION AND PULL BOXES, CABINETS  
26 05 33 - CONDUITS, FASTENINGS AND FITTINGS  
26 05 35 - OUTLET BOXES, CONDUIT BOXES AND FITTINGS  
26 05 37 - WIREWAYS AND AUXILIARY GUTTERS  
26 07 16 - WIRING TO MOTORIZED DOORS  
26 08 15 - ELECTRICAL COMMISSIONING  
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26 28 10 - POWER PANELS  
26 28 13 - FUSES - LOW VOLTAGE  
26 28 16 - MOULDED CASE CIRCUIT BREAKERS  
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27 05 28 - TELEPHONE & DATA RACEWAYS  
27 15 00 - COMMUNICATIONS CABLING  
27 41 17 - MEETING ROOM AUDIO VISUAL SYSTEMS  
27 52 23 - CODE WHITE SYSTEM  
27 52 24 - CARDIAC ARREST SYSTEM  
27 52 25 – WANDERING PATIENT SYSTEM  
27 52 52 - CLOCK SYSTEM

**DIVISION 28**

28 08 15 - 3RD PARTY FIRE ALARM VERIFICATION  
28 23 01 - SECURITY CCTV SYSTEM  
28 23 10 - ACCESS CONTROL SYSTEM  
28 31 13 - FIRE ALARM SYSTEM

**APPENDED**

SUNNYBROOK ICN CABLING STANDARDS  
SUNNYBROOK HUB ROOM ACCESS POLICY  
SUNNYBROOK CODE BLUE AND CODE WHITE SOP

**END OF SECTION**

## **ELECTRICAL GENERAL REQUIREMENTS**

### **26 05 01**

#### **PART - 1 GENERAL REQUIREMENTS**

##### **1.1 SCOPE**

- .1 This Section covers items common to Sections of Division 26. This section supplements requirements of Division 1.
- .2 Comply with General Conditions of Contract, Supplementary Conditions and Division 01 - General Requirements.
- .3 Where conflict occurs between Codes, Specification and Drawings, plan and riser, the maximum condition to govern, and the Tender to be based on whichever indicates the greater cost.

##### **1.2 WORK INCLUDED**

- .1 Work to be done under this section to include furnishing of labour, materials and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.
- .2 **Electrical Single Line Diagram**
  - .1 **The Hospital requires that the installing contractor:**
    - (a) **Provide written confirmation that proper, accurate circuit labelling has been provided in Power Panels and Electrical Panels**
    - (b) **Provide a new Electrical Single Line Diagram (or modify the existing Single Line Diagram) to reflect any/ all Distribution changes created under this project. The consultant will provide an auto-CAD Drawing of the existing Single Line to permit this added scope. Contractor shall modify the Drawing, provide a new frame with glass cover and hang the Drawing in the existing Electrical Room. Drawing size to be 36" x 24"**

##### **1.3 DOCUMENT ORGANIZATION**

- .1 Applicable Divisions for Electrical Work:
  - .1 Division 26 - Electrical
  - .2 Division 27 - Communications
  - .3 Division 28 - Electronic Safety and Security
- .2 For clarity, any reference in the Contract Documents to Division 26 includes Division 27 and 28.
- .3 The Specifications for these Divisions are arranged in Sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.
- .4 Contractor is responsible for completion of work whether or not portions are sublet.

##### **1.4 DIVISION 26, AS IT APPLIES TO DIVISION 27 AND 28**

- .1 Articles that are of a general nature, applicable to each Section of these Divisions.
- .2 Articles specifying materials, equipment, installation techniques and workmanship that are applicable to more than one Section of these Divisions.
- .3 Articles that are to be read in context with and form part of relevant Sections of these Divisions.

##### **1.5 DEFINITIONS**

- .1 The words "indicated", "shown", "noted", "listed" or similar words or phrases used in this Specification, mean that material or item referred to is "indicated", "shown", "listed" or "noted" on Drawings.
- .2 The words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected", or similar words or phrases used in this Specification, mean that material or item referred to is to be "approved by", "satisfactory to", "as directed by", "submitted to", "permitted by", "inspected by", Consultant.
- .3 Instructions using any form of word "provide" involves Contractor in furnishing labour, materials and services to supply and install referenced item.

1.6 **LANGUAGE**

- .1 Specification is written as series of instructions addressed to Contractor, and by implication to subcontractors and to suppliers. For clarity and brevity, use is made of numbered lists and bulleted lists. Where list follows semi-colon (;) punctuation is for clarity, where list follows colon (:) punctuation is to be read as short-hand form of verb "to be" or "to have" as context requires.
- .2 It is not intended to debate with Contractor reasons for these instructions, and words associated with justification for an instruction or restatement of anticipated performance have been omitted to avoid possible ambiguities.

1.7 **EXAMINATION**

- .1 Examine any existing buildings and services, local conditions, building site, Specifications, and Drawings and report any condition, defect or interference that would prevent execution of work.
- .2 Examine work of other Divisions before commencing this work, and report any defect or interference.
- .3 No allowance will be made for any expense incurred through failure to make these examinations of site and documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender.

1.8 **DESIGN SERVICES**

- .1 Provide design services for elements of the Work where specified in other sections of Division 20, sealed by a professional engineer licensed in the applicable jurisdiction.

1.9 **STANDARD OF MATERIAL AND EQUIPMENT**

- .1 Provide materials and equipment in accordance with Section 01 61 00 - Material and Equipment.
- .2 Materials and equipment:
  - .1 new and of uniform pattern throughout work,
  - .2 of Canadian manufacture where obtainable,
  - .3 labelled or listed as by Code and/or Inspection Authorities CSA certified and CMB listed. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Safety Authority.,
  - .4 standard products of approved manufacture.
  - .5 in compliance with Standards and Regulations with respect to:
    - (a) chemical and physical properties of materials,
    - (b) design,
    - (c) performance characteristics, and
    - (d) methods of construction and installation.
  - .6 identical units of equipment to be of same manufacture.
  - .7 In any unit of equipment, identical component parts to be of same manufacture, but various component parts comprising unit need not be from one manufacturer.

- .3 Materials and equipment are described to establish standards of construction and workmanship.
  - .1 Where manufacturers or manufacturers products are identified in lists with phrase "Standard of Acceptance", these are manufacturers and/or products which meet standards with regard to performance, quality of material and workmanship.
  - .2 Manufacturers and or products used are to be chosen from these lists.
- .4 Include items of material and equipment not specifically noted on Drawings or mentioned in Specifications but which are required to make an operating system.
- .5 Confirm capacity or ratings of equipment being provided, when based on ratings of equipment being provided under other trade Sections, before such items are purchased.
- .6 Factory fabricate control panels and component assemblies.
- .7 Select materials and equipment in accordance with manufacturer's recommendations and install in accordance with manufacturer's instructions.
- .8 Materials and equipment not satisfying these selection criteria will be condemned.
  - .1 Remove condemned materials from job site and provide properly selected and approved materials.

#### 1.10 **SUBSTITUTIONS**

- .1 The use of a substitute article or material which the Contractor represents to be of at least equal quality and of the required characteristics for the purpose intended may be permitted, subject to the following provisions:
  - .1 a substitution will not be considered for reasons of meeting the construction schedule unless the Contractor can demonstrate to the satisfaction of the Consultant they made all reasonable efforts to procure the specified product or material in a timely fashion,
  - .2 the Contractor must advise the Consultant of this intention to use an alternative article or material before doing so,
  - .3 the burden of proof as to the quality and suitability of alternatives to be upon the Contractor and they shall supply all information necessary as required by the Consultant at no additional costs to the Contract,
  - .4 the Consultant to be the sole judge as to the quality and suitability of alternative materials and their decision to be final,
  - .5 where use of an alternative material involves redesign or changes to other parts of the work, the costs and the time required to effect such redesign or changes will be considered in evaluating the suitability of the alternative materials,
  - .6 no test or action relating to the approval of substitute materials to be made until the request for substitution has been made in writing by the Contractor and has been accompanied by complete data as to the quality of the materials proposed. Such request to be made in ample time to permit appropriate review without delaying the work, taking into consideration that such a substitution request may be rejected and require providing the product or material as originally specified,
  - .7 Whenever classification, listing, or other certification by a recognized standards body is a part of the specifications for any material, proposals for use of substitute materials to be accompanied by reports from the equivalent body indicating compliance with the requirements of the specifications,
  - .8 The costs of all testing required to prove equality of the material proposed to be borne by the Contractor.

## **PART - 2 SUBMITTALS**

### 2.1 **SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings, manufacturers and product data and samples in accordance with Section 01 33 05;

- .1 Submit for each item of equipment such as Panelboards, Luminaire cuts and Special Systems.
- .2 Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and imperial measures may be included.
- .3 Submit shop drawings by email to: shopdrawings@hhangus.com
- .2 Include a H.H. Angus shop drawing cover sheet form prepared for this project, for each shop drawing (sample included at the end of this section), or, include the same information on the contractors submittal cover sheet:
  - .1 Information required on each submission:
    - (a) Client/Architect name
    - (b) Project Name
    - (c) H.H. Angus project number
    - (d) Date
    - (e) Contractor name
    - (f) Contractor reference No.
    - (g) Manufacturer name
    - (h) Product type
    - (i) Specification section number
    - (j) Contractor trade: mechanical, electrical, elevators, or general trades
    - (k) If a re-submission, the previous submission H.H. Angus reference number.
- .3 Submit shop drawings in PDF format;
  - .1 If submitted in hardcopy format, submit in 11 x 17, black and white originals of graphic quality suitable for photocopying. Allow one additional week for processing of shop drawings submitted in hardcopy format.
- .4 Manufacturers printed product data sheets for standard items are acceptable in place of shop drawings providing physical characteristics are identified and are related to specification references.
- .5 Submit manufacturers data sheets with typed schedules listing manufacturers and suppliers name and catalogue model number for such items as fire alarm system components, etc.
- .6 For luminaires, submit luminaire cuts with manufacturer's names and catalogue numbers for all luminaires to be used on the job. Identify and arrange the luminaire cuts and catalogue numbers in the same sequence as the Specification Luminaire list.
- .7 Shop drawings and product data to show:
  - .1 CSA or equivalent approval.
  - .2 Dimensioned outlines of equipment.
  - .3 Dimensioned details showing service connection points.
- .8 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
- .9 Where applicable, include wiring, single line and schematic diagrams.
- .10 Include wiring drawings or diagrams showing interconnection with work of other Sections.
- .11 Each shop drawing to be checked and stamped as being correct, by trade purchasing item, before drawing is submitted. If above requirements are not complied with, shop drawings will be rejected and returned forthwith.
- .12 Before manufacture or assembly of the equipment, submit only the shop drawings showing dimensioned outlines of equipment and elevations illustrating locations of visible equipment such as breakers and their trip settings, windows, meters, and description of operation as well as single line diagrams. Submit drawings showing construction details, component assemblies or interior wiring diagrams which may be necessary for the correct functioning of the equipment.

- .13 For manufacturer's data and lighting fixtures, submit for approval, bound sets showing the fixture cuts, manufacturer's name and catalogue numbers. Each folder or binder to be complete with all fixtures used on the job. Arrange the fixture cuts and catalogue numbers and identify in the same sequence as the specified fixture list.

## 2.2 **FIELD, FABRICATION, OR INSTALLATION DRAWINGS**

- .1 Contractor field, fabrication, installation, and/or sleeving drawings will not be reviewed as shop drawings. If submitted as a shop drawing, a transmittal only will be returned identifying the submitted drawings have not been reviewed.
- .2 Maintain a copy on site of such drawings for reference by the Consultant.
- .3 Provide a copy of such drawings to the Consultant for general information purpose only, upon request.

## 2.3 **OPERATING AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data bound in 210 mm x 300 mm x 50mm thick (8½ in x 11 in x 2 in thick) size, vinyl covered, hard back, three-ring covers.
  - .1 Organize material in volumes generally grouped by Division Section; Site services, Power, Lighting, Low Voltage Systems, Fire Alarm and Security.
  - .2 Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear Project Name, Project Number, Date, Trade Section, and List of Contents.
  - .3 Provide three hard-copies to Owner.
- .2 In addition, provide Adobe PDF files for each document, produced from original direct-to-digital file creations.
  - .1 Organize documents into separate PDF files for each Division Section identified above, and apply Adobe Bookmarks to create Table of Contents.
- .3 Include in operations and maintenance data:
  - .1 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.
  - .2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.
  - .3 Wiring and schematic diagrams and performance curves.
  - .4 Names and addresses of local suppliers for items included in maintenance manuals.
  - .5 Copy of reviewed shop drawings.
  - .6 The operating characteristics of the equipment supplied such as calibration curves and coordination data to allow proper co-ordination with owner's equipment.
  - .7 Description of operation of the controls and protective devices used.
  - .8 Maintenance and adjustment procedures, and lifting and jacking instructions.
  - .9 Fault locating guide.
  - .10 Spare parts list and an itemized cost.
  - .11 Name and telephone numbers of service organization and technical staff that will provide warranty service on the various items of equipment.

## 2.4 **OPERATING AND MAINTENANCE INSTRUCTIONS**

- .1 Supply the services of a skilled tradesman for a minimum of two consecutive full days to start each system in its proper sequence, and test and calibrate controls and set-up systems.
- .2 During this procedure thoroughly explain the operation and maintenance of each system, incorporating specialized instruction by manufacturers as described under other sections in this Division.
- .3 Arrange suitable time for instructions with Owner's operating and maintenance personnel.



- .4 Keep a record of date and duration of each instruction period together with the names of persons attending. Submit signed records at completion of instruction.
- 2.5 **CARE, OPERATION AND START-UP**
  - .1 Instruct Consultant and operating personnel in the operation, care and maintenance of equipment.
  - .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.
  - .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 every aspect of the operation, care and maintenance thereof.
- 2.6 **RECORD DRAWINGS**
  - .1 Provide record drawings in accordance with Section 01 78 05.
  - .2 A set of design drawings in AutoCad 2016 on CD or DVD ROM will be provided by the Consultant. Make sets of white prints for each phase of Work, and as Work progresses and changes occur mark white prints in coloured inks to show revisions. Dimension locations of drains, pipes, ductwork, conduit, manholes, foundations and similar buried items within the building, with respect to building column centres. Mark level with respect to an elevation which will be provided.
  - .3 Survey information from excavation and backfill of site services to be held on site, after approval, and to be similarly transferred to white prints.
  - .4 Retain these drawings and make available to Consultant for periodic review.
  - .5 On a weekly basis, scan marked-up drawings to Adobe .pdf format. Where a project has a FTP site, post these files on a weekly basis.
- 2.7 **AS-BUILT DRAWINGS**
  - .1 Prior to testing, balancing and adjusting, transfer site record drawing information to AutoCad 2016 (CAD) files, to record final as-built condition. Obtain a current set of CAD files from the Consultant.
    - .1 Drawings are to remain set to and follow Consultants AutoCad Standards. Do not alter drawing scales, X-refs, colours, layers or text styles.
    - .2 The Consultant's CAD files may not reflect all or any construction changes.
  - .2 Where items have been deleted, moved, renumbered or otherwise changed from contract drawings, revise the CAD files to record these changes. "Bubble" these revisions, and place these annotations on a separate and easily identified drawing layer.
  - .3 As-built drawings to show the final as-built condition.
  - .4 Show on electrical as-built drawings final location of conduit, outlets, panels, branch wiring, system wiring, pull boxes, bus ducts, and equipment.
  - .5 Show on site services as-built drawings survey information provided by Ontario Land Surveyor (OLS) monitoring services installation.
  - .6 Identify each drawing in lower right hand corner in letters at least 12 mm (½") high as follows "AS-BUILT DRAWINGS. This drawing has been revised to show systems as installed" (Signature of Contractor) (Date). The site services drawings are to include (Signature and Stamp of OLS) attached to note.
  - .7 The site services drawings are to include (Signature and Stamp of OLS) attached to note.
  - .8 Once "AS BUILT DRAWINGS" white prints are reviewed, transfer Consultant's comments to the CAD files. Return AutoCad drawings modified to "As Built" condition to Consultants on CD or DVD Rom.
  - .9 Submit three (3) sets of white prints and three (3) copies of CAD files with Operating and Maintenance Manuals.

**PART - 3 REFERENCE CODES STANDARDS AND REGULATIONS**

**3.1 CODES AND STANDARDS**

- .1 Do complete installation in accordance with Ontario Electrical Safety Code (OESC) except where specified otherwise.
- .2 Do underground systems in accordance with CSA C22.3 No.7-M86 except where specified otherwise.
- .3 Abbreviations for electrical terms: to CSA Z85-1983.
- .4 Comply with CSA Certification Standards and Ontario Electrical Safety Code Bulletins in force at time of Tender submission.
- .5 Where requirements of this specification exceed those of the above mentioned standards, this specification to govern.

**3.2 CONFINED SPACES**

- .1 Unless otherwise proscribed by the Constructor's / Owner's workplace safety program, treat spaces not designed and constructed for continuous human occupancy as "confined spaces", including but not limited to:
  - .1 horizontal and vertical service spaces, shafts, and tunnels,
  - .2 inside of equipment which permits entry of the head and/or whole body, and
  - .3 ceiling spaces which are identified as containing a hazardous substance.

**3.3 PERMITS, FEES AND INSPECTIONS**

- .1 Submit to Electrical Safety Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Pay associated fees.
- .3 Consultant will provide drawings and specifications required by Electrical Safety Authority at no cost.
- .4 Notify Consultant of changes required by Electrical Safety Authority prior to making changes.
- .5 Furnish Certificates of Acceptance from Electrical Safety Authority and authorities having jurisdiction on completion of work to Consultant.

**PART - 4 FIELD QUALITY CONTROL**

**4.1 TESTING**

- .1 Conduct and pay for following tests:
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .5 Systems: fire alarm system, communications.
- .2 Arrange and pay for services of applicable manufacturer's factory service engineer or certified independent testing organization to supervise initial start-up of specialized portions of installation and to check, adjust, balance and calibrate components including related wiring and controls. Provide these services for such periods, and for as many visits as may be necessary to put applicable portion of installation in complete working order. Provide a certificate indicating that the equipment is free and clear of deficiencies.

- .3 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .4 Insulation resistance testing.
  - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
  - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
  - .3 Check resistance to ground before energizing.
- .5 Carry out tests in presence of Consultant.
- .6 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .7 Submit test results for Consultant's review. Test electrical equipment to standards and function of specification and applicable codes in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.

#### 4.2 **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 and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, at completion of work, report listing phase and neutral current on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

#### 4.3 **CO-ORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as per equipment manufacturers recommendations for each piece of equipment.

#### 4.4 **CLEANING**

- .1 Do final cleaning [in accordance with Section 01 74 23.
- .2 At time of final cleaning, clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt, including the top surface, whether exposed or in the ceiling space.
- .3 Clean switch, receptacle, and communications outlets, coverplates, and exposed surfaces.
- .4 Clean all other electrical equipment and devices installed as part of this project.
- .5 Electrical, UPS Equipment or Communication Closets:
  - .1 Thoroughly vacuum and clean interiors and all panels, cabinets and other electrical equipment of all construction debris and dust prior to energization using a HEPA vacuum cleaner. Final clean using clean lint free cloths with a cleaning liquid as recommended by the manufacturer for the purpose.
  - .2 HEPA vacuum the top of all panels, cabinets, cable trays and conduits, followed by a thorough HEPA vacuuming of the floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.
  - .3 Thoroughly re-clean as necessary prior to final turn over.

#### 4.5 **FINAL INSPECTION**

- .1 At project completion submit written request for a final inspection of electrical systems. Include with this submission written certification that:
  - .1 Deficiencies noted during job inspections have been completed.
  - .2 Systems have been balanced and tested and are ready for operation.
  - .3 Completed maintenance and operating data have been submitted and approved.
  - .4 Tags are in place and equipment identification is completed.
  - .5 The cleaning up is finished in every respect.
  - .6 All electrical panels, switchboards, cabinets, and equipment surfaces have been touched up with matching paint, or re-finished as required
  - .7 Spare parts and replacement parts specified have been provided and receipt acknowledged.
  - .8 As-built and Record drawings are completed and approved.
  - .9 Owner's operating personnel have been instructed in operation and maintenance of systems.
  - .10 Fire alarm verification is 100% completed and Verification Certificate has been submitted and accepted.

## **PART - 5 EQUIPMENT**

### **5.1 WARNING SIGNS**

- .1 As specified and to meet requirements of Electrical Safety Authority and Consultant.
- .2 Porcelain enamel decal signs, minimum size 175 mm x 250 mm (7" x 10").

### **5.2 PROTECTION**

- .1 Protect exposed live equipment during construction for personnel safety.
- .2 Shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage.
- .3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.

### **5.3 SLEEVES AND CURBS**

- .1 Provide sleeves of galvanized steel for conduit and cable runs passing through concrete walls, beams, slabs and floor. Sleeves for bus ducts, wireways and cable trays to be minimum 3 mm (1/8") galvanized steel.
- .2 Provide concrete curbs, minimum 100 mm (4") high above finished floor surrounding openings where bus ducts, wireways and cable trays rise through slabs above grade to prevent debris and water from falling to floor below. Concrete curb to have sufficient area to adequately carry bus duct support brackets.
- .3 Provide concrete curbs, minimum 100 mm (4") high above finished floor for telephone cable risers and other openings intended for electrical use in slabs above grade.
- .4 Extend galvanized sleeves for conduit rising through slabs 100 mm (4") minimum above finished floors. Provide sleeves, passing through floors having a waterproof membrane, with an integral flashing clamp.
- .5 Where cables or conduits pass through floors and fire rated walls, pack space between wiring and sleeve full with Fireproofing, and seal with caulking compound conforming to CANZ-19.13.

### **5.4 FIREPROOFING**

- .1 The integrity of the fire resistance rating of the floors and walls to be maintained around electrical raceways and/or cables passing through such floors and/or walls.
- .2 Materials used to maintain fire resistance ratings to have a minimum 2 hour ULC or cUL listed rating.

- .3 Wiring may penetrate a fire resistance rated assembly provided it is enclosed in non-combustible conduit, and the passage of the conduit in turn is suitably sealed to the assembly with fire stop material.
- .4 Wiring with a combustible covering and not enclosed in non-combustible conduit penetrating a fire resistance rated assembly shall be grouped into separate fire sealed penetrations to ensure the overall diameter of the combined wire(s) in each penetration does not exceed 25 mm, and that the integrity of the fire rated assembly is not compromised.
- .5 Single conductor metal sheathed cables shall be arranged to individually penetrate the fire rated assembly and be individually fire stopped.
- .6 Where wiring is installed in cable trays and must penetrate a fire rated assembly, stop and independently support the cable tray immediately on each side of the fire rated assembly while allowing sufficient working room to properly install and inspect the fire rating materials and penetration.

*Standard of Acceptance*

- o Thomas & Betts - Flame-safe
- o Nelson/Wieland (Electrovert) - Flameseal
- o Double A/D Distributors Ltd. - Firebarrier Firestopping
- o Canstrut - Elasta-Seal MBF-KBF sealbags (where open tray passes through floor slab)

**5.5 SPRINKLER PROTECTION**

- .1 Equipment in sprinklered areas, except for weatherproof equipment, must be provided with hoods or shields and gasketed doors for protection against sprinkler discharge, and to comply with the requirements of OESC.
- .2 Ventilation openings to be overhanging drip proof type
- .3 Weatherproof equipment, where noted in the specifications and/or drawings to have EEMAC type 3 enclosures in accordance with the requirements of CSA C22.2 No. 94 Standard.
- .4 Surface panelboards, switchboards and other electrical equipment in sprinklered areas to be fitted with watertight hubs with insulated throat for all conduit entrances.

*Standard of Acceptance*

- o Thomas & Betts Ltd. - Series 401
- o Efcor of Canada Ltd. - Series 40-50B

**5.6 ACCESS DOORS**

- .1 In all cases where electrical elements, requiring access, are concealed above ceilings or in walls this Division is responsible to review, in the presence of the Owner, the Architect, the Consultants and the General Contractor, the exact details, locations and types of proposed access.
- .2 Submit list of proposed access door locations and obtain approval thereof before commencing access door installation.
- .3 Submit access door shop drawings for approval as soon as possible after Award of Contract, showing size, type and exact location of access doors.
- .4 Access doors, unless otherwise specified or shown, to be at least 3 mm (12 gauge) steel, finished prime coat only, with concealed hinges, anchor straps, plaster lock, without screws.
- .5 Access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive the tile insert.
- .6 Inside frame dimensions to be approximately 300 mm x 450 mm (12" x 18"). However, if it is necessary for personnel to enter through doors, they to be at least 600 mm x 450 mm (24" x 18").

- .7 Access doors to be as manufactured by:  
*Standard of Acceptance*
- o Zurn Industries Canada Ltd. - Inspectors
  - o LeHage Industries Ltd.
  - o A. G. Baird Limited - ABCO
  - o Stelpro Limited - Type 700
- .8 Provide access doors for locations where equipment requiring maintenance or adjustment is "built-in".
- .9 These access doors will be installed under the Division in whose work they occur. Arrange for and pay cost of access door installation.
- .10 Access doors are not required in removable acoustic panel type ceilings.
- .11 Provide approved coloured marking devices after completion of such ceilings, at four corners of each panel below point requiring access.
- .12 Size and locate access doors in applied tile, or in glazed or unglazed structural tile to suit tile patterns. Refer to Architectural Room Finish Schedule and details on Architectural Drawings in this regard.

## **PART - 6 COORDINATION**

### **6.1 GENERAL**

- .1 Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, etc, and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.
- .2 Lay out and coordinate Work to avoid conflict with work under other Divisions. Note: the Mechanical Contractor is responsible for preparing very detailed three-dimensional Co-ordination/ Interference Drawings (refer to Spec Section 20-01-03) and this Division must co-ordinate/ assist with the preparation of these Drawings ensuring Drawings show, in the three-dimension, all Lights, Power Elements, System Components AND CONDUITS (specifically important in the EP Suite areas)
- .3 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.
- .4 When equipment provided under other Sections connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided.
- .5 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- .6 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.
- .7 Location of conduit, bus duct, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .8 Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the work as an operating installation.

### **6.2 FIELD, FABRICATION, AND INSTALLATION DRAWINGS**

- .1 Prepare field, fabrication, and/or installation drawings to show location of equipment and relative position of services, and to demonstrate coordination with works of other trades.
- .1 Drawing scale: minimum 1:50 (1/4"=1'-0")

- .2 Use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings.
- .3 Layout equipment and services to provide access for repair and maintenance.
- .4 Submit drawings to other trades involved in each area and include note in drawing title block as follows;
  - .1 "This drawing was prepared and circulated for review and mark-up to related subcontractors as noted and initialed in the table below. Corrections and concerns identified through this coordination process have been addressed on this drawing. Areas that incorporate significant changes from layouts shown on Contract Drawings have been circled for Consultants' review"

### 6.3 **CUTTING AND REMEDIAL WORK**

- .1 Cutting and patching of existing work in the areas being renovated under the scope of this project and to accommodate the Work, unless otherwise noted, will be done by the General Trades Contractor. Layout such work for approval before undertaking same.
- .2 However, there are areas where work is delineated for this Division but that does not require work by the General Contractor (specifically, routing of new electrical services through existing un-renovated spaces). In these areas, cutting and patching of existing of general trades work and temporary removal/reinstallation of ceilings to accommodate work of this Division must be arranged and paid for under this Division.
- .3 Assume responsibility for prompt installation of work in advance of concrete pouring or similar work. Should any cutting or repairing of either unfinished or finished work be required because such installation was not done, employ the particular trade, whose work is involved, to do such cutting and patching. Pay for any resulting costs. Layout such work for approval before undertaking same.
- .4 Holes required in existing construction to accommodate cable, raceways, bus duct or cabletray to be cut neatly or drilled.
- .5 Division 26 contractor to be responsible for arranging and paying for all cutting and patching as required. Before cutting, drilling, or sleeving structural load bearing elements, obtain the Consultant's approval of location and methods in writing. Employ original installer or expert in the finishing of material required to perform cutting or patching for weather exposed or moisture resistant elements or sight exposed surfaces.
- .6 All core drilling through floor slabs to be X-rayed and verified with Owner's representative prior to coring. Relocate core drilling location if steel or conduit is found in the proposed location and repeat procedure. Reroute any circuits damaged by core drilling.

### 6.4 **WORK IN EXISTING BUILDING**

- .1 Refer to Division 01 - General Requirements.
- .2 During the tender period, the Contractor shall perform a site inspection of the place of work and surroundings including the accessible ceiling spaces and other areas where access could be considered reasonable. Make a thorough investigation of As Built conditions to determine scope of renovation or demolition work required prior to submitting tender.
- .3 Work includes changes to existing building and changes at junction of old and new construction. Route cabling, ducts, conduits and other services to avoid interference with existing installation.
- .4 Relocate existing pipes, ducts, conduits, bus ducts and any other equipment or services required for the proper installation of new work.
- .5 Maintain or relocate existing services which pass through the area of renovation or demolition, but which feed items located outside of these areas. Rewire devices to the original circuits.

- .6 Remove existing lighting fixtures, wiring, devices and equipment to suit new construction. Cut back and cap conduits and electrical outlets, not being used, so that finished work presents a neat and clean appearance. Disconnect at point of electrical supply, remove obsolete wiring and conduits, and make existing systems safe. Blank off openings in panels or boxes from removed conduits or ducts.
- .7 Unless noted to be reused, removed conduit, wiring and devices become the property of the Contractor and are to be taken from the site and disposed of appropriately.
- .8 Removed lighting fixtures and equipment shall be reviewed at site with the Owner's representative, and if the Owner instructs they wish to keep any items, they shall be moved to a designated location on the site. Lighting fixtures and equipment that the Owner does not want shall be taken from the site and disposed of appropriately.
- .9 Provide junctions boxes, outlet boxes, wiring, plates, etc..., as necessary for complete relocation of devices, fixtures and equipment.
- .10 Revise panelboard directories accordingly if affected by work.
- .11 Clean and re-lamp relocated lighting fixtures and replace any faulty ballasts.
- .12 On completion of relocations, confirm relocated devices and lighting fixtures are in proper working order.
- .13 Co-ordinate work affecting fire alarm system, fire safety, and detection systems with Consultant, Fire Alarm System Manufacturer, and authorities having jurisdiction prior to commencing work. Retain original fire alarm system manufacturer to verify all relocated fire alarm devices and all revised wiring. Provide temporary fire protection and/or a fire watch as required by authorities having jurisdiction in all areas affected by the demolition.
- .14 Where Owner wishes to take over renovated areas ahead of project completion date and these areas are intended to be fed from distribution systems in new building, make temporary connections to existing services in these areas. Reconnect to permanent services, at a later date, when new distribution systems are available.

#### 6.5 **CONTINUITY OF SERVICES**

- .1 Refer to Division 01 - General Requirements.
- .2 Connections to existing systems to be made at approved times. Obtain written approval recording times when connections can be made. Arrange work so that physical access to existing buildings is not unduly interrupted.
- .3 Be responsible for any damages caused to existing systems when making connections.
- .4 Keep existing buildings in operation with minimum length of shutdown periods. Include overtime work to tie-in piping or wiring at night or on weekends. Provide temporary feeders and connections as required to maintain systems in operation where shutdown periods will exceed 8 hours, or extend beyond the allowable time frame determined by the Owner.

#### 6.6 **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.

#### 6.7 **FINISHES**

- .1 Primary and final painting for Work, other than items specified as factory primed or finished, to be done under Finish Division 9.
- .2 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.



- .3 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .4 Leave a quart can or a pressurized spray can of paint, as used with switchboards, with owner for touch-up purposes.
- .5 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- .6 Store electrical materials and equipment such as switchboards, panels, transformers and luminaires in a dry, clean location and cover with polyethylene plastic to preserve factory finish.
- .7 Protect exposed or free standing equipment with plastic to minimize entry of dust and dirt and marring of finished surfaces during progress of work
- .8 Schedule luminaires, lamps and diffusers for installation as late as possible during construction in order to minimize accumulation of dust and/or dirt on them. Clean luminaires and diffusers, not acceptable because of dust and dirt, in an approved manner as specified by manufacturer. Wrap surface mounted and suspended luminaires, installed prior to painting and other dusty construction being completed in the area, in plastic to prevent dirt and paint from settling on them.

## 6.8

### **EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as follows:
- .2 Nameplates:
  - .1 Nameplates for panels and equipment to be 3 mm (1/8") thick, black lettering on white background, with bevelled edges and mechanically attached with self-tapping stainless steel screws.

NAMEPLATE SIZES			
Size #	Size	Lines	Letter height
1	10 x 50 mm (1/2" x 2")	1 line	3 mm (1/8") high
2	12 x 70 mm (1/2" x 3")	1 line	5 mm (1/4") high
3	12 x 70 mm (1/2" x 3")	2 lines	3 mm (1/8") high
4	20 x 90 mm (1" x 4")	1 line	8 mm (5/16") high
5	20 x 90 mm (1" x 4")	2 lines	5 mm (1/4") high
6	25 x 100 mm (1" x 4")	1 line	12 mm (1/2") high
7	25 x 100 mm (1" x 4")	2 lines	6 mm (1/4") high

- .3 Labels: Embossed plastic labels with 6 mm (1/4") high letters unless specified otherwise.
- .4 Wording on nameplates and labels to be approved by [Consultant][Engineer] prior to manufacture.
- .5 Allow for average of thirty-five (35) letters per nameplate and label.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

- .10 Identify other cabinets for low voltage systems, such as signals and communications, as for panelboards with a directory showing circuit numbers and room locations plus a blank for "Remarks", as well as a lamicon plate designating panel name.
- .11 Typical Identification Standards
- .1 Lighting, Receptacle and Power panels to each be identified with an engraved lamicon plate secured to top interior trim as:
- (a) LP-1A 12 mm (1/2") high lettering
  - (b) 120/208 volts 5 mm (1/4") high lettering
  - (c) Fed from PP 'AA' 5 mm (1/4") high lettering

- .2 Supply each panel with a directory card holder welded to inside of door, complete with a neatly typewritten list showing information as follows:

Panelboard Name	LP-1A
Panel Voltage	120/208 Volts
Circuit Number	Description
1	Lighting Room #34
2	Receptacles Room #34
3	Ice Machine Room #17

- .3 Cover list with a 0.8mm (1/32") minimum thick clear plastic sheet to protect it.
- .4 Identify equipment not listed above, such as incoming service cables, communicating cables, switchgear, transformers, disconnects, contactor motors, instruments, fire alarm, clock and program equipment and control panels, in a similar manner showing name and number of the equipment, voltage and load information.
- .5 Labels for Emergency Lights shall consist of a glue on red dot in one corner of the light lens clearly visible from the floor.
- .12 Identify feeder pull boxes and junction boxes with lettering stamped on brass or aluminum tags showing feeder or system concerned, voltage involved and data for both termination points whether equipment or panel. Tag to be held to boxes under lid screws using steel wire.
- .13 Apply a small dab of paint to inside of each outlet box, pull box and panel as it is installed, using colour code as follows:

Red	Fire Alarm System and Emergency Voice Communication System
Dark Blue	Intercom and Public Address
Dark Green	Telephone and Data Systems
Black	Annunciator and Buzzer System
Grey	Clock System

White	Central Dictation
Orange	Nurse Call
Yellow	Alarm Systems
Pink	Computer Systems
Light Green	TV Systems
Light Blue	Miscellaneous

- .14 Colour code is not required for regular lighting and power circuits.
- .15 Junction boxes in furred ceilings to have colour identification on both inside and outside.
- .16 Provide identification of emergency lights consisting of a glue-on red dot in one corner of the light unit.
- .17 For lighting luminaires specified with both a normal and emergency power connection provide identification on luminaires internal barrier designating dual power feeds.
- .18 Cubicles and/or cells to include main identifier nameplate on rear of cells  
*Standard of Acceptance*
  - o W. M. Brady Co. of Canada Limited - B350
  - o IDI Electric (Canada) Ltd. - Style A

## 6.9 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 C22.1-1990.
- .4 Use colour coded wires in communication cables, matched throughout system. Schedule and chart marker number or colour with corresponding equipment and include with record drawings or operation and maintenance data.
- .5 Connections in equipment to be Phase A, B, C from left to right when viewing from front or accessible direction.
- .6 Carry colour coding through from incoming utility supply down to and including panels as follows:
  - .1 Identify incoming utility service lines by Red - Phase "A", Black - Phase "B", Blue - Phase "C", with enamel paint.
  - .2 Band switchgear buswork in each switchboard and unit substation cubicle with tape identified in accordance with service lines colour-coding. In addition, where neutral bus is introduced, it to be banded white. Ground bus to be banded green.
  - .3 Band feeder and sub-feeder bus or conductors as above.
  - .4 Band main bus on lighting and power panels with tape as follows, to conform to the Electrical Safety Code.

Red	Phase A
Black	Phase B
Blue	Phase C
White	Neutral

Green	Ground
Orange	Control

- .7 Identify control conductors for motors and equipment by pressure sensitive tape markers or permanent PVC sleeve markers at each main terminal point and wherever they are introduced into ducts or equipment. Schedule and chart marker numbers with corresponding machine numbers and locations and include with Record Drawings.

#### 6.10 CONDUIT AND CABLE IDENTIFICATION

- .1 Label feeder conduits.  
.2 Locate labels as follows:  
.1 At every end of every conduit, duct or cable run, adjacent to item of equipment serviced.  
.2 On each exposed conduit, duct or cable passing through a wall, partition or floor (one on each side of such wall partition or floor).  
.3 At intervals of 15 m (50') along every exposed conduit, duct or cable run exceeding 15 m (50') in length.  
.4 At every access point on concealed conduit duct or cable.  
.3 Labels to be visible from 1.5 m (5') above adjacent floor or platform.

#### 6.11 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.  
.2 Manufacturers and CSA labels to be visible and legible after equipment is installed.

#### 6.12 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Division 01 - General Requirements.  
.2 Do not install outlets back-to-back in wall; allow minimum 150 mm (6") horizontal clearance between boxes.  
.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm (10'), 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 door.

#### 6.13 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.

Description	General Area	Barrier Free
Local switches	1200 mm (47")	1200 mm (47")

Description	General Area	Barrier Free
Wall receptacles: General	600 mm (24")	600 mm (24")
Wall receptacles: above top of continuous baseboard heater	200 mm (8")	200 mm (8")
Wall receptacles: above top of counters or counter splash backs	175 mm (7")	175 mm (7")
Wall receptacles: In Mechanical rooms	1200 mm (47")	1200 mm (47")
Panelboards	As required by code or as indicated	
Telephone outlets	600 mm (24")	600 mm (24")
Wall mounted telephone outlets	1500 mm (60")	1200 mm (47")
Fire alarm pull stations	1500 mm (60")	1200 mm (47")
Fire alarm bells	2100 mm (83")	
Television outlets	300 mm (12")	450 mm (18")
Wall mounted speakers	2100 mm (83")	
Clocks	2100 mm (83")	

#### 6.14 CONDUIT AND CABLE INSTALLATION

- .1 Sleeves through concrete: galvanized steel, minimum 3 mm (1/8") sized for free passage of conduit, and protruding 50 mm (2").
- .2 Arrange for holes through exterior walls and roof to be flashed and made weatherproof under Division 7.
- .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.
- .4 Supply and deliver inserts to site in ample time to be built into work of other trades. Provide necessary templates and adequate instructions and assistance to locate and install inserts.
- .5 Secure inserts firmly to form work before concrete is poured.
- .6 Provide sleeve and insert drawings as required.

#### 6.15 PLYWOOD BACKBOARDS

- .1 Provide plywood backboards in electrical and telecommunications rooms and closets where indicated on drawings and where referenced under various sections of the specifications for mounting of equipment.
- .2 Plywood to be securely fixed to the building structure.
- .3 Plywood to be 19mm, void free, good one side, mounted with good side exposed
- .4 Plywood to be Class A fire retardant, FSC certified, contain no added urea formaldehyde, and be suitable for compliance with LEED credits MR 5.1 + 5.2 (Manufactured and

Extracted Regionally), MR 7.0 (Certified Wood), and EQ 4.4. (Low Emitting Materials).  
Provide necessary documentation to support LEED credit application process.

- .5 Plywood to be treated as follows on all surfaces:
  - .1 Initially seal the plywood with one coat of Sherwin Williams part No. B49 W 2 wood primer
  - .2 Follow with one coat of Flame Control 10-10 Intumescent Fire Retardant Paint
  - .3 Finish with one coat of Flame Control 40-40 Fire Resistant Paint

#### 6.16 **WIRING OF MECHANICAL TRADES MOTORS**

- .1 To limit responsibility and to specifically define the Work under this Division, use the following procedure with regard to motors provided under Mechanical Division 20..
- .2 The Contractor under Mechanical Division 20 will be responsible for installing equipment which he supplies including motors, starters, disconnect switch, Motor Control Centres and miscellaneous controls of the type specified. **For Refrigeration Equipment compressor and D/X Air Conditioning Equipment, Division 26 is to provide a weather-proof disconnect at the equipment, mounted independent of the A/C Equipment and complete final connection to the equipment using a minimum of 610mm (24") length of seal-tight flex conduit**
- .3 In every instance whether pertaining to Plumbing, Air Conditioning, Refrigeration, Heating or Ventilating equipment, wire to line side of the Motor Control Centre, disconnect switch, or starter provided by these trades, in reasonable proximity to equipment being controlled.
- .4 From this point, unless otherwise noted, the cost of electrical material and labour will be borne by the particular trade whose work is involved. That trade will mount starter and wire from it to motor being controlled, together with control wiring, remote switches, and pilot lights.
- .5 Where individual starters and controls are grouped together, the Contractor under Mechanical Division 20 will provide a panel for mounting his equipment. Provide a feeder, main fused disconnect, a splitter of adequate size and capacity, [individual fused disconnect switches,] and wire to line side of the Division 20 starters.
- .6 For Refrigeration Equipment compressor and D/X Air Conditioning Equipment, Division 26 is to provide a weather-proof disconnect at the equipment, mounted independent of the A/C Equipment and complete final connection to the equipment using a minimum of 610mm (24") length of seal-tight flex conduit.
- .7 In the case of unit heaters, reheat coils, electrical control devices, and cabinet unit heaters, terminate wiring in an outlet immediately adjacent to motor or device being electrically powered. Wiring from this point to starter, thermostat, or other devices will be done under Mechanical Division 20.
- .8 Provide branch circuit wiring and an outlet for each motorized damper or heating control.
- .9 Ascertain exact locations of starters, Motor Control Centres and motors, from Mechanical Drawings.
- .10 Motors up to and including 0.25 kW (¼ HP) to be 120 volt, 60 Hz, single phase.
- .11 Motors .37 kW (½ HP) and above to be 3 phase, 60 Hz, voltage as noted

#### 6.17 **TEMPORARY AND TRIAL USAGE**

- .1 Temporary and trial usage by Owner of equipment or any other work or materials supplied before final completion and written acceptance is not to be construed as evidence of acceptance by Consultant.
- .2 Consultant to have the privilege of such temporary and trial usage, as soon as supplier claims that said work is completed and in accordance with specifications, for such reasonable length of time as is deemed to be sufficient for making a complete and thorough test of same.

- .3 Claims for damage not to be made by supplier for the damage to or breaking of any parts of such work which may be used, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.
- 6.18 **COMMISSIONING**
- .1 Equipment supplied on this project will be subject to detailed factory inspection and on-site testing and commissioning prior to being placed in service. The electrical contractor, their major system and equipment suppliers, and the Independent Testing Agent (ITA) will be required to participate in special commissioning meetings to review progress and status of the commissioning program.
- .2 Include in Bid amount for licenced electricians to participate in the commissioning program, to undertake temporary power connections, operation of equipment, opening and closing of panel boards and switchboards, testing of power and control wiring, and assisting the ITA and the equipment suppliers' field personnel in the start up and testing of the equipment.
- .3 The contractor and equipment suppliers to include in the Bid amount for all costs to accommodate and undertake factory and site testing.
- 6.19 **TRAINING**
- .1 Include in the major equipment supply tender prices the services of a qualified technical representative to conduct "hands-on" training programs for the Owner's staff.
- .2 The training to include an overview of equipment function and operation, basic inspection, housekeeping and logging procedures.
- .3 Submit an outline of the training program for review, adjustment and approval by the Consultant. Training will occur in up to 3 separate sessions, at a time convenient to the Owner, to suit multiple shift maintenance staff schedules.
- .4 Sessions may be videotaped by the Owner as an aid to ongoing training of Owners staff.
- 6.20 **PROTECTION DURING CONSTRUCTION**
- .1 Provide protection required to enable existing building and equipment to remain in continuous and normal operation, and maintain construction schedule.
- .2 Take the necessary precautions to protect equipment, existing building and service from damage during rearrangement. Accept responsibility for any damage which may occur and make good without cost to the Owner. Accept responsibility for damage to existing services and make good without cost to the Owner.
- .3 It is of vital importance, during work of this Contract, that all existing surfaces and items, including walls, floors, ceilings, windows, doors and frames, piping, ductwork and light fixtures, are not damaged in any way whatsoever by the work of all trades. Take all precautions required or necessary to prevent any such damage, supplying all protection, hoarding, tarpaulins and dust sleeves. Any damage caused because of lack of such protection or lack of preventative measures to be made good at no cost to the Owner. Ensure that the work in the existing building, such as floors, finishes and trim, is protected as completely as possible to hold the replacing of damaged work by each sub-contractor to a minimum.
- .4 Care to be taken when working above or around UPS modules, batteries and switchgear as this equipment must remain in service. Care to be taken to eliminate dust in these equipment areas.
- .5 Switchgear fronts must be protected from accidental breaker trips when working around or above them. Provide a extended shield with 12 mm (½") plywood coated with fire retardant paint a minimum of 450 mm (18") from board front to allow access to board.
- 6.21 **HOUSEKEEPING**

- .1 Scrap and refuse to be removed from the work area daily. Whenever possible, clean up immediately following completion of work. A high level of cleanliness must be maintained. Sweep and damp mop daily.
- .2 Oily and waste solvent rags are a fire hazard and to be deposited in approved containers.
- .3 Conduit, wires or cables, tools or equipment are not be left in such a way that they constitute a hazard.
- .4 Openings in the roof or floor to be guarded to prevent to prevent stock or scrap from dropping down.
- .5 Loose equipment and tools shall be cleaned off overhead areas before leaving each day.
- .6 Boards with protruding nails shall not be left on the floor.
- .7 Bolts shall be cut off at floor level to eliminate a possible tripping hazard.

6.22

**OWNER'S SPECIAL REQUIREMENTS**

- .1 Contractor must provide a written list of names for employees and sub-trades entering the building, advising which areas they need access to at least 48 hours prior to expected time of arrival. This lead time is required to prearrange security passes.
- .2 Security Passes must be visibly worn at all times by all employees.
- .3 All trades people must strictly adhere to Building Security regulations or entrance into the building will be denied.
- .4 All trades people are to enter the entrance identified by the Owner. Vehicles are to be parked in proper designated areas. Driveways are not to be blocked.
- .5 Freight elevator must be used at all times to transport tools and material. Freight elevator door must be shut immediately after exiting the cab.
- .6 Under no circumstances are any electrical or mechanical systems to be disabled or activated without prior knowledge and approval by the Owner's Project Manager. Prior to disabling or activation of any electrical or mechanical systems, Building Operations and Building Security must also provide approval.
- .7 Prior notification must be forwarded to Building Security Staff before any construction activity can start which will result in heat, smoke, dust or fumes, such as sawcutting, soldering, spray painting, which can affect the sensitive fire protection equipment.
- .8 Contractor responsible for scheduling and meeting the sub-trades daily on site, showing all trades people the work areas and work to be done.
- .9 Trades-people are to supply and use their own tools. No tools, ladders or equipment, etc. will be loaned.
- .10 Contractor is responsible for all associated environmental cleaning to the job site, daily during construction and upon completion. This includes both under raised floor and above ceiling. No materials or garbage will be permitted to be stored on the loading dock.
- .11 Special care and attention must be adhered to at all times when transporting equipment and materials to prevent accidental damage to the fire protection equipment and all furnishings and fixtures.
- .12 "No Smoking" - smoke free building. Violators will be denied entry. Smoking is not allowed on the roof.
- .13 If Building Operations deems that work on a particular system requires security escort, the Contractor should allow 48 hours to make appropriate arrangements.
- .14 For any fire system isolation requests, the Contractor should allow for 24 hours notification to Building Operations.
- .15 For any open flame work, a fire extinguisher and security fire watch is required, and will be provided and paid for by Owner. Provide 24 hour notice prior to work to allow Owner to make necessary arrangements.



- .16 Storage of materials on site must be cleared through the Building Manager.
  - .17 Contractors must perform a daily cleanup prior to leaving the site.
  - .18 Oxygen and acetylene cylinders are to be secured at all times and capped nightly.
  - .19 Work performed on operating and redundant systems must be restored to their normal condition at the end of each work day.
  - .20 At the conclusion of each work day, the Contractor's supervisor is to advise the Building Manager on the day's activities and plans for the next day's work. A security escort will be required for any work being done in secured areas, e.g. raised floor, computer room and mechanical/electrical rooms.
- 6.23 **CONTRACTORS SITE OFFICE & LUNCHROOM**
- .1 Contractor to provide site office and lunchroom facility.
  - .2 Contractor to provide and pay for temporary telephone/fax/ internet (email) service. Contractor will be responsible for all charges.
  - .3 Owner's cafeteria is off limits.
- 6.24 **CORE DRILLING**
- .1 Wherever core drilling is required, provide temporary dust proof screens as specified.
  - .2 In areas where core drilling through existing slab is necessary, the areas to be drilled to be marked out clearly on the underside of slab. Owner's representative to be notified at least 1 week prior to core drilling operation. Tarping of equipment will be responsibility of Contractor supervised by the Owner.
  - .3 During all core drilling operations, ensure that a minimum of one person is stationed directly below the area of drilling with a large plastic container pressed to underside of slab to hold core and water upon completion of operations.
  - .4 A wet/dry commercial quality vacuum to be used continuously at location of drilling operation to remove all excess water from area.
  - .5 Prior to core drilling, approval shall be obtained in writing from the [Consultant][Engineer]. Hole locations are to be x-rayed prior to drilling. Costs for x-rays are to be carried by the Contractor. X-raying will typically be required to occur during premium time
- 6.25 **TEMPORARY DUST PROOF SCREENS**
- .1 Provide temporary dust proof screens where required to separate areas of new work from existing areas and to prevent dust to settle on the Owner's plant and equipment. Dust proof material to be neoprene coated nylon tarpaulin or other types of fabric as approved by the [Consultant][Engineer].
  - .2 Extend dust proof screens from floor to underside of floor or roof above. Lap all sections of screen sheets 150 mm (6") minimum. Tape all lapped sheets.
  - .3 Provide all temporary framing required. Secure all screen sheets at top, bottom and ends. Tape perimeter of screen to ensure dust proof environment.
  - .4 Co-operate with Owners in the erection of temporary dust proof screens. Remove screens when and as directed by Consultant.
- 6.26 **PROTECTION OF FLOORS DURING EQUIPMENT INSTALLATION**
- .1 Provide protection of existing floor finishes during installation or removal of equipment, and at any other time when moving or installing heavy equipment.
  - .2 Protect floors in rooms noted
  - .3 Install 19mm (¾") plywood over 5 mil plastic over finished floor areas when moving heavy equipment that could damage floor finish.
  - .4 Repaint or re-tile any floors or walls damaged or scratched during construction.
- 6.27 **CONSTRUCTION POWER AND TEMPORARY ELECTRICAL SERVICES**

- .1 Provide temporary electrical power services during construction for temporary lighting and operating of power tools and other equipment. Provide necessary Revenue Canada approved kWhr metering unit.
- .2 Arrange for connection with the Owner into existing switchboards as indicated. Pay all costs for installation, maintenance and removal.
- .3 Provide and maintain temporary lighting throughout project. Level of illumination on all floors and stairs to not be less than 162 Lux.
- .4 Temporary electrical power service are available at site in locations designated by Owner.
- .5 Contractor and sub-contractors to provide transformers and suitable fused disconnect switches and wiring from locations as and where required and to maintain temporary services for use of light, tools, and apparatus, in order to facilitate completion of work, in accordance with applicable local by-laws.
- .6 Notwithstanding the above, where a Contractor proposes to use electric welding, a portable motor generator set to be provided by Contractor to avoid undue disturbances on the building's electrical distribution system, located to the satisfaction of Owner.
- .7 Electrical demand and consumption charges are to be metered
  - .1 Costs for this shall be paid by the General Contractor and all costs for the duration of the project shall be included in the Bid Amount.
- .8 If, during installation phase of project, it becomes necessary to have a temporary interruption in the Owner's utilities, Owner will inform Contractor as soon as possible before any such interruption. Contractor and sub-contractors to then take such action as is necessary to accommodate said interruption in their installation schedule.

6.28 **PRICING OF CHANGE NOTICES**

- .1 The value of a proposed change in the work shall be determined in one or more of the following methods:
  - .1 by time and material;
  - .2 by unit prices set out in the Contract or subsequently agreed upon:
  - .3 by labour and material costs submitted in a detailed quotation.
- .2 In the case of changes in the Work to be paid for under the time and material or the unit price methods, the form of presentation of costs and methods of measurement shall be agreed to by the Consultant and Contractor before proceeding with the change. The Contractor shall keep accurate records, as agreed upon, of quantities or costs and present an account of the cost of the change in the Work, together with vouchers, material receipts and invoices where applicable.
- .3 In the case of changes in the Work to be paid for under the time and material or the labour and material method, the material costs are to be less trade discounts. The discount to be provided from list price for items included in the Allpriser catalogue or Electrical Price Guide is 20%.
- .4 The detailed quotation referenced under the labour and material method is to include a summary of charges made up of three components: labour charges, material costs and fees.
  - .1 Labour Charges
    - (a) The labour hour estimates are to be based on the current NECA Column 2 manual of labour units.
    - (b) Labour costs are to include burden on wages such as taxes, worker compensation charges, CPP, EI, project insurance, safety meetings, estimating, as-built drawings, supervision, small tools, site facilities, labour warranty and clean up.
    - (c) The all inclusive hourly labour rate applicable for quotations submitted for changes to the work is 1.90 times the BASE RATE of the current Collective Agreement (ie if current rate for a Journeyman Electrician is

- \$31.70 x 1.9 = \$60.23 per hour per hour. The hourly labour rate for specialists not governed by union agreements (technicians or engineers) is 2.25 times the base rate for Electricians.
- (d) The all inclusive hourly labour rate indicated above is to include:
- Collective Agreement relevant to the place of work (vacation pay, RRSP, Health & Welfare, RST of Health & Welfare, Pension, Union admin fund, ECA fund (or others), Secretariat.)
  - Legislation as relevant to the place of work (Emp. Health Tax, E.I., CPP, WSIB, taxes)
  - Project insurance, safety meetings, estimating, lay outs, site facilities, warranties, storage,
  - clean up, office supervision and miscellaneous charges.
- (e) Foreman Electrician, General Foreman, Superintendent rates shall be as for the calculated Journeyman rate above plus 15% of the base rate. A maximum of 10% of the total calculated journeymen hours on a change may be charged as overhead supervision hours at the Foreman rate.
- (f) A maximum combined amount of 3% of the total calculated journeymen hours on a change may be charged as overhead supervision hours at the General Foreman / Supervisor rate.
- (g) No other overhead supervision hours will be permitted.
- .2 Material Charges
- (a) Material costs are to be less trade discounts. The discount for items included in the Allpricer catalogue or Electrical Price Guide is 20%.
- .3 Fees
- (a) The overhead and profit fee is to include for the Contractor's head office and site office expenses, project manager, assistants, site office and storage facilities, utility charges, site security, telephone and facsimile transmission costs, As Built's, expendable small tools, financing costs, coffee breaks, site facilities, general clean up and disposal, security, storekeeper, and all other non-productive labour.
- (b) **Refer to General Conditions.**

## **PART - 7 CONSULTANT REVIEWS**

### **7.1 GENERAL**

- .1 Consultant's attendance at site including but not limited to site meetings, demonstrations, site reviews and any resulting reports are for the sole benefit of the Owner and the local authority have jurisdiction.

### **7.2 SITE REVIEWS**

- .1 General reviews and progress reviews do not record deficiencies during the course of the Work until such time as a portion or all of the work is declared complete. In some instances before the work is completed, deficiencies may be recorded where the item is indicative of issues such as poor workmanship, incorrect materials or installation methods, or may be difficult to correct at a later date. Any such reported items, or lack thereof, shall not be relied on in any way as part of the Contractors quality assurance program nor relieve the Contractor in the performance of the Work.
- .2 Deficiency reviews conducted by the Consultant are performed on a sampling basis, and any deficiency item is to be interpreted as being indicative of similar locations elsewhere in the Work, unless otherwise shown.
- .3 Milestone Reviews
- .1 Specific milestone reviews are conducted at key stages by the Consultant, including:

- (a) Before backfilling of buried drainage,
  - (b) Before closing of shafts
  - (c) Before closing of ceilings
  - (d) Before closing of walls
  - (e) Equipment demonstration
  - (f) Substantial Performance deficiency review
  - (g) Total Performance deficiency review.
- .4 Coordinate with the Consultant the type and quantity of milestone reviews required and incorporate these requirements in the construction schedule.
- .5 Notify the Consultant in writing seven (7) calendar days in advance of work to be concealed to arrange a site review prior to the Work being concealed. Any noted deficiencies are to be corrected and reviewed again by the Consultant before being concealed. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

## **PART - 8 CONTRACTOR DUTIES DURING INSPECTION**

- .1 Inspection from the Consultant's team will be provided in accordance with Regulation 941/90 of the Professional Engineers Act. Inspections will be performed on a periodic basis to ensure general compliance only. Unscheduled random inspections and scheduled pre-occupancy inspections will be conducted to ensure installation generally meets specified quality standards and intent of the design according to the Ontario Building Code. Not all work will be inspected as walls and ceilings are closed in and buried services covered to meet schedule deadlines. It is the Contractor's responsibility to ensure that work is complete and constructed to specified standards.
- .2 The Division 26 Contractor shall each assign one person responsible for ensuring that work from all Division trades is complete prior to closing in wall, ceilings or burying services, and prior to Pre-occupancy Inspections. In conjunction with the Mechanical and Electrical Co-ordinator, the Contractor shall walk the site and thoroughly review that the work is complete, in good workmanship and installed according to the drawings and specifications. The Contractor shall then submit a "Statement of Completion" Report. In the case of pre-occupancy inspections, the Statement of Completion report will be submitted 24 hours prior to the scheduled Inspection.
- .3 Services to be covered (behind drywall or buried) shall be photographed and assembled in a journal to form a comprehensive documentation of the completed services. The photos will be turned over to the Inspector for review prior to pre-occupancy inspection and will again be turned over to the Owner for his use at the end of the Project.
- .4 In preparation for the pre-occupancy inspection of the area or phase being turned over to the Owner, the Division Contractor shall perform a comprehensive inspection of their own to ensure that their contractual obligations are met before requesting the pre-occupancy inspection. The written report or Statement of Completion shall consist of the following items:
  - .1 date and time of the inspection, signed by the person who conducted the inspection
  - .2 confirmation that previously noted deficiencies have been completed
  - .3 confirmation that the work is 100% complete, tested, balanced and deficiency free or include a list of outstanding work with a reason why work has not been completed (ie another trade has to complete their work)
  - .4 a plan of action to complete in-complete work with estimate of completion time.
- .5 The format of the Statement of Completion will be agreed upon with the Consultant. The Consultant's Inspector shall sign off the Statement of Completion Report and return a copy

to the Contractor. The Contractor will retain on site a log of all signed off Statement of Completion reports.

- .6 If Statement of Completion is not received, the Consultant reserves the right to withhold pre-occupancy inspection.
- .7 If the Statement of Completion is received and the Inspector enters an area that is obviously not ready for inspection (ie the report was falsified), the Inspector shall immediately leave the site without completing the inspection. The Division Contractor shall request another inspection 72 hours in advance and shall resubmit the Statement of Completion 24 hours prior to the inspection.

## **PART - 9 CORRECTION AFTER COMPLETION**

### **9.1 GENERAL**

- .1 At completion, submit written guarantee undertaking to remedy defects in work for a period of one year from date of substantial completion. This guarantee is not to supplant other guarantees of longer period called for on certain equipment or materials.
- .2 Guarantee to encompass replacement of defective parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation work.
- .3 Submit similar guarantee for one year from date of acceptance for any part of work accepted by Owner, before completion of whole work.

### **9.2 FINAL REVIEW**

- .1 At project completion submit written request for final review of mechanical and electrical systems.
  - .1 Refer to section 26 08 19 Project Close-Out.



H.H. Angus & Associates Limited Consulting Engineers

*SHOP DRAWING COVER SHEET*

1127 Leslie Street Toronto Ontario M3C 2J6 Canada

T: (1) 416 443 8200 F: (1) 416 443 8290

***Include this cover page with each shop drawing submission.  
Submissions without this form will be returned without review.***

Client/Architect: **ABC Architects Ltd**  
Project Name: **University Healthcare Wing**  
HHA Project No: **2081001**

***Contractor to complete the following for each submission.***

Date: \_\_\_\_\_

Contractor Reference No: \_\_\_\_\_

Manufacturer Name: \_\_\_\_\_

Product Type: \_\_\_\_\_

Specification Section No: \_\_\_\_\_

Contractor Trade:

☐ Mechanical

☐ Electrical

☐ Elevators

☐ General Trades

**If this is a resubmission, check here:**

☐

Previous submission reference no.: \_\_\_\_\_  
(HHA reference No. only)

HHA distribution - for internal use only:

Mechanical review: John Smith

Electrical review: Joan Smith

Elevators review:

**END OF SECTION**

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## **PROJECT PHASING**

**26 05 05**

### **PART - 1 GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 as applicable.

#### **1.2 REFERENCE PHASING REQUIREMENTS**

- .1 Portions of the Work impact on the existing hospital. Notify the Owner and the Consultant, in writing, at least one week in advance of the work where work requires shut-down or isolation of existing services.
- .2 Except as identified below, shut-downs of existing services will be restricted to the hours from 10:00 PM to 5:00 AM.
- .3 The Contractor shall be responsible for isolation of applicable systems under strict supervision from Hospital Staff. The Contractor shall be responsible for temporary services as required to suit their work.
- .4 Access to the existing ceiling spaces is to be considered hazardous due to possibility of Infection Controls concerns. Entry is restricted and Contractors shall comply to the hospitals Health and Safety regulations for work in this area. Arrange with Health and Safety at least 48 hours prior to access. All members of construction crew must be trained in Infection Controls procedures.
- .5 Carefully examine the phasing plan from the Architectural drawings and develop an Electrical construction plan to ensure all services will be complete and available for occupancy of the phased spaces. Route all services within the boundaries of the phased areas to ensure services are ready when required for occupancy.
- .6 The Electrical work necessary to maintain services will not be restricted to the architectural phased areas of work. This Division will have work in the existing building, obtaining and modifying services for new phased areas.
  - .1 The Contractor shall maintain existing systems until the new services are ready for use. In some areas provide additional feeders, lighting, circuits, wiring, etc as required to maintain services in phased areas. Remove temporary redundant Electrical services used for phasing at end of project.
  - .2 In new work, provide temporary Electrical services and connections between phased areas to avoid un-necessary system shutdowns.

#### **1.3 WORK IN OCCUPIED AREAS**

- .1 Work in Owner occupied areas to be scheduled with the Hospital. Access to these area will be during after normal working hours; schedule the work with the hospital for availability of work areas.
- .2 The phasing of the construction work as recommended has been coordinated with the Client and meet the Hospital's need to maintain the life activities operational during construction work. The General Contractor will schedule the construction work to meet the

requirements of starting completing the work as per the phasing listed in the Contract Documents.

1.5 **PHASED OCCUPANCY, EQUIPMENT MAINTENANCE, EQUIPMENT OPERATION AND WARRANTY.**

- .1 *Although there are several phases to this project, it is one project and substantial performance will be granted at the end of the project. There will be no phased substantial performance or phased release of holdback.*
- .2 *The Electrical Contractor to ensure Lighting Systems, UPS Systems (if included in the Construction) are operational for the appropriate phase of construction.*
- .3 *The Electrical Contractor will be responsible to maintain and operate the new equipment (and systems) supplied under this project until the project is formally handed over to the Owner. Maintenance shall include all manufacturer recommended maintenance and cleaning. Maintenance and system downtime to be minimized and scheduled to suit the Hospital.*
- .4 *The Electrical Contractor shall operate the systems to the Owners benefit to ensure that the occupied phases are fully serviced to the Owners schedule. Provide a list of emergency contacts so they can respond 24/7 to issues with their system. Repairs to be made quickly to minimize disruption to the Hospital.*
- .5 *Training of Owners maintenance personnel to be done at end of project prior to formal turnover to Hospital. Training will not be required at the end of each phase as the contractor will be maintaining and operating the equipment/systems installed under this project.*
- .6 *Equipment and system warranties to start after substantial performance even though equipment may be operating during early phases. **Notify equipment supplier of this situation during bidding and include any additional costs related to operating the equipment during the construction period or include extended equipment warranty to cover contract duration plus the standard warranty period starting after substantial performance.***

**END OF SECTION**



## **FIRE STOPPING & SMOKE SEALS**

### **26 05 10**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL REQUIREMENTS**

.1 Comply with the General Conditions of the Contract, Supplementary Conditions and other Sections of Division 1 and with Section 26 05 01, Electrical General Requirements.

##### **1.2 SYSTEM DESCRIPTION**

.1 Work of this Section comprises firestopping materials and/or systems to provide closures to fire at openings around penetrations, at un-penetrated openings, at projecting or recessed items, and at openings and joints within fire separations and assemblies having a fire-resistance rating, including openings and spaces at perimeter edge conditions.

.2 Work of this Section also comprises smoke sealants applied over firestopping materials or combination smoke seal/firestop seal material to form air tight barriers to retard the passage of gas and smoke.

.3 The installed firestopping/smoke sealant system shall provide and maintain a fire-resistance rating equivalent to the rating of the adjacent floor, wall or other fire separation assembly to the requirements of and as acceptable to the authorities having jurisdiction and to the Consultant.

.4 Firestopping and smoke seals within electrical assemblies (i.e. inside electrical cable ducts/ trays if applicable) shall be provided as part of the Work of Divisions 26. Refer to Section 26 05 01, Article 5.4 and include firestopping and smoke seals around the outside of such mechanical and electrical assemblies where they penetrate fire-rated separations shall be part of the Work of this Section unless otherwise indicated by the Contractor.

.5 Confirm locations of exposed/non-exposed fireproofed surfaces with consultant prior to application.

.6 Penetrations will have single or multiple conduits passing through and Work will consist of firestopping all penetrations with pre-approved ULC assemblies.

##### **1.3 RELATED SECTIONS**

.1 Sealing around service penetrations through rated floors and walls - under Division 26, Division 27 and Division 28.

##### **1.4 QUALITY ASSURANCE**

.1 Provide experienced and competent installers, trained by material or system manufacturer.

.2 Applicator Qualifications:

.1 Applicator shall have at least three years experience in installing materials of types specified and shall have successfully completed at least three projects of similar scope and complexity.

.2 Applicator shall designate a single individual as project foreman who shall be on site at all times during installation.

.3 Applicator shall be approved for this Work by Product Manufacturer or listed below:

- (a) Beverly F.S. (Tel: 905-659-3367)
- (b) Dominion Caulking (Tel: 905-883-8355)
- (c) Profirestop (Tel: 416-293-0993)
- (d) RILI Firestopping (Tel: 905-349-3779)

- .4 Obtain firestop materials from single manufacturer for each different product required.
- .5 Manufacturer shall instruct applicator in procedures for each material.
- .6 Refer to notes on Drawings for additional information, instructions and clarifications.
- 1.5 **REGULATORY REQUIREMENTS:**
  - (a) Firestop System installation must meet requirements of CAN/ULC-S 115-11 tested assemblies that provide a fire rating equal to that of construction being penetrated.
  - (b) Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
- 1.6 Arrange a pre-job conference between Contractor, applicator, inspection and testing representative, manufacturer's representative and Consultant.
- 1.7 Fire Protection Consultant will test (Review) up to 2% of completed Work (Penetrations). Contractor to provide installer and enclosures at Consultant's discretion.
- 1.8 Consultant may or may not require destructive testing to be done. Contractor shall cover costs of repairing fire separation after destructive tests are performed.
- 1.9 **SUBMITTALS**
  - .1 Shop Drawings
    - .1 Submit drawings indicating the ULC or Warnock Hersey assembly number, the required temperature, hose stream, and flame rating, material thicknesses, installation methods and materials of firestopping and smoke seals, primer, supports, damming materials as applicable, reinforcements, anchorages, fastenings and methods of installation for each condition to be encountered.
    - .2 Designate on shop drawings both fixed and moving penetrants, relative positions, expansion and control joints in rated slabs and walls, firestopping details at receptacles and similar poke-through devices and surrounding permanent materials. Identify re-entry locations.
    - .3 Manufacturer's Product Data: Submit data for materials and prefabricated devices, providing descriptions sufficient for identification on Site.
    - .4 Certificates: Submit manufacturer's certification that installed firestopping and smoke seal material comply with specified requirements.
    - .5 ULC or Warnock Hersey Listings: Submit copies of Listing cards for review.
  - .2 Samples
    - .1 Submit only as requested various types of firestopping and smoke seal material.
    - .2 Mock-Up
      - 1. Construct mock-up for each separation type prior to commencing Work at locations as designated by Consultant in accordance with Section 01 00 00.
      - 2. Mock-ups shall be reviewed and approved by manufacturer and Consultant.
      - 3. Accepted mock-ups may remain as part of completed work.
      - 4. Mock-ups shall be modified as many times as necessary to obtain acceptance.
  - .3 Delivery, Storage and Handling
    - .1 Deliver the materials to the job site in the manufacturer's unopened

- containers, containing the classification label, with labels intact and legible at time of use.
- .2 Store material in accordance with manufacturer's recommendations with proper precautions to ensure fitness of material when installed.
- .3 Before handling, read product data sheets and material safety data sheets. Do not use damaged or expired materials.
- .4 Identification
  - .1 Identify, through-penetration fire stopping and smoke seal systems with pressure sensitive, self adhesive, printed vinyl labels. Attach labels permanently to surfaces of penetration construction on both sides. Labels must be visible from 5'-0" above the floor. Labels must show the following information:
    - (a) the words "Warning: through-penetration firestopping system, Do not disturb"
    - (b) the applicators name, address and telephone number
    - (c) designation of applicable testing and inspection agency
    - (d) date of installation
    - (e) manufacturers name for materials
- .5 Photography
  - .1 Provide digital photography of every fire separation penetration showing both the before and after installations. Picture must indicate day and time and be labelled to show exact location.
  - .2 Duplicate copies of digital photo records are to be submitted directly to the Hospital at the completion of the installation in each building/ wing.

## **PART - 2 PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS / INSTALLATION SPECIALISTS**

#### **.1 General**

.1 Manufacturers of firestopping products and installation specialist for this Work are limited to applicable assemblies as required for Project and having ULC or C-UL-US or Warnock Hersey labelled packaging.

#### **.2 Approved manufacturers:**

- (a) 3M Canada
- (b) A/D Fire Protection Systems Inc
- (c) Grace
- (d) Nuco Inc. (1-800-583-3984)
- (e) Tremco Canada

### **2.2 MATERIALS**

.1 Firestopping and smoke seals shall conform to the following:

.1 Asbestos free materials and systems.

- .2 Provide a fire-resistance rating not less than the fire-resistance rating of the surrounding or adjacent floor, wall or other assembly.
- .3 FTH Rated and certified in accordance with CAN/ULC-S115-95, and be labelled (WH, cUL, ULC).
- .2 Sealants and putty for overhead and vertical joints shall be non-sagging; seals for floors, self-levelling, silicone based.
- .3 Products shall be compatible with abutting dissimilar architectural coatings and finishes at floors, wall, ceiling, waterproofing membranes and the like. Check with requirement of Contract Documents and manufacturer of selected materials being installed.

## **PART - 3 EXECUTION**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: Comply with manufacturer's product data including product technical bulletins, product catalogue installation instructions and product packaging instructions.

### **3.2 PREPARATION**

- .1 Examine sizes, anticipated movement and conditions to establish correct thickness and installation of back-up materials.
- .2 Clean bonding surfaces to remove deleterious substances including dust, paint, rest, oil, grease, moisture, frost and other foreign matter which may otherwise impair effective bonding.
- .3 Remove insulation from insulated pipe and duct where such pipes or ducts penetrated a fire separation unless listed assembly permits such insulation to remain within the assembly, or where mechanical trades have installed special fire rated insulated sleeves.
- .4 Prepare surfaces, prime, mask adjacent surfaces and clean in accordance with manufacturer's directions and to requirements of tested assembly.

### **3.3 INSTALLATION**

#### **.1 General**

- .1 Mix and apply firestopping, gas and smoke seals in strict accordance with manufacturer's instruction and tested designs to provide required flame rated seal, to prevent the passage of gas and smoke, and where specifically designated, the passage of fluids.
- .2 Provide temporary forming and packing as required. Apply materials with sufficient pressure to properly fill and consolidate the mass to seal openings.
- .3 Tool or trowel exposed surfaces.
- .4 Notify Consultant when random completed installations are ready for review, as directed by Consultant, prior to concealing or enclosing firestopping and as applicable, smoke seals.

### **3.4 IDENTIFICATION**

- .1 Provide identification of all firestopping as specified.

### **3.5 PHOTOGRAPHY**

- .1 Provide digital photography of every fire separation penetration showing both the before and after installations. Picture must indicate day and time and be labelled to show exact location.
- .2 Duplicate copies of digital photo records are to be submitted directly to the Hospital at the completion of the installation in each building/ wing.

### **3.6 CLEAN UP**

- .1 Remove excess materials and debris and clean adjacent surfaces immediately after application.  
Remove and or correct staining and discolouring or adjacent surfaces as directed.

**END OF SECTION**

## **WIRES & CABLES 0-1000 VOLTS**

### **26 05 19**

#### **PART - 1 GENERAL**

##### **1.1 PRODUCT DATA**

- .1 Submit product data in accordance with Section 26 05 01 Electrical General Requirements.

#### **PART - 2 PRODUCTS**

##### **2.1 BUILDING WIRES**

- .1 Copper conductors: size as indicated, stranded for 10 AWG and larger, with 1000 V insulation for 347/600 Volt systems, and 600 V insulation for 120/208 V systems, of chemically cross-linked thermosetting polyethylene material rated RW90 and/or RWU90 to CSA C22.2 No. 38.
- .2 Use RWU90 for wiring installed underground.
- .3 Wiring in channel back of luminaires shall be 600 volt type GTF or TEW, temperature rating as required by CSA and/or manufacturer requirements..
- .4 Conductors shall be colour coded. Conductors No. 10 AWG and smaller shall have colour impregnated into insulation at time of manufacture. Conductors No. 8 AWG and larger may be colour coded with adhesive colour coding tape but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible.
- .5 Minimum wire size shall be No. 12 AWG. Home runs to lighting and receptacle panels which exceed 25 m (75') in length shall be minimum No. 10 AWG. Home runs which exceed 40 m (120') in length shall be minimum No. 8 AWG. Home runs which exceed 60 m (180') in length shall be minimum 6 AWG.
- .6 Colour coding shall be as follows: Red - Phase A, Black -Phase B, Blue - Phase C, White - Neutral, Green - Ground, Orange - Control.

##### *Standard of Acceptance*

- o Aetna Insulated Wire
- o General Cable
- o Nexans Canada Inc
- o Pirelli Cables Ltd.
- o Southwire

##### **2.2 MINERAL INSULATED CABLE**

- .1 Cable shall have ULC listed 2 hour fire rating.
- .2 Cable shall be shipped with ends temporarily sealed and shall be stored under dry conditions.
- .3 Cable shall be of capacities and types noted on drawings and shall be terminated using suitable terminating hardware.

##### *Standard of Acceptance*

- o Pyrotanax

##### **2.3 INSTRUMENTATION AND CONTROL CABLING**

- .1 Control cables shall be designed according to CSA Standard Can3-C2.1-M86 Control Cables - 600 Volts.

.2 Control cables shall be as follows:

Conductors	Quantity, arrangement and gauge shown on drawings or specified elsewhere
Identification	Colour coded or numbered
Insulation	XLPE
Armour	Steel (No armour required if installed in conduit or approved wireway)
Jacket	FT4 Flame Retardant PVC FT6 Plenum rated in open style cable trays in ceiling spaces

.3 Shielded cables shall provide 100% shield coverage and be complete with drain wire.

.4 Multipair twisted shielded cables shall have individual pairs shielded, overall shield and drain wires and overall rated jacket.

*Standard of Acceptance*

- o BICC
- o Belden
- o Nexans Canada Inc

## **PART - 3 EXECUTION**

### **3.1 GENERAL**

.1 Provide grounding / bonding conductor in all conduits whether metallic or non-metallic, sized as per Ontario Electrical Safety Code, and connect to grounding bus. All receptacles, lighting fixtures, panels, transformers, motors, heaters, communications conduits and other powered devices shall be grounded via ground wires.

.2 A dedicated neutral conductor shall be provided for each single phase branch wiring power circuit.

### **3.2 INSTALLATION OF BUILDING WIRES**

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 33.

.2 In wireways and auxiliary gutters in accordance with Section 26 05 37.

.2 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.

.3 Splice wire, up to and including No. 6 AWG with nylon insulated expandable spring type connectors. Connector body shall be moulded of thermoplastic and spring insert shall be an expandable square-edged design. Splice larger conductors using split-bolt or compression type connections wrapped with PVC tape.

.4 Where colour coding tape is utilized, it shall be applied for a minimum of 50 mm (2") at terminations, junction and pullboxes. Do not paint conductors under any conditions. Colour coding shall also apply to bussing in panels and bus duct.

### **3.3 INSTALLATION OF MINERAL INSULATED CABLES**

.1 Cable shall be installed in trays or exposed on walls, beams, purlins or ceilings, using clamps available from the manufacturer. Fire rated circuits shall be supported on centres not exceeding 1000 mm (3'). Care shall be taken when handling the cable to avoid cable kinks; it is recommended that cable be

uncoiled from supply reel by rolling. Cables shall be bent using a suitable hickey with a minimum bending radius of six times the cable diameter.

- .2 Embedded cables shall be protected against punctures and mechanical damage.
- .3 Single conductor cables forming part of a circuit shall be run in contact with one another throughout their length.
- .4 Single conductors in parallel shall be arranged in groups and the groups shall be at least two cable diameters apart.
- .5 Cables shall be terminated with manufactured gland and seals. Gland and seal assembly shall be prepared with tools specifically designed for the purpose. Upon completion of termination, the insulation resistance of the cable shall be checked with an insulation tester in accordance with values to be determined by the [Engineer][Consultant].
- .6 Cables forming part of circuits rated 200 A and above shall be terminated at each end on a suitably sized minimum 6 mm thick brass plate, installed by removing the steel of the termination panel. A copper bonding conductor, sized per Table 16 of the Safety Code, shall be connected to the termination plate via a Burndy Servit type KC connector or type YA compression connector, and extended to the equipment ground bus and terminated with a Burndy YA compression connector with 12mm stainless steel bolt and hardware.
- .7 The entire installation shall be made in accordance with the recommendations of the manufacturer, who shall be retained by the Contractor under this Section to inspect the cable installation and termination methods.

#### **3.4 INSTALLATION OF INSTRUMENTATION, COMMUNICATION AND CONTROL CABLING**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 33.
  - .2 In wireways and auxiliary gutters in accordance with Section 26 05 37.
  - .3 In open style corridor cable trays in ceiling spaces, using FT6 plenum rated cable assemblies.
- .2 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.
- .3 Run all instrumentation, communication and control cabling point to point and terminate on terminal strips. Do not splice communication or control cabling. Where long runs make a continuous point to point installation impractical, make splices on labelled terminal blocks installed in an accessible labelled terminal cabinet, installed at 1200 mm (48") above floor, and indicate cabinet location, terminal And wire numbers on As-built drawings.
- .4 Terminate control cables in equipment with suitable connectors.
- .5 All control cables shall be clearly identified, at both ends, with permanent PVC wire markers, Electrovert type Z or equal, indicating Cable Number and wire numbers.

**END OF SECTION**



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**GROUNDING SECONDARY**  
**26 05 27**

**PART - 1      GENERAL**

**1.1            REFERENCES**

- .1      IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.
- .2      CSA C22.1 Electrical Safety Code
- .3      CSA-Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

**1.2            GENERAL REQUIREMENTS**

- .1      Conform to Sections of Division 1 as applicable.
- .2      Conform to Section 26 05 01, Electrical General Requirements.

**1.3            SHOP DRAWINGS AND PRODUCT DATA**

- .1      Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2      Nameplates shall be in accordance with Article "Equipment Identification".

**1.4            WORK INCLUDED**

- .1      Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

**1.5            OPERATION AND MAINTENANCE DATA**

- .1      Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

**PART - 2      PRODUCTS**

**2.1            EQUIPMENT**

- .1      Clamps for grounding of conductors, size as required to electrically conductive underground water pipe.
- .2      Insulated grounding conductors: green, type RW90 copper.
- .3      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.
- .4 Perimeter ground bus, 6 mm x 50 mm (¼" x 2") copper, mounted 150 mm (6") above floor on insulated spacers 600 mm (24") on centre.
- .5 Ground bus mounting spacers
  - .1 stand off insulators to UL 891
  - .2 25 to 32 mm high waterproof glass fibre reinforced polyamide
  - .3 750V insulated
  - .4 UL 94VO self extinguishing
  - .5 bichromated zinc plated threaded steel inserts
  - Standard of Acceptance*
    - o Erico ISO I series c/w insulator mounting kits
    - o Approved equal
- .6 Communication and Computer room raised floor ground clamps: Burndy Uniground

## **PART - 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Install complete permanent, continuous, system and circuit, equipment, grounding systems including, electrodes, conductors, connectors, accessories, as indicated, to conform to requirements of local authority having jurisdiction over installation.
- .2 Ground electrical equipment and wiring in accordance with Ontario Electrical Safety Code and ANSI/IEEE Standard 142-1982.
- .3 Install connectors in accordance with manufacturer's instructions.
- .4 Protect exposed grounding conductors from mechanical injury.
- .5 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process.
- .6 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .7 Soldered joints not permitted.
- .8 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.
- .9 Install separate ground conductor in all conduits. Ground conductor shall be sized as per Table 16 of CSA C22.1 with one ground conductor for every three hot conductors. Minimum size of ground conductor shall be #12 AWG copper.
- .10 Connect building structural steel and metal siding to ground by welding copper to steel.
- .11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .12 Install grounding conductors outside electrical rooms and electrical closets in conduit and conceal where possible.

- .13 Provide separate ground wire for every feeder, sized as per Table 16 of the OESC.

### 3.2 **ELECTRODES**

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter. Install water meter shunt.
- .2 Install [rod], [plate] electrodes and make grounding connections.
- .3 Provide rod electrodes at corners of main electrical room and connect to perimeter ground bus.
- .4 Bond separate, multiple electrodes together.
- .5 Use size 4/0 AWG copper conductors for connections to electrodes.
- .6 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails.

### 3.3 **SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit insulated copper grounding connections to neutral of secondary systems and for common grounding conductors per CSA C22.1 Table 17.
- .2 Install insulated copper grounding conductor for service raceways and service equipment per CSA C22.1 Table 18.
- .3 Install grounding conductors in conduit.

### 3.4 **EQUIPMENT GROUNDING / BONDING**

- .1 Install insulated copper bonding connections per CSA C22.1 Table 16 to typical equipment including, but not necessarily limited to following list: Service equipment, transformers, frames of motors, starters, control panels, building steel work and panels, outdoor lighting.
- .2 Install bonding conductors in conduit.

### 3.5 **COMMUNICATIONS SYSTEMS**

- .1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:
  - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
  - .2 Communications system grounding in accordance with ANSI/EIA/TIA 607, 568A, 569 standards.
  - .3 Sound, fire alarm, intercommunication systems as indicated

### 3.6 **RAISED FLOOR GROUNDING**

- .1 Install [#2] [#6] bare copper grounding conductors in a grid pattern on four foot centres in each direction of the floor grid. Install Burndy Uniground ground clamp to raised floor pedestals on four foot centres, at each intersection of the ground grid conductors.
- .2 Bond each item of equipment on the raised floor to the raised floor ground grid with minimum #6 tinned copper flat braid extra flexible bonding jumper.

- .3 Extend #1/0 green insulated copper ground conductor in EMT conduit from ground grid to the building main grounding system. Terminate using NEMA 2 hole compression connectors.

### 3.7 **PERIMETER GROUND BUS**

- .1 Provide exposed perimeter ground bus in main electrical rooms and generator room.
- .2 Mount on stand off insulated spacers to wall using zinc plated steel studs, washers, lock washer and nuts.
- .3 Connect exposed metal work in electrical rooms and generator room to perimeter ground bus with insulated stranded copper connections, size 2/0 AWG copper in conduit.
- .4 Protect ground bus with one coat of insulating varnish.

### 3.8 **FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

**END OF SECTION**

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**FASTENINGS AND SUPPORTS**  
**26 05 29**

**PART - 1      GENERAL**

**1.1            RELATED WORK**

- .1 Fastenings and supports: Section 01 61 00 - Common Product Requirements.
- .2 Concrete bases and housekeeping pads for electrical equipment shall be arranged and paid for by Division 26, and installed by trade specialists under respective Carpentry, Concrete, and Painting Divisions.

**1.2            SHOP DRAWINGS**

- .1 Submit design drawings for custom fabricated trapeze hangers, sealed by a professional engineer licensed in the project location jurisdiction.
  - .1 Shop drawing details:
    - (a) construction detail drawings for each loading condition,
    - (b) span deflection calculations,
    - (c) building attachment load calculations and type.
- .2 Provide services of engineer who sealed the custom trapeze hanger shop drawings to conduct a general review of the completed installation on site.

**PART - 2      PRODUCTS**

**2.1            SUPPORT CHANNELS**

- .1 Hot dipped galvanized steel, U shape, size 41 mm x 41 mm x 2.5 mm (1e" x 1e" x 1/10") thick, surface mounted, suspended or set in poured concrete walls and ceilings.

**2.2            INSERTS**

- .1 Inserts for conduits and raceway hangers, for single, double and multiple runs shall be galvanized.
  - Standard of Acceptance*
    - Unistrut Canada
    - Burndy (Canada) Ltd. - Flexibar
    - Pilgrim Technical Products Ltd. - Tufstrut

**2.3            HANGERS**

- .1 Hangers for electrical conduit shall be hot dipped galvanized after fabrication.
  - Standard of Acceptance*
    - Burndy Canada Ltd.
    - Canstrut
    - Electrovert Ltd.
    - E. Myatt & Co. Ltd
    - Steel City Electric Ltd.
    - Pilgrim Technical Products Ltd.

## 2.4 **TRAPEZE HANGERS**

- .1 Performance:
  - .1 Manufactured:
    - (a) to product load listings.
  - .2 Custom fabricated:
    - (a) maximum deflection between supports: 1/250 (0.4%) of span
    - (b) minimum factor of safety : 5 times load to ultimate tensile or compressive strength.
- .2 Construction:
  - .1 Carbon steel shapes, to suit load application:
    - (a) hollow steel section,
    - (b) equal leg EI section, or
    - (c) double C channel "strong-back", with welded clips.
  - .2 Hanger rods:
    - (a) as specified above, and
    - (b) minimum two support rods,
    - (c) rods selected for minimum factor of safety of 5 times load to ultimate tensile or compressive strength of rod.
- .3 Finish:
  - .1 hot dipped galvanized finish in mechanical rooms and outdoors.
  - .2 black steel finish in other areas.

*Standard of Acceptance*

  - ° Anvil Fig 45, 46, 50

## **PART - 3 EXECUTION**

### 3.1 **INSTALLATION**

- .1 Supply and deliver inserts to site in ample time to be built into work of other trades. Provide necessary templates and adequate instructions to locate and install inserts.
- .2 Secure equipment to masonry, tile and plaster surfaces with lead anchors.
- .3 Secure equipment to poured concrete with expandable inserts.
- .4 Secure surface mounted equipment with T-bar support hanger fastened to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

*Standard of Acceptance*

  - ° Caddy model No. 512 c/w BHC clip
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 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 (2") and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm (2").
  - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm (¼") dia threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm (¼") dia threaded rod hangers where direct fastening to building construction is impractical.

- .8 For surface mounting of two or more conduits use channels.
- .9 Provide galvanized after fabrication metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 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][Consultant].
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .14 Supply and erect special structural work required for the installation of electrical equipment. Provide anchor bolts and fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.
- .15 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets. Install angle or channel iron supports to bear the equipment where it is shown in or on structural tile walls, or walls that are inadequate to bear the equipment.
- .16 Provide channel iron or other metal supports where necessary to adequately support lighting fixtures. Do not use wood. Lighting fixtures shall be supported totally independent of ceiling and supported from structure above.
- .17 Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members required between beams for supporting conduits.
- .18 Do not use explosive drive pins in any section of work without obtaining prior written approval.
- .19 Provide re-enforced concrete pads under switchboards, generators, and all other floor mounted electrical equipment. Pads are to be formed with chamfered edges to prevent chipping. Pads are to be sealed and painted to prevent dust from entering and interfering with electrical equipment.

**END OF SECTION**

---

**SPLITTERS, JUNCTION AND PULL BOXES, CABINETS**  
**26 05 32**

**PART - 1      GENERAL**

**1.1            SHOP DRAWINGS AND PRODUCT DATA**

- .1      Submit shop drawings and product data for cabinets in accordance with Section 26 05 01 Electrical General Requirements.

**1.2            REFERENCE**

- .1      CSA C22.2 No. 76 Splitters.
- .2      CSA C22.2 No. 40 Junction and Pull Boxes.
- .3      Cabinets to Section 26 27 18 Panel Trim.

**PART - 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 and connection bars 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.
- .4      Distribution riser splitters shall be of special construction with hinged access door, copper bus bars predrilled to accept two hole compression connectors for all incoming and outgoing cables.

**2.2            JUNCTION AND PULL BOXES**

- .1      Welded steel hot dipped galvanized construction with screw-on flat covers for surface mounting.
- .2      Covers with 25 mm (1") minimum extension all around, for flush-mounted pull and junction boxes.

**2.3            CABINETS**

- .1      Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- .2      Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing sheet steel backboard for surface or flush mounting as indicated.
- .3      Surface mounted cabinets shall be finished in ASA 61 grey.



## 2.4 INSTRUMENTATION AND CONTROL TERMINAL CABINETS

- .1 Surface mounted, gasketed, drip proof and dust tight, JIC enclosure, CEMA type 12 With hinged door, lock, 2 keys, white raised and removable internal mounting panel, diagram pocket, finished with ASA 61 grey.  
  

*Standard of Acceptance*

  - ° Hammond
- .2 Panel wiring to be contained in PVC wiring ducts complete with cover strips, minimum 50 mm x 50 mm (2" x 2"). Wireway fill to be limited to 60%. Where there are a large number of door mounted devices, door wiring harnesses shall also be contained in wiring ducts at rear door. All door wiring devices to emanate from the control panel terminal strips. Wiring to panel face mounted devices to be bundled neatly on hinge side of panel, enclosed in flexible spiral wrap, and installed such that wiring will not be damaged when opening and closing door. Ground panel door to panel with a flexible copper bonding strap. Label all wiring with permanent PVC sleeve type markers.
- .3 Phoenix contact terminal blocks with mounting rails, end covers, terminal markers, partition plates and accessories: UK 2.5 termination of wiring 22 to 12 AWG; UK 5 and UK 10 series for current transformers and other leads #10 AWG and #8 AWG; UDK or UK 5 twin for connecting two or more conductors to one terminal block; DIK 1.5 for three wire sensor device wiring; MTKD for thermocouple leads.
- .4 Provide lamacoid nameplates for all panel mounted control and indicating devices, and all internal components such as terminal strips, control transformers, control devices, relays, etc. as per 26 05 01.

## PART - 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 (6'-6") above finished floor.
- .3 Install terminal block as indicated in Type T cabinets
- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m}{100} of conduit run between pull boxes.

### 3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical - General Requirements.
- .2 Install size 2 identification labels indicating system name, voltage, phase and source of power.

- .3 Provide a typed directory in cabinets showing following information: Nature, actual quantities and room number of device or devices connected to each terminal, as well as signal circuit number where applicable.

**END OF SECTION**

## **CONDUITS, FASTENINGS AND FITTINGS**

**26 05 33**

### **PART - 1 GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

#### **1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.

#### **1.3 WORK INCLUDED**

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.
- .2 Location of Conduit
- .3 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

#### **1.4 REFERENCES**

- .1 CSA C22.2 No. 83 Electrical Metallic Tubing
- .2 CSA C22.2 No. 56 Flexible Metal and Liquid-Tight Flexible Metal Conduit
- .3 Conduit accessories, conduits and fittings to CSA C22.2 No. 18.

#### **1.5 WIRING METHODS**

- .1 Install wiring in surface mounted EMT conduit unless otherwise specified. In finished areas, conceal conduit in walls and ceiling spaces.
- .2 Where shown on drawings, armoured cable shall be Teck 90 type. Jackets of cable shall have FT-4 rating identified. Connectors shall be equal to T&B Star Teck Type
- .3 Runs of conduit and cables, where shown, are indicated only by general location and routing. Install conduits and cables so as to provide maximum head room and to interfere as little as possible with free use of spaces through which they pass.
- .4 Use EMT conduit for branch circuit and signal wiring in ceilings, furred spaces, and in hollow walls and partitions.
- .5 Flexible conduit and armoured cable will be accepted in parts of existing building, where furred spaces above ceilings are too congested to permit conduit to be installed, but only with Consultants written permission. Terminate armoured cable, where shown, in accordance with the manufacturer's recommendations.

- .6 Flexible steel conduit with integral insulated green ground wire is permitted for the final connection to luminaires mounted in suspended ceilings from the branch wiring junction box above, with flexible conduit length not to exceed 3 m (10'), and be neatly installed and attached to luminaire support chain
- .7 Flexible armoured conduit (or BX) with an integral insulated green ground wire may be used where concealed in walls for wiring to receptacles, and for the final connection to luminaires.
  - .1 The junction box interfacing the horizontal EMT conduit to the flexible conduit shall be located within 3 m (10') horizontally from the end device in open areas, and in enclosed rooms, located in the same room as the devices being served, in reasonable proximity to the walls, in order to keep the horizontal portion of the run of flexible conduit to less than 3 m (10').
  - .2 The flexible conduit shall be neatly installed parallel or perpendicular to building lines, and independently supported from the slab structure above.]
- .8 Conduit shall be of sufficient size to permit easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.
- .9 Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.
- .10 Where existing locations of flush mounted electrical devices (switches, receptacles, etc.) correspond to new devices shown, the existing dropdown conduit and outlet box may be re-used. Provide new devices, new coverplates, new home-run conduit and complete new wire.
- .11 Vertical raceways to be provided with insulated cable support bushings or other approved method of supporting the weight of the cable, where vertical runs exceed those of Table 21 of the Electrical Code.

## **PART - 2 PRODUCTS**

### **2.1 CONDUITS**

- .1 Electrical metallic tubing (EMT), [hot dipped] galvanized: with couplings.
- .2 Flexible metal conduit and liquid-tight flexible metal conduit.
- .3 Conduit shall be of sufficient size to allow easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.

### **2.2 CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits 50 mm (2") and smaller. Two hole steel straps for conduits larger than 50 mm (2").
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits.
- .4 Six mm dia threaded rods to support suspended channels.

### **2.3 CONDUIT FITTINGS**

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90° bends are required for 25 mm (1") and larger conduits
- .3 Insulated throat steel set screw or raintight insulated throat steel compression] connectors and couplings for EMT.
- .4 Threaded or compression type raintight/concrete tight insulated throat zinc plated steel connectors and couplings for rigid steel conduit.
- .5 Raintight insulated throat steel connectors at all surface panelboards, switchboards and other electrical equipment in sprinklered areas for all conduit terminations.

## 2.4 **EXPANSION FITTINGS**

- .1 Electrogalvanized steel with internal grounding for EMT suitable for 100mm linear conduit movement.
  - Standard of Acceptance*
    - ° Cooper Crouse Hinds XJG-EMT
- .2 Weatherproof expansion fittings with internal bonding assembly suitable for 100mm (4") linear expansion.
- .3 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm (3/4") deflection in all directions.
- .4 Concrete type, water tight, corrosion resistant for conduit installations embedded in concrete
- .5 Weatherproof expansion fittings for linear expansion at entry to panel.

## 2.5 **FISH CORD**

- .1 Polypropylene

## **PART - 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 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Use electrical metallic tubing (EMT).
- .4 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment
- .5 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .6 Use raintight connectors or hubs for terminating conduits at all surface or floor mounted panelboards, switchboards, and other equipment located in sprinklered areas or where at risk of exposure to dripping liquids.

- .7 Install wiring in conduit unless otherwise specified.
- .8 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 19mm (3/4") dia.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .11 Install fish cord in empty conduits.
- .12 Run two 25 mm (1") spare conduits up to ceiling space and two 25 mm (1") spare conduits down to ceiling space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm) 6" x 6" x 4") junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in flush concrete type box.
- .13 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .14 Dry conduits out before installing wire.
- .15 Conduit manufacturer's touch up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.
- .16 Install junction boxes or cable anchor boxes wherever necessary for proper pulling or anchoring of cables. Install so as to be accessible after building is completed and set to come within finished lines of building.
- .17 Where EMT is used, run green insulated ground wire in conduit, with minimum one ground conductor per three ungrounded conductors.
- .18 Provide expansion couplings, with bonding jumper and ground clamps where raceways cross building control joints.
- .19 Runs of conduit and cables, where shown, are indicated only by general location and routing. Install conduits and cables so as to provide maximum head room and to interfere as little as possible with free use of spaces through which they pass. They shall be installed as close to building structure as possible such that, where concealed, necessary furring can be kept to a minimum. Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.

### 3.2 **SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5m (5') clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm (3") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.

### 3.3 **CONCEALED CONDUIT**

- .1 Do not install horizontal runs in masonry walls.
- .2 Do not install conduits in terrazzo or concrete toppings.

**END OF SECTION**

---

**OUTLET BOXES, CONDUIT BOXES AND FITTINGS**  
**26 05 35**

**PART - 1      GENERAL**

**1.1            RELATED WORK**

- .1      Box connectors to Section 26 27 28.

**1.2            REFERENCES**

- .1      CSA C22.2 No. 18.  
.2      CSA C22.1 Canadian Electrical Code, Part 1, Ontario Hydro Electrical Safety Code.

**PART - 2      PRODUCTS**

**2.1            OUTLET AND CONDUIT BOXES - GENERAL**

- .1      Size boxes in accordance with CSA C22.1  
.2      102 mm (4") square or larger outlet boxes as required for special devices  
.3      Gang boxes where wiring devices are grouped.  
.4      Blank cover plates for boxes without wiring devices.  
.5      Combination boxes with barriers where outlets for more than one system are grouped.

**2.2            SHEET STEEL OUTLET BOXES**

- .1      Hot dipped galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 mm x 50 mm x 38 mm (3" x 2" x 1½") or as indicated. 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.  
.2      102 mm (4") square or octagonal outlet boxes for lighting fixture outlets.  
.3      102 mm (4") square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

**2.3            MASONRY BOXES**

- .1      Hot dipped galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

**2.4            CONCRETE BOXES**

- .1      Hot dipped galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

**2.5            FLOOR BOXES**

- .1      Concrete tight hot dipped galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brass or brushed aluminum faceplate. Device mounting plate to



accommodate short or long ear duplex single or receptacles. Minimum depth: 28 mm (1¼") for receptacles; 73 mm (3") for communication equipment.

- .2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12 mm (½") and 19 mm (¾") conduit. Minimum size: 73 mm (3") deep.

## 2.6 CONDUIT BOXES

- .1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle, outside building and where weatherproof boxes are required.
- .2 Explosion proof boxes in areas indicated on drawings.

## 2.7 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 (1½") and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

## PART - 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 (¼") of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area in which it is to be installed.
- .6 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.
- .7 Offset outlet boxes, shown back to back in partitions, horizontally to minimize noise transmission between adjacent rooms.
- .8 Use gang boxes at locations where more than one device is to be mounted. Use combination boxes with suitable barriers where outlets for more than one system are shown.

Where 100 mm (4") square boxes are installed in exposed concrete or cinder block in finished areas, blocks will be cut under masonry division as instructed under this section. Openings shall be cut to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Mortar shall not be used to patch up openings that are cut too large or to patch ragged edges.

---

**END OF SECTION**

## **WIREWAYS AND AUXILIARY GUTTERS**

### **26 05 37**

#### **PART - 1 GENERAL**

##### **1.1 PRODUCT DATA**

- .1 Submit product data in accordance with Section 26 05 01 Electrical General Requirements.

#### **PART - 2 PRODUCTS**

##### **2.1 WIREWAYS (LAY-IN CABLE DUCT)**

- .1 Fabricated from code gauge sheet steel and complete with hinged covers and standard knockouts on 300 mm (12") centres, unless noted otherwise. Inside and outside shall be treated with a rust inhibiting etching process.
- .2 Finish: **Inside and outside shall be treated with a rust inhibiting process and outside shall be finished in Sherwin Williams Paint, #F65Y4 (Yellow).**
- .3 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.
- .4 Cross-section dimensions as indicated.

##### *Standard of Acceptance*

- W. C. Pursley Ltd.
- Square D Company Canada Ltd.
- G. A. Harding Ltd.
- Pilgrim technical Products Ltd.

#### **PART - 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**

## **SPECIAL HOSPITAL WIRING**

### **26 07 05**

#### **PART - 1 GENERAL**

##### **1.1 DESCRIPTION**

- .1 Patient care areas are as follows:
  - .1 Intermediate Patient Care Areas

#### **PART - 2 PRODUCTS**

##### **2.1 RECEPTACLES**

- .1 Receptacles connected to the emergency power system shall be coloured red.
- .2 Receptacles in patient care areas shall be Hospital Grade.
- .3 Receptacles in patient care areas shall have a circuit identification lamaroid in accordance with CSA Z32-99 Lamaroid shall be secured to the wall above the receptacle and shall be engraved with panel name and circuit number. Lettering shall be minimum 1/4" (6 mm) high and shall be:
  - .1 Black letter, white lamaroid for normal power
  - .2 Red letter, white lamaroid for emergency power

#### **PART - 3 EXECUTION**

##### **3.1 BONDING TO GROUND**

- .1 Bonding to ground of receptacles and permanently wired electrical equipment in the patient care areas shall be carried by installing an insulated green equipment bonding conductor in the same conduit as the branch circuit conductors. The bonding conductor shall be terminated in the outlet box and the device at the load end and a ground bar in the panel supplying the equipment or outlet at the source end. A separate bonding conductor shall be provided for each circuit and the bonding conductor shall be sized equal to the branch circuit conductors. In critical care areas the minimum bonding conductor size shall be #10 AWG.
- .2 Where the single phase receptacles in a patient care environment are supplied from two 2-wire branch circuits in the same conduit, a single bonding conductor may be provided for the two circuits.
- .3 Items to be grounded shall include all receptacles, wall-mounted lights and any other equipment located within 1.5 m horizontally from the nominal position of the bed and 2.3 m vertically above the floor.
- .4 Interconnect the ground bus in emergency and normal electrical panels which serve patient care areas with an insulated green copper conductor installed in conduit and sized as in Table 16 of the Electrical Safety Code, but not less than #6 AWG.

### 3.2 **NEUTRAL CONDUCTORS**

- .1 In both Intermediate Patient Care Areas, a separate neutral conductor shall be provided for each branch circuit phase conductor back to the panel supplying the outlet. Since the neutral is a full current carrying conductor, it is suggested that not more than two beds have a 25 mm conduit home run to the panel to avoid conductor de-rating.

**END OF SECTION**

## **WIRING TO MOTORIZED DOORS**

### **26 07 16**

#### **PART - 1      GENERAL**

##### **1.1            RELATED WORK**

- .1      Door control panel will be provided with door. Interconnecting power and control wiring and on-off switch will be provided by Division 26.

#### **PART - 2      PRODUCTS**

##### **2.1            DISCONNECT**

- .1      On-off switch shall be rated 15A, 120 volt.

#### **PART - 3      EXECUTION**

##### **3.1            INSTALLATION**

- .1      Provide conduit, wiring and on-off switch for each motorized door. Mount door control panel. Install interconnecting power and control wiring to motor, controller, sensors and limit switches.
- .2      On-off switch shall be mounted in ceiling space above door.
- .3      Wire to fire alarm system to de-energize doors when fire alarm system is activated.

**END OF SECTION**

## **SYSTEM COORDINATION, VERIFICATION AND TESTING**

### **26 08 05**

#### **GENERAL**

#### **GENERAL REQUIREMENTS**

Conform to Section 26 05 01, Electrical General Requirements.

#### **PART - 1**

#### **WORK INCLUDED**

1.1

.1

The Division 26 contractor shall retain and pay for the services of an Independent Testing Organization (ITO) to provide System Co-ordination Study, Verification and On-Site Commissioning Service in accordance with the details specified herein:

1.2

.1

System Co-ordination Study related to the new 208 volt Moulded Case Circuit Breaker being added in the existing 120/208 volt Emergency Power Panel, the feeder to the new 208 to 600 volt step-up Transformer and the Feeder to the Roof-Top Ventilation System

.1

In order to ensure the requirement for independence, the ITO must be retained directly by the Division 26 contractor. The ITO must not be retained by an equipment manufacturer or their distributor as part of an equipment package.

.2

.3

The Division 26 Contractor shall include in the Bid Amount the cost for the services of tradesmen to handle equipment, make temporary connections, operate equipment and make repairs and adjustments and assist the testing organization's on-site specialists during the on-site pre-service inspection, testing, calibration, on-site witness testing and supplementary Commissioning phase of the work and as required by the Consultant until the equipment and systems are accepted by the Owner.

1.3

#### **APPROVED TESTING ORGANIZATIONS**

**System co-ordination and verification shall be done by a firm with detailed knowledge of the complete Sunnybrook Health Sciences Centre's K Wing Electrical Distribution System. System co-ordination and verification agent shall, to maintain consistency of engineering studies completed for other K Wing projects and for records consistency be:**

#### **PART - 2**

2.1

**Haronitis and associates ltd. (905-474-0800) - [haronitisandassociatesltd@bellnet.ca](mailto:haronitisandassociatesltd@bellnet.ca).**

.1

#### **PRODUCTS**

.2

#### **PRELIMINARY CO-ORDINATION STUDY**

.3

Include liaison with the equipment manufacturers to obtain appropriate information and to recommend appropriate devices to obtain co-ordination of the system, immediately after award of Contract.

For the new 208 to 600 volt Emergency Systems investigate the overcurrent settings and determine the correct setting.

The recommended breaker settings should be documented in a report format and submitted as a shop drawing for review by the Consultant within 2 weeks of award of Contract. The purpose of this report is to allow the breaker to be released to production.

### **PRE-SERVICE ON-SITE INSPECTION, TESTING OF EQUIPMENT AND DEVICES**

Upon Completion of the installation and prior to energization of components and systems, perform a complete inspection and testing to verify phase and polarity match of feeders with equipment and the tightness of power wiring terminations.

In addition perform the following tests and functions:

2.2

.1

Power Feeders

(a) Thorough physical inspection

.2

(b) Insulation resistance of the feeder

.1

(c) Polarity and rotation tests of power terminations

### **EXECUTION**

#### **TESTING, ADJUSTING AND VERIFICATION**

PART - 3

3.1

Provide necessary test equipment, material, labour and miscellaneous services during the testing, adjusting, verification and commissioning procedure.

.1

#### **REPORTS**

3.2

Completed Study and Test Report shall be submitted simultaneously to the Consultant as well as part of the requirements of the Maintenance Manuals.

**END OF SECTION**



## **TESTING OF INTEGRATED ELECTRICAL LIFE SAFETY AND FIRE PROTECTION SYSTEMS 26 08 11**

### **1 GENERAL**

#### **1.1 Scope**

- .1 Provide testing of integrated life safety and fire protection systems and related equipment provided under Divisions 26 to 28 with those provided under other Divisions of the Work, in accordance with specification Section 01 75 11.
- .2 This specification is limited to testing of the interconnections between life safety and/or fire protection systems. Refer to separate technical specification sections for the individual testing and commissioning requirements for those systems.

#### **1.2 Related Sections**

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
  - .1 Section 01 75 11            Testing of Integrated Life Safety and Fire Protection Systems
  - .2 Section 26 08 15            Commissioning – Electrical

#### **1.3 Definitions and Abbreviations**

- .1 Refer to Section 01 75 11.

#### **1.4 Applicable Codes and Standards**

- .1 Installation codes and standards:
  - .1 CAN/ULC-S1001            Integrated Systems Testing of Fire Protection and Life Safety Systems

#### **1.5 Qualified Tradesperson**

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

### **2 PRODUCTS**

- .1 Not used.

### **3 EXECUTION**

#### **3.1 General Requirements**

- .1 Conduct complete and thorough testing and documentation of the systems interface and integration between various LSFP systems provided under Divisions 26 to 28 and those provided under other Divisions of the Work.
- .2 Include all labor and material as required to participate in and implement the integrated LSFP testing process for equipment and systems provided under Division 26 to 28.

### **3.2 Integrated Test Plan and Procedures - Development**

- .1 Participate in the development of the integrated LSFP test plan and procedures in accordance with the requirements of specification Section 01 75 11.
- .2 Supply manufacturer's operating and testing instructions to the ITC prior to the development of the integration LSFP test plan.

### **3.3 Integration Test Plan – Implementation**

- .1 Complete related LSFP system acceptance testing in accordance with the applicable technical specification sections of Divisions 26 to 28, prior to implementation of integrated LSFP testing. Where acceptance testing of such systems inherently test the LSFP system interconnection(s), such testing is not required to be duplicated for the integrated LSFP testing provided the results of the integration test are recorded in accordance with the requirements of the integrated LSFP test plan.
- .2 Prior to implementing any integrated LSFP test,
  - .1 provide written confirmation from each trade contractor under Divisions 26 to 28 of the Work, that their respective LSFP related equipment or systems, or parts thereof, have been installed in accordance with the design and are ready for integrated LSFP testing,
  - .2 where applicable, provide test verification reports from the organization that verified the installation of any LSFP system as required by referenced codes or standards, such as NFPA or ULC.
  - .3 provide a copy of any inspection report from an authority having jurisdiction governing a LSFP system.
- .3 Coordinate with the ITC and provide all necessary resources to implement the integrated LSFP test plan.

### **3.4 Final Test Results Report**

- .1 The final test report will be prepared by the ITC.

**END OF SECTION**

## **TESTING OF HOSPITAL WIRING**

### **26 08 13**

#### **PART - 1 GENERAL**

##### **1.1 RELATED SPECIFICATION SECTIONS**

- .1 Comply with all requirements of Division 1
- .2 Section 26 05 01 Electrical General Requirements

##### **1.2 DESCRIPTION**

- .1 Test and check all portions of the electrical system for satisfactory operation. All tests and checks to be done in the presence of the Consultant, suitably logged, tabulated, signed and incorporated into the Operating and Maintenance Brochures. Testing and checking to be carried out under this Contract at no extra cost to Owner. Procedures and tests outlined below are electrical tests required in addition to normal visual and mechanical inspection which shall be carried out prior to placing equipment in service.
- .2 Provide certified copies of all production tests required by CEMA and CSA for all power distribution equipment.
- .3 All work found to be defective as a result of the testing procedures covered by this Section shall be made good at no cost to the Owner and on completion of remedial work the tests shall be repeated. The costs of such second and subsequent tests is the responsibility of the Contractor and is a pre-requisite to establishing "Substantial Completion" as referred to in "Supplementary Instructions to Bidders".
- .4 Give timely notice to the Consultant that the work is ready for testing. The satisfactory completion of all tests is a prerequisite to establishing Substantial Completion of the project.
- .5 Testing of electrical systems shall be done by only one of the following acceptable professional independent testing organizations and one complete copy of all reports, studies and test results shall be submitted directly to the Consultant:
  - .1 Haronitis & Associates
  - .2 Rondar
  - .3 Brosz & Associates
  - .4 Schneider Canada Service
- .6 Refer to CSA Standard Z32 for test circuits.

##### **1.3 REPORTS**

- .1 Prepare and submit the following reports. Submit separate reports for each area to suit construction phasing and occupancy requirements within 5 days of completion of testing in each area. Simultaneously submit one copy directly to the Consultant and a further 6 copies to the contractor to be processed as a shop drawing:
  - .1 Conductor Insulation Integrity Test
  - .2 Receptacle retentive force test.
  - .3 Receptacle polarity test.
  - .4 Branch circuit impedance.

- .5 Test of ground point voltage rise under fault conditions at patient and bed locations.
- .6 Potential difference between ground points.
- .2 One complete copy of all reports, studies and test results shall be submitted directly to the Consultant and the Owner along with a certificate, bearing a professional engineer's seal and signature, stating that the installation meets the requirements of the CSA Z32-04 standard, and is suitable for patient use.
- .3 Submit additional copies of all reports, studies and test results to the contractor for inclusion in the Maintenance Manuals as required under Section 26 05 01.

## **PART - 2 PRODUCTS**

### **2.1 NOT USED**

## **PART - 3 EXECUTION**

### **3.1 PRELIMINARY CHECKS**

- .1 All equipment and devices to be visually inspected and cleaned. Document that all equipment and devices have correct services, connections, settings, supply voltages, alarm circuits, heater elements, etc., and that they are operational and in accordance with the requirements of contract specifications and drawings, and the manufacturers specifications and recommendations.

### **3.2 ELECTRICAL TESTS**

- .1 This Section outlines the tests to be carried out and submitted to the Consultant for approval. Be responsible at no cost to the Owner for rectifying all equipment or installations which do not meet the requirements of the various tests listed.
- .2 The following tests shall be carried out in accordance with the latest edition of CAN/CSA-Z32-04 "Electrical Safety and Essential Electrical Systems in Health Care Facilities":
  - .1 Conductor Insulation Integrity Test
  - .2 Receptacle retentive force test.
  - .3 Receptacle polarity test.
  - .4 Branch circuit impedance.
  - .5 Test of ground point voltage rise under fault conditions at patient and bed locations.
  - .6 Potential difference between ground points.

### **3.3 CONDUCTOR INSULATION INTEGRITY TEST**

- .1 Using a 500V dc megohmmeter, measure the insulation resistance of each branch circuit conductor with all wiring devices connected.
- .2 Isolate the branch circuits under test as required to ensure that other circuits serving patients or sensitive equipment are not exposed to the test voltage.
- .3 Record all results on tests forms.
  - .1 Submit tests forms to Consultant for approval.
  - .2 Where measured values are below the values listed in Z32, the Contractor shall replace the wiring and the independent testing organization shall test the replaced

wiring. This process shall be repeated until satisfactory results are obtained. The cost of such work shall be the responsibility of the Contractor.

### 3.4 RECEPTACLE RETENTIVE TEST FORCE

- .1 Requirements: A force of 1.1 Newtons shall not remove a test pin from the ground slot of a receptacle. A force of 13.3 Newtons shall not remove a test attachment plug of the same configuration for a receptacle.
- .2 Method: Test pins and methods of test specified in CSA Standard C22.2 No. 42 shall be used. As an alternative, a commercially available "tension tester" complying with CSA Standard C22.22 No. 42, General Use Receptacles, Plugs and Similar Wiring Devices may be employed.
- .3 Implementation:
  - .1 Using tension checker, ensure device has calibration as to tension (Newtons) for single-ground pin and tension (Newtons) for multiple pin testing.
  - .2 For each outlet within a designated area, check tension of ground pin (minimum 1.1 Newtons) and tension of entire plug (minimum 13.3 Newtons).
  - .3 Record go/no go tension reading for each outlet on a per room and branch circuit basis.
  - .4 Replace any receptacle which does not meet the requirements listed in method.

### 3.5 RECEPTACLE POLARITY TEST

- .1 Requirements: Ensure all receptacles are connected in accordance with configurations listed in Canadian Electrical Code CSA C22.1, latest edition Section 26.
- .2 Method: Utilizing polarity test set, check all receptacles on a room by room basis.
- .3 Implementation: Correct connection of receptacles where polarity indication is incorrect.

### 3.6 BRANCH CIRCUIT IMPEDANCE TEST (VOLT DROP)

- .1 Requirements:
  - .1 Ensure that all branch circuit wiring from panelboards to receptacles does not exceed a maximum voltage drop of 3% when 80% of the breaker rating is applied at the receptacle. The Contractor shall test all receptacles on a room by room, circuit by circuit basis.
  - .2 The equipment to be utilized by the Contractor for this test shall be approved by the Consultant. See Figure 1 in standard sheet "Test Circuit Configurations" for test circuit.
- .2 Method:
  - .1 Ensure that all circuits other than the one under test are de-energized.
$$\frac{V_o - V_L}{V_o} \times 100$$
  - .2 Record no load voltage at receptacle (Vo).
  - .3 Apply current to 80% of the rating of the overcurrent device protecting the circuit under test record voltage (VL).
  - .4 Remove load and reconfirm value of Vo.

- .5 Calculate voltage drop at receptacle by the formula:
- .3 Implementation:
  - .1 Record all results on tests forms.
  - .2 Submit tests forms to Consultant for approval.
  - .3 Where volt drop exceeds 3% by calculation in method, the Contractor shall take all necessary steps to reduce the voltage drop to the required value. The cost of such work shall be the responsibility of the Contractor.

### 3.7 **GROUND POINT VOLTAGE RISE**

- .1 Requirements: Bonding conductors shall be sized and installed so as to limit the voltage rise at the ground point of any receptacle within a patient care area to 3 V when tested. Bonding conductors for branch circuits shall be insulated.
- .2 Method: Using the test circuit of Figure 3 in standard sheet "Test Circuit Configurations":
  - .1 Connect the test circuit to the outlet. With switch SW open, record the voltage indicated by voltmeter V1 as VN, the neutral to ground voltage without load. If it exceeds about 2 V, determine the cause and correct the defect.
  - .2 Using the low voltage supply, (nominally 5 V open circuit) apply a load of 80% of the rated current of the circuit, between the neutral and the bonding conductor for a period of from 1 to 5 s. To ensure accuracy, the low voltage supply should be energized from a circuit other than the one being tested. Record the current I, the voltage indicated by voltmeter V1 as VR, and the voltage indicated by voltmeter V2 as VO.
- .3 Implementation
  - .1 Record all results on tests forms. Submit test forms to Consultant for approval.
  - .2 The return path voltage rise VO shall be not greater than 3 V where voltage rise exceeds 3 V. The Contractor shall take all steps necessary to correct the situation.

### 3.8 **POTENTIAL DIFFERENCE BETWEEN GROUND POINTS**

- .1 Requirements: The maximum potential difference between the grounding poles of all receptacles at a patient care location and between these poles and all other exposed conductive non-current-carrying parts at the same patient care location, shall be:
  - .1 less than 20 mV in Basic Care Areas
  - .2 less than 20 mV in Intermediate Care Areas; and
  - .3 less than 10 mV in Critical Care Areas
- .2 Method:
  - .1 Using the standard frequency-weighted test circuit of Figure 2 in standard sheet "Test Circuit Configurations", the following test procedure shall be performed.
  - .2 Confirm that all receptacles have been installed and that no utilization equipment, either permanently wired or cord-connected, is connected to the system.
  - .3 Energize the system.
  - .4 Select a local reference point known to be bonded to ground and record the measured voltage between this chosen reference and each receptacle ground pole and each exposed conductive non-current-carrying metal part in turn. If the test

leads are long, the readings should be corrected for pickup (zero reading) when connected together.

- .3 Implementation:
  - .1 Using the standard frequency-weighted test circuit of Figure 2 in standard sheet "Test Circuit Configurations", the procedure shall be carried out.
  - .2 The voltage measured shall meet the requirements above.
  - .3 Record all results on tests forms and submit test forms to Consultant for approval.

**END OF SECTION**

## **ELECTRICAL COMMISSIONING**

### **26 08 15**

#### **PART - 1 GENERAL**

##### **1.1 SCOPE**

- .1 The Hospital will retain an Independent Commissioning Agent (CA) who will provide actual Commissioning Services including witness Testing and Commissioning Services as required.
- .2 Include all labor and material as required to participate in the commissioning process, as outlined in this section, for equipment installed under Division 26.

##### **1.2 WORK INCLUDED**

- .1 Commissioning work of Division 26 includes, but is not limited to:
  - .1 Participation in regular construction meetings as well as separate Commissioning Meetings during the construction period associated with the scheduling, coordination, and implementation of the various commissioning activities within the overall construction program.
  - .2 Site Testing and start-up of equipment.
  - .3 Detailed acceptance testing as described under various equipment specifications including supplementary testing required by Commissioning Authority
  - .4 Cooperation with the Commissioning Authority in developing and implementation of the commissioning plan.
  - .5 Providing qualified personnel for participation in implementing commissioning test procedures.
  - .6 Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
  - .7 Providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification in a timely manner.
  - .8 Providing training and demonstrations for the systems specified in this Division prior to turnover to Owner.
- .2 Conduct complete and thorough evaluation and documentation of the operation and performance of all components, systems, and sub-systems, including the following equipment and systems:
  - .1 Fire Alarm System Verification
  - .2 Nurse Call System Verification
  - .3 Security System Verification
  - .4 Emergency Battery Lighting System Verification



Note:

All of the above Electrical Systems are to be tested/ verified by this Contractor. Commissioning Scope is to ensure the work is completed and acceptable. Requires some active witnessing of some testing.

**PART - 2      PRODUCTS (NOT USED)**

**PART - 3      EXECUTION**

**3.1            COMMISSIONING MEETINGS**

- .1      Participate in periodic commissioning team meetings, and trade commissioning meetings.
- .2      Construction and Post-Construction:
  - .1      participate in commissioning meetings as scheduled by the General Contractor.
  - .2      participate in trade commissioning meetings as required, in addition to the regular commissioning team meetings,
  - .3      identify to the commissioning group problems relating to the commissioning schedule, identification of start-up issues, etc, and participate in the resolution of these problems.

**3.2            COMMISSIONING PROCEDURES**

- .1      The Owner's designated Commissioning Authority provides the commissioning procedures (checklists, etc) for use by the contractor.
- .2      Each commissioning procedure tests the equipment and systems, and consists of the following elements:
  - .1      Document sign-off
  - .2      Pre-start and Initial test
  - .3      Installation Verification - Equipment
  - .4      Installation Verification - Systems
  - .5      Performance Validation
- .3      Document Sign-Off:
  - .1      each completed procedure is signed off by the following parties:
    - (a)      Contractor, for testing,
    - (b)      Commissioning Consultant, for review and witnessing,
    - (c)      Owner, for test acceptance.
- .4      Installation Verification - Equipment
  - .1      Checklists to verify the installation of equipment, including: design specification requirements, drawing requirements, manufacturer installation requirements, and other experience-related items.
  - .2      Use of pre-printed manufacturer installation and start-up checklists are permitted and encouraged; however, the commissioning procedure checklists may contain supplemental items.

- .5 Installation Verification - System: Checklists to verify the installation of the system associated with the equipment.
- .6 Performance Validation: Specific test procedures and record documentation requirements for performance measurements of the various systems.

### 3.3 COMMISSIONING TEST METHODOLOGY

- .1 Step 1 : Notify the Commissioning Consultant in accordance with an agreed schedule and notification period when testing will begin on each procedure type. The Commissioning Consultant will witness the testing on an audit basis, including the first instance, the last instance, and at random during other times.
- .2 Step 2 : complete the commissioning procedures including recording results, and sign-off and date separately the completion of Part "A" Verification, and Part "B" Validation. Any deficiencies discovered during this testing are to be corrected prior to sign-off of the test.
- .3 Step 3 : on completion of systems which do not require witness demonstration, finalize the report and submit to the Commissioning Consultant and the Consultant for review.
- .4 Step 4 : on completion of systems which have been witnessed by the Commissioning Consultant, the Commissioning Consultant is to sign-off the completed procedure document as being witnessed.

### 3.4 COMMISSIONING IMPLEMENTATION

- .1 Conduct operating tests and checks to verify that all components, equipment, systems, and interfaces between systems, operate in accordance with contract documents.
- .2 Demonstrate and verify operating modes, interlocks, specified control sequences, specific responses to abnormal or emergency conditions, and verification of the proper response to the Building Automation System, security system, and fire alarm system as applicable.
- .3 Roles and Responsibilities:

Organized by:	General Contractor
Test sheets provided by:	Commissioning Authority
Testing Conducted by:	Division 26 Contractors Equipment Suppliers Technical Personnel as appropriate Independent Testing Agent as specified
Testing recorded by:	Division 26 Contractors Equipment Suppliers Technical Personnel as appropriate Independent Testing Agent as specified Commissioning Authority
Tests witnessed by:	Commissioning Consultant Owner (selected tests)
Reports reviewed by:	General Contractor Commissioning Consultant Design Consultant Owner / Commissioning Authority
Reports Accepted by:	Owner

### 3.5 OPERATING CHECKS

- .1 The Commissioning Consultant witnesses selected equipment and system tests on an audit basis.
- .2 Set the system equipment into operating mode to be tested including but not limited to:
  - .1 Normal start up, operation, and shut-down
  - .2 Normal auto position
  - .3 Normal manual position
  - .4 Unoccupied cycle
  - .5 Emergency power operation, including transition states.
  - .6 Status and Alarm conditions
- .3 Inspect and verify the position of each device and interlock identified on the checklist.
- .4 Repeat the above tests for each operating mode that applies to the system being tested.
- .5 For failed test items, provide appropriate comments to the checklist data sheet and classify whether it is a "Major" or "Minor" deficiency.
  - .1 The Consultant retains the right to make the final decision regarding classifications of deficiencies.
- .6 Test failure is defined as:
  - .1 Refer to relevant specification sections.
- .7 Acceptance
  - .1 The final reports will be reviewed by the Commissioning Consultant and the Consultant, to determine if verification is complete and the operating systems are functioning in accordance with the contract documents.
  - .2 The Commissioning Consultant, in conjunction with the Consultant, reviews and makes final classification of all noted deficiencies. Correct deficiencies classified as "Major" before acceptance of the Verification stage.
  - .3 The Owner will make the final acceptance of test results.

### 3.6 PERFORMANCE VALIDATION TESTING

- .1 Conduct performance tests and checks to validate that equipment and system components are providing the required performance (capacity) for each equipment and system.
- .2 Special testing requirements:
  - .1 Conduct acoustic measurement tests outside the building when generators are running, in accordance with local noise by-law procedures.
  - .2 Conduct acoustic measurement tests inside of generator room when generators are running.

### 3.7 PROBLEM RESOLUTION

- .1 In the event that additional work is required to either correct systems, misapplied or improperly installed equipment, and/or deficient performance under varying load conditions, assist the Owner and Commissioning Consultant in developing an acceptable resolution to the problem, including the resources of equipment suppliers.

- .2 The Owner has final approval over any additional work required to achieve the required level of performance.
- .3 Complete corrective work in a timely fashion to permit the completion of the commissioning process.

### 3.8 **ACCEPTANCE**

- .1 Any identified deficiencies will be reviewed by the Consultant in conjunction with the General Contractor/Construction Manager to determine if correction of the deficiency is as a result of a defect in the equipment or installation.
- .2 If it is determined the performance deficiency is as a result of a defect in the equipment or its installation, rectify the deficiency and repeat the performance test until the required performance levels are achieved.
- .3 If it is determined the equipment or system has been constructed in accordance with the contract documents, the Owner will decide whether to accept the performance as is, or, direct the installation contractor to make changes to the system as required to obtain performance levels which meet the design intent, and retest the system.

### 3.9 **POST-SUBSTANTIAL PERFORMANCE COMMISSIONING**

- .1 Provide commissioning after Substantial Performance:
  - .1 Performance testing which is weather or live-load dependent;
  - .2 For out-of-season system performance testing, conduct initial performance tests to demonstrate off-peak load performance. Schedule peak load performance testing over the succeeding nine (9) months to ensure all equipment is tested at peak load prior to the expiry of the warranty period.
  - .3 Infra-red thermal imaging of equipment under peak building live-load conditions,
  - .4 90 day security system testing,
  - .5 Alternatively, provide temporary equipment (load banks, etc) to simulate full load conditions. Submit proposed methodology for review by the Commissioning Authority and Consultant.

### 3.10 **ADDITIONAL COMMISSIONING**

- .1 Additional commissioning activities may be required after completion of system performance testing. Include in the tender cost a reasonable reserve to complete this work, including assistance from manufacturers' service technicians.

### 3.11 **SYSTEMS OPERATING MANUALS**

- .1 Provide Operating and Maintenance Manuals in accordance with the requirements of section 16010.
- .2 The Systems Operating Manuals (SOM) are in addition to the Operating and Maintenance Manuals (OMM) required under Section 16010.
  - .1 Provided by Commissioning Authority and/or Consultant.

### 3.12 **TRAINING**

- .1 Equipment Training:
  - .1 Provide equipment training in accordance with Section 26 05 01 and the relevant equipment specification sections. The manufacturer's representative training will emphasize operating instructions and preventative maintenance.[]
- .2 Systems Training:
  - .1 In addition to the equipment training described above, provide additional training to describe the operational requirements and design intent of each system.
  - .2 Include classroom instruction, delivered by competent instructors. Place emphasis on overall systems diagrams and descriptions, and design criteria and conditions.
  - .3 If required, obtain and pay for the services of the Design Consultant to provide the instructor services and to provide lecture material for inclusion in the training manual.
  - .4 Training topics to include:
    - (a) Types of installed systems
    - (b) Design intent and design criteria
    - (c) Design constraints
    - (d) Different operating modes – occupied, unoccupied, emergency conditions, etc.
    - (e) Seasonal operating modes
    - (f) Energy efficiency
    - (g) System operation
    - (h) Automatic controls
    - (i) Service, maintenance, diagnostics and repairs
    - (j) Use of reports and logs
    - (k) Troubleshooting
  - .5 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, with the services of the manufacturers' representative as required. Demonstrate the start-up and shut-down of each system.
  - .6 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each topic, separated by approximately one week each, to allow for shift coverage.
  - .7 Structure each training session based on type of maintenance personnel attending the training session, ie. Plumbers, fitters, general maintenance, controls technicians, etc. Develop the proposed training plan and obtain approval from the Owner before commencing the training.
  - .8 Complete the training as close to Substantial Performance as possible, so that the Owner's operations staff are prepared to operate the system after Substantial Performance is certified.

- .3 Training Manuals
  - .1 Provide training material hand-outs for each session.
  - .2 Collect training material and bind into separate binders.

**END OF SECTION**

**PROJECT CLOSE-OUT ELECTRICAL**  
**26 08 19**

**PART - 1      GENERAL**

**1.1            SCOPE**

- .1      Provide documentation deliverables at completion of the Work.

**1.2            SUBSTANTIAL PERFORMANCE**

- .1      Complete the Substantial Performance Checklist and submit with required documentation when applying for Substantial Performance of the Work.
- .2      Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.
- .3      Prepare and submit to the Consultant a comprehensive deficiency list of items to be completed or corrected, as part of the application for a review by the Consultant to establish Substantial Performance of the Work, or for each designated portion of the Work in the case of phased Substantial Performance.
  - .1      Failure to include an item on the list does not alter the Contractor's responsibility to complete the Work.
- .4      Within five working days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

**1.3            TOTAL PERFORMANCE**

- .1      Submit the following documentation with the application for Total Performance. Application for Total Performance cannot be submitted any earlier than the date of Alternate Season testing.
  - .1      Where documentation has already been submitted to the Owner, provide a copy of the transmittal.

SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

*The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.*

- ☐ Contractor has compiled and submitted a detailed deficiency list, identifying work still to be completed, incomplete, or requires correction.
- ☐ Equipment start-up reports (Interim).
- ☐ Building department inspection reports.
- ☐ ESA field inspection reports.
- ☐ Fire alarm verification certificate.
- ☐ Independent testing company, coordination study and testing reports submitted.
- ☐ Equipment and wiring identification completed
- ☐ Clean-up completed.
- ☐ Spare parts and replacement parts turned over to Owner; transmittal attached.
- ☐ Warranty certificates
- ☐ Operating and Maintenance Manuals, draft, submitted.
- ☐ As-built drawings submitted
- ☐ Training completed and attendance logs submitted.
- ☐ Commissioning reports submitted and reviewed by Consultant

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> <u>Incomplete or deficient - resubmit</u>
Signed:	
Date:	



TOTAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

*The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.*

- ☐ All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- ☐ Final commissioning reports submitted and accepted by Owner.
- ☐ Operating and Maintenance manuals - finalized and submitted (if final version was issued at time of Substantial Performance indicated here:
- ☐ As-built drawings final version submitted (if final version was issued at time of Substantial Performance indicate here: ☐ Date of delivery: \_\_\_\_\_

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

**END OF SECTION**

## **DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY**

### **26 22 13**

#### **1 GENERAL**

##### **1.1 General Requirements**

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

##### **1.2 Applicable Codes and Standards**

- .1 Latest edition of:
  - .1 CSA C22.2 No. 47 Air-Cooled Transformers (dry type),
  - .2 CSA C9 Dry-Type Transformers,
  - .3 CAN/CSA C802.2-18 Minimum Efficiency Values for Dry-Type Transformers.
  - .4 NRCan 2019

##### **1.3 Scope**

- .1 **Transformer shall be 150kVA, designed for 208 volt to 600 volt Step-Up Transformation**
- .2 Provide labour, materials, and equipment for the installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

##### **1.4 Submittals**

- .1 Submit shop drawings and product data for each type and rating of transformer.

#### **2 PRODUCTS**

##### **2.1 General**

- .1 Constructed in accordance with the referenced standards except where indicated otherwise.
- .2 Self-contained, free standing units suitable for floor mounting.
- .3 Up to and including 150 kVA to also be suitable for ceiling mounting.
- .4 Supply wall/ceiling mounting brackets for transformers shown to be wall/ceiling mounted.
- .5 Vacuum impregnated epoxy or polyester resin construction.
- .6 Type ANN.
- .7 Efficiency to meet or exceed CSA C802.2-18 and NRCan 2019.
- .8 Windings: copper.
- .9 Buswork and all current carrying parts, other than the windings: copper.
- .10 Primary and secondary voltages and kVA ratings as indicated.
- .11 Delta connected 120/208 volt primary and 600 volt connected secondary.
- .12 Secondary neutral terminals, suitable for the connection of:
  - .1 #6 AWG copper grounding conductor and
  - .2 bonding conductor.
- .13 Taps: four (4) @ 2.5% full capacity primary taps, two above and two below nominal voltage.
- .14 Provisions for incoming and outgoing conductor entry of sizes shown.

- .15 Front accessible primary and secondary conductor entry and connections, unless indicated otherwise.
- .16 System bonding lugs, connected to the enclosure for:
  - .1 primary feeder bonding conductor,
  - .2 secondary feeder bonding conductor and,
  - .3 bonding conductor to the secondary neutral terminal.
- .17 System bonding lugs sized to accommodate cables sizes in accordance with Table 16 of the Ontario Electrical Safety Code.
- .18 Core bonded to the enclosure, either inherently by design or by a bonding strap.
- .19 Labelled to warn of an arc flash potential in accordance with the Ontario Electrical Safety Code.

*Standard of Acceptance*

- Atlas Transformer Inc.
- Square D
- Delta Transformers Inc.
- Hammond Manufacturing Co. Ltd.

## 2.2 Ratings

- .1 KVA capacity based on Class 220 degree C insulation, with 150 degree C rise.
- .2 K-Rating: K13
- .3 Impedance:
  - .1 per Table 7 of CSA C9, except where indicated otherwise,
  - .2 not less than 3% ,
- .4 Full load voltage regulation at 80% power factor:  $\leq 3\%$ ,
- .5 Noise levels:
  - .1 Per Table 8 of CSA C9

## 2.3 Support and Isolation

- .1 Support core and coil assemblies on in-shear vibration isolation mounting pads. Pads to:
  - .1 provide a uniform deflection under weight and weight distribution of supported equipment,
- .2 Finish:
  - .1 rust-inhibiting metal treatment process,
  - .2 powder coat finish to UL50 3R, **Exterior to be finished with paint equal to Sherwin Williams Emergency power - # F65E37 International Orange**

## 2.4 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 01 01 - Electrical General Requirements.

# 3 EXECUTION

## 3.1 Installation

- .1 Mount transformers: suspended, on wall brackets or on floor as indicated.
- .2 Install transformers in level upright position.
- .3 Provide suitable mounting hardware.
- .4 Install the external spring isolation hangers in the support rods of suspended transformers.

- .5 Position transformers to provide:
  - .1 adequate clearance for ventilation,
  - .2 adequate access to connections,
  - .3 adequate access to taps.
- .6 Remove shipping supports only after transformer is installed and just before putting into service.
- .7 Loosen isolation pad bolts until no compression is visible.
- .8 Make final primary and secondary connections using flexible steel conduits.
- .9 Make primary and secondary connections in accordance with wiring diagram.
- .10 Provide a #6 AWG green insulated copper ground conductor in rigid PVC conduit from transformer secondary neutral to the building grounding system.
- .11 Connect the bonding conductors from the primary and secondary feeders to the transformer bonding lugs.
- .12 Provide nameplates in accordance with Article "Equipment Identification".
- .13 Energize transformers after installation is complete.
- .14 Adjust transformer taps as required to achieve suitable secondary voltage at loads, with the transformer operating under its typical load.

**END OF SECTION**

## **LIGHTING & RECEPTACLE PANELS**

### **26 27 16**

#### **PART - 1 GENERAL**

##### **1.1 REFERENCES**

- .1 CSA C22.2 No. 29-M1989.

##### **1.2 RELATED WORK**

- .1 Plywood Backboard: Section 06 10 00 - Rough Carpentry

##### **1.3 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

##### **1.4 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 26 05 01 Electrical General Requirements.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- .3 Nameplates shall be in accordance with Article "Equipment Identification".

##### **1.5 WORK INCLUDED**

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

##### **1.6 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

##### **1.7 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

##### **1.8 OPERATING AND MAINTENANCE INSTRUCTIONS**

- .1 Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

##### **1.9 PLANT ASSEMBLY**

- .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.

1.10 **IDENTIFICATION**

- .1 Panels shall be identified with lamacoid plate with shall include panel designation 12 mm (½") lettering, voltage and phase 5 mm (¼") lettering and where panel is fed from 5 mm (¼") lettering.

**PART - 2 PRODUCTS**

2.1 **PANELBOARDS**

- .1 Product of one manufacturer. **Overall Cover shall be hinged to permit access to breakers and wiring compartment.**
- .2 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. When numbering breakers, number from top to bottom and from left to right.
- .3 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .4 Two keys for each panelboard and key panelboards alike.
- .5 Copper bus with neutral of same ampere rating as mains.
- .6 Panels shall be constructed and finished in accordance with details specified in Section 26 27 18 "Panel Trim".
- .7 Panels shall be surface or flush mounted type, as shown.
- .8 Panels shall be dead front type in code gauge steel enclosure.
- .9 Each panel shall be complete with a typewritten directory which shall be mounted inside door with clear plastic cover.
- .10 Panels shall have mains of voltage and capacity, and main and branch breakers and contactors, as shown on the "Lighting and Receptacle Panel Schedule". Spaces shall include the necessary bus work such that Owners, at a later date, need buy only the breakers.
- .11 Breakers shall have bolted type connections.
- .12 **Panels shall include non-automatic Main Breaker and a bus-mounted, 120/ 208 volt, 3 phase, 4 wire, 200,000 ampere maximum surge capacity built-in transient surge suppression device.**
- .13 Panels for 120/208 volts, three phase, four wire systems shall be complete with full size breakers, having a symmetrical interrupting rating of at least 10,000 A.
- .14 Where indicated breakers shall have a ground fault interrupter.

*Standard of Acceptance*

- **PANELS MUST MATCH EXISTING HOSPITAL STANDARDS AND BE AS MANUFACTURED BY SQUARE D**

2.2 **BREAKERS GENERAL**

- .1 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation.

- .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 to range from 5 - 10 times current rating.
- .4 Circuit breakers with interchangeable trips over 150 A.
- .5 Lock-on devices for clock outlet, fire alarm, security systems, battery chargers, door supervisory, intercom, stairway, exit and night light circuits.

## 2.3 **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.

## 2.4 **TRIM**

- .1 Front panel trim shall be overall hinged type, door within door construction. Trim assembly shall provide hinged access to the internal tub and wiring channels for access to wiring and breaker terminals without removal of the trim assembly. With overall trim assembly closed and secured, a second integral hinged door forming part of the trim assembly shall provide access to the circuit breakers only for opening and closing purposes
- .2 Panels shall be given a rust-resistant treatment to both tub and trim. Locks shall be chrome plated.
- .3 Flush panels shall have concealed hinges and flush type combination lock latch. Doors shall open minimum 135 degrees. Trims shall have fasteners concealed and shall be prime coated to receive room finish paint.
- .4 Surface mounted panels shall be constructed in accordance with CSA Type 2 enclosures with overall door assembly protecting all circuit breakers. Door(s) shall be gasketed, with overhanging drip shield, with T-handle 2 point locking system complete with lock and latch.
- .5 **Panels shall be finished with two coats of paint in accordance with the following Sherwin Williams colour code:**
  - .1 **Normal Power: #F65L7, Pale Blue**
  - .2 **Emergency Power: #F65E37 International Orange**
- .6 Panel locks shall be common to one key throughout project.

## 2.5 **EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Nameplate for each panelboard size 4 engraved, Submit nameplate wording.
- .3 Complete circuit directory with typewritten legend showing location and load of each circuit. Cover directory with a 0.8 mm (1/32") thick clear plastic sheet.
- .4 Nameplates for electrical panels shall indicate panel designation and mains voltage, i.e. 120/208 V, 3  $\phi$ , 4 W and panel and circuit number from which this panel is fed

**PART - 3      EXECUTION**

**3.1            INSTALLATION**

- .1      Locate panel boards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2      Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.
- .3      Mount panelboards to height specified in Section 26 05 01 - Electrical General Requirements, or with top of trim at uniform height of 2000 mm (6' -6") or to match door heads or to suit tile layout, or as indicated.
- .4      Co-ordinate panel finish with Room Finish Schedule.
- .5      Deliver ten (10) duplicate keys for panel locks to Owner.
- .6      Connect loads to circuits.
- .7      Connect neutral conductors to common neutral bus with respective neutral identified.
- .8      Provide minimum #6 AWG green insulated copper bonding conductor in conduit to interconnect normal and emergency power panels serving common patient care areas.

**END OF SECTION**



## **MULTI OUTLET ASSEMBLIES**

### **26 27 19**

#### **PART - 1 GENERAL**

##### **1.1 PRODUCT DATA**

- .1 Submit product data in accordance with Section 26 05 01.
- .2 Indicate type of multi-outlet assemblies with similar terminology to these documents.
- .3 Product is generally referred to as "Wiremold"

#### **PART - 2 PRODUCTS**

##### **2.1 SURFACE RACEWAY FOR WIRING DEVICES**

- .1 Two piece assembly manufactured for mounting wiring devices and associated wiring.
- .2 Cross-section dimensions: as indicated.
- .3 Finish: buff enamel.

##### *Standard of Acceptance*

- ° Wiremold
- ° Canadian Electric Raceways

##### **2.2 SERVICE POLES**

- .1 Service poles shall be constructed of extruded aluminum trim and shall have snap-on covers. Poles shall be complete with necessary hardware for floor and ceiling attachment. Unless otherwise noted, poles shall be suitable for installation against ceiling of 10'-0"  $\pm$  2" (confirm exact floor to ceiling height prior to purchasing).
  - .2 Standard Receptacles in Service Poles raceways are, unless otherwise noted, to be 15/20 ampere type.
  - .3 Service poles minimum 2" square with snap-on covers to provide access to wiring without removing unit. Barrier to isolate Normal Power from Emergency Power where applicable.
  - .4 Service poles with fastening accessories at top of pole to secure to inverted T-Bar ceiling using set screws to permit relocation. Flange at ceiling to conceal wiring.
  - .5 Metal sleeve at bottom of pole to conceal vertical adjustment. Reversible grip-tight devices for carpet and tile floors to prevent movement of poles
  - .6 Service poles for Communications shall have cut-outs for telephone jacks and data outlets as detailed.
-

*Standard of Acceptance*

- **Canadian Electrical Raceways**
- **Wiremold Canada Inc.**
- **Pilgrim Technical Products**

**2.3 WIRING DEVICES**

- .1 Wiring devices: as indicated, refer to Section 26 27 26 - Wiring Devices including specified stainless steel cover plates.
- .2 Data Jacks, as indicated, refer to Section 27 15 00 – Communication Cabling

**2.4 GROUNDING**

- .1 Ground system through raceway separate insulated conductor.

**2.5 FITTINGS**

- .1 Elbows, tees, couplings and hanger fittings manufactured as accessories to product line supplied.

**PART - 3 EXECUTION**

**3.1 FITTINGS**

- .1 Install supports, elbows, tees, connectors, fittings.
- .2 Keep number of elbows, offsets and connections to minimum.
- .3 Install barriers where required.

**3.2 WIRING**

- .1 Install wiring as indicated.
- .2 Where Normal and Emergency Power wiring are required to “share” the power section, Contractor is to utilize BX Cable to provide the required separation between sources. Cover is to include suitable labeling noting two sources.

**2.2 SERVICE POLES**

- .1 Service poles shall be constructed of extruded aluminum trim and shall have snap-on covers. Poles shall be complete with necessary hardware for floor and ceiling attachment. Unless otherwise noted, poles shall be suitable for installation against ceiling of 10'-0" ± 2" (confirm exact floor to ceiling height prior to purchasing).
- .2 Standard Receptacles in Service Poles raceways are, unless otherwise noted, to be 15/20 ampere type. Specialized Receptacles in Service Poles (208 volt type) are to be mounted in a surface mounted box to facilitate the actual device..
- .3 Service poles minimum 2" square with snap-on covers to provide access to wiring without removing unit. Barrier to isolate Normal Power from Emergency Power where applicable.
- .4 Service poles with fastening accessories at top of pole to secure to inverted T-Bar ceiling using set screws to permit relocation. Flange at ceiling to conceal wiring.
- .5 Metal sleeve at bottom of pole to conceal vertical adjustment. Reversible grip-tight devices for carpet and tile floors to prevent movement of poles

- .6 Service poles for Communications shall have cut-outs for telephone jacks and data outlets as detailed.
- Standard of Acceptance*
- **Canadian Electrical Raceways**
  - **Dualite Wiring Products**
  - **Wiremold Canada Inc.**
  - **Pilgrim Technical Products**
- .2 Wiring Devices
- .1 Wiring devices, **unless otherwise noted, to be 15/ 20 ampere type as specified** in Section 16141, Wiring Devices (including specified stainless steel coverplates). Provide lamicaid circuit identifiers as specified elsewhere.
- .3 Grounding
- .1 Ground system through raceway separate insulated conductor.
- .4 Fittings
- .1 A full complement of fittings for the surface metal raceway/ Service Poles shall be provided including but not limited to elbows (internal and external), couplings for joining raceway sections, wire clips for holding conductors or cables in place, blank end fittings for closing open ends of raceway, transition connectors to other surface metal raceways and to 12mm to 38mm trade size conduit or armored cable. In addition, device brackets to install two gang devices both horizontally or vertically within the raceway and combination receptacle and telephone outlet covers shall be provided.
- .5 EXECUTION
- .1 Provide surface aluminum raceways/ Service Poles and appropriate fittings for a complete installation. Ensure raceway is painted to a colour as identified by the Consultant. Provide receptacles with stainless steel coverplates as specified elsewhere. Provide lamicaid nameplate for each receptacle identifying panel and circuit number feeding same.
- .2 Provide wiring from receptacles to panel designated and ground outlets throughout.
- .3 Fittings
- .1 Install supports, elbows, tees, connectors, fittings.
  - .2 Keep number of elbows, offsets and connections to minimum.
  - .3 Install barriers where required.
- .4 Wiring
- .1 Install wiring as indicated.

**END OF SECTION**

## **WIRING DEVICES**

### **26 27 26**

#### **PART - 1 GENERAL**

##### **1.1 REFERENCES**

- .1 CSA C22.2 No. 111-M1986 Switches.
- .2 CSA C22.2 No. 42-M1984 Receptacles.
- .3 Section 26 28 19 - Ground Fault Circuit Interrupters.

##### **1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with 26 05 01 Electrical General Requirements.

##### **1.3 IDENTIFICATION**

- .1 Receptacles shall have a circuit identification lamacoid in accordance with CSA Z32 - 09.
  - .1 Lamacoid shall be secured to the wall above the receptacle and shall be engraved with panel name and circuit number from which the receptacle is fed. Lettering shall be minimum 6 mm (¼") high and as follows:
    - (a) normal power: black lettering on white lamacoid.
    - (b) emergency power: red lettering on a white lamacoid.
  - .2 Provide additional lamacoid for dedicated circuit receptacles, of matching colour, indicating the words: "Dedicated Circuit"

##### **1.4 PRE/ POST OCCUPANCY PROVISIONS**

- .1 Assuming the Hospital will, as the time for occupancy approaches or even after occupying, resolve that some additional receptacles/ power outlets will be required. Include, in the Contract, the following additional installations:
  - a) **five (5) Emergency Power 15 amp, 120 volt Duplex Receptacles**
  - b) **five (5) Normal Power 15 amp, 120 volt Duplex Receptacles**
  - c) **five (5) 15 amp, 120 volt direct connection outlets**
  - d) **two (2) 15 amp, 208 volt direct connection outlets**
  - e) **one (1) 120-24 volt Power Supplies for "Paper Towel Dispensers"**
  - f) **two (2) LED compatible Dimmers**
- .2 Each component with an average of 50'-0" of wire in conduit installed and terminated at the nearest Electrical Panel will be required. Include outlet box, wire, conduits, face-plates, labels, terminations, testing, and documentation for each. Assume, for bidding purposes, that these can be added at any time during construction including at the end of the construction and in any location as directed on site. Devices not installed at the construction completion are to be turned over to the Hospital as spare parts for future installation.

## **PART - 2 PRODUCTS**

### **2.1 SWITCHES**

- .1 20 A, 120 V, silent, AC type, CSA listed, single pole, double pole, three-way, four-way switches "decorative type".
- .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 moulding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 White coloured "rocker" toggle.
- .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.
- .5 Catalogue numbers listed below have been used for convenience only to indicate quality standards:

TYPE	APPROVED CATALOGUE NUMBERS	
	HUBBELL(120 VOLT)	
SINGLE POLE	HBL2121WA	
DOUBLE POLE	HBL2122WA	
THREE-WAY	HBL2123WA	
FOUR-WAY	HBL2124WA	

- .6 Combination switches shall have neon pilot light and jewel on stainless steel plate
- .7 Switches controlling lights on 120 volt emergency circuits shall be with lighted handle as follows:

TYPE	APPROVED CATALOGUE NUMBERS	
	HUBBELL(120 VOLT)	
SINGLE POLE	HBL2121ILWA	
THREE-WAY	HBL2123ILWA	

*Standard of Acceptance*

- Pass & Seymour
- Harvey Hubbell of Canada Ltd.
- Bryant Electric
- Cooper Wiring Devices
- Leviton

## 2.2 DIMMER SWITCHES

- .1 Dimmers for use on LED Luminaires shall be equal to Lutron, "Nova Series", LED compatible as noted and white cover plates.
- .2 Matching switches shall be used adjacent to dimmers.
- .3 Where more than one dimmer is shown in the same location, mount dimmers in individual backboxes. Provide matching switches where shown adjacent to dimmers.

## 2.3 RECEPTACLES

- .1 Receptacles shall be decorator style to be complete with following features:
  - .1 urea moulded housing.
  - .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 rivetted grounding contacts.
  - .6 receptacles to be Heavy duty Hospital grade type
- .2 Receptacles of one manufacturer throughout project.
- .3 Receptacles shall be colour coded as follows:
  - .1 Normal power: white
  - .2 Emergency power: red
- .4 Receptacles shall be as shown and as specified. For convenience, only one or two catalogue numbers of manufacturers have been shown.

*Standard of Acceptance*

- Pass & Seymour
- Harvey Hubbell of Canada Ltd.
- Bryant Electric
- Cooper Wiring Devices
- Leviton

- .1 The receptacles listed below represent the most common configurations available and are not necessarily used on this project. Refer to drawings for types used.
- .2 Duplex receptacle: 15 ampere, 120 volt, grounded CSA Configuration 5-15R:

*Standard of Acceptance*

TYPE	APPROVED CATALOGUE NUMBERS				
	P & S	HUBBELL	BRYANT	LEVITON	COOPER
STANDARD (NON-DECORA)  (HOSPITAL GRADE)	5262 8200	5262 8200	5262 8200	5262 8200	5262 8200
DECORA  (HOSPITAL GRADE)	26252 26262HG	2152 2172	9252 9200	5280 16262- HG	6262 8262

- .3 Weatherproof, 15 ampere, 120 volt equal to those above but complete with gasketted cast plate and hinged covers, equal to Leviton No. 4926 (vertical).
- .4 Twistlock receptacle: 15 ampere, 120 volt, grounded CSA Configuration L5-15R

*Standard of Acceptance*

- Single: Hubbell/P&S/Bryant/Leviton/Cooper 4710
  - Duplex: Hubbell/P&S/Bryant/Leviton/Cooper 4700
- .5 Duplex receptacle: 15 / 20 ampere, 120 volt, grounded CSA Configuration 5-20R:

*Standard of Acceptance*

TYPE	APPROVED CATALOGUE NUMBERS				
	P & S	HUBBELL	BRYANT	LEVITON	COOPER
STANDARD (NON-DECORA)  (HOSPITAL GRADE)	5362 8300	5362 8300	5352 8300	5362 8300	5362 8300
DECORA  (HOSPITAL GRADE)	26352 26362HG	2162 2182	9352 9300	- 16362- HG	6362 8362

## 2.4 FLOOR OUTLETS

- .1 Duplex floor receptacles in flush mounted floor box, 15 ampere, 120 volts shall be complete with adjustable, watertight floor boxes, CSA Configuration 5-15R.

*Standard of Acceptance*

- Hubbell B2431 single gang box (brass)
  - Hubbell B2432 double gang box (brass)
  - Hubbell B2433 three gang box (brass)
- .2 Service fitting for floor receptacle shall be complete with receptacle specified above, unless noted otherwise.

*Standard of Acceptance*

- Hubbell S3625, duplex screw cover (brass)
- Hubbell S3825, duplex flap (brass)

## 2.5 COVER PLATES

- .1 Switch, receptacle and other plates shall be smooth white nylon decorative style in finished areas and pressed steel in unfinished areas. Cover plates shall be Hubbell "Style Line" or equal as manufactured by:
- Arrow-Hart of Canada Ltd.
  - Pass & Seymour Inc.
  - Smith & Stone Ltd.
  - Leviton
  - Westinghouse Canada Ltd.
- .2 Cover Plates shall be finished as follows:
- .1 Light Switches: White
  - .2 Receptacles, Normal power: gray
  - .3 Receptacles, Emergency power: red
- .3 Cover plates for wiring devices. Cover plates from one manufacturer throughout project.
- .1 Stainless steel 18-8 chrome metal alloy, Type 302, vertically brushed, 1 mm (1/32") thick cover plates for wiring devices mounted in flush-mounted outlet box.
  - .2 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
  - .3 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
  - .4 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.
  - .5 Letters shall be 6 mm (1/4") high filled with red paint where engraving is indicated. Engraving shall be parallel to finished floor level.

*Standard of Acceptance*

- Pass & Seymour #93000 Series
- Harvey Hubbell of Canada Ltd. #93000 Series



- Bryant Electric #S600 Series
- Leviton #84000 Series
- Cooper #93000 Series

## 2.6 GROUND FAULT CIRCUIT INTERRUPTERS

- .1 Units shall be CSA approved Type A.
- .2 Ground fault circuit interrupters (GFCI) shall be complete with receptacle, test feature and reset switch.
- .3 Units shall include a 15A grounded duplex decora receptacle, a button to test operation of unit and current transformer and sensing mechanism. Unit to be complete with suitable outlet box.
- .4 Units in Hospitals to be hospital grade.
- .5 Unless noted otherwise, unit shall trip at 6 mA.
- .6 Where shown in outdoor locations, units shall be enclosed in weatherproof surface-mounted enclosures. In other locations units shall be furnished with stainless steel cover plate.

### *Standard of Acceptance*

- Pass & Seymour 1595HG
- Harvey Hubbell of Canada Ltd. GFR8200 Series
- Bryant Electric GF82 Series
- Leviton 7599-HG
- Cooper VGFH15

## PART - 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 Mount toggle switches at height specified in Section 26 05 01 - Electrical General Requirements or as indicated.
- .2 Receptacles
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height specified in Section 26 05 01 - Electrical General Requirements or as indicated.
  - .3 For each type of receptacle 20 ampere or larger, supply and hand to Owner two heavy duty caps.

- .4 For each type of receptacle 30 ampere or larger, supply and hand to Owner two heavy duty caps.
- .5 Connect receptacle grounding terminal to the outlet box with an insulated green ground strap.
- .6 Exact position of service fittings shall be verified to suit furniture layout.
- .7 Do not mount receptacles directly on a column, unless column has been appropriately furred, to avoid breaking fire barrier.
- .3 Cover Plates
  - .1 Protect stainless steel 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.
- .4 Install explosion proof wiring and devices in hazardous locations of Class, Division and Group as indicated on Drawings.
- .5 Ground fault circuit interrupters:
  - .1 Mount receptacles at height indicated in Section 26 05 01 - Electrical General requirements or as indicated.
- .6 Outlets in Movable Partitions
  - .1 Co-ordinate installation of outlet boxes and conduits with the particular trade involved.

**END OF SECTION**

## **OCCUPANCY SENSOR SWITCHES**

### **26 27 27**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 01 01, Electrical General Requirements.

##### **1.2 WORK INCLUDED**

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

##### **1.3 GENERAL DESCRIPTION**

- .1 The Lighting Control System is to be a complete motion sensing system. All components and services described herein are part of the Division 26 scope.
- .2 The system and services are comprised of, but not limited to, the following main components
  - .1 Power and auxiliary relay packs.
  - .2 Ultrasonic Occupancy sensors.

##### **1.4 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01300 - Shop Drawings, Product Data, Samples and Mock-ups and Section 26 01 01 Electrical General Requirements.
- .2 Drawings to include electrical detail of, relay type and quantity, ampacity, power supplies, enclosure construction and dimensions.
- .3 Submit typical wiring diagrams for all components including, but not limited to, relays, occupancy sensors.

##### **1.5 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 16010 Electrical General Requirements.

##### **1.6 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials as required and as specified in Section 26 01 01 Electrical General Requirements.

##### **1.7 OPERATING AND MAINTENANCE INSTRUCTIONS**

- .1 Provide operating and maintenance instructions as specified in Section 26 01 01 Electrical General Requirements.

## **PART - 2      PRODUCTS**

### **2.1            OVERVIEW DESCRIPTION**

- .1      The lighting control system consists of occupancy sensors and auxiliary relay packs.
  - Standard of Acceptance*
    - °      **Wattstopper** (or approved equal by Consultant)
- .2      Occupancy sensors, and relay packs shall be mounted in the spaces as indicated. Low voltage wiring from the switches and sensors to the relay packs shall be installed in conduit.
- .3      Each low voltage wire shall be labeled with the relay number at each switch or sensor. Use only properly color coded, stranded #20 AWG (or larger) wire. All relays and switches shall be tested after installation to confirm proper operation and the loads recorded on the directory card in each panel.

### **2.2            SYSTEM OPERATION**

- .1      Lighting in areas shown on drawings is to be turned on and turned off by the occupancy sensors after an adjustable 3 minute to 30 minute delay of no action within the space. The system is to be programmed so if there is activity detected by an occupancy in a room that is accessible via another room(s) and not the corridor, then the lights will remain on the adjacent room(s)

### **2.3            AUXILIARY RELAY PACKS**

- .1      Lighting control relay power packs shall have a 120-24 volt transformer for control of 120 volt lighting.
- .2      The power pack shall be plenum rated with teflon coated low voltage leads and plenum rated plastic housed in a ABS, UL-rated 94V-0 enclosure.
- .3      Switching the relay shall be accomplished with ONE signal wire and a common return. The signal wire shall be able to signal ON and OFF and shall also carry status current that indicates if the relay is ON or OFF.

### **2.4            EQUIPMENT IDENTIFICATION**

- .1      Provide equipment identification in accordance with Section 26 01 01 - Electrical General Requirements.

### **2.5            SWITCH PLATES**

- .1      Select switch plates to suit number of switches as shown on the plans. Up to 3 switches can be installed in a 1 gang box.
- .2      All switch plates are to be made of stainless steel

- .3 Provide switch plates for combination of low voltage switches and line voltage dimmer as shown on the drawings.

## 2.6 **OCCUPANCY SENSORS**

- .1 All ceiling mounted occupancy sensors to be ultrasonic, equal to Watt Stopper WT or UT-300 series.
- .2 Ceiling sensors shall be sized for the particular room controlled, with sufficient coverage area to permit site adjustment to particular occupancy patterns and room layouts.
- .3 All wall sensors are to be passive inferred, equal to Watt Stopper WA-200 series. Mount sensor at a high level above the latching side of the door. Wall sensors are to be complete with manual override.
- .4 Sensors to be integrated into the system that they can provide both on/off switching or off-only switching.
- .5 All sensors shall be directly compatible with the power and auxiliary relay packs described above and shall wire directly to the relays without any auxiliary components or devices above the ceiling.
- .6 Sensitivity and time delay adjustments shall be readily accessible to the user with LED indication of sensed movement to simplify set up.
- .7 User adjustable time delay shall be from 30 seconds to 30 minutes.

## 2.7 **SYSTEM START UP SERVICES**

- .1 Manufacturer to provide a factory authorized technician to confirm proper installation and operation of all system components.
  - .1 Typical wiring diagrams for each component.
- .2 Manufacturer to provide, install and commission system programming including:
  - .1 Wiring documentation
- .3 Notify Consultant and Commissioning Agent of testing schedule prior to any testing.

## **PART - 3 EXECUTION**

### 3.1 **INSTALLATION**

- .1 Provide motion sensing switching of the type designated in locations as shown on the drawings.
- .2 Provide wiring as recommended by the manufacturer. Low voltage wiring to local control devices to be installed in conduit. Adhere to manufacturer's recommendations as to maximum wire length and maximum quantity of relays per switch.

**END OF SECTION**

**WIRE AND BOX CONNECTORS 0-1000 V**  
**26 27 28**

**PART - 1 GENERAL**

**1.1 REFERENCES**

- .1 CSA C22.2 No.65-93 (R1999) Wire Connectors.
- .2 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

**PART - 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 copper conductors or bars
  - .2 Clamp for copper conductors or bars.
  - .3 Stud clamp bolts.
  - .4 Bolts for copper conductors or bars.
  - .5 Sized for conductors or bars as indicated or required.
- .4 Clamps or connectors for armoured cable, mineral insulated cable, and flexible conduit, as required.

**PART - 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Remove insulation carefully from ends of conductors and:
  - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
  - .2 Install fixture type connectors and tighten. Replace insulating cap.
  - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2.
  - .4 Install crimp type connectors.
- .2 Install box connectors.

**END OF SECTION**

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**DISCONNECT SWITCHES UP TO 1000 VOLTS  
26 27 33**

**PART - 1      GENERAL**

**1.1            REFERENCES**

- .1      CSA C22.2 No. 4-M89 Manual Switches.
- .2      CSA C22.2 No. 39 Fuse Holder Assemblies.
- .3      Section 26 28 13 Fuses - Low Voltage

**1.2            GENERAL REQUIREMENTS**

- .1      Conform to Sections of Division 1 as applicable.
- .2      Conform to Section 26 05 01, Electrical General Requirements.

**1.3            SHOP DRAWINGS AND PRODUCT DATA**

- .1      Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2      Nameplates shall be in accordance with Article "Equipment Identification".

**1.4            WORK INCLUDED**

- .1      Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

**1.5            OPERATION AND MAINTENANCE DATA**

- .1      Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

**1.6            MAINTENANCE MATERIALS**

- .1      Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

**1.7            OPERATING AND MAINTENANCE INSTRUCTIONS**

- .1      Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

**PART - 2      PRODUCTS**

**2.1            DISCONNECT SWITCHES**

- .1      Fusible and non-fusible disconnect switch in sprinkler proof EEMAC 3 enclosure, size as indicated.
- .2      2 pole or 3 pole as required for single phase or three phase circuits

- .3 2 pole with solid neutral or 3 pole with solid neutral for three wire and four wire circuits with neutral
- .4 6 pole for two speed motor applications
- .5 Provision for padlocking in off switch position.
- .6 Mechanically interlocked door to prevent opening when handle in ON position.
- .7 Fuses: size as indicated, to Section 26 28 13 - Fuses - Low Voltage.
- .8 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .9 Heavy Duty, quick-make, quick-break action.
- .10 ON-OFF switch position indication on switch enclosure cover.
- .11 Complete with auxiliary NO/NC contact for hydraulic elevator motors.

*Standard of Acceptance*

- Square D Company (Canada) Ltd.
- Cutler Hammer
- Siemens Canada Ltd.
- Federal Pioneer Ltd.

## 2.2 **THREE POLE DOUBLE THROW SWITCHES**

- .1 Non-fusible manual load transfer switch in sprinkler proof EEMAC 3 enclosure, size as indicated.
- .2 Continuous duty rated and suitable for switching HP loads
- .3 Visible blades for positive indication that switch is in the OFF position
- .4 Provision for padlocking in the centre OFF switch position, and in the ON positions.
- .5 Heavy Duty, quick make, quick break operating mechanism
- .6 Phenolic insulating bases
- .7 Compression lugs for switches over 100A
- .8 Mechanically interlocked door to prevent opening when handle in ON position.
- .9 ON-OFF-On switch position indication on switch enclosure cover.

*Standard of Acceptance*

- Square D Company (Canada) Ltd.

## 2.3 **EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Indicate name of load controlled on size 4 nameplate.



**PART - 3      EXECUTION**

**3.1            INSTALLATION**

- .1      Install disconnect switches complete with fuses.

**END OF SECTION**

## **HEADWALL UNITS – TYPES A1 & A2**

### **26 27 45**

#### **1 GENERAL**

##### **1.1 Product Data**

- .1 Submit product data in accordance with Section 16010 Electrical General Requirements.

##### **1.2 Shop Drawings and Product Data**

- .1 Submit detailed Shop Drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.

##### **1.3 Work Included**

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

##### **1.4 General Requirements**

- .1 Units shall provide grouped services as shown, as detailed and as required. They shall be pre-wired electrical and pre-piped medical gas outlets and space for nurse call system, telephone/ data systems, monitor systems, etc specified elsewhere.
- .2 Colour of insert panels for each unit will be selected at a later date. Note that each unit may have an individual insert panel colour. Submit a full range of colour chips for the Consultant's review. However, the Consultant reserves the right to select custom colours.
- .3 Conform to Sections of Division 1 as applicable.
- .4 Conform to Section 26 05 01, Electrical General Requirements.
- .5 Gas piping to unit will be connected by Contractor under Section 15.
- .6 Medical gas piping shall conform to latest edition of CSA Standard Z305.1.
- .7 Overall unit shall have CSA approval or carry Special Hydro Approval label.
- .8 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

#### **2 PRODUCTS**

##### **2.1 HEADWALL UNITS**

###### **1 General**

- .1 **The Headwall Units, Type 'A1' – Single Bed & Type 'A2' – Two Bed shall be wall mounted and extending from the finished ceiling line to 6" above the floor.**

- 
- .2 Refer to Drawings for overall arrangement.
- .3 The Headwall Units shall be factory equipped with all receptacles indicated and all internal wiring to labelled terminal strips in the units as part of the scope of supply, for field connection by Division 26 with the circuits indicated on the Electrical Drawings
- .4 Headwall Units Components
- .1 The Headwall Units shall have provision for nurse call system, communications devices, clocks and wiring. All Nurse Call and Code wired, and tested by Division 26.
- .2 All communications outlets for data will be supplied, installed, wired and tested as part of the work of Division 27. The Division 26 contractor will install all conduit systems as indicated from the units to the Hub Room.
- .3 Review the shop drawings for these systems and ensure adequate provisioning is being made to permit field installation of the specified devices.
- .4 The Headwall Units shall be factory equipped with all medical gas outlets and internal gas piping as part of the scope of supply. The DISS gas outlets shall be complete with indexed flexible hose assemblies connected to DISS check valves on the pre-assembled gas manifold.
- .5 Headwall Units shall be as manufactured by:  
**Class 1**
- .6 All Nurse Call, Code White and Code Blue system devices are to be supplied, installed on site,
- .7 Headwall Unit Construction Features:
- .1 Units shall be complete with structural frame, service panels, service chases, covers and other equipment as required.
  - .2 Units shall be of heat treated clear anodized aluminum extrusion base of unit construction with support members as required. Unit shall be complete with barriers and enclosed wireways to separate different electrical services.
  - .3 A fascia of high pressure laminate over 16 gauge galvanized steel shall run the full length of the unit and the service chases, punched with openings for the devices indicated. The devices and gas outlets shall typically be spaced on 125mm centres to provide adequate space for connection of services. Exact spacing and positioning of devices will be resolved as part of the shop drawing approval process
  - .4 Units shall be supplied as a complete unit with removable front panels. Units shall have all devices, except where noted, pre-wired and pre-piped. Wiring shall be terminated on junction boxes or terminal strips.
  - .5 The height is to be determined by the ceiling height of the specific room each Unit is to be installed in and the desired height of the Unit above the finished floor, as indicated on the Drawings.
  - .6 The front corners to include a universal aluminum extrusion track providing continuous adjustments points for accessory equipment.
  - .7 Front panels shall be formed in one piece to fit the base channel and shall have openings to receive electrical and medical gas outlets as required. Front panels shall be sectionalized to allow access to services.
  - .8 Unit shall be complete with mounting holes for fastening to wall structure.
  - .9 Channels or barriers shall be provided to separate normal and emergency power, as well as communication systems.
  - .10 Wiring shall be terminated at labelled junction boxes or terminal strips.

- .11 Medical gas piping shall:
  - .1 extend 150 mm above the top of the unit;
  - .2 fitted with plastic caps to prevent dirt from entering piping.
- .12 Electrical Components:
  - .1 Cover plates shall be Type #302 stainless steel with a #4 finish.
  - .2 Receptacles and switches to be in accordance with Section 26 27 26 Wiring Devices.
  - .3 Receptacles shall be Hospital Grade type - white for normal power, red if connected to emergency power.
  - .4 As noted on drawings, switches shall be 120 volts 20A silent type single pole for direct connection to lights
  - .5 Ganged outlet box with knock-outs for nurse call station, other call stations, code blue, elapsed timers, data outlet, monitoring outlet, and telephone outlets specified elsewhere.
  - .6 Wiring for **Units in Intermediate Patient Care areas shall** consist of #10 copper conductors with RW90 90°C X-Link insulation. A separate #10 green insulated grounding conductor shall be provided from each circuit to the grounding bar in the breaker panel.
  - .7 Components shall be mounted in suitable backboxes and shall have a common cover plate for services shown horizontally.
  - .8 Individual outlet boxes and EMT conduit shall be furnished for each electrical service item by Division 16.
- 13 Medical Gases
  - .1 Medical gas piping shall be copper hard temper Type "L" with wrought copper fittings.
  - .2 Joints shall be brazed with a silver solder conforming to the American Welding Society Specification BCUP5. Flux shall not be used. During brazing operation the pipe shall be filled with nitrogen to eliminate inside piping scaling.
  - .3 Make up threaded joints with sealing compound formulated specifically for the medical gas service involved.
  - .4 The tail pipe of the medical gas outlets shall be increased immediately from 6 mm as follows:
    - .1 to 12 mm for oxygen and medical air
    - .2 to 20 mm for medical vacuum
  - .5 Piping shall be labelled to prevent incorrect hook up.
  - .6 Upon completion of piping the piping shall be pressure tested to 1035 kPa and checked for leaks for means of an oxygen compatible commercial leak detector.
  - .7 Medical gas outlets shall be supplied and factory installed by the headwall manufacturer.
  - .8 Medical gas terminal units:
    - .1 Recessed wall outlets designed for concealed piping,

- .2 UL listed CSA approved,
- .3 DISS type,
- .4 rough in consisting of Type "K" 6.4mm copper inlet pipe stub silver brazed to 32mm diameter one piece brass outlet body
- .5 outlet bodies for positive pressure gas services fitted with primary and secondary check valves, and secondary check valve rated at 1379 kPa
- .6 factory assembled, tested, cleaned, and degreased,
- .7 fitted with screw connection interfaces of chrome plated brass for connecting hoses and equipment. White metal fittings will not be permitted.
- .8 identified by faceplate covers with coloured background coded for each medical gas service with English and French language printed service identification

### **3- EXECUTION**

- 1 Installation
- .1 Provide Headwall Units as shown and as specified.
- .2 Locate Units as detailed on Architectural Drawings
- .3 Verify final overall height prior to ordering.
- .4 Fasten units to wall/ ceiling support systems in accordance with the recommendations of the manufacturer.
- .5 Co-ordinate the nurse call space requirements with the equipment supplier.
- .6 Co-ordinate the telephone, data, and monitoring system requirements with Division 27. Provide conduits, outlet and junction boxes, and coverplates.
- .7 Provide all conduit, boxes and wiring within Units for the devices factory provisioned as part of the Unit.
- .8 Provide and field install in the units the indicated nurse call stations, code white, code blue stations, clock, etc. as indicated, each in accordance with the requirement of the applicable specification section. Provide all conduit, boxes and wiring within the units for these devices.
- .9 Connect wiring from the unit to the required electrical services such as receptacles.
- .10 Provide a separate #10 green ground conductor for each normal and for each emergency outlet installed in the same conduit which supplies the circuit conductors to the ground bars of the respective panels supplying the outlets.
- .11 Provide and install lamacoid circuit identification labels for each receptacle.
- .12 All testing for wiring and electrical devices is to be included as part of the work of Division 16
- .13 Installation of medical gas piping up to the unit will be by Division 15. Medical gas piping internal to the unit will be factory installed and pre-tested by the headwall manufacturer. Testing of the overall medical gas installation is part of the work of the Division 15 Contractor.

**END OF SECTION**

## **FUSES – LOW VOLTAGE**

### **26 28 13**

#### **1.1 GENERAL**

#### **1.2 REFERENCES**

- .1 To CAN/CSA Standard C22.2 No. 106-M90.

#### **1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 26 05 01.
- .2 Submit fuse performance data characteristics for each fuse type and size above 200 A. Performance data to include: average melting time-current characteristics,  $I^2t$  (for fuse coordination), and peak let-through current.

#### **1.4 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Section 26 05 01.
- .2 Six spare fuses of each type and size installed up to and including 600 A.

#### **1.5 DELIVERY AND STORAGE**

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in motor control centres, or disconnect switches.
- .3 Store fuses in original containers in storage cabinet.

### **PART - 2 PRODUCTS**

#### **2.1 FUSES GENERAL**

- .1 Fuse type references L1, L2, J1, R1 etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer
- .3 Fuses rated to 600A shall be CSA certified HRCI-J.
- .4 Fuses rated 601A and above shall be CSA certified HRCI-L.

#### **2.2 FUSE TYPES**

- .1 HRCI-J fuses, current limiting, time delay, with blown fuse indication

##### *Standard of Acceptance*

- Ferraz Shawmut: Amptrap 2000 type AJT
- Bussman: LPJ
- Littlefuse: JTD ID series

- .2 HRCI-L fuses, current limiting, time delay.

##### *Standard of Acceptance*

- Ferraz Shawmut: Amptrap 2000 type A4BQ

- Bussman: KRP-C
- Littlefuse: KLPC Series Power-Pro

## 2.3 FUSE STORAGE CABINET

- .1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door finished in accordance with Section 26 05 01 - Electrical-General Provisions.

## PART - 3 EXECUTION

### 3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Provide a spare set of six fuses of each size and type installed on the project [and turn over to Owner] [and locate in fuse storage cabinet].
- .5 Mount fuse storage cabinet on wall [in main electrical room] [in maintenance shop] [as directed on site by Owner's maintenance personnel]

**END OF SECTION**

## **MOULDED CASE CIRCUIT BREAKERS**

### **26 28 16**

#### **PART - 1 GENERAL**

##### **1.1 REFERENCES**

- .1 CAN/CSA C22.2 No. 5.1. Moulded case circuit breakers.

##### **1.2 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

##### **1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2 Nameplates shall be in accordance with Article "Equipment Identification".
- .3 Include time-current characteristic curves for breakers with ampacity of 200 A and over or with interrupting capacity of 22,000 A symmetrical (rms) for 120/208 volt and 25,000 A symmetrical (rms) for 600 volt..

##### **1.4 WORK INCLUDED**

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

##### **1.5 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

##### **1.6 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

##### **1.7 OPERATING AND MAINTENANCE INSTRUCTIONS**

- .1 Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

#### **PART - 2 PRODUCTS**

##### **2.1 BREAKERS GENERAL**

- .1 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation.
- .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 to range from 5 - 10 times current rating.

- .4 Circuit breakers with interchangeable trips over 150 A.

- .5 25,000 Amps symmetrical interrupting rating at 600 volts

## 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 a 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 phase, ground fault and short circuit protection

## 2.4 **FEATURES**

- .1 Include
  - .1 on-off locking device
  - .2 handle mechanism

## 2.5 **ENCLOSURE**

- .1 Mount individually mounted breakers in CEMA 3 enclosure.

## **PART - 3 EXECUTION**

### 3.1 **INSTALLATION**

- .1 Install circuit breakers as indicated.

**END OF SECTION**

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**GROUND FAULT CIRCUIT INTERRUPTERS**  
**26 28 19**

**PART - 1      GENERAL**

**1.1            SHOP DRAWINGS AND PRODUCT DATA**

- .1      Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.

**PART - 2      PRODUCTS**

**2.1            BREAKER TYPE GROUND FAULT INTERRUPTER**

- .1      Single or Two pole ground fault circuit interrupter for 15A, 120 or 208V, 1 phase circuit c/w test and reset facilities.

**2.2            RECEPTACLE TYPE GROUND FAULT INTERRUPTER**

- .1      Unit shall include a 15A grounded duplex receptacle, a button to test operation of unit and current transformer and sensing mechanism. Unit to be complete with suitable outlet box.
- .2      Units in Hospitals to be hospital grade.
- .3      Unless noted otherwise, unit shall trip at 6 mA.
- .4      Where shown in outdoor locations, units shall be enclosed in weatherproof surface-mounted enclosures. In other locations units shall be furnished with stainless steel coverplates.

*Standard of Acceptance*

- Bryant #GFR82 Series
- Pass & Seymour #2091-S
- Hubbell #GF8200 Series

**PART - 3      EXECUTION**

- .1      Installation
- .2      Provide dedicated branch wiring neutral conductor for each individual breaker type ground fault interrupter.
- .3      Do not ground neutral on load side of ground fault relay.
- .4      Connect wiring to equipment in accordance with manufacturer's recommendations.

**3.2            FIELD QUALITY CONTROL**

- .1      Perform tests in accordance with Section 26 05 01 - Electrical - General Requirements.
- .2      Demonstrate simulated ground fault tests.

**END OF SECTION**

## **LIGHTING**

### **26 51 13**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL REQUIREMENTS**

- .1 Conform with the requirements of Section 26 05 01 Electrical General Requirements.

##### **1.2 WORK INCLUDED**

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.

##### **1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Section 26 05 01 Electrical General Requirements - Shop Drawings and Product Data.
- .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Consultant.
- .3 Photometric data to include:
- .4 Total input watts, candlepower summary, candela distribution zonal lumen summary, luminaire efficiency, CIE type, coefficient of utilization, lamp type and lumen rating in accordance with IESNA testing procedures.

##### **1.4 REQUIREMENTS**

- .1 Luminaires shall not be delivered to building or stored therein until dry and protected space is available for proper storage of luminaires.
- .2 Submit samples of luminaires which are not catalogue items for approval. Additional luminaires shall not be manufactured until sample has been approved. Each approved sample shall be retained on job site until final completion of project. Luminaires which do not match quality and workmanship of standard sample will be rejected.
- .3 Finishes of luminaires, as specified in the "Luminaire List" must be maintained. Where the description of the luminaire directs a "colour/ finish to suit Architect" it is to be understood that during construction the final colour/finish will be selected. The Architect must be permitted to make their choice from a standard colour/finish range but the selected colour will apply to all of the particular type of luminaire unless otherwise specified.
- .4 "Allowances" when shown, are in Canadian dollars and cover the cost of the lighting luminaires and lamps. Allowances do not include applicable taxes, delivery to the site, handling, installation, overhead or profit.

##### **1.5 SUBSTITUTIONS**

- .1 Luminaires included under this Section are specified by approved manufacturer and type. Furnish equipment, as specified, unless substitutions are mutually agreed upon, as follows:
- .2 During the construction period, no substitutions shall be considered unless compelling reasons are given such as inability to meet delivery schedule. This reason shall not be acceptable if delay is caused by Contractor's failure to order luminaires in accordance with

the schedule. In such cases, it is the Contractor's responsibility to provide luminaires as specified without delay to the project and without additional cost to the Owner.

- .3 Substitutions shall be named, samples, catalogue cuts and complete photometric reports submitted, and cost savings documented. Submit a written request for proposed luminaires to be substituted to Lighting Consultant at least two weeks before the end of the bid period. Make the request an alternate, separate proposal, accompanied by complete descriptive and technical data. Indicate addition or deduction from the base bid. Substitutions proposed less than two weeks before the end of the bid period, or not including proper documentation shall not be considered. Lighting Consultant shall accept or reject proposed substitutions.
- .4 Where proposed substitutions alter functional or visual design, or change the space requirements or mounting details indicated here or on the drawings, detail such changes in the proposal and include costs for revised design and construction for trades involved.
- .5 Reimburse Consultant and Sub-Consultants for costs of evaluating proposed substitutions, after the bid period, whether or not such substitutions are accepted.

## **PART - 2 PRODUCTS**

### **2.1 GENERAL**

- .1 Similar luminaires shall be products of same manufacturer.
- .2 Luminaires shall be suitable for individual or continuous mounting.
- .3 Supply recessed luminaires, where installed in plaster or in acoustic ceilings, complete with plaster trim frame or ring and mounting brackets.
- .4 Fluorescent troffers in ceiling shall be equipped with adjustable mounting brackets.
- .5 Luminaires shall be completely assembled in factory and shall be delivered to building in cartons or in palletized form, as directed.

### **2.2 LAMPS**

- .1 Light Emitting Diodes (Accent/Decorative)
  - .1 Greater than 50 lumens per watt
  - .2 30 to 40 lumens per watt (3200°K)
  - .3 0.5 to 1 watt per LED chip
  - .4 Bin number requirements for colour temperature consistency
  - .5 Maximum temperature at the base of the "LED cap" mounted to the sub-strate shall be controlled to ensure full lamp life.
  - .6 Warranty: 5 years

*Standard of Acceptance* LED Drivers shall be high frequency to prevent "FLICKER"

*Standard of Acceptance - Driver Acceptance*

- Advance
- Lite Tech
- VLM (Italy)
- Lumi-Drives (UK)
- Osram

*Standard of Acceptance - Lamp Acceptance:*

- Cree
- Lumileds
- Nichia
- Osram

**2.3 LENSES**

- .1 K12 distribution acrylic lenses. 3.2mm (125") thick, shall have a recessed prismatic pattern of 5mm (3/16") square based female cones running 45° to the parallel and perpendicular axis to the panel. Panel shall be made of ultraviolet inhibited injection moulded clear virgin acrylic.
- .2 Panels shall be strain-free and uniform in production. There shall be no fade-outs or streaks to detract from job performance.
- .3 Lenses shall be low brightness, sparkling crystal panel that provides maximum efficiency and good brightness control in the direct glare zone.

*Standard of Acceptance*

- A.L.P. Lighting and Ceiling Products
- I.C.I. Acrylics Canada Inc.
- Holophane Canada Inc.

**PART - 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated.
- .2 Locate hangers on tile centres or intersections. Mount recessed incandescents, troffers and surface mounted luminaires in or on full tiles.
- .3 Verify quantity of luminaires before placing orders.
- .4 Verify ceiling types with the latest revised Architectural Drawings and order luminaires to suit the correct ceiling.
- .5 Check lighting luminaires and mountings for their electrical and physical characteristics in relation to conditions due to building construction and mechanical equipment. Make necessary adjustments to luminaires or hanging arrangement without expense to Owners. Give notification at time of shop drawings and before construction if decision on necessary changes is required.
- .6 Co-operate with other trades to ensure proper installation of lighting luminaires.
- .7 Carefully align luminaires, shown in continuous lines or rows, so that rows appear as straight lines.
- .8 Mount luminaires perfectly level or plumb. Luminaires shall fit tightly to ceiling without showing a space or light leak between frame and ceiling.
- .9 Take down any improperly installed luminaires and re-install without expense to Owner.
- .10 Standard octagonal boxes may be supplied where conduits feeding luminaires in finished areas are exposed on ceiling if hanger canopies entirely cover outlet boxes and are neatly notched for conduit. Otherwise, provide cast conduit outlet boxes with a diameter larger than canopies.

- .11 Attach boxes or hickies directly to poured concrete with 6mm (¼") minimum diameter bolts and lead expansion anchors where luminaires are suspended directly from concrete slabs. Use 8mm (5/16") minimum bolts through precast slabs, welded to 100mm x 100mm (4" x 4") minimum, 3.5mm (10 gauge) plate above slabs.
- .12 Do not mount luminaires above pipes, ducts or equipment. In event of unavoidably tight locations, provide hangers to clear obstructions. Check layouts of other trades on job and plan co-operatively. Luminaires in any room shall hang at one height. Obtain approval before any changes are made to layouts shown
- .13 All luminaires mounted in or on ceilings shall be supported independently of ceiling by means of chains.
- .14 Provide continuous 12mm x 38mm (½" x 1½") channel above the ceiling, where luminaires are suspended or mounted on furred ceilings. Fasten luminaires to channel with two 6mm (¼") minimum diameter studs with minimum 1220mm (4'- 0") on centre.
- .15 Luminaires installed in or on "T" bar ceilings shall be equipped with safety chains anchored in an approved manner to the floor slab or roof structure above. Fluorescent luminaires shall have two chains, each supporting two corners of the luminaire. Chain shall be #10 Tensile jack chain, installed as noted below.
- .16 Chain shall be No. 10 Tensile jack chain, bright zinc coated, with a strength of 180 kg (400 lbs.) where luminaires are indicated to be chain hung. Attachments shall be made using a No. 10 "S" hook. Caddy fasteners may be used where applicable. "S" hooks must be closed after installation.
- .17 Industrial luminaires where suspended shall be 12mm (½") conduit hangers and ARB ball aligners. Length and location shall clear equipment, ducts and pipes. Metal strut (Flexibar or equal) may be used for mounting of luminaires in mechanical areas and electrical rooms.

### 3.2 **LIGHTING LUMINAIRES**

- .1 Provide lighting luminaires exactly as shown and as specified in the following schedule. Luminaires shall be complete with necessary accessories and lamps at time of acceptance.
- .2 All luminaires shall be ULC or CSA certified.
- .3 Each fluorescent luminaire installed on branch circuits with voltage exceeding 150 volts-to-ground shall be provided with a disconnecting means integral to the luminaire that simultaneously opens all circuit conductors between the branch circuit conductors and the supplying ballast(s) and marked in a conspicuous, legible and permanent, manner adjacent to the disconnecting means, identifying the specific purpose in accordance with the Canadian Electrical Code Part 1 Rule 30-308(4).

### 3.3 **LUMINAIRE LIST**

- .1 Luminaire manufacturers are listed in alphabetical order and not in order of preference.

Title	Description	Lamp Schedule
LA	<p>Recessed 2'-0" x 4'-0" LED Ambient luminaire. Luminaire shall be complete with die-formed steel housing and reflector with a post painted powder coat painted in matte white colour, one piece lens door assembly. Luminaire shall be suitable for a <u>'T'-bar ceiling</u>.</p> <p>Minimum L70 for 150,000 hours</p> <p>Luminaire shall include 0-10volt dimmable LED Driver</p> <p>Voltage: 120 volt</p> <p>Manufacturers:  BJ Take BLRD-2X4-4L-935-120-B11-XX - Canadian manufacture</p> <p>Note:  Include in the Contract an additional TWO (2) spare Type 'LA' luminaires including installation (include an average of 20'0" of wire in conduit for each additional luminaire and connection to an adjacent circuit). Assume, for bidding purposes, that these luminaires can be added at any time during construction including at the end of the construction and in any location as directed on site. Any luminaires not installed shall be turned over to the Hospital</p>	4000 Lumen, 3500K LED
LA-1	<p>Recessed 1'-0" x 4'-0" LED Ambient luminaire. Luminaire shall be complete with one piece lens door assembly, with a post painted powder coat painted in matte white colour. Luminaire shall be suitable for a <u>'T'-bar ceiling</u>.</p> <p>Minimum L70 for 150,000 hours</p> <p>Luminaire shall include 0-10volt dimmable LED Driver</p> <p>Voltage: 120 Volt</p> <p>Manufacturers:  BJ Take BLRD-1X4-4L-935-UNV-B11-XX - Canadian manufacture</p>	4000 Lumen, 3500K LED
LA-2	<p>Recessed 1'-0" x 4'-0" LED Ambient luminaire. Luminaire shall be complete with one piece lens door assembly. Luminaire shall be suitable for a <u>Drywall ceiling</u>.</p> <p>Luminaire shall include 0-10volt dimmable LED Driver</p> <p>Voltage: 120 Volt</p> <p>Manufacturers:  BJ Take BLRD-1X4-4L-935-UNV-B11-H40-XX - Canadian manufacture</p>	

Title	Description	Lamp Schedule
LB-L LB-R	<p>Wall mounted, 4'-0" long x 5" high LED bed light. The upward and downward lamp housing shall be UV Stabilized, high impact frosted acrylic lenses securely fixed in an aluminum housing with a powder coated finish.</p> <p>Luminaire to include four lamp up-light and four lamp down-light and complete with a four sequence built-in pullcord control of the up-lights and down-lights. The pullcord for the up-light, down-light lighting control shall be on the opposite side of the Night Light</p> <p>Luminaire shall have a built in LED Night Light, located on the LEFT (L) or RIGHT) as noted in the Type definition and when facing the light and complete with a built-in pullcord controlling the night light.</p> <p>The luminaire housing shall be constructed of Marine grade aluminum body with die cast end caps. C/W UV Stabilized High Impact resistant extruded pearlescent polycarbonate lens, smooth exterior, fluted interior, 0.125" thick.</p> <p>This Luminaire shall also provide a safety feature of controlled power shut-off to the motorized bed to prevent I.V. rod/traction equipment hazard to luminaire. The safety circuit shall incorporate two momentary contact switches which are operated by pressure being applied to lower lens of the luminaire. When either of the safety switches are triggered, power shall be shut off to the bed receptacle.</p> <p>Luminaire finished in "antimicrobial matte finish" in a colour to suit Architect's colour selection. Assume the architect might select more than one colour for different Luminaires. Provide a colour chart for standard finishes available.</p> <p>Voltage: 120 volt</p> <p>Manufacturers:  BJ Take # BLB-4'-4L-835-4L-835-N835-120V-L99-S2-NS1LA/ NS1RA  (night light left/ right) – SES - Canadian manufacturer</p> <p>Note:  Include in the Contract an additional TWO (2) spare Luminaires, one being a Type 'LB-L' and one being a Type 'LB-R luminaires including installation (include an average of 20'0" of wire in conduit for each additional luminaire and connection to an adjacent circuit). Assume, for bidding purposes, that these luminaires can be added at any time during construction including at the end of the construction and in any location as directed on site. Any luminaires not installed shall be turned over to the Hospital</p>	integral 2 X 4 x 835 lumen, 3500 degree K LED



Title	Description	Lamp Schedule
LC	<p>Recessed 4" (nominal) round, lensed, LED downlight. Luminaire to have low profile aluminum housing , black anodized aluminum passive heat sink and with matte white reflector and white self-flanged trim and regressed frosted lens</p> <p>Luminaire shall be CUL Listed for damp locations and suitable for a drywall or T-bar ceiling.</p> <p>Luminaire shall include electronic 0-10V, 1% to 100% dimmable LED Driver</p> <p>Voltage : 120 volt</p> <p>Manufacturer:</p> <p>Atlantic Lighting: #COM4-SYL15-35K-120-9CR-4CMFR-XX</p> <p>Note:  Include in the Contract an additional TWO (2) spare Type 'LC' luminaires including installation (include an average of 20'0" of wire in conduit for each additional luminaire and connection to an adjacent circuit). Assume, for bidding purposes, that these luminaires can be added at any time during construction including at the end of the construction and in any location as directed on site. Any luminaires not installed shall be turned over to the Hospital</p>	1500 lumen, 3500K LED with a CRI of 90
LD	<p>Existing Cove Lighting modernization. Contractor is to remove the existing cove louvre and fluorescent striplights and install new linear LED Lighting and new cube louvre</p> <p>Re-connect new lights to existing circuiting</p> <p>Voltage: 120 volt</p> <p>Manufacturer:  LinmoreLED #AL-STI-3/4-35K-36W-DF</p> <p>New louvre shall be a continuous (assume 60" length but confirm on site) combination panel of 12" wide (confirm width on site), 1" x 1" x 1" major cell and 1/2" x 1/2" x 1/2" high minor cell white metal interleaved louvre with 45° cut-off for the entire cove. Supports supplied under another Division.</p> <p>Manufacturers: Electra "Luma Mod" or Intalite "Check-Cel"</p>	

Title	Description	Lamp Schedule
LE	<p>Surface mounted LED undercabinet luminaire. Luminaire shall be 48" long suitable secured to the underside of the metal shelf, Extruded aluminum housing, soft focus lensing and 350mA operating current. LED spacing is 100mm along length of extrusion. Nominal dimensions of 22mm width x 8mm height. Run lengths shown on drawings, install as per manufactures instructions for even illumination on task surface.</p> <p>Luminaire to be complete with Remote Driver. Electrical Contractor to locate the power supply in an inconspicuous location and to coordinate driver location with architect and manufacturer, and shall provide all mounting hardware and assembly requirements for installation</p> <p>Voltage: 120 volts</p> <p>Manufacturers:</p> <p>Capri #CUCL Series  Revlite Technologies Inc. # Series 5 - #3014X  Danalite: # DL100 Series  Acolyte # Channel: CHAS1-M-HOUSING COLOUR XX + Ribbonlyte: RB-90-XACTA20-1.530-6FT or 8ft + Driver: DRVRFWDVW2490120</p>	<p>1.2 Watt  LED  3000 K</p>
LF	<p>Recessed 6" (nominal) round LED downlight complete with clear polycarbonate lens and 0-10 volt dimming driver.</p> <p>Luminaire shall be suitable for a drywall or T-bar ceiling.</p> <p>Voltage : 120 volt</p> <p>Manufacturer:  Atlantic Lighting #COM6-SYL30-35K-120-9CR-6CM10-XX</p> <p>Note:  Include in the Contract an additional TWO (2) spare Type 'LF' luminaires including installation (include an average of 20'0" of wire in conduit for each additional luminaire and connection to an adjacent circuit). Assume, for bidding purposes, that these luminaires can be added at any time during construction including at the end of the construction and in any location as directed on site. Any luminaires not installed shall be turned over to the Hospital</p>	<p>3000 lumen, 3500K  LED with a CRI of 90</p>

Title	Description	Lamp Schedule
LG	<p>Suspended or Surface Mounted, industrial type luminaire (+/- 50" long x 8" wide). Luminaires shall be suspended from ceiling/structural steel at a height that avoids interference with mechanical/electrical equipment. Mount luminaires with a chain suspension system.</p> <p>Luminaire must include a frosted lens and a minimum L70 for 150,000 hours</p> <p>Voltage: 120 volt</p> <p>Manufacturers:  BJ Take #BLV-4-5.5-840-120-L18  Pioneer #STO-0850-5.4L-3500-UNV</p>	39 watt, Integral 3500K LED
LH	<p>Recessed LED Shower Light with dropped opal lens, white trim ring and suitable for installation in a wet location.</p> <p>Luminaire complete with 0-10 volt dimming driver and to be suitable for installation in a drywall ceiling</p> <p>Voltage: 120 volt</p> <p>Manufacturer:  Atlantic #LED7-DLM15-35K-1-7LEDDO-WH</p>	1500 Lumen, 3500K LED
LJ	<p>Recessed incandescent Infrared Heat Lamp with enamelled aluminium housing, heat dissipating surfaces and white seamless aluminium trim and gasketed Fresnel lens.</p> <p>Luminaire to include a rustproof housing that exceeds 1000 hours of 5% salt spray test, a specular alzak aluminum reflector. Luminaire to include thermal protection that provides high temperature automatic cut-off</p> <p>Luminaire to be suitable for installation in a drywall ceiling</p> <p>Voltage: 120 volt</p> <p>Manufacturer:  Kirlin #MRR-09740-LP</p> <p>Contractor to provide a flush mounted adjustable 0 to 15 minute remote timer control</p>	175 watt, PAR38 infrared lamp

Title	Description	Lamp Schedule
LK	<p>Surface Mounted LED Striplight, 48" long. Luminaires ceiling surface mounted and complete with white coloured wire guard</p> <p>Voltage: 120 volt</p> <p>Manufacturers: BJ Take #BLSP-4-2.5-840-120-G1</p>	2500 Lumen, 3500K LED
LL	<p>Wall mounted 8"x 12" x 2" deep (nominal) L.E.D. luminaire sign with custom wording to read as follows: <b>"ROOM OCCUPIED"</b>. Luminaire shall be constructed of extruded aluminum. Message shall be red letters screened onto a black background and complete with "black-out" feature. Frame to be black. Verify mounting height with Architect prior to installation.</p> <p>Voltage: 120V</p> <p>Manufacturer:</p> <p>Beghelli #BE2000 "ROOM OCCUPIED"  Emergi-lite #CLLPEX52B-120V "ROOM OCCUPIED"  Lumacell #LE450SW "ROOM OCCUPIED"/Back/Blank out of face</p> <p>Notes:  Luminaire shall have double the amount of LED's that are standard. They will require a strip of High Brightness LED's on the top as well as on the bottom of the interior of the luminaire.  Wording must not be visible when light is "off" and must be readily visible when light is "on".</p>	

Title	Description	Lamp Schedule
X	<p>L.E.D. edge lit, wall mounted exit sign, with <b>RECESSED</b> trim plate shall be constructed of brushed aluminum. Faceplate stencil without arrows will be required</p> <p>Voltage: 120 volt</p> <p>Manufacturers:</p> <p>Beghelli "Guida Series"  Lumacell "LER 1100 Series"  Emergi-lite, Uniglo, Ready-Lite, Dual-lite, Stanpro &amp; Aimlite equal</p> <p>Notes:</p> <ol style="list-style-type: none"> <li>Exit sign shall not exceed 5 watts (including transformer).</li> <li>Exit lights shall be listed to CSA Standard #C860.</li> </ol> <p>Note:</p> <p>Include in the Contract an additional TWO (2) spare Type 'X' luminaires including installation (include an average of 20'0" of wire in conduit for each additional luminaire and connection to an adjacent circuit). Assume, for bidding purposes, that these luminaires can be added at any time during construction including at the end of the construction and in any location as directed on site. Any luminaires not installed shall be turned over to the Hospital</p>	
X1	<p>Universal (Running man) green L.E.D. all climate exit sign. The surface mounted exit sign shall be constructed with a polyvinyl chloride enclosure to ensure protection from high abuse environments, vibrations, strong impacts, water and temperature fluctuations.</p> <p>The exit sign shall be surface mounted where shown in drawings.</p> <p>Voltage: 120 volt</p> <p>Manufacturers:</p> <p>Emergi-lite LPEX Series  Lumacell LER 3000 Series  Equals: Uniglo, Ready-Lite, Dual-lite, Aimlit</p> <p>Notes:</p> <ol style="list-style-type: none"> <li>Exit sign shall not exceed 3 watts.</li> <li>Exit lights shall be listed to CSA Standard #C860.</li> </ol>	

**END OF SECTION**

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**UNIT EQUIPMENT FOR EMERGENCY LIGHTING**  
**26 52 00**

**PART - 1      GENERAL**

**1.1            REFERENCE**

- .1      CSA C22.2 No. 141 Unit Equipment for Emergency Lighting.

**1.2            GENERAL REQUIREMENTS**

- .1      Conform to Sections of Division 1 as applicable.
- .2      Conform to Section 26 05 01, Electrical General Requirements.

**1.3            SHOP DRAWINGS AND PRODUCT DATA**

- .1      Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2      Nameplates shall be in accordance with Article "Equipment Identification".

**1.4            WORK INCLUDED**

- .1      Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

**1.5            OPERATION AND MAINTENANCE DATA**

- .1      Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

**1.6            MAINTENANCE MATERIALS**

- .1      Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

**1.7            OPERATING AND MAINTENANCE INSTRUCTIONS**

- .1      Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

**1.8            WARRANTY**

- .1      For batteries, the 12 months warranty period is extended to 120 months, with a no-charge replacement during the first 60 months and a pro-rate charge on the second 60 months.

**1.9            TESTING**

- .1      Conduct witnessed testing of battery lighting systems including disconnecting power to each battery unit for the minimum length of time required for full run down time and verify each and every light head. Record exact length of time the battery maintains the full lighting and "certify" both the battery life and remote lighting operation. Notify Consultant and Commissioning Agent of testing schedule prior to conducting tests.
- .2      Submit test reports directly to the Consultant and the Commissioning Agent.

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**PART - 2      PRODUCTS**

**2.1            EQUIPMENT**

- .1      Supply voltage: 120 V, AC.
- .2      Output voltage: 12 V DC.
- .3      Operating time:
  - .1      12 volt units: 180 watts for 60 minutes.
- .4      Battery: sealed, maintenance free, lead acid or lead calcium.
- .5      Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected. Unit shall have externally accessible means for testing of unit and shall have two lamps indicating A.C. on, and high charge. Unit shall include a low voltage cut-off protection circuit and self diagnostic auto test.
- .6      Solid state transfer.
- .7      Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8      Signal lights: solid state, life expectancy 100,000 h minimum, for 'AC Power ON' and 'High Charge'.
- .9      Lamp heads: integral on unit and remote, 360° horizontal and 180° vertical adjustment.
- .10     Lamp type (integral and remote):
  - .1      Finished Areas:
    - (a) Wall mounted adjustable type LED, 12 VDC, glare free mounted in a Lexan cube approximately 113 mm square
- .11     Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12     Cabinet finish: Painted steel enclosure
- .13     Units shall include "Flasher" remote test system with one hand-held controller.
- .14     Auxiliary equipment for central battery units:
  - .1      Ammeter.
  - .2      Voltmeter.
  - .3      Lamp disconnect switch.
  - .4      Test switch.
  - .5      Time delay relay.
  - .6      Battery disconnect device.
  - .7      ac input and dc output terminal blocks inside cabinet.
  - .8      Shelf.
  - .9      RFI suppressors.

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**2.2 WIRING OF REMOTE HEADS**

- .1 Conduit: type EMT, to Section 26 05 33 - Conduits Fastenings and Fittings.
- .2 RFI suppressors.
- .3 Conductors: RW90 type to Section 26 05 19 - Wires & Cables 0-1000 Volts, sized in accordance with manufacturer's recommendations.

*Standard of Acceptance*

- Emergi-Lite
- Lumacell Inc.
- Beghelli

**PART - 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Provide complete emergency battery lighting system as shown and specified.
- .2 Unless otherwise noted, mount units on the wall 2440mm above floor. Unit shall be hardwired to source. Provide lock-on devices on breakers.
- .3 Where heads are shown remote from unit, provide suitable outlet box at 2440 mm and install head. Connect with conduit to battery and charger unit. Wire size to suit manufacturer's recommendations, but not less than #10 gauge, and for a minimum of 3% voltage drop at remote heads. Ensure remote head wiring lengths are reviewed with manufacturer prior to installation. Voltage drops will be tested by Engineer and Building Inspector. Replace any wiring not passing the 3% voltage drop test with new size and retest.
- .4 Direct heads as indicated. Allow for re-adjustment of head directions as requested by Consultant after completion of emergency light review.

**END OF SECTION**



**INTERCOM SYSTEM**  
**27 05 14**

**PART 1 - GENERAL**

- 1.1 Overview
  - .1 Local Intercom Systems shall consist of Intercom Stations, Power Supply and necessary interconnecting cables. Intercom System shall include communication from the Master Station to each Remote Stations. Master Stations are to include a remote door release control
- 1.2 General Requirements
  - .1 Conform to Sections of Division 1 as applicable. Conform to Section 16010, Electrical General Requirements. The system shall be CSA and/or UL approved Standard 1069 Hospital Signaling Equipment.
  - .2 Transistors, capacitors, integrated circuits, and other components shall not be operated to exceed their rated values. Design systems for 24-hour continuous operation.
- 1.3 Shop Drawings and Product Data
  - .1 Submit shop drawings and product data in accordance with Section 01300 - Shop Drawings, Product Data, Samples and Mock-ups and Section 16010 Electrical General Requirements.
- 1.4 Work Included
  - .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.
  - .2 System as provided by the manufacturers will include the following:
    - .1 Control equipment including auxiliary power supplies.
    - .2 All system equipment and devices.
    - .3 All wiring required for complete system operation.
- 1.5 Operation of the Intercom System
  - .1 To originate a call, a person shall depress a single "call" button.
  - .2 This shall automatically and simultaneously cause the following to occur:
    - .1 Visual and audio signals shall be activated at the remote stations.
    - .2 Visual indication shall be provided at the calling station showing that the call has been placed.
    - .3 Audio & Visual indication shall be provided in the Pharmacy showing that a call has been placed.
    - .4 Necessary circuitry shall be activated to permit a two-way conversation to take place.
  - .3 When the called station is not in a "private" position, it shall now be possible for both parties to engage in a two-way conversation without the need to operate any buttons or controls. At the end of the conversation, either party shall be able to cancel the call.
  - .4 Call cancellation shall be possible by pressing a suitable "Cancel" or "Reset" button, or
  - .5 A called station hall be able to respond to a call by speaking into the built-in speaker microphone

## **PART 2 - PRODUCTS**

- 2.1 Stations
- .1 Stations shall be wall mounted
  - .2 Stations shall incorporate the following features and facilities:
    - .1 Sturdy modern style appearance and colour
    - .2 Solid state circuitry
    - .3 Built-in device to provide tone signal for incoming calls, called station on Privacy, speech channel available.
    - .4 Built-in lights to announce incoming calls or busy exchange.
    - .5 Talk-Listen or Press-To-Talk, Release-To~Listen button.
    - .6 High quality microphone housed behind grille enabling person to answer incoming calls from anywhere within the room.
    - .7 High quality speaker or speakers housed behind grille set to an adequate volume level enabling person called to receive voice message anywhere within the room.
    - .8 Cancel or Release button
    - .9 Privacy button
    - .10 Volume control
- 2.2 Power Supplies
- .1 The operating voltage shall be obtained from a line supply of 100 - 120 volt, 60 Hz and shall permit satisfactory operation of the exchange with line voltage variations of plus and minus 10%.
- 2.3 Wiring
- .1 Provide all wiring, conduits, pull boxes, accessories, required for a complete intercom system as shown on the Drawings and specified herein.
  - .2 No lubricants other than talc shall be used while drawing wires into the conduit. No spliced joints shall be used on wiring.
- 2.4 **Manufacturer / Supplier**
- .1 **The system shall be:**  
**Aiphone 'JP' Series c/w Video, Intercom & Remote Release Control and be as supplied by: Aatel Communications**

## **PART 3 - EXECUTION**

- 3.1 Installation
- .1 Provide a complete intercom system as shown on Drawings and as specified.
  - .1 Wall mounted stations shall be arranged 1350 mm above floor.
  - .2 Install ceiling Speakers/ Microphones flush in the ceiling
  - .3 Wiring to stations shall be installed in conduit in accordance with the recommendations of the equipment supplier. Wiring shall consist of multi-conductor, colour-coded twisted pairs with a PVC outer jacket. Shielded wiring shall be used where recommended by the manufacturer

END OF SECTION

## **TELEPHONE & DATA RACEWAYS**

### **27 05 28**

#### **PART - 1 GENERAL**

##### **1.1 SYSTEM DESCRIPTION**

- .1 Empty raceways systems shall consist of outlet boxes, cover plates, conduits, pull boxes, fish wires and service poles.
- .2 Empty conduit systems being installed shall be for installation of wiring installed at a later date by communications contractor:
  - .1 Telephone and data communications systems.

##### **1.2 PRE/ POST OCCUPANCY PROVISIONS**

- .1 Assuming the Hospital will, as the time for occupancy approaches or even after occupying, resolve that some additional telephone/ data outlets/ monitor/ CCTV/ Security System outlets will be required. Include, in the Contract, the following additional installations:
  - Two (2) typical Data/ VoIP outlets
  - One (1) Building Automation System Network Connection outlets
- .2 Each drop with an average of 20m of conduit installed and terminated at the Hub Room will be required. Assume, for bidding purposes, that these can be added at any time during construction including at the end of the construction and in any location as directed on site.

#### **PART - 2 PRODUCTS**

##### **2.1 MATERIAL**

- .1 Conduits: EMT type, to Section 26 05 33 - Conduits Fastenings and Fittings.
- .2 Junction boxes and pull boxes to Section 26 05 32 - Splitters, Junction and Pull Boxes, Cabinets.
- .3 Outlet boxes, and fittings: to Section 26 05 35 - Outlet Boxes, Conduit Boxes and Fittings.
- .4 Cover plates: to Section 26 27 26 - Wiring Devices.
- .5 Fish wire: polypropylene type

#### **PART - 3 EXECUTION**

##### **3.1 INSTALLATION**

- .1 Install empty raceway system, including fish wire, outlet boxes, pull boxes, cover plates, conduit, service poles, miscellaneous and positioning material to constitute complete system.
- .2 Verify exact location of outlets to suit furniture layout.
- .3 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install 3 mm (c") polypropylene pull cord continuously from outlet to outlet, through conduit and fasten at each box.

- .4 Conduit bends shall have a bending radius of not less than ten times conduit diameter. Ream out conduits and identify end with green paint.
- .5 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 m (100') in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease.
- .6 Minimum space requirements in pull boxes, having one conduit each in opposite ends of box, shall be as follows:

Maximum Size of Conduit in Millimetres (Inches)	Size of Box in Millimetres (Inches)			For each Additional Conduit, Increase Width (Millimetres)Inches)
	Width	Length	Depth	
20 mm (¾")	100 mm (4")	300 mm (12")	75 mm (3")	50 mm (2")
25 mm (1")	100 mm (4")	400 mm (16")	75 mm (3")	50 mm (2")
32 mm (1¼")	150 mm (6")	500 mm (20")	75 mm (3")	75 mm (3")
38 mm (1½")	200 mm (8")	675 mm (27")	100 mm (4")	100 mm (4")
50 mm (2")	200 mm (8")	900 mm (3')	100 mm (4")	125 mm (5")

- .7 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum Size of Conduit in Millimetres (Inches)	Size of Box in Millimetres (Inches)			For each Additional Conduit, Increase Width Millimetres (Inches)
	Width	Length	Depth	
20 mm (¾")	150 mm (6")	300 mm (12")	100 mm (4")	50 mm (2")
25 mm (1")	200 mm (8")	400 mm (16")	150 mm (6")	50 mm (2")
32 mm (1¼")	250 mm (10")	450 mm (18")	200 mm (8")	75 mm (3")
38 mm (1½")	300 mm (12")	600 mm (24")	250 mm (10")	100 mm (4")
50 mm (2")	350 mm (14")	750 mm (30")	300 mm (12")	125 mm (5")

- .8 Maintain separation of communications conduits to sources of electromagnetic interference as follows:

Item	Minimum Clearance
Fluorescent ballasts	150mm (6")
Conduit and cables used for electrical distribution less than 1kV	300mm (12")
Conduit and cables used for electrical distribution greater than 1kV	1000mm (36")
Motor	1200mm (48")
Transformer	1200mm (48")

- .9 The above tables provides a guideline and at all times the Consultant may advise greater clearances if the currents being carried through these devices are particularly likely to cause interference.
- .10 Interference shall be minimized by ensuring that, wherever possible, communications conductors cross sources of interference at right angles.
- .11 Install cables, conduit and cable tray, etc. along or at right angles to building lines unless impractical to do so. Verify specific cases of deviation in advance with consultant.

**END OF SECTION**

## **COMMUNICATIONS CABLING**

### **27 15 00**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Conditions of Contract, Supplementary Conditions and Division 01 - General Requirements.
- .2 Where conflict occurs between Codes, Specification and Drawings, plan and riser, the maximum condition to govern, and the Tender to be based on whichever indicates the greater cost.
- .3 Conform with the requirements of the Electrical Tender Specifications and Drawings.
- .4 **Refer also to Sunnybrook 'Data Centre and Hub Room Access Policy' Appended to this Specification. Refer also to Sunnybrook 'ICN Cable Installation Standards' Appended to this Specification**

##### **1.2 WORK INCLUDED**

- .1 Price quotations are to include the furnishing of all materials, equipment, maintenance and training manuals, tools, and the provision of all labor and services necessary or proper for the completion of the work, except as may be otherwise expressly provided in the Contract Documents. The Owner will not be liable for any costs beyond those proposed herein and awarded.
- .2 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete Communications systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation. Provide equipment, materials, labor, and services not specifically mentioned or shown which may be necessary to complete or perfect all parts of this installation and in compliance with requirements stated or reasonably inferred by the Contract Documents.
- .3 All work shall be performed as per the schedule prepared by the General Contractor. Allow for work to be done after hours and on weekends as dictated by the schedule.
- .4 **Installations in existing Hospital Network Hub Rooms:**
  - .1 **Access to Sunnybrook Hospital Network Rooms is severely restricted and Contractors will not be allowed to access these rooms un-escorted/ un-supervised.**  
**To complete this installation the following applies:**
    - **Contractor must retain the Hospital's Security Department to allow access to and supervise activities of the Contractor while in the Hub Room for any Cable/ Equipment installation in the Hub Room (it is assumed Contractor can install Cabling to a point outside of the Hub Room but can not install the Cable into the Hub Room without Security**

**Supervision) and to complete Cable connections and equipment installation (Patch Panels)**

- **Arrangements for Security Supervision is to be coordinated directly between Security and the Contractor with the Contractor providing a minimum seven days written request**
- **The Hospital's Security Department will charge the Contractor \$50.00 (fifty dollars) per hour for a minimum four hours at any one time**

**.6 AS THE CONTRACTOR IS RESPONSIBLE TO COVER ANY/ ALL COSTS REQUIRED TO RETAIN THE HOSPITAL'S SECURITY GROUP, IT IS STRONGLY RECOMMEND THE CONTRACTOR PROPERLY SCHEDULE THE NEED TO ACCESS HUB ROOMS AND THAT THE TIMES REQUIRING ACCESS BE ACCURATELY INDICATED ON THE PROJECT SCHEDULE**

**.7 GENERAL:**

**.1 "CATEGORY 6 CABLING JACKS"**

To clarify all Network Type outlets require 'Category 6 Jacks' and 'Category 6 Cabling'. There is no 'Category 5E' jacks/ cabling on this project.

**.8 Pre/ Post Occupancy Provisions**

- .1** Assuming the Hospital will, as the time for occupancy approaches or even after occupying, resolve that some additional telephone/ data outlets/ monitor/ CCTV/ Security System outlets will be required. Include, in the Contract, the following additional installations:
- two (2) typical Data/ VoIP outlets
  - one (1) Building Automation System Network Connection outlets
- .2** Each drop with an average of 90m of cables installed and terminated at the Hub Room will be required. Include cable, patch cords, jacks, face-plates, labels, terminations, testing, and documentation for each drop. Assume, for bidding purposes, that these can be added at any time during construction including at the end of the construction and in any location as directed on site. Devices not installed at the construction completion are to be turned over to the Hospital as spare parts for future installation.

**1.3 INSTALLATION STANDARDS**

- .1** The following are typical outlet types used on this project:
- Emergency Telephone outlet consisting of a single gang box with one 'RJ-45' voice jack and one 'Cat 3' voice cable in conduit/ wireway system to Telephone backboard
  - Wireless Receiver (WAP) outlet consisting of a single gang in-line 'RJ-45' data jack and one 'Cat 6' cable in conduit/ wireway system to Hub Room. Provide a minimum 25'-0" cable coiled in ceiling space to allow flexible location of the receiver.
  - typical Data/ VoIP outlet consisting of a single gang box with three 'RJ-45' data jacks (two for "data" and one for "VoIP") and three 'Cat 6' data cables in conduit/ wireway system to Hub Room

- Data/ VoIP/ Printer outlet consisting of a single gang box with three 'RJ-45' data jacks and three 'Cat 6' data cables in conduit to Hub Room
  - Data/ VoIP/ Printer/ Telephone (could be Fax or Conference Phone) outlet consisting of a single gang box with three 'RJ-45' data jacks, one 'RJ-45' voice jack, three 'Cat 6' data cables in conduit/ wireway system to Hub Room and one 'Cat 3' voice cable in conduit/ wireway system to Telephone backboard
  - CCTV to Network outlet consisting of a single gang box with one 'RJ-45' CCTV jack and one 'Cat 6' data cable in conduit to Hub Room
  - Security System to Network outlet consisting of a single gang box with one 'RJ-45' Security System jack and one 'Cat 6' data cable in conduit to Hub Room
  - Smart Board outlet consisting of a single gang box with one 'RJ-45' data jack and one 'Cat 6' data cable in conduit to Hub Room
  - Alarm outlet consisting of a single gang box with one 'RJ-45' Alarm jack and one 'Cat 6' Alarm cable in conduit to Code White System
- .2 All Data, Monitor, TV, CCTV and Security System outlets shall be PS5+ Gigaflex eight (8) position Cat 6 module.
- .3 All cables shall have **"Category 6", white coloured**, eight -24 AWG thermoplastic insulated, solid conductors formed into individually twisted pairs and enclosed in a **CMP (FT-6)** rated thermoplastic jacket and all individual conductors to be insulated with fluorinated ethylene propylene (FEP).
- .4 All drops will be routed through conduit system provided and installed by Division 16 Contractor. If conduits are provide for the entire route of the cable, CMR (FT-4) cable can be used.
- .5 Where cable is run through modular furniture all cables must be protected by spiral wrap from the "service" pole to the furniture race way. The Communication Cabling Contractor is responsible to supply and install spiral wrap.
- .6 All cables will be terminated on flush mount outlets as determined by the type of wall or furniture used.
- .7 All Data/ VoIP Cables must have a orange coloured insert, all Voice Cables must have a blue insert, all TV Cables must have yellow insert, all CCTV to Network Cables and all Security to Network Cables must have white inserts.
- .8 All **Data, CCTV to Network and Security System to Network drops** will terminate on 48 port MDVO modular patch panels completely filled with black EZ MDVO PS5 modular jacks in the telecommunications room as noted on drawings. The number of patch panels will be determined by the total number of data ports that the closet must serve plus 20% space capacity for future use.
- .9 All **Voice drops** will terminate on the BIX blocks. The pigtail cable shall connect voice patch panel with the BIX block on the wall. See Drawings for details.
- .10 All drop locations and quantities to be confirmed prior to the start of the installation.
- .11 Performance of the cables shall comply with the latest draft of ANSI/EIA/TIA-568A Addendum 5 Attenuation and Power Sum Near End Cross Talk (NEXT) parameters for UTP Category 6 cable.



- .12 For horizontal voice terminations provide spare QCBIX1A4 and QCBIX 1A connectors in any spare or partially filled mount, such that all mounts are completely filled. Use standard BIX single jumper channel layout.
- .13 The number of patch panels shall be as required for outlets shown on the floor plans plus 20 % spare capacity which shall be provided for the future applications.
- 14 The communication contractor shall refer to the construction schedule prepared by the General Contractor and include for premium labour costs if required to meet the schedule.
- .15 Horizontal Data and Monitor cabling will be split and dressed down the back and each side of the Rack, terminating on **Beldon 48 port HD Patch panels**.
- .16 For horizontal Data terminations, **provide one spare Patch Panel**. For horizontal voice terminations, **provide one spare QCBIX1A4 connector** in any spare or partially filled mount. Use standard BIX single jumper channel layout.
- .17 The Rack mountable Patch Panels performance shall comply with the latest draft of ANSI/EIA/TIA-568A Attenuation and Power Sum Near End Cross Talk (NEXT) parameters for UTP Category 6 hardware.
- .18 All Patch Cords shall be factory assembled and not site prepared.

#### 1.4 **INSTALLATION REQUIREMENTS, WORKSTATION**

- .1 All Data, Voice, TV, CCTV to Network and Security to Network outlets shall be **Beldon EZ-MDVO RJ45** flush mounted where possible, otherwise a **Beldon** surface mount shall be used unless otherwise indicated on the supplied drawings.
- .2 The number of patch panels shall be as required for the number of cables shown plus the spare specified.

#### 1.5 **INSTALLATION GUIDELINES**

- .1 Codes and Standards
  - .1 All work performed on this project will be installed in accordance with the current edition of the Canadian Electrical Code and all local codes and ordinances, authorities having jurisdiction, and the following standards (including all sub-headings, addenda, and TSBs):
    - ANSI/TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements, 2001.
    - ANSI/TIA/EIA-568-B.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components, 2001.
    - ANSI/TIA/EIA-568-B.3, Optical Fiber Cabling Components Standard, April 2000
    - ANSI/TIA/EIA-569-B, Commercial Building Standards for Telecommunications Pathways and Spaces, 2003.
    - ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, 2002
    - ANSI J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2002.

CSA C22.1-02, Canadian Electrical Code, Part 1, 2002.  
CSA T527, Grounding and Bonding for Telecommunications in Commercial Buildings, 1999.  
CAN/CSA T528, Design Guidelines for Administration of Telecommunications Infrastructure in Commercial Buildings, 1997.  
CSA T529, Telecommunications Cabling Systems in Commercial Buildings, 2000  
CSA T530, Commercial Build Standard for Telecommunications Pathways and Spaces, 1999  
Building Industry Consulting Service International (BICSI) TDM Manual latest editions at the time of tender  
Manufacturers design guide

- .2 The Contractor's performance of the work shall comply with applicable national, provincial and local laws, rules, and regulations. The Contractor shall give required notices, shall procure necessary governmental licenses and inspections, and shall pay without burden to the Owner, all fees and charges in connection therewith unless specifically provided otherwise. In the event of violation, The Contractor shall pay all fines and penalties, including attorney's fees, and other defense costs and expenses in connection therewith.

## 1.6 **QUALIFICATION OF SYSTEM**

- .1 General
- .1 Acceptable proposed system will be covered by a two part certification program provided by the single manufacturer and that manufacturer's Reseller (Vendor, Installer or similar designation).
- .2 Manufacturer shall administer a program through the Installer to provide support and service to the purchaser.
- .3 The first part is an assurance program which provides that the certified system will support the applications for which it is designed, during the lifetime of the certified system.
- .4 The second portion of the certification is a 25-year warranty provided by the Manufacturer and the Reseller on all products within the system (jacks, cables, cross-connects, baluns, etc.).
- .5 In the event that the certified system ceases to support the certified applications, whether at the time of cut over, during normal use or when upgrading, the Manufacturer and Reseller shall commit to promptly implement corrective action.
- .6 Documentation proving the cabling system's compliance to the recommendations, as listed in the Codes and Standards section shall be provided by the Reseller prior to the structured cabling system being installed.
- .7 Workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) TDM manual and the NeIS document "Installing Commercial Building Telecommunications Cabling".
- .8 Purchaser demands strict adherence to the performance specifications listed in the Codes and Standards section. The manufacturer shall maintain 9001 Quality Control certification for the facilities that manufacturer the product used in this cabling system.

## **PART - 2 MANUFACTURER**

### **2.1 GENERAL**

- .1 Manufacturer refers to the company that manufactures the components and is responsible for the design and installation guidelines used by the Reseller (Installer, Vendor, or similar designation) to complete this cabling system installation.
- .2 The manufacturer along with the Reseller is responsible for the final warranty and certification of the application assurance.
- .3 The Reseller shall show proof of a contractual relationship with the Manufacturer, and shall pass through the Manufacturer's certification to purchaser.
- .4 The cabling manufacturer shall provide an end-to-end cabling solution, including horizontal cables, backbone cables, jacks and connectors, patch panels, termination blocks, patch cords and jumpers. For this project only end-to-end solutions shall be accepted.
- .5 Where no manufacture is specified, provide products from manufactures in compliance with the listed requirements.

### **2.2 SUBMITTALS**

- .1 Pre-construction Submittals
- .2 Submit the following documents for Review prior to construction:
  - .1 A cable labelling schedule (see Administration Section for more information)
  - .2 Cross-connect schedule for approval by the Owner.
  - .3 A list of all staff to be used, including proof of experience of installing structured cabling.
  - .4 Shop drawings:
    - .1 Submit shop drawings, product data, and samples with promptness as not to cause delay in work or in the activities of separate contractors. Submit shop drawings, product data, and samples as a complete set within thirty (30) days of award of contract for Engineer's Review.
    - .2 By submitting shop drawings the Contractor represents that the materials have been carefully reviewed and verified, as well as related quantities, field measurements, and field construction criteria. It also represents that the Contractor has checked, coordinated, and verified that information contained within shop drawings and samples conform to the requirements of the contract documents.
    - .3 The Review of shop drawings, product data, and samples submitted by the Contractor shall not relieve the Contractor of responsibility for deviations from requirements of the contract documents, unless the contractor has specifically informed the Engineer in writing of such deviation at time of submittal, and the

Engineer has given written approval of the specific deviation. The Contractor shall continue to be responsible for deviations from requirements of the contract documents not specifically noted by the Contractor in writing, and specifically approved by the Engineer in writing.

- .4 The Engineer's Review of shop drawings, product data, and samples shall not relieve the contractor of responsibility for errors or omissions in such shop drawings, product data, and samples.
  - .5 The Engineer's Review of shop drawings, product data, and samples, is for the limited purpose of checking for conformance with information given and design concept expressed in the contract documents. The Engineer's Review of such submittals is not conducted for the purpose of determining accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the contractor as required by the contract documents. The Review shall not constitute approval of safety precautions or of construction means, methods, techniques, sequences, or procedures. The Engineer's Review of a specific item shall not indicate approval of an assembly of which the item is a component.
  - .6 Perform no portion of the work requiring submittal and review until the Engineer has Reviewed the respective submittal.
  - .7 Submit two (2) copies of each shop drawing for Review. One (1) copy shall be retained by the Engineer. All other copies shall be returned.
- .5 Post-construction Submittals (Maintenance Manuals)
- .1 The Contractor shall submit within two (2) weeks of the end of construction:
- .1 Manufacturer's technical documentation on all devices used in cabling system.
  - .2 Manufacturer supplied Application Guidelines for required applications.
  - .3 The Manufacturer's and Contractors Warranty and Certification
  - .4 Complete cable testing documentation in hard and soft copies. Provide licenced versions of any software required for viewing test results.
  - .5 An End User's Manual describing the essential system elements as well as the end user's responsibility for maintaining the integrity of the cabling system over time. This Manual shall include, as a minimum, guidelines for system expansion and modification (moves, additions, changes of service) as well as labelling and record keeping.
  - .6 The project shall not be considered complete until all documents, including the original Manufacturer's Certification, have been delivered to the Owner.
  - .7 Within 30 days prior to substantial completion, the Contractor shall submit a draft copy of the proposed contents of each manual to the Consultant for review prior to substantial completion. Within 10 days the Consultant shall provide a review of this document to the Contractor.

- .8 Once the draft copy is approved, the Contractor will supply four (4) copies in suitably labelled, hard back, D-Ring type commercial binders, each complete with an index and tabbed title sheets for each section. Final copies of manuals are to be received by Consultant not less than 7 days prior to substantial completion.

## 2.3 AS-BUILT DRAWINGS

- .1 The Contractor shall keep one complete set of prints at the site office, including all addenda, change orders, site instructions, clarifications and revisions for the purpose of record drawings. As the work on site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions that deviate from the original contract documents.
- .2 Within two (2) weeks of the Project's completion the Contractor shall submit a complete set of As-Built drawings including cable routing, Telecommunication Rooms layouts, riser diagrams and telecommunications outlets. The layout shall detail locations of all equipment and indicate all wiring pathways, and outlets (including cable ID numbers). This as-built information shall include Addenda, Change Orders, Clarifications, Revisions, and Site Instructions.
- .3 Upon completion the Contractor shall certify, in writing that the as built records are complete and that they accurately indicate all communication services related to the communications infrastructure. This shall include all visible and all invisible items. The information shall also correspond with all identifications applied by the Contractor to cables and termination devices in the buildings.
- .4 The Contractor shall forward a letter of certification to the Consultant for final review and as-built CAD drawings to the Consultant for final review.
- .5 The contractor may obtain copies of the telecommunication contract drawings (Tender Issue) in dwg format from the Consultant on request. A drawings release form needs to be signed by the Contractor prior to releasing the drawings.
- .6 After as-built drawings have been reviewed, print four (4) full size copies of the drawings. Deliver two (2) copies to the Owner and two (2) copies to the Facilities Management (if different from the Owner).

## PART - 3 COMMUNICATIONS CONTRACTOR

### 3.1 PROJECT MANAGER

- .1 Within ten (10) days of the date of acceptance of this Bid, the Contractor shall notify the Consultant of the appointment of a competent Project Manager, experienced in the design and installation of structured cabling systems and in the supervision of similar contract work.
- .2 The Project Manager shall be available during the entire life of the Contract to answer all questions pertaining to the contractual work, and shall be available at the site from the commencement date of equipment delivery to the commissioning completion date.
- .3 The Project Manager shall represent the Contractor and shall have authority to carry out directions given to him as the Contractor's representative.

### 3.2 COMMUNICATIONS INSTALLERS

- .1 The staff selected for the installation of the structured cabling system shall conform to the following:
  - .1 An installer on site that is a current member of BICSI and holds a valid RCDD designation. This installer along with the Project Manager will ultimately be responsible for the construction of this project.
  - .2 The Contractor must also have BICSI Registered Installers and Technicians on staff and assign them to this project. The project shall be staffed at all times by Installers and Technicians who, in the role of lead craftspersons, will be able to provide leadership and technical resources for the remaining craftspersons on the project.
  - .3 Submit to the Consultant within seven days of Contract Award a list of all staff to be used in above installation including proof of experience.
  - .4 ONLY qualified technicians directly employed by the CSV or Reseller shall terminate all cables (at both ends), test and perform cross-connects.
  - .5 Certification in the installation of structured cabling system under the title of CSV, Reseller, Vendor, or other similar status issued by the cabling manufacturer.
  - .6 Provide Manufacturer's Certification Number within two weeks upon award of contract.
  - .7 If, in the opinion of the Owner, the RCDD does not possess adequate qualifications to support the project, the Owner reserves the right to require the Contractor to assign an RCDD who, in the Owner's opinion, possesses the necessary skills and experience required of this project.

## PART - 4 INSTALLATION GENERAL REQUIREMENTS

### 4.1 GENERAL REQUIREMENTS

- .1 All voice and data outlets shall be flush mounted where possible; otherwise a surface mount shall be used unless otherwise indicated on the supplied drawings.
- .2 All face plates shall be coloured to match electrical face plates in the area unless otherwise noted.
- .3 Blank inserts are to be placed in to outlet ports not containing communications jacks. The blanks are to be coloured to match the faceplate.
- .4 All four pairs of horizontal cables are to be terminated. ISDN T568A wiring configuration is to be used. The splitting of pairs is strictly prohibited.
- .5 All drop locations and quantities to be confirmed prior to the start of the installation. Allow a variation of 4.5m (15').

- .6 Horizontal cabling will be split and dressed on ply-wood backboards and rack. Distribute cables evenly and neatly in bundles.
- .7 The length of each individual run of horizontal cable from the patch panel on each floor to the telecommunications outlet shall not exceed 90m (295').
- .8 All cables shall be loosely bundled using Velcro cable ties every 150mm (6"). To minimize the effects of alien cross-talk, do not comb-out cables.
- .9 Utilize all indicated and available cable pathways such as conduit, cabletrays, ducts, raceways and furniture system channels except where otherwise noted. Exercise caution when pulling cables in such pathways to avoid damage to any cabling and to ensure that the cable manufacturers' maximum pull-force and minimum bend radii specifications are adhered to.
- .10 All free running cables shall be securely fastened to appropriate cable supports so that cables routed to the under side of the floor tiles with a maximal inter-harness cable sag of 150mm (6"). All cables shall be completely supported by the harness so that the entire mass of the cables and harnesses are self supporting and no weight is transferred to any other existing fixture or structure in the ceiling space. The Contractor shall be responsible for the supply of all materials (such as hangers, harnesses or supports) and labour that may be required to achieve this.
- .11 Route all cables to maintain minimum separations from sources of lighting, power cables, HVAC and electrical equipment as indicated in the Manufacturer's minimum separation schedule or otherwise required. The Contractor shall be responsible for the supply of all materials (such as hangars, harnesses or supports) and labour that may be required to maintain the indicated minimum separations.
- .12 In the Telecommunications Rooms all communications cables shall be neatly bundled, supported and routed to the corresponding termination panel. The Contractor shall be responsible for the supply and installation of any additional cable supports. Velcro tie-wraps on cables should be loose and rotate freely.
- .13 Each run of cable between the termination block and the data outlet shall be continuous without any joints or splices.
- .14 Where the Contractor is required to remove ceiling tiles, such work shall not break or disturb grid or tiles.
- .15 Terminated conductor ends shall be properly trimmed to assure a minimum clearance of 0.250" between the conductors of adjacent modules.
- .16 Ground all Telecommunications equipment, racks and cabletrays using green insulated #6 AWG copper wire to the Telecommunications Ground Bar. All ground wires shall be home-run back to the Telecommunications Ground Bar. Do not daisy chain.
- .17 Completely test out systems and, before they are turned over to Owner, demonstrate them to Owner's representative until such time as he is fully conversant with the operation of the systems.
- .18 Six months after installation has been accepted by Owner, arrange a time convenient to the Owner to do necessary re-aligning, and replace defective components.

## 4.2 COMMUNICATIONS HORIZONTAL CABLING

### .1 General

- .1 All horizontal cables will be FT6 rated for plenum environment (CMP).
- .2 All terminations shall be in T568A configuration.
- .3 For all horizontal cables provide 3m of slack at the cabinet end and 1m of cable slack at the workstation end.
- .4 Follow the Manufacturer's guidelines for pulling force. If no guidelines are present the maximum pull-force for 4-pair horizontal twisted-pair cables is 111N (25 lbf).
- .5 Maintain the manufacturer's recommended bend radius at all times. If no guidelines are present ensure the bend radius does not exceed four (4) times the outside cable diameter.
- .6 The communications wiring system shall be an end-to-end solution provided by a single manufacturer.
- .7 Cables will be routed through conduits, cabletray. The Division 26 Contractor will provide the conduits and cabletray where shown.
- .8 Approved manufactures for the end-to-end cabling solution are as follows:

**Standard of Acceptance**  
**Belden/CDT (To match existing facility standard)**

### .2 Horizontal Data Cables

1. Provide horizontal cables to connect each information outlet to the backbone subsystem on the same floor.
2. All horizontal cabling shall be **BELDON Category 6, IBDN for FT-6** environment. All Category 6 cables shall conform to or exceed the EIA/TIA 568 Commercial Building Wiring Standard. Horizontal Cable Section and the EIA/TIA Technical Systems Bulletin 36 for Unshielded Twisted Pair Cables. Other standards supported include IEEE 802.3, 1Base5, 10BASE-T; IEEE 802.5, 4 Mbps, 16Mbps (328 ft [100m], 104 Workstations) and proposed ANSI X3T9.5 TTPMD requirements for UTP at 100 Mbps. In addition, cables shall be capable of supporting evolving high-end applications such as 155 Mbps ATM.
3. The 4 pair UTP cable shall be UL Listed type CM. or CMP.
4. All plenum rated Category 6 Unshielded Twisted Pair (UTP) cables shall be composed of 24 AWG solid copper conductors, dual insulated with high density polyethylene (HDPE). The insulated conductors are twisted into pairs and jacketed with Polyvinyl Chloride (PVC) and shall meet or exceed the Electrical Specifications listed below:
  1. Maximum DC resistance 28.6 S/1,000 ft (9.38S/100m) Maximum DC resistance



2. Unbalance: 5% Mutual Capacitance @1kHz: 14nF/1,000 f
3. Mutual Capacitance Unbalance (pair to ground): 40OpF/1,000 ft (131.2 pF/100m)
4. Attenuation (dB/1,000 ft [305m]): @ 0.772 MHz: 5.5@ 1.0 MHz: 6.3@ 4.0 MHz: 13@ 8.0 MHz: 18@ 10.0 MHz: 20@ 16.0 MHz: 25@ 20.0 MHz: 28@ 25.0 MHz: 32@ 31.25 MHz: 36@ 62.5 MHz: 52@ 100 MHz: 67
5. Characteristic Impedance (S): @ 0.064 MHz: 125 ± 15S @ 0.128 MHz: 115 ± 15S @ 0.256 MHz: 110 ± 15S @ 0.772 MHz: 105 ± 15S @ 1.0-25.0 MHz: 100 ± 15S
6. Pair to Pair Next (db) at 1,000 ft (305 m):

FREQUENCY	EIA STANDARD	90 <sup>TH</sup> PERCENTILE
1.0 MHZ	62	68
4.0 MHZ	53	59
8.0 MHZ	48	54
10.0 MHZ	47	53
16.0 MHZ	44	50
20.0 MHZ	42	48
25.0 MHZ	41	47
31.25 MHZ	40	46
62.50 MHZ	35	41
100.0 MHZ	32	38

7. UL Listed
8. CSA Certified
5. The UTP-based cabling system shall be capable of supporting the following applications:
  6. 1.2 Gbps ATM\*
  7. Gigabit Ethernet (1000BASE-T)
  8. Broadband Video
  9. 25/52/155/622 Mbps ATM
  10. Fast Ethernet (100BASE-TX, 100BASE-T4)
  11. 100VG-AnyLAN
  12. TP-PMD
  13. Ethernet (10BASE-T)

14. 4/16 Mbps Token-Ring
  15. Baseband Video
  16. ARCnet/ARCnet Plus
  17. IBM System 370/3270
  18. IBM 3x - AS/400
  19. IBM 4700 Financial Communication System
  20. IBM 5080/6090 Graphics System
  21. EIA-232/EIA-422
  22. Voice
- .3 Information Outlet (eight (8) position Category 6 modular jacks at working station. Unless otherwise noted all information outlets shall be:
- 1 Eight (8) position Cat 6 modular type
  - 2 insulation displacement
  - 3 modular
  - 4 universal application/multi vendor supportive
  - 5 accepting most phone and data plugs. Provide corresponding faceplate 4. All Category 6 outlets shall be:
    - 1 The outlet UTP connection module shall be Power Sum rated, with a Power Sum NEXT performance equal to or better than ANSI/TIA/EIA-568 Category 6 pair-to-pair NEXT performance specifications, and shall have a PS5 marking to indicate compliance.
    - 2 The eight-position outlet UTP connection module shall accommodate sixposition modular plug modular cords without damage to either the cord or the module.
    - 3 The outlet UTP connection module shall use a hand-termination installation method, without the need for punch down tools or slip lock pliers.
    - 4 The outlet UTP connection module shall have an optional cover to protect the module when not in use.
    - 5 The outlet UTP connection module and its optional cover shall be available in the following colours: grey, almond, white, black, orange, red, yellow, green, blue, purple, and brown.
    - .6 The outlet UTP connection module shall be designed for use at the Work Area, Telecommunications Closet and/or Equipment Room without modification.
    - .7 The outlet UTP connection module shall only have a single insulation displacement connection block for the termination of wire pairs.
    - .8 The outlet UTP connection module shall be available in both the T568A-ISDN and T568B-ALT wiring configurations.
    - .9 The outlet UTP connection module shall be UL Listed and CSA Certified.
    - .10 The outlet UTP connection module shall be made of fire-retardant UL 94V-0 plastic.
    - .11 The outlet UTP connection module shall have an insulation displacement connection featuring insulation-slicing, tin-plated clips, forming a gas-tight connection.
    - .12 The outlet UTP connection module shall have a maximum Contact Resistance of 1 milliohm per contact.

- .13 The outlet UTP connection module shall have an minimum Insulation Resistance of 100 megaohms between clips.
- .14 The outlet UTP connection module shall have a durability rating of 200 insertions/withdrawals of any combination of 24 and 26 AWG wire.
- .15 The outlet UTP connection module modular jack shall be FCC Part 68, Subpart F compliant.
- .16 The outlet UTP connection module modular jack durability shall be 1500 mating cycles.
- .17 The outlet UTP connection module modular jack contact material shall be nickel with 50 micro-inches gold plated.
- .18 The outlet UTP connection module modular jack maximum Current Rating shall be 1.5 amperes.
- .19 The outlet UTP connection module modular jack Dielectric Strength shall be 1000V RMS at 60 Hz for 1 minute.
- .20 The outlet UTP connection module modular jack minimum Insulation Resistance shall be 500 megaohms.
- .21 Outlet Faceplate:
  - 1. The faceplate housing the outlet UTP connection modules shall provide a symmetrically-centered appearance for the modules.
  - 2. The faceplate housing the outlet UTP connection modules shall have no visible mounting screws.
  - 3. The faceplate housing the outlet UTP connection modules shall be removable without requiring the removal of screws or other fasteners.
  - 4. The faceplate housing the outlet UTP connection modules shall have an outlet wiring diagram stamped on the inside.
  - 5. It shall be possible to inspect and/or reterminate the UTP cable at the outlet through front access at the faceplate.
  - 6. The faceplate housing the outlet UTP connection modules shall have aperture plugs to cover any unused openings in the faceplate.
  - 7. It shall be possible to install the outlet UTP connection modules in wall mounted single and dual-gang electrical boxes, utility poles and modular furniture (cubicle) access points using manufacturer-supplied faceplates and/or adapters, equipped with front, side or angled-entry options for modular cords.
  - 8. The faceplate housing the outlet UTP connection modules shall be available in the following colors: grey, almond, white, and black.
- .22 Outlets shall be wired in an EIA/TIA 568 A configuration.
- .23 Unless otherwise noted on the floor plans, the information outlet shall be surface flush mounted, single or multi jacks as indicated.
- .24 Each work area shall be supplied with a telecommunications outlet/connector (previously called a modular jack) for connection to the horizontal media. All telecommunications outlet/connectors shall be installed in an appropriate faceplate. All telecommunications outlet/connectors shall be complete with faceplate and attached permanently to a fixed structure, such as building walls, utility poles or modular furniture partitions.

- .25 The work area telecommunications outlet/connector must provide maximum flexibility in supporting UTP, fibre, and coax while maintaining performance in order to meet the changing requirements that are likely to occur throughout the life of the system.
- .26 8 Position modular telecommunications outlet/connectors shall accept 8 position modular plugs while providing proper electrical connection and not damaging telecommunications outlet/connector (jack). Manufacturer shall warrant all 8 position modular outlets used in such a manner to be usable for 8 position modular plugs in the future.
- .27 In order to allow normal expansion of service during the life of the cabling system, flush work area telecommunications outlets shall provide sufficient density to support up to a maximum of eight connectors per single gang telecommunications outlet and twelve connectors per double gang telecommunications outlet.

## 2 PATCH PANELS

1. The termination block shall support the appropriate 'Category 6' applications and facilitate cross-connection and inter-connection using cross connect wire. The UTP cross-connect/interconnect system rack mount shall feature built-in wire management to secure cable bundles, control and maintain proper cable bend radius and provide physical protection for terminations..
2. Patch panel installations shall contain a retaining trough between every 50 pair termination block.
3. The wiring block shall be able to accommodate 24 AWG cable conductors.
4. Termination blocks that require rotation after connection of horizontal/vertical wiring will not be allowed.
5. The block shall be Underwriter's Laboratories (UL) listed.
6. All 'Category 6' Patch Panels shall support 100 Mbps TP-PMD and 155 Mbps ATM and shall meet or exceed the NEXT Values listed as follows: 1.0 MHz: 86@ 4.0 MHz: 74@ 8.0 MHz: 68@ 10.0 MHz: 66@ 16.0 MHz: 62@ 20.0 Mhz: 60@ 25.0 MHz: 58@ 31.25 MHz: 56@ 62.50 MHz: 50@ 100.0 MHz: 46
7. Horizontal cabling will be split and dressed down the back and each side of rack 2, terminating on NORDX 48 port HD Patch panels.
8. The termination block shall support the appropriate Category 6 applications and facilitate cross-connection and inter-connection using cross connect wire. The UTP cross-connect/interconnect system rack mount shall feature built-in wire management to secure cable bundles, control and maintain proper cable bend radius and provide physical protection for terminations.
9. The wiring block shall be able to accommodate 24 AWG cable conductors.
10. Termination blocks that require rotation after connection of horizontal/vertical wiring will not be allowed.
11. The block shall be Underwriter's Laboratories (UL) listed.
12. Contractor shall supply cross-connect wire and patch cords for cross-connection and inter-connection of termination blocks and fibre optics termination units.
13. One patch cord shall be provided for each workstation outlet, and one for each data port in the telecommunications closet.
14. The type of jumper cables shall depend on EIA/TIA Category 6 applications and the termination block used. i.e. a punch panel, a patch panel termination block.
15. The UTP data patch cord for connecting a computer workstation to its corresponding equipment jack shall be manufactured by NORDX.

16. The UTP data patch cord lengths shall be as follows: 10 ft
17. The Plus series patch cord shall be available in 4 pair version with lengths of 10 feet and shall meet or exceed the following electrical, mechanical and NEXT specifications listed below:
19. The modular plug shall meet the requirements of the latest issue of ANSI/TIA/EIA-568.
  - a. The modular plug shall meet the requirements of the latest issue of ISO/IEC 11801.
  - b. The modular plug shall meet the requirements of the latest issue of FCC Part 68, Subpart 5.
  - c. The modular plug shall meet the requirements of the latest issue of IEC 603-7
  - d. The modular plug shall have a maximum Voltage Rating of 150V AC.
  - e. The modular plug shall have a minimum Dielectric Withstanding Voltage of 1000V RMS at 60 Hz for 1 minute.
  - f. The modular plug minimum insulation resistance shall be 500 megaohms.
  - g. The modular plug maximum contact resistance shall be 10 milliohms.
  - h. The modular plug housing shall be made of UL 94V-0 rated polycarbonate.
  - i. The modular plug contacts shall be made of phosphor bronze.
  - j. The modular plug contacts shall be plated with a minimum of 50 microinches of gold.
  - k. Each modular plug of every modular cord shall be legibly and indelibly stamped with the wiring configuration of the cord (T568A or T568B).
  - l. The modular plug shall be crimped such that the distance between the top of each contact and the bottom of the plug is 0.237 +/- 0.005 inch. The insulated conductor shall be visible from the front of the plug.
  - m. The modular plug shall be UL 94V-0 Flame Rating compliant.
20. Plus Series Modular Cord Assembly:
  - a. The modular cord assembly shall meet or exceed the short link NEXT requirements of 34 dB when tested with enhanced Category 5 connecting hardware.
  - b. The modular cord assembly shall meet the requirements per the latest issue of ANSI/TIA/EIA-568
  - c. The modular cord assembly shall meet the requirements per the latest issue of ISO/IEC 11801
  - d. The modular cord assembly shall be UL listed as a Communication Cable Assembly.
  - e. The modular cord assembly shall be CSA Certified as a Communication Cord Set.

- f. The modular cord assembly shall be capable of withstanding an 11.25 pound pull test. Each of the individual conductors shall be capable of withstanding a 3 pound pull.
  - g. Each conductor in every modular cord assembly shall be capable of withstanding, without breakdown for 1 minute, an AC (RMS) potential of 1000V (1500V DC). Each conductor shall be tested against all other conductors and/or any metal enclosure part of a connector, all electrically connected together and grounded. The test voltage shall be increased from zero at a rate not exceeding 200 V/s until the required value has been attained.
21. The patch cord shall have built-in exclusion features to prevent accidental polarity reversals and split pairs.

#### **4.5 COMMUNICATIONS CONNECTING CORDS, DEVICES AND ADAPTERS**

- i. Data Patch Cords
  - 1. For each data drop installed provide one (1) patch cord at the patch panel end. Provide quantities as follows:
    - a. 100% Category 6 patch cords (RJ45-RJ45), 1.2m (4') in length
  - 2. For each data drop installed provide one (1) patch cord at the workstation end. Provide quantities as follows:
    - a. 100% Category 6 patch cords (RJ45-RJ45), 2.1m (7') in length
  - 3. All data patch cords shall be installed by the Contractor.
  - 4. All data patch cords shall be RJ45 to RJ45 with booted connector ends.
  - 5. All patch cords shall be FT6 rated.

#### **1.6 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS**

- .1 General
  - .1 The Administration Subsystem links all of the subsystems together. It consists of labelling hardware for providing identification.
  - .2 Administration shall be in compliance with the TIA/EIA-606-A standard for Class 2 Administration. Identifiers are required in the following locations:
    - (a) Security Server Room
    - (b) Intrabuilding backbone cable
    - (c) Horizontal link
    - (d) Cabinets
    - (e) Patch panels
    - (f) TMGB
    - (g) TGB
  - .3 The Owner may deviate from the TIA/EIA-606-A standard to suit they own particular administration system.
  - .4 Submit a complete labelling schedule (as noted in the per-construction submits section) to the Owner for review. Allow for the Owner to make changes.
  - .5 The Contractor shall provide labels at the following locations:
    - (a) At each end of the cable jacket within 6" of where the jacket has been stripped.
    - (b) On the front of each faceplate
    - (c) On the inside of each outlet box

- (d) On the front of the patch panel or termination block
  - (e) At each end of each patch cord and pigtail cable within 50mm (2") of the connector
- .6 Labels shall be machine printed with black text on white backing.
- .7 The minimum height of text shall be 3/16".
- .8 Use labels produced by the cabling manufacture as recommended for the application.
- .9 For labels on racks, cabinets, and patch panels supply lamicoid name plates. Colours shall be black text on white backing.
- .2 Numerical Identification
  - .1 Label Telecommunication Rooms as follows:
    - (a) FS
    - (b) F = floor the Telecommunications Room is located
    - (c) S = unique identifier for the Telecommunications Room on that floor (A, B, C...)
  - .2 Label all horizontal data links as follows:
    - (a) FS-DXXX
    - (b) FS = the Telecommunications Room identifier for the room the cable is terminated
    - (c) D = Data
    - (d) XXX = unique cable number
  - .3 Label all horizontal voice links as follows:
    - (a) FS-VXXX
    - (b) FS = the Telecommunications Room identifier for the room the cable is terminated
    - (c) V = Voice
    - (d) XXX = unique cable number
- .3 Coloured Identification
  - .1 Use the following colours to identify different systems:
  - .2 All horizontal UTP cables shall be coloured blue.
  - .3 All workstation jacks shall be coloured white.
  - .4 All jacks in patch panels shall be coloured black
  - .5 Patch cords shall be coloured as follows:
    - (a) data = white
    - (b) voice = blue

## **5 COMMISSIONING OF COMMUNICATIONS**

### **5.1 GENERAL**

- .1 Provide Commissioning Verification, Inspection and Certification.
- .2 Provide commissioning verification, inspection and certification of all communications cables installed.
- .3 100% of all cables installed must be tested, and certified.

## **5.2 COPPER CABLE TEST REQUIREMENTS**

- .1 Every cabling link in the installation shall be tested in accordance with the field test specifications defined by the Telecommunications Industry Association (TIA) standard ANSI/TIA/EIA-568-B.1.
- .2 The installed twisted pair horizontal links shall be tested from the IDF in the Telecommunications Room to the telecommunication outlet in the work area against the Basic Link performance limits specification as defined in ANSI/TIA/EIA-568-B.1.
- .3 100% of the installed cabling links must be tested and must pass the requirements of the standards mentioned in above specifications. Any failing links must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section below.
- .4 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.
- .5 The test equipment (tester) shall comply with the accuracy requirements for Level III field testers as defined in TIA-568-B.1
- .6 The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
- .7 The tester interface adapters must be of high quality and the cable shall not show excessive twisting or kinking resulting from repetitive coiling and storing of the tester interface adapters.
- .8 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail\* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass\*.
- .9 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (\*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks.
- .10 A representative of the consultant and end-user shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase 5 business days before testing commences.
- .11 A representative of the consultant and end-user will select a random sample of 5% of the installed links. The representative (or his authorized delegate) shall test these randomly selected links and the results are to be stored in accordance with the prescriptions in Specifications. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

## **5.3 COPPER CABLE TEST STANDARDS**

- .1 Test all horizontal copper cable links to Category 6 standards.



- .2 The test parameters for Category 6 are defined in ANSI/TIA/EIA 568B.1. The test of each link shall contain all of the following parameters as detailed below. In order to pass the link test all measurements (at each frequency in the range from 1 MHz through 250 MHz) must meet or exceed the limit value determined in the above-mentioned Category 6 standard.
- .3 When testing cables the correct NVP value must be entered in to the tester for the particular cable being tested or the test results will be considered void.

#### **5.4 TEST RESULT DOCUMENTATION**

- .1 The test results information for each link shall be recorded in the memory of the field tester upon completion of the test.
- .2 The test results records saved by the tester shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test.
- .3 The test results records saved by the tester shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test.
- .4 The database for the completed job shall be stored and delivered on CD-ROM including the software tools required to view, inspect, and print any selection of test reports.
- .5 A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information
- .6 The identification of the link in accordance with the naming convention defined in the overall system documentation.
- .7 For OTDR testing include all ray traces and graphical outputs.
- .8 The date and time the test results were saved in the memory of the tester. Ensure that the correct information has been entered.
- .9 Test results must be received by the Consultant for review within 2 weeks of completion of testing or they will be considered void.

#### **5.5 CLEAN-UP**

- .1 General
  - .1 Remove all redundant cables completely-both horizontal and vertical cable
  - .2 All existing cables and communications equipment needs to be removed.
  - .3 The Telecommunications Rooms are to be cleaned using canned compress air suitable for cleaning electronic equipment. All equipment shall be cleaned of dust and debris. The floors are to be vacuumed and all garbage removed prior to the owner taking occupancy.
  - .4 Do not dust and vacuum until all trades have completed work.

## **5.6 OCCUPANCY**

### **.1 General**

- .1 When the owner is ready to take occupancy the Communications Contractor is to provide an onsite communications technician to assist during the move.
- .2 The communications technician is to have extensive knowledge in the design and construction of the system.
- .3 The communications technician is to assist the owner during the move and answer any questions related to the system.
- .4 If the owner deems the technician unable to provide proper assistance for any reason, another technician will be provided by the contractor immediately with no addition charge to the owner.
- .5 The owner will decide the time and date that the technician is to arrive. The owner must give at least 48 hours notice to the communications contractor before such time.
- .6 The technician is to remain on site for a maximum of 8 hours. These hours may occur during premium time or during weekends. Any additional time must be arranged with the Communications Contractor.

## **6 EXECUTION**

- 1 Data Cable Installation
- 2 Communications cables shall be placed through shafts, conduit, raceways or floor penetration.
- 3 Supply all materials and labour for the installation of the complete Riser Cabling system including all cables and terminations.
- 4 Ensure that proper cable support techniques are utilized for suspending and supporting riser cables as per manufacturer's specifications. Cable ties shall also be used to prevent side to side movement of the cable. The cable ties shall not be installed so as to deform the cable jacket.
- 5 Supply all materials and labour for the installation of the complete Communications Cabling system including all cables and terminations.
- 6 Ensure that proper cable support techniques are utilized for suspending and supporting riser cables as per manufacturer's specifications. "Velcro" cable ties shall also be used to prevent side to side movement of the cable. The cable ties shall not be installed so as to deform the cable jacket.
- 7 Provide, install and terminate the indicated quantities of riser cables in the communications rooms.
- 8 All cables shall be neatly bundled, tie-wrapped and routed together. Secure cable bundles to vertical and horizontal supports and neatly fasten to plywood backboards or termination racks when routing to termination panels.
- 9 Installation shall be suitably tested and demonstrated to the Engineer consistent with standard industry practice.
- 10 Connect equipment is to closet ground bus with #6 AWG green grounding wire.
- 11 Submit shop drawings of all communications equipment, cabling, receptacles and miscellaneous hardware.
- 12 Installation shall conform to the standard, EIA/TIA 568A. The length of each individual run of horizontal cable from the administration subsystem (Communications Closet) on each floor to the information outlet shall not exceed 295 ft (90 m).
- 13 All cables shall be neatly bundled and tie-wrapped. Secure cable bundles to vertical and horizontal supports in Communications rooms to support cable bundles.
- 14 Utilize all indicated and available cable pathways such as conduit, cable trays, ducts, raceways and furniture system channels except where otherwise noted. Exercise caution

- when pulling cables in such pathways to avoid damage to any cabling and to ensure that the cable manufacturers' maximum pull-force and minimum bend radii specifications are adhered to.
- 15 All free-running cables shall be securely fastened to appropriate cable supports and harnesses a minimum of every 1500mm so that cables are bundled tightly. All cables shall be completely supported by the harness so that the entire mass of the cables and the harnesses is self supporting and no weight is transferred to any other existing fixture or structure in the ceiling space (such as suspended ceiling or light fixtures). The Contractor shall be responsible for the supply of all materials (such as hangers, harnesses or supports) and labour that may be required to achieve this.
  - 16 Route all cables to maintain minimum separations from sources of lighting, power cables, HVAC and electrical equipment as indicated in the "NORDX/CDT" minimum separation schedule or otherwise required. The Contractor shall be responsible for the supply of all materials (such as hangers, harnesses or supports) and labour that may be required to maintain the indicated minimum separations.
  - 17 In the building Communication Closets all communications cables shall be neatly tie-wrapped, bundled, supported and routed to the corresponding termination panel in the hub rooms or computer room. The Contractor shall be responsible for the supply and installation of any additional cable supports. Tiewraps on Cat 5e cables must be velcro type only (plastic cable ties are not acceptable)
  - 18 The communications contractor is to coordinate the installation of the data and voice cables with other contractors and tenants as required for the installation of these cables.
  - 19 Inform the Consultant of any cable lengths in excess of 90 m in length prior to installation.
  - 20 Each run of cable between the termination block and the data outlet shall be continuous without any joints or splices.
  - 21 In suspended ceiling and raised floor areas where systems duct, cable trays or conduit are not available, the Contractor shall bundle station wiring with velcro cable ties at appropriate distances (plastic cable ties are not acceptable for Cat 5e cabling). The cable bundling shall be supported via "J" hooks attached to the existing building structure and framework. Plenum cable will be used in all appropriate areas where cables are not enclosed in metal raceways or concrete encased conduits.
  - 22 If the interior of walls are not obstructed, the Contractor shall conceal horizontal distribution wiring internally within the walls. If such obstructions exist. Contractor shall secure approval prior to the use of an alternate method.
  - 23 Where the Contractor is required to remove ceiling tiles, such Work shall not break or disturb grid or tiles.
  - 24 Contractor shall provide detailed cable run diagrams for cable runs within raised floors detailing exact locations of cable for review and approval after coordination with other contractors and engineer.
  - 25 Conduit runs installed by the contractor should not exceed 100 feet or contain more than two 90 degree bends without utilizing appropriately sized pull boxes.
  - 26 Dedicated four-pair 24 AWG UTP horizontal distribution cable shall be provided for each application or service planned, present and future. Each of the four cable pairs of each horizontal cable must be terminated on an individual 8 position modular connector at the telecommunications outlet/connector. Pairs within a cable shall not be split and all pairs must be terminated.
  - 27 The splitting of pairs within a cable between different jacks is not permitted. Terminating resistors in the case of ISDN applications shall be placed external to the telecommunications outlet/connector.
  - 28 Cable shall be provided on reels or in Reelex boxes. Cable shall be marked decrementally from 100 ft to indicate both the length of a run as well as the amount of cable remaining on the reel or within the carton
  - 29 The installation of the horizontal cable shall follow the appropriate recommendations covered in the Manufacturer's Design Guide and the appropriate standards documents.

- This is done in order to ensure adequate protection from Electro-Magnetic Interference (EMI) sources and to ensure that all components and cables are in good condition after installation.
- 30 Copper cables shall be handled, installed, and supported as per the manufacturer's guidelines. During the laying of the cable, installer shall take care not to over stress the cable. After the cable is installed, installer shall make sure that all parts of the cable are supported properly and shall be stress free at both ends and throughout their length.
  - 31 Appropriate attention shall be given to the handling of Category 5e copper and optical fibre cables to ensure that bending radius conforms to the manufacturer's requirements. At no time shall the cable's static or dynamic bending radius be exceeded.
  - 32 All telecommunications outlet/connectors shall be securely mounted at all work area locations and shall be located so that the cable required to reach the work area equipment will be no more than 3 meters long.
  - 33 All optical fibre and copper cables shall be handled, installed, and supported as per the manufacturer's guidelines. During the laying of the cable, installer shall take care not to over stress the cable. After the cable is installed, installer shall make sure that all parts of the cable are supported properly and shall be stress free at both ends and throughout their length.
  - 34 Appropriate attention shall be given to the handling of Category 5e copper and optical fibre cables to ensure that bending radius conforms to the manufacturer's requirements. At no time shall the cable's static or dynamic bending radius be exceeded.
  - 35 All telecommunications outlet/connectors shall be securely mounted at all work area locations and shall be located so that the cable required to reach the work area equipment will be no more than 3 meters long.
  - 36 The total optical attenuation through the cross-connect from any terminated fibre to any other terminated fibre shall not exceed 2.0 dB. Optical fibre splices, fusion or mechanical, shall not exceed a maximum optical attenuation of 0.3 dB when measured in accordance with ANSI/EIA/TIA-455-34.
  - 37 Surface mount telecommunications outlets where indicated shall provide up to six telecommunications outlet/connectors.
  - 38 A non-impact termination method using either a stuffer cap with pliers or fullcycle terminating tool having both tactile and audible feedback to indicate proper termination shall be used. High impact tools are not permitted.
  - 39 Terminated conductor ends shall be properly trimmed to assure a minimum clearance of 0.250 in. between the conductors of adjacent modules.
  - 40 Face plates shall be clean in appearance. Mounting hardware shall not be visible on the faceplate. If colour coded modules are employed, colors shall comply with the requirements of CAN/CSA 528.
  - 41 The work area telecommunications outlet/connectors shall not be responsible for creating "resonance" on short cable runs as described in the Field Testing TSB 67 (Draft 13 section 7.8 Short Links/Channels). This problem is related to return loss and/or the balance of the link and can cause transmission errors.
  - 42 Telecommunications outlet/connector shall require (or specifically not allow more than) only one single connection to horizontal cable as per TIA/EIA-568-B.
  - 43 Flush mounted face plates shall accommodate modular telecommunications outlet/connectors and be available in four connectors per single gang telecommunications outlet.
  - 44 All telecommunications outlets shall be made of high impact plastic.
  - 45 The same modular telecommunications outlet/connectors as found in the flush and surface mount telecommunications outlets shall be installable in utility poles and modular furniture using manufacturer face plates or adapters for this purpose. Each telecommunications outlet shall house as many as three telecommunications outlet/connectors.
  - 46 The eight position modular UTP telecommunications outlet/connector and its pin assignments shall meet the requirements described in the standard CAN/CSA-T529 as T568A.

- 47 Each telecommunications outlet shall be uniquely labelled. The label shall form an integral part of the faceplate.

**7 WARRANTY**

- 1 Provide written verification confirming that the testing and inspection has been completed and that all cable runs have passed. Also document that all defects have been identified, corrected, and retested successfully.
- 2 Contractor shall provide a 25 year Extended Product Warranty and System Assurance Warranty for this Structured Cabling System.
  - .1 Provide "NORDX" IBDN certification, certifying that the cabling system is Installed In accordance to manufacturer's Category standards. The certification must include a minimum of 25 years application assurance warranty, which warranties that the installed cabling system Is compliant with standard current network applications and emerging technologies such as TPPMD, 100 Mbps Ethernet, Gigabit Ethernet, UTP based ATM and other 100 + Mbps applications.

**END OF SECTION**

## **ENTERTAINMENT TV SYSTEM 27 41 16**

### **1 GENERAL**

#### **1.1 General Requirements**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.
- .3 The system shall be CSA and/or UL approved Standard 1069 Hospital Signaling and Nurse Call Equipment.

#### **1.1 Work Included**

- .1 *There **are two Entertainment Televisions required, one on K-2-E in the Conference/ Multipurpose Room #K2E-Co1 and other on K-3-E in the Staff Lounge, Room #K3E-30. The entertainment TV system shall provide TV in locations as shown and shall include a built-in Cable Tuner. Provide Entertainment Television installations as follows:***
  - *wall mounted 42" colour TV and outlet complete with wall mounting support devices**In each of these locations there needs to be an outlet c/w a Coax Cable, in conduit, to the Cable TV Splitter. In these rooms the A-V System will provide the TV and any integration*
- .2 *The system shall derive its signal from the existing Cable Splitter located in Rooms #K2E-34/ K3E-34 (the Electrical Closets on each floor).*
- .3 System components, including actual Televisions, backing plates, connectors, outlets and mounting brackets/ devices are to be supplied and installed by this Division.
- .4 For each Entertainment TV provide a compatible wireless hand-held Controller
- .5 **Televisions are to be purchased from:**
  - **LOC Medical**  
**Ron Arseneau**  
email: [rsarseneau@locmedical.com](mailto:rsarseneau@locmedical.com)  
Tel: 647-901-9529

### **PART 2 - PRODUCTS**

#### **.1 Televisions**

- .1 Commercial grade; rated for 24/7 operation; minimum dimensions as indicated; built-in speakers; Aspect ratio: 16:9; LED or LCD; Energy-star rated; Native resolution: minimum 4K; Response time: <5ms; Non-glare viewing surface; Smart TV feature; free of geometric distortion; Inputs: IPTV, set-top box;
- .2 Capable of withstanding regular cleaning as per Owner's IPAC policies, where accessible by public;
- .3 Power source: 120V, 60 Hz;
- .4 Complete with mounting hardware:
  - .1 Compatible with display;
  - .2 Rated for display size and weight;

- .3 Steel construction;
- .4 Tamperproof/locking screws to prevent unauthorized removal;
- .5 Correct colour saturation and colour phase to produce colour bar test signal, compliant with SMPTE standards;

*Standard of Acceptance*

- Sharp
- Panasonic
- LG
- NEC
- Samsung

**PART 3 - EXECUTION**

- .1 Installation
  - .1 Provide Television, backing plates, outlets, mounting brackets/ devices, cable and conduit in an arrangement shown on Drawings.
  - .2 Install the network wiring in conduit and complete with final connections.
  - .3 For wall mounted Televisions the wall plate is to be mounted at/ near the ceiling and is to include both the TV outlet and a receptacle. Provide the cable outlet, the receptacle and the mounting structure.

**END OF SECTION**

## AUDIO VISUAL NURSE CALL SYSTEM 27 52 22

### PART - 1 GENERAL

#### GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.
- .3 The Hospital will be installing in the existing K Wing, 2<sup>nd</sup> & 3<sup>rd</sup> Floor East Nursing Units, and under a separate Contract, a like for like replacement Audio Visual Nurse Call System. The new System will be a Rauland Responder 5.
- .4 However, the proposed 2<sup>nd</sup> & 3<sup>rd</sup> Floor Unit Renovations will require Differences between the like for like installation and the new installation. These differences will include, but are not limited to:
  - .1 a reduced number of two Patient Stations and more single Patient Stations
  - .2 Addition of Duty Stations wall mounted over the Door to the various rooms to provide a local individual room Alarm
  - .3 addition of Code Blue integration
  - .4 Addition of Code White integration
  - .5 Provide new/ altered Nurse Call System Components for the new Rauland Responder 5 Audio Visual Nurse Call System as required.
- .5 The new system components shall be CSA and/or UL approved Standard 1069 Hospital Signaling and Nurse Call Equipment. Transistors, capacitors, integrated circuits, and other components shall not be operated to exceed their rated values. Design systems for 24-hour continuous operation
- .6 Refer also to Sections regarding Code Blue and Code White
- .6 Conform to the "Sunnybrook – Code White, Code Blue & Nurse Call Installation policy" appended to this Specification

#### WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.
- .2 An existing Rauland R4K nurse call system presently serves existing K Wing, 2<sup>nd</sup> & 3<sup>rd</sup> Floor areas and these areas are to be upgraded to the R5 system. In addition to upgrading the K Wing 2<sup>nd</sup> & 3<sup>rd</sup> Floor East areas, retained the existing R5 devices and function in the K Wing 2<sup>nd</sup> & 3<sup>rd</sup> Floor East Nursing Units. Include and engage Hospital's existing system vendor: **Aatel Communications Inc, to provide system work and products. Contact for existing system vendor is Paulette Francella. Telephone (905) 526-2382, Email paulettef@aatel.com.**
- .2 System vendor to be typically responsible for but not be limited to provision of:
  - .1 required modifications to accommodate removal of devices in K2E & K3E from existing R4K head-end
  - .2 Upgrading the existing R5 head-end control unit including; branch regional controller, power supply, wall mounting cabinet and accessories as required for the inclusion of the equipment required for the new area
  - .3 software programming and system setup;
  - .5 R5 VOIP nurse console at PAA;
  - .6 New Emergency Call Stations of pull cord type with audio in bathrooms and showers
  - .7 New single Enhanced Two additional call input jacks Audio Visual Patient Bed Stations
  - .8 4 position corridor dome lights;



- .9 wiring as per system manufacturer's requirements, run in conduit and provision of required ancillary devices; (coordinate supply and installation of wiring with Electrical Contractor
- .10 integration of system with other nurse call systems of complex, coordinate with Sunnybrook IS to integrate R5 system with existing Connexall alarm management;
- .11 plexi-covers for stations as indicated on drawings including emergency response buttons;
- .12 ring tones to match other devices serving same area;
- .13 nurse call devices to ring at consoles designated by Owner.
- .14 ancillary devices as required for a complete system;
- .15 end to end testing and verification of new and old rooms on systems with plant and users as part of verification training time 2-4 hours; preparation of test reports;
- .16 providing technical assistance to Electrical Contractor with regards to conduit, wiring and component installation requirements.
- .3 Generally, Electrical Contractor is responsible for following:
  - .1 arranging and coordination of system vendor's work to clearly identify responsibilities of system vendor and Electrical Contractor;
  - .2 supervision of system vendor onsite;
  - .3 provision of system conduits and boxes, power feeders, to suit system requirements and as per requirements of Section 26 05 00 and as per system manufacturer's requirements;
  - .4 installing system components, wiring, wiring accessories, and identification and labelling of each wiring run; (coordinate supply and installation of system wiring with system vendor;
  - .5 assist system vendor in onsite system testing, inspection and verification work upon completion of each phase (as applicable);
  - .6 submission of copies of testing and verification reports signed by manufacturer's authorized representative and by Electrical Contractor;
  - .7 preparing as-built drawings and other submittals to requirements of Section 26 00 10.
- .4 Upgraded consoles, stations and other products to be 100% compatible to upgraded system and hospital's existing alarm management system (Connexall). Prior to submission of shop drawings, contact Owner's Project Manager and department user representative to confirm exact model and version of products to be supplied.
- .5 The system to be based on provision of a Rauland Borg "Responder 5" voice over IP based audio/visual nurse call system. The system to be a multiplexed solid-state microprocessor based networked system providing two-way full duplex voice communications between any console(s) and patient stations, and staff/duty stations. Provide equipment, accessories and material required for the installation of system. Any material and/or equipment necessary for the proper operation of the system not specified or described herein is to be deemed part of this specification. The equipment described and provided to be the standard product of one manufacturer.
- .6 Components and system as a whole to meet or exceed the minimal standards issued by CSA, EEMAC and ULC. The system to also be compliant with requirements of UL-1069. Each major component to bear the manufacturer's name, catalogue number, place of manufacture and CSA/ULC label.
- .7 The system to be UL 1069 listed as a Nurse Communications Network. The system to be capable of interconnecting with the hospital's LAN (Local Area Network). This connection to be minimal and utilize only one Ethernet 100 Mbps (or optionally 1 Gb) connection to accomplish all ADT, hospital information, reporting software and information exchange. The HL-7 standard to be confirmed with Owner to be utilized for receipt of patient information from the ADT system, as required by Owner.
- .8 The system head end equipment and software to also be capable of handling an additional

minimum 20% future expansion. Include for sufficient cabinet/panel/rack spaces, sufficient power supplies, and sufficient space for future zone/device connection modules and include in system software programming to easily accommodate future expansion requirements.

- .9 System sequence of operation to be confirmed with and approved by Owner prior to start of work.
- .10 Existing system stations and components being disconnected and not re-located for use on this project, to be properly decommissioned, packaged, identified with label and turned over to Owner.

## **2 PRODUCTS**

### **2.1 BASE MASTER STATION**

Base master station, including the handset, shall be located at each nursing station. It shall include a 16-character LCD display, a compact dial pad, a control panel containing permanently designated rubber-conductive pushbuttons sealed to resist moisture, and a combination of a speaker/microphone, volume control, and telephone handset for voice communications with patient, duty, and staff stations.

### **2.2 STAFF STATIONS**

- .1 Dynamic device which supports various workflows and communication between staff members.
- .2 Full-duplex audio communication.
- .3 Wall-mounted.
- .4 Complete with Emergency Call Button where indicated
- .5 Functionality:
  - .1 Place or answer calls with other nurse call devices;
  - .2 Place Emergency (Staff Assist) calls where indicated.
  - .3 Announce other calls on the Nurse Call System.

### **2.3 DUTY STATIONS**

- .1 Dynamic device which supports alarms on the local Nurse Call.
- .2 Full-duplex audio communication.
- .3 Wall-mounted (over the Patient Room door where indicated)
- .4 Functionality:
  - .1 Display/ Alarm calls from the respective Nurse Call in-room Devices.

### **2.4 SINGLE PATIENT STATION**

The single patient bedside station shall contain all the necessary electrical components to support all stations within the room, including the Lavatory Stations, the Code Blue Stations, the Code White Stations, the Staff Emergency Stations, manual or automatic presence stations, and four-section corridor lights

Stations shall include:

- Two additional call input jacks
- jack for Pillow Speaker and for other ancillary devices

### **2.5 LAVATORY EMERGENCY STATIONS**

The lavatory emergency station shall provide audio and visual communication with the Patient. The Station shall include a pull cord version, equipped with a built-in Speaker/ Microphone, a CANCEL button and call assurance LED, all mounted on a two-gang, non-conductive chassis.

### **2.6 CORRIDOR LIGHTS**

Multi section corridor lights, suitable for wall or ceiling mounting, shall be provided outside the entrance to each patient room and all staff/duty rooms, clearly visible from all directions.

The chassis, similar in design and material to the patient station, shall accommodate four long-life, colour-coded lamps, separated by snap-in metal barriers to meet the functional requirements of each room.

#### **2.7.1 PILLOW SPEAKERS**

A combination nurse call/entertainment pillow speaker shall be provided for each bed and plug into the receptacle of each patient station. It shall be able to withstand a 1.8 m (6 ft) drop to a hard tiled floor without damage.

All control buttons shall be non-mechanical conductive rubber switches with a permanently designated overlay to identify the function of each pushbutton, mounted into a high-impact, Cyclooy® C2800 plastic housing with no sharp or protruding corners.

A large, 3.8 cm (1-1/2 in) by 2.5 cm (1 in), raised and clearly designated pushbutton shall be provided for placing a call to the master station.

A light green call assurance LED shall illuminate when a call is placed from the pillow speaker. If staff reminder is set, the LED shall flash slowly.

A red privacy LED shall illuminate whenever communication is established with the room station. The speaker shall be 6.4 cm (2-1/2 in) or larger in diameter and include a moisture-resistant Mylar® cone capable of reproducing quality audio from both the master station and the television set. It shall also act as a microphone for two-way communications with the master station.

An adjustable breakaway cord clamp shall be provided in addition to the standard bed sheet clamp to secure the pillow speaker to the bed for the patient's convenience.

If the pillow speaker is removed from the station receptacle, the entertainment and lighting control shall become inoperable, a "cord out" call shall be placed, and if the call is answered, the communications shall automatically be transferred to the wall speaker

#### **2.8.1 INTEGRATION WITH THE WANDER PATIENT SYSTEM**

Integrate the Wandering Patient System to the Nurse Call System to initiate/ indicate an Alarm as a tagged patient approaches either of the monitored doors

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- .1 Provide a complete extension to the existing audio-visual nurse call system as shown on the drawings and specified herein. Install equipment in accordance with manufacturer's instructions
- .2 Interconnect equipment.
- .3 Provide specified various nurse call systems components in areas as shown and as required. Programme system on servers/terminals/nurse consoles, as required. Obtain Owner's approval of room nomenclature prior to start of programming. Customize software to suit Owner's specific applications. Program sequence of operation and user information as required. Include for system manufacturers authorized representative to program systems. Programme exact programming requirements as confirmed with Consultant and/or Owner in writing prior to start of Work. Utilize manufacturer's recommended configuration chart during installation and record respective device names, serial number, room name and number and comments, as outlined on sheets. Submits sheets with test reports.
- .4 Locate head end equipment, terminal cabinets, racks, patch panels, UPS, and central computer terminal in locations as shown and/as directed by Consultant. Locate equipment in electrical or telecom closets or as noted. Provide terminal cabinets/panels as required, and locate in electrical or telecom closets as approved by Consultant. Do not locate in ceiling spaces or public/patient areas, corridors, stairways or offices. Ventilate areas as required for proper equipment performance. Confirm cabling standards with system manufacturer and perform installation to suit standards. Clearly label each cable run and port. Install devices in strict accordance with system manufacturer's instructions and recommendations.

- .5 Provide power receptacles, feeders, data jack/drop as required to accommodate for installation of new head-end equipment. Exact locations to be confirmed with Consultant prior to roughing-in. Coordinate work of all trades.
- .6 Provide dedicated conduit feeder(s) into the equipment cabinets and UPS units. Generally, required sizing of breakers, feeders and conduits to be as noted on drawings, but in absence of directions, size distribution to local governing electrical code requirements to
- .7 Provide stations and install into locations. Install components at the mounting heights as noted on drawings, on architectural elevations and as required and confirmed with Consultant. Generally, wall mount devices onto recessed boxes. Provide suitable conduits and backboxes to accommodate device installations. Confirm back box requirements with system vendor prior to roughing-in.
- .8 Generally, install new dome lights in locations as shown but reviewed with Consultant prior to roughing-in. Connect patient room smoke detectors to new dome lights and remote communicators, as applicable. Coordinate work with fire alarm system technicians of fire alarm system vendor. Install zone lights to ceilings on recessed boxes in locations
- .9 Generally, install emergency call stations of pull cord type in locations as shown. Silicone seal between the wall and the device to prevent water from entering the device for all devices located in wet locations including but not limited to showers.
- .10 Provide system wiring. Wiring to be copper conductor, colour coded, and in accordance with the system manufacturer's recommendations and instructions. Connect equipment in accordance with the system manufacturer's certified wiring diagrams and instructions and under direct supervision of the manufacturer. Provide and arrange for authorized system manufacturer's representative to make final equipment connections. Run conductors in conduit or where identified on drawings, in cable tray.
- .11 Perform system integration connections to various systems as required. Include costs for systems service vendors to perform required integration and programming requirements.
- .12 Ground and bond system as required by local governing electrical code and authority and system manufacturer.
- .13 When work is complete, arrange for attendance at the site of the system manufacturer's authorized representative to make final equipment connections and provide testing and verification requirements.
- .14 Provide signed documented test report verifying that system components have been tested successfully and that the system is in proper working order. Testing and verification of system to be witnessed by the Consultant and Owner at times approved by Consultant.

### **3.2 EXISTING NURSE CALL SYSTEM WORK**

- .1 Delete and/or relocate existing nurse call system devices as noted. Include for following:
  - .1 disconnecting and decommissioning of devices;
  - .2 removal of obsolete boxes, wiring and conduit;
  - .3 patching and making good surfaces as coordinated with General Trades Contractor;
  - .4 provision of additional boxes, wiring and conduit for relocated devices;
  - .5 engaging Owner's existing system vendor to decommission devices, re-program existing system to suit renovations work, test and verify operation of existing system is in proper order after system changes;
  - .6 turn over deleted devices to Owner if requested by Owner;
  - .7 proper disposal of materials not wanted by Owner.

### **3.3 SYSTEM TRAINING, INSTRUCTIONS AND TRAINING UNIT**

- .1 Provide to Owner's designated staff, onsite training sessions to Owner's designated personnel on the operation and maintenance procedures with regards to the system. Each session may be held on different days and locations, at Owner's discretion. Exact times and dates to be coordinated with and approved by Owner.

**END OF SECTION**

## **CODE WHITE SYSTEM**

### **27 52 23**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.
- .3 The system shall be CSA and/or UL approved Standard 1069 Hospital Signaling and Nurse Call Equipment.
- .4 Transistors, capacitors, integrated circuits, and other components shall not be operated to exceed their rated values. Design systems for 24-hour continuous operation.
- .5 **Conform to the “Sunnybrook – Code White, Code Blue & Nurse Call Installation policy” appended to this Specification**

##### **1.2 CODE WHITE SYSTEM**

##### **1.3 WORK INCLUDED**

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation of Code White System as shown as specified and as otherwise required.
- .2 System will include the following:
  - .1 Supply and installation of control equipment including auxiliary power supplies.
  - .2 Supply and installation of all system equipment and devices (both Pushbuttons and Wireless Receivers as shown).
  - .3 Supply and installation of all wiring required for complete system operation.
  - .4 All required system programming, testing and verification.
  - .5 Complete layout, wiring and installation diagrams for overall system design.
  - .6 Complete instruction to Owner on system operation.
  - .7 Technical data on each product, including finishes.
  - .8 Factory prepared operation and service manual for each system, operation details, schematics, wiring diagrams, colour coding, terminal numbers, and component values for printed circuit boards.

##### **1.4 SYSTEM VERIFICATION**

- .1 Test and demonstrate the operation of the complete system to the Owner. This shall include, but not be limited to:
  - .1 detailed test and demonstration of each operable device
  - .2 detailed test and demonstration of overall system operation
  - .3 interfacing of various components.

- .2 On completion of the installation the manufacturer/supplier shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.

## **PART - 2 PRODUCTS**

### **2.1 GENERAL**

- .1 The Specifications for this system are a description of the various components with the minimum requirements of the operational sequence, facilities and features required.

### **2.2 CODE WHITE (PERSONAL ALERT PANIC ALARM) SYSTEM**

- .1 Provide, as indicated on the plans, a wireless Code White (Personal Alert Panic Alarm) System complete with a fixed location Code White Button. The System shall be integrated to the existing Hospital Central Code White System. Buttons shall be located where indicated on the drawings and provide adequate coverage insuring system operation anywhere within each room.
- .2 The system shall permit staff , when activating the Code White Button, signal emergency call placement causing the following to occur;
  - .1 annunciate on the local annunciator,
  - .2 simultaneously signal the main security office via a new remote console installed within the security office.
  - .3 **Simultaneously send a signal to the Unit entry doors to release the magnetic locks (permitting Security un-restricted entry). Locks shall remain un-locked until the Code White is reset**
- .3 The system shall include all necessary hardware and software permitting the future integration to the facilities in house pocket paging system enabling Code White calls to be dispatched to security personnel remotely via alpha-numeric pocket pager.
- .4 Discreet annunciation shall be provided by the Code White system at the local annunciator via a touch screen master console, and at the Security Office defining the call type and pinpointing location by room number where the call originated.
- .5 **Manufacturers**
  - .1 **The manufacturer for this system to be manufactured/ supplied by:**
    - **For Pushbuttons: Rauland, and as supplied by Aatel Communications.**

## **PART - 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Provide a complete Code White System as shown and as specified.
- .2 Install Code White Buttons as indicated on Drawings with suitable backboxes.
- .3 Wiring to be of a type recommended by manufacturer, to be colour-coded, and to be installed in conduit.
- .4 Provide interface wiring from Code White System to the existing Central Code White System via the Hospital Network.

.5 Test complete installation.

**END OF SECTION**



## **CODE WHITE SYSTEM**

### **27 52 23**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.
- .3 The system shall be CSA and/or UL approved Standard 1069 Hospital Signaling and Nurse Call Equipment.
- .4 Transistors, capacitors, integrated circuits, and other components shall not be operated to exceed their rated values. Design systems for 24-hour continuous operation.
- .5 **Conform to the “Sunnybrook – Code White, Code Blue & Nurse Call Installation policy” appended to this Specification**

##### **1.2 CODE WHITE SYSTEM**

##### **1.3 WORK INCLUDED**

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation of Code White System as shown as specified and as otherwise required.
- .2 System will include the following:
  - .1 Supply and installation of control equipment including auxiliary power supplies.
  - .2 Supply and installation of all system equipment and devices (both Pushbuttons and Wireless Receivers as shown).
  - .3 Supply and installation of all wiring required for complete system operation.
  - .4 All required system programming, testing and verification.
  - .5 Complete layout, wiring and installation diagrams for overall system design.
  - .6 Complete instruction to Owner on system operation.
  - .7 Technical data on each product, including finishes.
  - .8 Factory prepared operation and service manual for each system, operation details, schematics, wiring diagrams, colour coding, terminal numbers, and component values for printed circuit boards.

##### **1.4 SYSTEM VERIFICATION**

- .1 Test and demonstrate the operation of the complete system to the Owner. This shall include, but not be limited to:
  - .1 detailed test and demonstration of each operable device
  - .2 detailed test and demonstration of overall system operation
  - .3 interfacing of various components.

- .2 On completion of the installation the manufacturer/supplier shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.

## **PART - 2 PRODUCTS**

### **2.1 GENERAL**

- .1 The Specifications for this system are a description of the various components with the minimum requirements of the operational sequence, facilities and features required.

### **2.2 CODE WHITE (PERSONAL ALERT PANIC ALARM) SYSTEM**

- .1 Provide, as indicated on the plans, a wireless Code White (Personal Alert Panic Alarm) System complete with a fixed location Code White Button. The System shall be integrated to the existing Hospital Central Code White System. Buttons shall be located where indicated on the drawings and provide adequate coverage insuring system operation anywhere within each room.
- .2 The system shall permit staff , when activating the Code White Button, signal emergency call placement causing the following to occur;
  - .1 annunciate on the local annunciator,
  - .2 simultaneously signal the main security office via a new remote console installed within the security office.
  - .3 **Simultaneously send a signal to the Unit entry doors to release the magnetic locks (permitting Security un-restricted entry). Locks shall remain un-locked until the Code White is reset**
- .3 The system shall include all necessary hardware and software permitting the future integration to the facilities in house pocket paging system enabling Code White calls to be dispatched to security personnel remotely via alpha-numeric pocket pager.
- .4 Discreet annunciation shall be provided by the Code White system at the local annunciator via a touch screen master console, and at the Security Office defining the call type and pinpointing location by room number where the call originated.
- .5 **Manufacturers**
  - .1 **The manufacturer for this system to be manufactured/ supplied by:**
    - **For Pushbuttons: Rauland, and as supplied by Aatel Communications.**

## **PART - 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Provide a complete Code White System as shown and as specified.
- .2 Install Code White Buttons as indicated on Drawings with suitable backboxes.
- .3 Wiring to be of a type recommended by manufacturer, to be colour-coded, and to be installed in conduit.
- .4 Provide interface wiring from Code White System to the existing Central Code White System via the Hospital Network.

.5 Test complete installation.

**END OF SECTION**

## **CARDIAC ARREST SYSTEM**

### **27 52 24**

#### **PART - 1      GENERAL**

##### **1.1              GENERAL REQUIREMENTS**

Conform to Sections of Division 1 as applicable.

Conform to Section 26 01 01, Electrical General Requirements.

The system shall be CSA and/or UL approved Standard 1069 Hospital Signaling and Nurse Call Equipment.

- .4      Conform to the "Sunnybrook – Code White, Code Blue & Nurse Call Installation policy" appended to this Specification

##### **1.2              SHOP DRAWINGS AND PRODUCT DATA**

Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.

Include: Details for devices.

##### **1.3              WORK INCLUDED**

Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

Equipment design considerations for future expansion when indicated.

Materials list and backbox schedule (including unique backboxes).

Factory prepared operation and service manual for each system, operation details, schematics, wiring diagrams, colour coding, terminal numbers, and component values for printed circuit boards.

##### **1.4              OPERATION AND MAINTENANCE DATA**

Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

##### **1.5              MAINTENANCE MATERIALS**

Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

##### **1.6              OPERATING AND MAINTENANCE INSTRUCTIONS**

Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

##### **1.7              SYSTEM VERIFICATION**

Test and demonstrate the operation of the complete system to the Owner. This shall include, but not be limited to:

    detailed test and demonstration of each operable device

detailed test and demonstration of overall system operation  
interfacing of various components.

On completion of the installation the manufacturer/supplier shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.

## 1.8 **OPERATION**

If any Cardiac Arrest station is operated by Code Blue Button, the following events to take place simultaneously and continuously until reset:

- a call placed light to appear at the station originating the call, identifying blue.
  - a dome light to become illuminated and flash steadily at the ceiling over the door to the room where the call originated
  - a light to flash steadily in the annunciator at the associated nurses' stations and a signal to sound at two (2) second intervals
  - a pilot light to be illuminated in an annunciator to identify the general area at the communications Centre and a signal to sound at two (2) second intervals
- Simultaneously send a signal to the Unit entry doors to release the magnetic locks (permitting un-restricted entry). Locks shall remain un-locked until the Code Blue is reset**

To reset the call, the switch which originated the call to be returned to its original position. It to not be possible to cancel the call from any other location.

## **PART - 2      PRODUCTS**

### 2.1 **GENERAL**

The Specifications for this system are a description of the various components with the minimum requirements of the operational sequence, facilities and features required.

### 2.2 **CALL PLACEMENT STATIONS**

Each station to include the following:

- backbox of required dimension
- call placed switch
- call placed light
- reset feature

### 2.3 **DOME LIGHT**

Dome light to be single gang with trim and to feature blue plastic or alternatively clear plastic with blue lamp.

If combined with nurse call system, dome light to be two-gang with barriered sections.

2.4            **MANUFACTURER/ SUPPLIER:**

System shall be as manufactured by Rauland (Responder 5) and as supplied by Aatel Communications

**PART - 3        EXECUTION**

3.1            **INSTALLATION**

Provide a complete Cardiac Arrest (Code Blue) System as shown and as specified.

Install call placed stations at elevations indicated on Drawings with suitable backboxes and plaster rings.

Install dome lights on ceiling at door to room originating call.

Wiring to be of a type recommended by manufacturer, to be colour-coded, and to be installed in conduit.

Test complete installation.

**END OF SECTION**

## **CARDIAC ARREST SYSTEM**

### **27 52 24**

#### **PART - 1      GENERAL**

##### **1.1              GENERAL REQUIREMENTS**

Conform to Sections of Division 1 as applicable.

Conform to Section 26 01 01, Electrical General Requirements.

The system shall be CSA and/or UL approved Standard 1069 Hospital Signaling and Nurse Call Equipment.

- .4      Conform to the "Sunnybrook – Code White, Code Blue & Nurse Call Installation policy" appended to this Specification

##### **1.2              SHOP DRAWINGS AND PRODUCT DATA**

Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.

Include: Details for devices.

##### **1.3              WORK INCLUDED**

Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

Equipment design considerations for future expansion when indicated.

Materials list and backbox schedule (including unique backboxes).

Factory prepared operation and service manual for each system, operation details, schematics, wiring diagrams, colour coding, terminal numbers, and component values for printed circuit boards.

##### **1.4              OPERATION AND MAINTENANCE DATA**

Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

##### **1.5              MAINTENANCE MATERIALS**

Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

##### **1.6              OPERATING AND MAINTENANCE INSTRUCTIONS**

Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

##### **1.7              SYSTEM VERIFICATION**

Test and demonstrate the operation of the complete system to the Owner. This shall include, but not be limited to:

    detailed test and demonstration of each operable device

detailed test and demonstration of overall system operation  
interfacing of various components.

On completion of the installation the manufacturer/supplier shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.

## 1.8 **OPERATION**

If any Cardiac Arrest station is operated by Code Blue Button, the following events to take place simultaneously and continuously until reset:

- a call placed light to appear at the station originating the call, identifying blue.
  - a dome light to become illuminated and flash steadily at the ceiling over the door to the room where the call originated
  - a light to flash steadily in the annunciator at the associated nurses' stations and a signal to sound at two (2) second intervals
  - a pilot light to be illuminated in an annunciator to identify the general area at the communications Centre and a signal to sound at two (2) second intervals
- Simultaneously send a signal to the Unit entry doors to release the magnetic locks (permitting un-restricted entry). Locks shall remain un-locked until the Code Blue is reset**

To reset the call, the switch which originated the call to be returned to its original position. It to not be possible to cancel the call from any other location.

## **PART - 2      PRODUCTS**

### 2.1 **GENERAL**

The Specifications for this system are a description of the various components with the minimum requirements of the operational sequence, facilities and features required.

### 2.2 **CALL PLACEMENT STATIONS**

Each station to include the following:

- backbox of required dimension
- call placed switch
- call placed light
- reset feature

### 2.3 **DOME LIGHT**

Dome light to be single gang with trim and to feature blue plastic or alternatively clear plastic with blue lamp.

If combined with nurse call system, dome light to be two-gang with barriered sections.



2.4            **MANUFACTURER/ SUPPLIER:**

System shall be as manufactured by Rauland (Responder 5) and as supplied by Aatel Communications

**PART - 3        EXECUTION**

3.1            **INSTALLATION**

Provide a complete Cardiac Arrest (Code Blue) System as shown and as specified.

Install call placed stations at elevations indicated on Drawings with suitable backboxes and plaster rings.

Install dome lights on ceiling at door to room originating call.

Wiring to be of a type recommended by manufacturer, to be colour-coded, and to be installed in conduit.

Test complete installation.

**END OF SECTION**

## **WANDERING PATIENT SYSTEM**

### **27 52 25**

#### **1 GENERAL**

##### **1.1 General Requirements**

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

##### **1.2 Shop Drawings and Product Data**

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2 Include:
  - .1 Detail assembly and internal wiring diagrams for control unit.
  - .2 Overall system riser wiring diagram identifying control unit, circuits; identifying terminations, terminal numbers, conductors and raceways.
  - .3 Details for devices.
  - .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
  - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.
- .3 The Contractor in co-operation with the supplier of the system shall prepare a detailed riser diagram of the complete system showing all major components, devices and necessary interconnecting wiring.
  - .1 Diagram is to indicate wiring quantities, sizes and colour code and to indicate conduit sizes.
  - .2 Riser Diagram is to be produced on AutoCad and is to be submitted as a Shop Drawing.
  - .3 Riser Diagram is to be revised 'As-Built' at the completion of the project and submitted with Maintenance Manuals (submit both a copy of the Drawing and an AutoCad disc).

##### **1.3 Work Included**

- .1 Provide a complete and fully operational Wandering Patient System, complete with Door Controllers at each door, bypass Keypad at each door, Manager for Programming at the PAA Station, Resident Tags and a Tag Detector at the PAA Station all as shown, as specified and as otherwise required.
- .2 All components of the system shall be of the same manufacture.
- .3 Provide operating and maintenance instructions as specified in Section 26 05 01.

##### **1.4 References**

#### **2 PRODUCTS**

##### **2.1 General**

- .1 The system shall be a totally integrated alarm system to detect and prevent exiting of the tagged Patient. The system must activate ancillary functions, (activate door magnetic lock system, etc).

- .2 System shall include:
  - .1 automatic lock activation
  - .2 door by-pass to allow staff to escort patients without alarm.
  - .3 Activation of an Alarm on the Nurse Call System
  - .4 activation of CCTV system to record alarm incidents.

## **2.2 Manufacturer / Supplier**

- .1 **The system shall be:**  
**Stanley WanderGuard Blue and be as supplied by: Aatel Communications**

## **2.3 System Operation**

- .1 At Exit Doors with Magnetic Locks: as a tagged Patient approaches the exit door the system shall automatically:
  - .1 immediately activate the specific door magnetic lock to prevent resident exit. The tagged Patient leaving the vicinity of the door will deactivate the magnetic lock
  - .2 activate an Alarm on the Nurse Call System
  - .3 place the appropriate CCTV camera on the CCTV System detail monitor.

## **2.4 Equipment**

- .1 System shall consist of, but not be limited to, the following:
  - .1 receivers mounted on the wall above the controlled doors.
  - .2 door magnetic locks activators.
  - .3 CCTV controls
  - .4 Patient worn active transponders.
- .2 Local Door Monitor, Activator (Patient Tracking Receiver)
  - .1 Located at each "monitored" location this device must detect a tagged Patient approaching, exiting each location, activate the alarm system, "read" the patient data available from the tag and initiate appropriate function.
  - .2 Local Door Monitor Activator devices shall operate on 120 volts at 60 Hertz.
- .3 Patient Tags (Transporter)
  - .1 The Patient tag must be a device that can be worn or attached to the Patient, ie a wrist band.
  - .2 The tag must be specifically coded to identify the Patient to the system.
  - .3 Batteries within the tag are to be long life providing a minimum 12 months. Units shall be totally sealed and waterproofed.
  - .4 System shall be provided with a means for testing the functionality of patient tags at each Nurses' Station equipped with a monitor.
  - .5 Quantity required 30.
- .4 Interconnections
  - .1 The Wandering System must be inter-connected with the door control system to ensure, where applicable, magnetic locks are activated as a tagged Patient approaches. The system must activate the magnetic locks and prevent exit of the tagged Patient.

- .2 The Wandering System must be inter-connected with the Nurse Call System to activate an Alarm as a tagged Patient approaches.
- .3 The Wandering System must be inter-connected with the CCTV System to activate the Camera at the door as a tagged Patient approaches.

### **3 EXECUTION**

#### **3.1 Installation**

- .1 Wiring shall be installed in conduits.
- .2 The supplier shall prepare wiring diagrams, wiring running drawings and all other information required, so that the wiring and completed system can be properly installed. Wiring diagrams and wiring running drawings shall be submitted as shop drawings and included in Data Books.
- .3 The supplier shall co-ordinate the final installation of the system with the Contractor to ensure the system is completely operational. Include in the Contract price the cost of a qualified technician to "de-bug" the system and correct all installation faults.
- .4 The actual system manufacturer shall provide a qualified technician to verify each and every connection and device and confirm in writing that each device has been inspected and is properly connected and operating. The "verification process" shall be spot checked witnessed by the Owner and Consultant. Signatures must be obtained to prove this "spot checking".
- .5 The magnetic locks shall be released during a fire alarm condition allowing free exiting from the area.
- .6 Provide signals/interface with Nurse Call System, CCTV system and Security system as described in System Operation.
- .7 Locate sensors at all exit doors.

**END OF SECTION**

## **CLOCK SYSTEM**

### **27 53 13**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL REQUIREMENTS**

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.
- .3 Conform to Section 27 15 00, Communications Cabling.

##### **1.2 REFERENCES**

- .1 Industry Canada specifications RSS 119 Issue 6.
- .2 Bluetooth wireless technology standard 4.1.

##### **1.3 WORK INCLUDED**

- .1 Work to be done under this Section includes furnishing of labour, materials, software and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.
- .2 Furnish and install all system devices, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating Wireless Clock System using the Primex OneVue platform. The model designations are that of Primex.
- .3 System to include the system devices below:
  - .1 **Digital Clocks**

##### **1.4 SYSTEM DESCRIPTION**

- .1 General Specifications
  - .1 System to provide synchronized time by way of system devices and a cloud-based system software hosted by the Manufacturer that allows Owner to manage and monitor system devices.
  - .2 System shall consist of system Clocks enabled with IP Ethernet/PoE technology.
  - .3 System shall provide synchronized time by way of system devices connected to IP Ethernet/PoE network
  - .4 System shall not require the installation of any onsite system hardware or software, with the exception of the specified system devices.
  - .5 Clocks shall be capable of automatically adjusting for Daylight Saving Time.
  - .6 Clocks shall be fully portable, capable of being relocated at any time.
  - .7 Clocks shall receive UTC time from a Network Time Protocol (NTP) time source; allow up to three NTP time sources for failover purposes.
  - .8 Clocks shall operate with a free-running accuracy of .45 seconds per day, and will continue to operate in the absence of receiving the UTC time from an NTP time source.

- .2 System devices with Ethernet network communication
  - .1 Network Communication Protocols: Hypertext Transfer Protocol Secure (HTTPS) | IP Addressing: Dynamic Host Configuration Protocol (DHCP), static IP addressing | Data Packet Size: typically less than 5 kilobytes (kB).
  - .2 Network setting data is stored locally in devices shall be encrypted and access to locally stored setting data can be controlled by a system admin user.
  - .3 Manufacturer to provide stand-alone configuration software to locally configure a device to meet Owner security policies if network setting data cannot be stored in third-party software or to troubleshoot device network connectivity issues.

## 1.5 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit samples and cut sheets of clocks for review and selection of the desired types and styles. Samples to be equivalent to the specified types and styles.
- .2 Provide one additional set of reviewed drawings, shipped with the equipment, for start up and maintenance use.
- .3 Include with the shop drawings;
  - .1 description of system operation,
  - .2 riser diagrams.

## 1.6 OPERATION AND MAINTENANCE DATA

- .1 Include detailed instructions to permit effective operation and maintenance of the equipment.
- .2 Technical data to be included;
  - .1 Setup and operation instructions,
  - .2 Cut sheets with specification for each component used in the system,
  - .3 List of spare parts included with the system,
  - .4 Illustrated parts lists with part catalogue numbers,
  - .5 "as built" layout, wiring and installation diagrams.

## PART - 2 PRODUCTS

### 2.1 SYNCHRONOUS CLOCK SYSTEM

- .1 General
  - .1 The system and equipment is specified as described in this section.
  - .2 All bids to be based on the equipment as specified herein. **The model designations are that of Primex.**
- .2 System Software:
  - .1 Basis of Design Software Product: Primex OneVue
  - .2 System Software Platform: Cloud-based software platform that resides on Amazon Web Services (AWS) and is accessed via the internet.
  - .3 System stores and monitors system devices operating conditions.

- .4 All system device and system settings are managed within the system software.
- .3 Digital Clocks:
  - .1 **The clock LED display must include a 12- or 24-hour time display, a PM indicator light, and an alternating time and date display option.**
  - .2 Clock to be capable of automatically adjusting for Daylight Saving Time.
  - .3 Power over Ethernet (PoE) models shall have an IEEE 802.3af compliant power supply built into the clock assembly.
  - .4 Clock shall have a power outage memory backup and maintain the correct time up in its memory for a minimum of 1 hour without power.
  - .5 Clock shall be viewable from 150 ft. (45.7 m).
  - .6 Clock shall have highly visible 7-segment LED digits.
  - .7 Clock shall have display dimmer options, including 100%, 75%, 50%, and 25%.
  - .8 Clock enclosure shall be ABS plastic and junction box shall be UL listed (UL 50E 1st Ed; listing number E469550).
  - .9 SUPPLY MODELS - Digital Clocks
    - Surface Mount 2.5" Digits
    - Number of Digits: 6 Digit
  - .10 Digit Color: Green
  - .11 Bracket: 4" Slope Bracket,
- .4 System Verification
  - .1 Test and demonstrate the operation of the complete system to the Owner, including:
    - a) **test and demonstration of overall system operation,**
    - b) **test and demonstration of each operable device,**
  - .2 On completion of the installation, manufacturer/supplier to supply documentation including:
    - a) **record sheets showing the location of each device,**
    - b) **record sheets showing the test results for each device,**
    - c) **a certificate confirming that the system is installed and operates in accordance with the Specifications and the Manufacturer's recommendations.**

*Standard of Acceptance*

**Primex OneVue**

**Supplied by:**

**Troy Life & Fire Safety Ltd.**

**Luch Condarcuri**

**Fire Systems Sales Representative**

**T: 905 672 5348 ext 303**

**C: 647 331 0093**

[luch.condarcuri@troylfs.com](mailto:luch.condarcuri@troylfs.com)

## **PART - 3      EXECUTION**

### **3.1            EXAMINATION**

- .1      Examine conditions with the Installer present for compliance with requirements and other conditions affecting the performance of the system and system devices.
- .2      Do not proceed until unsatisfactory conditions have been corrected.

### **3.2            INSTALLATION**

- .1      General: Install system devices in accordance with applicable codes.
- .2      Install system devices in accordance with Manufacturer written instructions.
- .3      Provide all system equipment necessary for a complete and operable system.
- .4      Comply with requirements of Division 27 Sections "Common Work Results for Communications" and "Communications Horizontal Cabling."
- .5      Inspection: Make observations to verify that system devices and components are properly labeled.
- .6      Prior to final acceptance, inspect each system device and component, adjust as required, and replace parts that are found defective.
- .7      At the completion of system device installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly and that the system software and all system devices and components are functioning.
- .8      Commissioning General: Provide system commissioning in accordance with Manufacturer written recommendations. Perform operational testing to verify compliance with requirements. Adjust as required.
- .9      Services shall include a specified level of commissioning services.
- .10     Remote commissioning service: system deployment training, including system setup, device configuration, and system functionality by way of a web conference.
- .11     Onsite commissioning service: system training, system setup, validation of device configuration and system functionality, verification of device network connections, and device installation training.
- .12     Onsite installation and commissioning service: system training, configuration, validation of device configuration, training on system functionality, verification of device network connections, and device installation.
- .13     **CLEANING**
  - .1      Prior to final acceptance, clean exposed surfaces of devices, using cleaning methods recommended by Manufacturer.
  - .2      Perform cleanup as work progresses and leave the work area clean at the end of each day.
- .14     **DEMONSTRATION**
  - .1      Initial Demonstration: provide a demonstration to identified OWNER facility staff that is responsible to maintain the system.



- .2 Demonstrate maintenance procedures for system devices.
    - .3 Demonstrate the system features, including monitoring and management of system devices.
  - .15 PROTECTION
    - .1 Protect finished installation until the final project acceptance.
    - .2 Repair damage to adjacent materials caused by the system installation.
- 3.3 **CLOCKS:**
  - .1 Do not install clocks until painting and other finish work in each room is complete.
  - .2 Locate clocks 450 mm (18 in) below finished ceiling unless indicated otherwise.
  - .3 Provide a deep recessed receptacle at each clock.
  - .4 Provide new batteries in battery powered clocks.
  - .5 Set clocks to correct time, time zone, Standard/Daylight Savings Time and date.
  - .6 Adjust the display brightness of each digital and combination clock to suit both daytime and nighttime illumination levels, to the satisfaction of the Owner.
  - .7 Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer.
- 3.4 **WIRING**
  - .1 Provide wiring as required for a complete, fully operating system.
  - .2 Provide wiring in accordance with the recommendations of the clock system manufacturer.
  - .3 Install wiring in conduit.
- 3.5 **TESTING**
  - .1 Conduct complete testing of the system to verify:
    - .1 operation during loss of power,
    - .2 operation on generator power,
    - .3 ability to correct secondary clocks,
    - .4 ability to restore correct time following loss and restoration of power,
    - .5 Daylight Saving Time adjustment,
    - .6 time zone adjustment.
  - .2 Submit a written report, identifying the results of the above tests and certifying that the system has been installed correctly and is functioning correctly.
  - .3 Assist the manufacturer in conducting the manufacturer's verification of the system. Submit a written report, prepared by the system manufacturer, identifying the verification results and certifying that the system has been installed in accordance with the manufacturer's recommendations.

3.6            **TRAINING**

- .1            Provide the Owner's staff with complete training in the operation and maintenance of the system and it's components. Allow for two separate (repeat) sessions so that all of the Owner's facility personnel can attend.

**END OF SECTION**

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**3RD PARTY FIRE ALARM VERIFICATION  
28 08 15**

**PART - 1      GENERAL**

**1.1            GENERAL REQUIREMENTS**

- .1      Conform to Sections of Division 1 as applicable.
- .2      Conform to Section 26 05 01, Electrical General Requirements.

**1.2            WORK INCLUDED**

- .1      The Division 26 contractor shall retain and pay for the services of an Independent 3<sup>rd</sup> Party Fire Alarm Verification Specialist Firm to provide Fire Alarm and Emergency Voice and Communications System Inspection and Verification services in accordance with the details specified herein. This does not eliminate the requirement for the Fire Alarm System manufacturer to perform testing and verification as part of their scope of work as indicated in Section 28 31 19 - Addressable Fire Alarm System.
- .2      The Division 26 Contractor shall include in the Bid Amount the cost for the services of tradesmen to handle equipment, make temporary connections, operate equipment and make repairs and adjustments and assist the verification organization's on-site specialists during the on-site inspection, testing, and verification phase of the work.
- .3      The Bidders for Division 26 work shall advise all fire alarm equipment suppliers bidding for the equipment supply for this project prior to Bid close of the requirement for comprehensive 3<sup>rd</sup> party verification and ensure the services and associated costs on the part of the fire alarm equipment supplier are included in the suppliers' quotations for the project and in the Division 26 bid amount.
- .4      The Owner Fire Prevention Coordinator will also be involved to witness Verification. Contractor to co-ordinate with Owner.

**1.3            GENERAL SCOPE**

- .1      Witness and provide 3<sup>rd</sup> party verification of the Fire Alarm, Emergency Voice Communication System, and submit completed typed copies of inspection record sheets as described herein. Ensure that the complete system is left fully functioning.
- .2      Provide adequate qualified technicians to witness the complete system verification being performed under the Div 16 contract in accordance with the Division 26 contractor's schedule. Provide any necessary equipment, test apparatus, ladders and scaffolding as required.
- .3      The Fire Alarm & Emergency Voice Communication System supplier will undertake testing and verification of their system in accordance with applicable standards and the Authorities Having Jurisdiction over the project.

**1.4            VERIFICATION REPORTS**

- .1      Submit verification reports in accordance with Section 26 05 01 Electrical General Requirements.

1.5      **ACCEPTABLE AGENCIES FOR INDEPENDENT 3<sup>RD</sup> PARTY WITNESS OF TESTING AND VERIFICATION.**

- .1      The firm selected for the independent 3<sup>rd</sup> party witnessing of the testing and verification of the Fire Alarm, Emergency Voice Communication System shall be suitably recognized by the Professional Engineers of Ontario. Completed copies of reports shall be submitted directly to the Consultant as well as part of the requirements for shop drawings/data books
- .2      The independent agency shall act as an independent witness on behalf of the Owner of the complete testing and verification of the fire alarm system.

*Standard of Acceptance*

- °      Insta Tech (416 565-6762)

**PART - 2      SCOPE OF WORK**

2.1      **GENERAL**

- .1      System verification shall be in accordance with the current CAN/ULC-S537" Standard for the Verification of Fire Alarm System". On completion of the verification, the witnessing agency shall submit directly to the Owner one signed certificate together with detailed inspection record sheets outlining location of each system, item, device and certification of the test results per unit. The certificate must clearly confirm that the system is installed, supervised and operates in accordance with the Project Specification and applicable Codes and Regulations.

2.2      **SYSTEM VERIFICATION**

- .1      Make a detailed inspection of all components installed for the Fire Alarm, Emergency Voice Communication System to ensure the following:
  - .1      The completed installation is in accordance with:
    - (a)      Project Specification and Drawings
    - (b)      ULC requirements
    - (c)      Manufacturer's recommendations and guidelines
  - .2      Wiring has been inspected at each device and that wire type, gauge and colour coding are in accordance with the Project Specification.
  - .3      Each manual pullstation, thermal detector, smoke detector, sprinkler flow switch, sprinkler supervisory switch and signalling device are in compliance with the ULC Standards, and that the installation details are in accordance with CAN/ULC-S524.
    - (a)      each and every device has been inspected for apparent damage which may interfere with its operation
    - (b)      every device has been tested for alarm situation and trouble initiation and circuit polarity
    - (c)      the emergency firefighter's telephones have been tested and that two-way voice communication is clear and audible, and that indications at Communication Centre and applicable local control panels are correct.
    - (d)      adjacent EVAC speakers have been connected to alternate circuits and that speakers are properly zoned.

- (e) each zone has been tested for remote bypass "Activation" and "Restoration" from the fire alarm video terminal in the power plant.
- .4 The most remote device on each circuit receives operating power. Also confirm that replaceable over-current protection devices are inspected for proper rating. Where new devices (i.e. door holders, magnetic locks, fan shutdown relay, EVAC speakers) are added to the circuit, ammeter load readings are taken and recorded for that circuit.
- .5 Non-damaging tests shall be applied to all the new smoke detector(s) and rate of rise heat detector(s) to activate an alarm in the Communication Centre. In the event that new smoke detectors, heat detectors or pullstations are added to an existing zone, apply simulated test to one randomly-picked existing device in the same zone. Verify printout of the alarm on the Video terminal printer.
- .6 Each alarm and trouble initiating device properly activates the Fire Alarm System such that the Communication Centre and all Annunciator Panels indicate the Zone(s) and the building from which the alarm or trouble originated. The zone description shall match the assigned zoning schedule.

## **PART - 3 EXECUTION**

### **3.1 REPORTS**

- .1 Prepare and submit the following reports. Simultaneously submit one copy directly to the engineer and a further 6 copies to the contractor to be processed as a shop drawing:
  - .1 Site Verification Report for each area requiring partial occupancy within 5 working days of completion of site test.
  - .2 Site verification report(s) reflecting each significant phase of system completion.
- .2 Complete and submit in binder form 6 copies of detailed inspection sheets including Appendix "C", Items "C1", "C2", "C3", "C4", "C5", "C6" and "C7" of the CAN/ULC-S537-97 Standard. In lieu of the ULC Appendix "C", the Verification Agent's own Standard forms, together with the completed Fire Alarm and Voice communication System Verification Report Summary will be accepted if in a comparable format. Information must be clearly defined and legible.
- .3 Completed reports shall also be included as part of the project maintenance manuals / data books.

### **END OF SECTION**

## **SECURITY CCTV SYSTEM**

### **28 23 01**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1.
- .2 Conform to Electrical General Requirements

##### **1.2 WORK INCLUDED**

- .1 **The Hospital currently have, and it is the Scope of this Project to expand the existing, Central CCTV System Network and Network Video Recording/ Monitoring System. The expansion involved in this project are as follows:**

- **'Cat 6' Cabling from new Cameras and Monitors to Security System "Hub" terminated in 'Cat 6' Jacks at both ends**
- **Cat 6 Patch Cables, as required**
- **Installation must implement latest Avigilon Platform and must include integration of the new Cameras/ Monitors into the existing System. It is imperative that the new CCTV Cameras be integrated into the now fully functional Avigilon CCTV NVAR "Cluster" installed in the existing Security Server Room CB-11**

Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete CCTV systems as shown, as specified and as otherwise required. Electrical Contractor shall ensure complete systems shall be left ready for continuous and efficient satisfactory operation.

Details of Typical Camera Network Cabling, Network Racks, Patch Panels (Cat 6 and Fibre), UPS System, Patch Cables, etc. shall be as specified in Section 28 15 00.

- .2 The system, including all components and appurtenances, shall be configured and installed to yield a mean time between failure (MTBF) of at least 10,000 hours, and shall be calculated based on the configuration specified.
- .3 Provide equipment, wiring and other materials for a complete and operational closed circuit television (CCTV) system. The system shall be modular and expandable as herein specified or as the Owner may direct up to full system capacity.
- .4 The system shall consist of state-of-the-art, IP Based programmable dome cameras, various lens sizes, mounts, housings, associated controls.
- .5 Provide low voltage power supplies where required.
- .6 Provide line extending equipment for long distance cabling in Network Based applications.
- .7 Provide suitable low voltage power and connect signal wiring to suit manufacturers' recommendations.
- .8 Provide and test for proper operation, a colour low light level security CCTV system to include focus, resolution and signal level.

- .9 The CCTV system is intended to give clear views of both the site and any one individual, such that the security department can use the video for recognition purposes. The lens shall be chosen by the contractor, in order to achieve the proper result.

### 1.3 **SYSTEM SUPPLIER**

- .1 The entire CCTV System shall be fully compatible with connection, monitoring and recording via the Avigilon™ Server Hardware and Storage Expansions Model 10.0TB-HD-NVR2 supplied, installed and commissioned by a certified experienced Security Contractor acting as a Sub Contractor to this Division. The approved Security Sub Contractor shall be:

**OHM Security LTD**  
**Attn: Andrew Browne**  
Phone: 905-299-8255  
Email: [andrew.browne@ohmsecurity.com](mailto:andrew.browne@ohmsecurity.com)

### 1.4 **CCTV INTEGRATION REQUIREMENTS**

- .1 The CCTV Contractor shall be included as part of this project and will be certified in the solution provided as per this specification.
- .2 Provide SDK for CCTV video management system that will enable access control events to cause the change in the recording frame rate of the associated CCTV views. The system shall automatically select and present ready for operator review of the recording of the associated CCTV views for a pre-selected time window prior to the event and after the event.
- .3 The selected and alarm events on the system shall cause immediate security staff notification. On the CCTV system they shall initiate change in the recording frame rate of the associated CCTV views and the security system shall automatically select and present ready for operator review of the recording of the associated CCTV views for a pre-selected time window prior to the event and after the event.
- .4 The video surveillance System shall be interfaced to the Access Control system such that selected Physical Access Control events shall cause the associated video surveillance camera(s) view(s) to be called up on a specified monitor at specified operator station(s). Access Control system is Keyscan.
- .5 The Video Management System shall integrate with Networked Digital Video Recording system.
- .6 This contractor will be responsible to work with the Sunnybrook Project Manager to deliver the required solution. This will include working with Sunnybrook IT Department, to implement and onboard the solution on to the Security VLAN Network.
- .7 The successful proponent will be required to attend all project meetings along with any conference call and/or meetings with Sunnybrook IT department to facilitate the solution through the onboarding process. This contractor shall produce and distribute minutes of meetings.
- .8 This will include but not limited to providing system requirements any antivirus and firewall port exceptions. They will also be required to populate and complete all Sunnybrook Forms and Sunnybrook collaboration sheets to complete the above denoted tasks.
- .9 The Contractor shall attend meetings with an Owner representative and key staff to identify the specifics of the system programming and integration into Sunnybrook's Security VLAN Network.

- .10 The Contractor shall be responsible to record all decisions and parameters discussed during these meetings. The Contractor shall submit in a document all configurations, parameters and receive approval for all programming parameters prior to implementation.

- .11 The Contractor shall ensure that the operation of the system matches and meets the programming requirements determined in the pre-installation meetings.

#### 1.5 **QUALITY ASSURANCE**

- .1 The entire closed circuit television system shall be designed in accordance with and conform to the requirements of:

- .1 Canadian Standards Association (CSA)
- .2 Ontario Hydro Safety Code
- .3 Underwriters' Laboratories Canada (ULC)
- .4 Provincial and Local Bylaws and Regulations

#### 1.6 **SHOP DRAWINGS**

- .1 Submit complete sets of shop drawings following an award of order. Shop drawings shall include copies of dimensional drawings completely describing installation that will be performed with relation to the space available for installation.

- .2 Part of the shop drawings submittals shall be a Functional Design Manual and Technical Data Package.

- .1 The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions.
- .2 A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.
- .3 The Contractor shall prepare Technical Data Package with test procedures and reports for the performance verification test and the endurance test.
- .4 The contractor shall provide a report detailing the results of the field test and a video tape as specified in paragraph Contractor's Field Testing." The final performance verification and endurance test report shall be delivered after completion of the tests.

#### 1.7 **MANUFACTURERS' DATA**

- .1 Submit data in the form of catalogue cuts or special data sheets as prepared by the manufacturer.

#### 1.8 **OPERATION AND MAINTENANCE MANUALS**

- .1 Submit copies of parts, lists and preventive maintenance requirements for systems to be installed.
- .2 A draft copy of the operation and maintenance manuals shall be delivered to the Owner's prior to beginning the performance verification test for use during site testing.



- .3 The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

#### 1.9 **OPERATOR'S MANUAL**

- .1 The operator's manual shall explain all procedures and instructions for operation of the system:
  - .1 Cameras equipment
  - .2 Use of the software
  - .3 Operator commands
  - .4 System start-up and shut-down procedures
  - .5 Recovery and restart procedures
  - .6 Hardware Manual
- .2 A manual shall describe all equipment furnished, including:
  - .1 General hardware description and specifications.
  - .2 Installation and checkout procedures.
  - .3 Equipment electrical schematics and layout drawings
  - .4 System schematics and wiring lists
  - .5 System setup procedures
  - .6 Manufacturer's repair parts list indicating sources of supply
  - .7 Interface definition

#### 1.10 **DEVIATIONS**

- .1 The approval of shop drawings by the Consultant shall not relieve the installer from responsibility for deviation from drawings or the specifications unless he has called attention in writing to such deviations at the time of submission and has obtained the approval of the Consultant thereon. When such deviations are called to the Consultants attention, and no mention is made of extra cost, it will be assumed that any proposed change will be made at no extra cost to the Owner.

#### 1.11 **SUBSTITUTIONS**

- .1 The intent of these Specifications is to establish the quality of the materials and/or workmanship desired for this project. Substitutions shall be in conformance with the requirements as indicated.

#### 1.12 **CCTV SYSTEM TECHNICAL DATA PACKAGE**

- .1 The data package shall include the following:
  - .1 System block diagram
  - .2 Security center CCTV equipment installation, interconnection with equipment, block diagrams and wiring diagrams

- .3 Camera wiring and installation drawings.
- .4 Surge protection device installation.
- .5 Final copies of each of the manufacturer's commercial manuals arranged as specified bound in hardback, loose-leaf binders, shall be delivered to the Owner's within 30 days after completing the endurance test.
- .6 The draft copy used during site testing shall be updated prior to final delivery of the manuals. Each manual's contents shall be identified on the cover.
- .7 The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system.
- .8 The manuals shall have a table of contents and tab sheets.
- .9 Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix.
- .10 The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance.
- .11 The number of copies of each manual to be delivered shall be as specified.

1.13 **WARRANTY, MAINTENANCE, TESTING AND CERTIFICATION**

- .1 Warranty servicing shall be provided for a one (1) year period commencing at system acceptance. This service shall include:
  - .1 Maintenance service as required during or after regular working hours during warranty period
  - .2 Replacing defective parts and components as required.
  - .3 Servicing by factory trained and employed service representatives of the equipment manufacturer.
  - .4 Maintenance of system programming.
- .2 Servicing and maintenance of the CCTV system shall be performed by qualified technicians in regular employment.

1.14 **OPERATION**

- .1 Performance of scheduled adjustments and repair shall verify operation of the CCTV system as demonstrated by the applicable portions of the performance verification test.

1.15 **SYSTEM MODIFICATIONS**

- .1 The Contractor shall make any recommendations for system modification in writing to the Owner's.
- .2 No system modifications, including operating parameters and control settings, shall be made without prior approval of the Owner's.
- .3 Any modifications made to the systems shall be incorporated into the operations and maintenance manuals, and other documentation affected.

**1.16 PRODUCT INSTALLATION AND HANDLING**

- .1 Before and during installation care must be exercised to prevent damage to the sensitive parts and components of the system and be responsible for the storage and handling of all components until acceptance of the completed installation.

**1.17 DEFINITIONS**

- .1 Bridging: Connecting two electrical circuits in parallel.
- .2 Brightness: The attribute of visual perception in accordance with which an area appears to emit more or less light.
- .3 Burned-in Image: An image which persists in a fixed position in the output signal of a camera after the camera has been turned to a different scene.
- .4 CCTV: Abbreviation for closed circuit television.
- .5 Contrast: the range of difference between light and dark values in a picture.
- .6 Depth of Field: The in-focus range of a lens or optical system.
- .7 ESS-Electronic Security System
- .8 Environment-Resistant: General term meaning capable of operating in extremes of temperature, humidity, vibration and dust.
- .9 Footcandle: The illuminance at a surface, all points of which are at a distance of one foot from a uniform source of one candela.
- .10 Iris: An adjustable aperture built into a camera lens to control the amount of light passing through the lens.
- .11 Monitor: a Device for viewing TV connected directly to the camera output.
- .12 Pan and Tilt: The capability which allows a camera to be moved in both the azimuth (pan) and in the vertical (tilt) plane.
- .13 Scanning: Moving the electron beam of an image pickup tube diagonally across the target or screen area of a tube.
- .14 Sensitivity: A factor expressing the incident illumination on a scene required to produce a specified picture signal at the output terminals of a television camera.
- .15 SIT (Silicon Intensifier Target): Trade names for a TV image pickup tube of the direct read out type designed for low light applications.
- .16 CCD: A solid state cameras, charged coupled devices.
- .17 Zoom: To enlarge or reduce the size of a televised image.

**1.18 REQUIREMENTS**

- .1 The CCTV system shall consist of IP Based Type colour format cameras, lens, housings, mounts, controls, cable interface equipment any necessary auxiliary devices for a complete operating system.
- .2 The closed circuit television system shall be synchronized to eliminate vertical roll and jitter when cameras are being switched.

- .3 The signal input level from all cameras to the CCTV switcher system shall be minimum 1 volt peak to peak with equalization (flat) to 5 MHz.
- .4 System shall be provided to prevent ground loop interference.
- .5 Drawings and Specifications: Exact locations of all items shall be determined by reference to the general plans and measurements of the building and shall be subject to the approval of the Consultant.
- .6 The Consultant reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.
- .7 Should any change be deemed necessary by the installer to the proposed contract drawings, the shop drawings, descriptions and the reason for the proposed changes shall be submitted for approval.

## **PART - 2 PRODUCTS**

### **2.1 GENERAL**

- .1 All system hardware components shall be produced by manufacturers regularly engaged in the production of CCTV equipment.
- .2 Units of the same type of equipment shall be products of a single manufacturer.
- .3 All material and equipment shall be new and currently in production.
- .4 Each major component of equipment shall have the manufacturer's name address, and the model and serial number in a conspicuous place.

### **2.2 COLOUR CAMERAS**

- .1 Camera shall transmit images over over 100BASE-TX using advanced H. 264 or MPEG 4 compression technology to achieve the lowest network bandwidth and most efficient image storage. Where required, the data will be converted from PoE+ to fibre. The camera shall be a High-resolution with 2.6-6 mm variable focal auto iris lens mounted in a high impact vandal resistant housing.
- .2 **Acceptable Camera Manufacturer (must be compatible with the Avigilon System)**
  - .1 **Avigilon**
  - .3 Signal-to-noise ratio shall not be less than 50 dB unweighted.
  - .4 The camera shall exhibit no geometric distortion.
  - .5 The lenses shall be integral to the camera block and feature vari-focal length and auto iris
  - .6 The camera shall operate from 10 to 50 degrees C without auxiliary heating or cooling, and with no change in picture quality or resolution.
  - .7 The camera shall operate on 60 Hz AC power, and shall be capable of operating at a voltage of 120 or 24 Volts.
  - .8 The camera shall have a solid state imaging array, and the picture produced by the camera shall be free of blemishes as defined by EIA 330.
  - .9 The camera shall provide not less than 480 lines of horizontal resolution, and resolution shall not vary over the life of the camera.

- .10 The imager shall have at least 768 horizontal x 494 vertical active picture elements.
- .11 Sensitivity
  - .1 The camera shall be a high-resolution color 1/4" CCD type with 480 lines of resolution and light sensitivity at F1.4 of 3.0 lux at 50 IRE and 0.4 lux at 20 IRE
- .12 Camera Synchronization
  - .1 The camera shall also have the capability of synchronization by line-locking to the AC power line frequency at the zero crossing point, and shall provide not less than plus or minus 90 degrees of vertical phase adjustment.
- .13 Connectors
  - .1 Cameras with lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors and wiring as needed to operate the lens functions.
  - .2 Video signal output connector shall be a BNC.
  - .3 Cameras with integral fiber optic video transmitters shall have straight-tip bayonet type fiber optic video output connectors.
  - .4 Connector shall be provided for external sync input.
- .14 Automatic Circuits
  - .1 The camera shall have circuitry for through the lens (TTL) white balancing, fixed white balancing, and automatic gain control.

## 2.3 **CAMERA HOUSINGS AND MOUNTS**

- .1 Provide adequate camera housing and mounts to accommodate adequate protection and installations of CCTV cameras:
  - .1 The camera and lens shall be enclosed in a tamper resistant housing as specified below.
  - .2 Any ancillary housing mounting hardware needed to install the housing at the camera location shall be provided as part of the housing.
  - .3 The camera and lens contained in a camera housing shall be installed on a camera support using manufacturer recommended procedures.
  - .4 Any ancillary mounting hardware needed to install the support and to install the camera on the support shall be provided as part of the support.

## 2.4 **GROUND ISOLATION TRANSFORMER**

- .1 Provide necessary ground isolation transformers and other components to prevent ground loop interference.
- .2 Ground Loop Corrector
  - .1 The ground loop corrector shall eliminate the measured ground loop Interference (common mode voltage) in wireline or coaxial video transmission lines.
  - .2 The ground loop corrector shall pass the full transmitted video bandwidth with no signal attenuation or loss.

- .3 Clamping ground loop correctors shall be capable of rejecting at least an 8 volt peak-to-peak 60 Hz common mode signal.
- .4 Ground isolation transformers shall be capable of rejecting at least a 10 volt peak-to-peak 60 Hz common mode signal.
- .5 Ground isolation amplifiers shall be capable of rejecting at least a 30 volt peak-to-peak 60 Hz common mode signal.
- .6 Differential ground loop correctors shall be capable of rejecting at least a 100 volt peak-to-peak 60 Hz common mode signal.
- .3 All wire and cable components shall be able to withstand the environment the wire or cable is installed in for a minimum of 20 years.
- .4 Twisted pair low voltage control wiring to be used above ground or as direct burial cable shall be provided as described in Section 16792. Plenum or riser cables shall be IEEE C2 CL2P certified.

## 2.5 **DIGITAL DATA INTERCONNECTION WIRING**

- .1 Interconnecting cables carrying digital data between equipment located at the security center or at a secondary control/monitoring site shall be not less than 20 AWG and shall be stranded copper wire for each conductor.
- .2 The cable or each individual conductor within the cable shall have a shield that provides 100 percent coverage.
- .3 Cables with a single overall shield shall have a tinned copper shield drain wire.
- .4 Plenum or riser cables shall be IEEE C2 CL2P certified.

## 2.6 **CAMERA POWER SUPPLIES**

- .1 Provide camera power supplies as required. Camera power supplies to be CSA approved or to have special Hydro approval. Power supplies to have 24VAC output/120VAC input, individually fused outputs, and a cabinet with suitable lock.
- .2 Representative units to be #ALTV2416-ULX Video Camera Power Supply for 16 cameras and #ALTV248-UL Video Camera Power Supply for up to 8 cameras.

## 2.7 **“POWER OVER INTERNET” NETWORK SWITCH**

- .1 Provide “Power over Internet” Network Switches, Rack mountable type as required for the System Network connections. Switches shall have adequate power capacity for the ultimate number of connected devices, shall be IEEE.802.3af compliant with adequate 10/100 PoE Ports as required plus minimum 4 spares.
- .2 **Network Switches and associated Service requirements to be purchased from:**  
**TELUS Enterprise Solutions**  
**Contact: Michele K House, Sales Specialist**  
**(416)-999-6109**  
[michele.house@telus.com](mailto:michele.house@telus.com)

Switches shall be 1u and be as manufactured by CISCO as follows:

CATALYST 9300 48-PORT POE+ NETWORK ESSENTIALS	C9300-48P-E
SOLN SUPP 8X5XNBD CATALYST 9300 48-PORT POE+ NETWORK ESSE	CON-SSSNT-C93004PE
C9300 NETWORK ESSENTIALS 48-PORT LICENSE	C9300-NW-E-48
NORTH AMERICA AC TYPE A POWER CABLE	CAB-TA-NA
50CM TYPE 1 STACKING CABLE	STACK-T1-50CM
CATALYST 3750XSTACK POWER CABLE 30 CM	CAB-SPWR-30CM
C9300 DNA ESSENTIALS 48- PORT TERM LICENSES	C9300-DNA-E-48
C9300 DNA ESSENTIALS 48- PORT 3 YEAR TERM LICENSE	C9300-DNA-E-48-3Y
715W AC CONFIG 1 POWER SUPPLY	PWR-C1-715WAC
Catalyst 9300 8 x 10GE Network Module	C9300-NM-8X
NO SECONDARY POWER SUPPLY SELECTED	C9300-SPS-NONE
UA POWER SUPPLY BLANK	PWR-C1-BLANK
CAT9300 UNIVERSAL IMAGE	S9300UK9-166

.3 Service to be provided by Telus

Service Description	Service Code	Minimum Hours
Site: Main Site		
System: CCTV System		
Stand-alone rtr/sw or First switch in a stack (static routes, RIP, no QOS)	NENG	4.00

Stand-alone rtr/sw or First switch in a stack (static routes, RIP, no QOS)	NICD	2.00
Technical Project Management REG	NIMPMR	1.00
Stand-alone rtr/sw or First switch in a stack (static routes, RIP, no QOS)	NISOL	1.00

## 2.8 **UPS SYSTEM**

- .1 Security System Network UPS Systems should be 3kVA, 120 volt Nominal, Eaton #SPX-3000RT-2U complete with Network-MS Monitoring xx and #EHBPL-3000R-PDUIU 'Hot Swap Bypass' component (See also attached cut sheet)

## **PART - 3 EXECUTION**

### 3.1 **INSTALLATION**

- .1 Provide CCTV system as shown on Drawings and as specified.
- .2 The Contractor shall install all system components including Owner's furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- .3 Raceways shall be furnished and installed as specified in Electrical General Requirements, Cabletroughs, Wire & Cables 1-1000 Volts, and Splitters, Junction and Pull Boxes, Cabinets.
- .4 DTM shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring.
- .5 All other electrical work shall be as specified in the above sections including grounding to preclude ground loops, noise, and surges from adversely affecting system operation.
- .6 Provide wiring as required.
- .7 Provide power and signal at cameras as required.
- .8 Install all equipment in accordance with manufacturers' instructions.
- .9 Provide necessary mounting accessories.
- .10 Mount cameras in enclosures on ceilings as per Drawings. Provide suitable power and signal wiring to suit a manufacturer. Selected enclosure must be suitable for each camera location.
- .11 Test each camera output on monitors in the presence of the Consultant to finalize the selection of lenses for cameras.



- .12 Test each system component and feature to prove the system performance and response under normal conditions.
- .13 Test each system component and feature to prove the system performance and response under normal conditions.
- .14 Provide all system wiring in conduits.
- .15 All video cables to be adequately shielded and are not to be run with power cables in same conduits.
- .16 Provide necessary corrective circuitry to accommodate location of CCTV cabling in close proximity to high voltage cabling.
- .17 Install security equipment in the main security office as shown and as specified and install, connect and test all components for a complete operating system.
- .18 Connect all CCTV cameras and control equipment in the building to the same phase in all lighting and receptacle panels.

### 3.2 **CAMERAS**

- .1 Install:
  - .1 the cameras with the proper focal length lens as indicated for each zone;
  - .2 connect power and signal lines to the camera;
  - .3 set cameras with fixed iris lenses to the proper f-stop to give full video level;
  - .4 aim camera to give field of view as needed to cover the alarm zone;
  - .5 synchronize all cameras so the picture does not roll on the monitor when cameras are selected.
- .2 Dome cameras shall have all preset positions defined and installed.
- .3 Calibrate and test all equipment, verify operation, place the integrated system in service, and test the integrated system.
- .4 Deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner's that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing.
- .5 The report shall also include a copy of the approved performance verification test procedure.
- .6 Note any objects in the field of view that might produce highlights that could cause camera blinding.
- .7 Note any objects in the field of view or anomalies in the terrain which may cause blind spots.
- .8 Note if a camera cannot be aimed to cover the zone and exclude the rising or setting sun from the picture.
- .9 Note night assessment capabilities and whether lights or vehicle headlights cause blooming or picture degradation.

- .10 If any of the above conditions or other conditions exist that cause picture degradation or interfere with the camera field of view, inform the project manager.
- .11 Provide the Owner's with the digital media record as part of the documentation of the system and shall submit a letter certifying that the CCTV system is ready for performance verification testing.

### 3.3 **TESTING**

- .1 The field testing shall as a minimum include:
  - .1 Verification that the video transmission system and any signal or control cabling have been installed, tested, and approved as specified.
  - .2 All software functions shall be exercised.
  - .3 Verification that all video sources and video outputs provide a full bandwidth signal that complies with EIA 170 at all video inputs.
  - .4 Verification that all video signals are terminated properly.
  - .5 Verification that all cameras are aimed and focused properly.
  - .6 The Contractor shall conduct a walk test of the area covered by each camera to verify the field of view.
  - .7 When dome camera mounts are used in the system, verify that all preset positions are correct and that the dome also operates correctly in a manual control mode.
  - .8 Deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner's that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing.
  - .9 The report shall also include a copy of the approved performance verification test procedure.

**END OF SECTION**

## **ACCESS CONTROL SYSTEM**

### **28 23 10**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Electrical General Requirements.
- .3 Materials and equipment described in each Section of the Specification are designed to establish standards of construction and workmanship.
  - .1 Where manufacturers or manufacturers products are identified in lists with phrase "Standard of Acceptance", these are manufacturers and/or products which meet standards with regard to performance, quality of material and workmanship
  - .2 Manufacturers and or products used are to be chosen from these lists.
  - .3 Where the Specification states "to match existing Hospital Standards" it is mandatory that the existing Standard be maintained and that the product must be as manufactured the identified manufacturer and must be the product identified. Quality Assurance.

##### **1.2 WORK INCLUDED**

- .1 The Access Control, Security Systems involved in this project are as follows:
  - Key-Scan System serving the Hospital Campus
- .2 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete Access Control, Security Systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.
- .3 Provide equipment, wiring and other materials for a complete and operational Access Control, Security System. The system shall be modular and expandable as herein specified or as the Owner may direct up to full system capacity.
- .4 The system shall consist of state-of-the-art controls.
- .5 Provide low voltage power supplies where required.
- .6 Provide all required mounting hardware and brackets.
- .7 Provide suitable low voltage power and connect signal wiring to suit manufacturers' recommendations.
- .8 Provide and test for proper operation.

1.3 **"KEY-SCAN" ACCESS CONTROL, SECURITY SYSTEM SUPPLIER**

- .1 The "Key-Scan" Access Control, Security System, to serve the new areas, shall be supplied, installed and commissioned by the following approved Security Contractor acting as a Sub Contractor to this Division. The approved Security Sub Contractor shall be:

**OHM Security LTD**  
**Attn: Andrew Browne**  
Phone: 905-299-8255  
Email: [andrew.browne@ohmsecurity.com](mailto:andrew.browne@ohmsecurity.com)

1.4 **QUALITY ASSURANCE**

- .1 The Access Control, Security Systems shall be designed in accordance with and conform to the requirements of:

- .1 Canadian Standards Association (CSA)  
.2 Electrical Safety Code

1.5 **SUBMITTALS: SUBMITTALS SHALL BE OF ADEQUATE DEPTH TO DEFINE FULLY THE SYSTEM OFFERED.**

- .1 Shop Drawings: Submit complete sets of shop drawings following award of order. Shop drawings shall include copies of dimensional drawings completely describing installation that will be performed with relation to the space available for installation.
- .2 Manufacturer's Data: Submit data in the form of catalogue cuts or special data sheets as prepared by the manufacturer.
- .3 Maintenance Data: Submit copies of parts, lists and preventive maintenance requirements for systems to be installed.
- .4 Training Data: Submit copies of the proposed employee training plan and documentation for the system.

1.6 **PRODUCT INSTALLATION AND HANDLING**

- .1 Before and during installation care must be exercised to prevent damage to the sensitive parts and components of the system and be responsible for the storage and handling of all components until acceptance of the completed installation.

1.7 **WARRANTY:**

- .1 Systems shall include a standard warranty on parts and warranty on labour. Any required system repairs which occur between the date of acceptance by the owners and the one year anniversary shall be provided without cost.
- .2 The supplier shall maintain a service department, necessary spare parts, after hours telephone answering services and call dispatching services required to implement the service standard stated below as part of this contract.

1.8 **1.8 SYSTEM VERIFICATION**

- .1 Test and demonstrate the operation of the complete system to the Owner. This shall include, but not be limited to:
- a) detailed test and demonstration of each operable device

- b) detailed test and demonstration of overall system operation
- c) interfacing of various components.

- .2 On completion of the installation the manufacturer/supplier shall supply, to the Consultant and Commissioning Agent, a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.

#### 1.9 **SCOPE, "KEY-SCAN" SYSTEM**

- .1 The "Key-Scan" Access Control, Security System installation required for this installation incorporates:
  - .1 Card Readers to control entry to doors indicated
  - .2 Electric Strikes and Power Supplies
  - .3 Request to Exit Devices
  - .4 Magnetic locks including Magnetic Lock Permits
  - .5 Door alarm contacts for connection to Central Security System
  - .6 local power supplies as required
  - .7 Wire, conduit and connections to card reader, door alarms, electric strike, magnetic locks on doors and power supplies to controlled doors.
  - .8 Connection to Hospital Network System for connection to Central Security System
  - .9 Integration between the Security System and the CCTV System.
  - .10 For doors equipped with a Wandering Patient Detector, integration between the Security System and the Wandering Patient System

#### 1.10 **THE ACCESS CONTROL SYSTEMS SHALL BE USED TO PROVIDE:**

- .1 Access control to the protected doors
- .2 Whenever a card is read by a card reader/ key-reader, the reader shall check for valid entry in the following manner:
  - .1 The card must be authorized.
  - .2 The priority/access level must match that of the card reader
  - .3 The time must fall within the access schedule for the card reader
- .3 The information from the card reader shall include provision for transmission the Central Security Computer which shall (activate or deactivate by operator's command) display related information such as card number, employee name, department, reader number, time and date on the card access CRT display terminal. Alarm messages and transactions from assignable readers shall be displayed on the card access CRT display terminal and a hard copy printout initiated on the appropriate printer.
- .4 If the card is valid, the electric locking devices shall be bypassed for a preset time. The preset bypass time will vary for each access controlled door which will be determined on site.
- .5 Exit through card access doors shall be by free-exit through motion sensor.
- .6 If the door is held open longer than the preset time, the door monitoring switch shall initiate an alarm to the Security Computer

- .7 All invalid or unauthorized access attempts or alarm conditions shall initiate an alarm to the future Security Computer.
- .8 All information shall be stored in disk form with the ability to retrieve information on a day, time, card number, employee name or reader number when requested by operator's command.

## **PART - 2 PRODUCTS**

### **2.1 DOOR MONITORING:**

- .1 All doors as indicated on the Drawings shall be monitored
- .2 Each door shall be capable of being monitored in one of three modes:
  - .1 Free access
  - .2 Secure
  - .3 Schedule controlled free access
- .3 Selected (manual override) doors in the building to be manually controlled from the security office. Activation of associated code on the security terminal keyboard will release locking devices and by pass monitor switch.
- .4 Activation of the fire alarm system or power failure shall cause the electro-magnetic locks on exit doors to release. Provide the necessary interconnection with the fire alarm system for system operation.
- .5 The release shall be of the failsafe type ensuring unlocking of doors for any malfunction of the security system or if the fire alarm system alarms. The arrangement shall be on the approval of the local authorities having jurisdiction

### **2.2 "KEY-SCAN" INTELLIGENT PROXIMITY CARD READERS INCLUDING:**

- .1 Fully compatible with cards produced by the Hospital's "IdentiCam" photo card system.
- .2 LCD back-lighted with EL lamp
- .3 Each door shall be considered a separate security alarm point or zone.
- .4 System shall include dry contacts for remote alarms.

### **2.3 SECURITY SYSTEM COMPUTER SOFTWARE:**

- .1 System must be compatible with existing photo imaging system "Identicam".
- .2 Software must have ability to be integrated with the CCTV System.
- .3 Computerized software shall monitor new doors or zones.
- .4 The security system shall up-date/ provide any required automatic display of colour floor plan maps of the building (showing area in alarm) on the graphic CRT display terminal screen.
- .5 An alarm condition shall be displayed on the graphics by a colour code change and the flashing of the standard symbol used to highlight the location of the device which initiated an alarm and identifying the current status of the device.

- .6 Each time a map is displayed, the system shall determine and display the status of the monitored points represented in the map. The system shall be provided with all software and hardware required for an operator to create and maintain maps.
- .7 The colour graphics display shall identify input circuit conditions such as circuit secure, circuit in alarm, circuit in trouble and circuit manually shunted (ie. difference colour codes). Create maps, with necessary active points including building or area outlines, symbols, stairs, elevators, corridors for areas in which security devices are shown. Mapping data base to be programmed by cursor or other approved method and have the capability of printing maps. Include all menus, charts, and symbols required for total system outline and hardware required to produce the graphics to the Consultant's approval.

## 2.4 **TAMPER OPERATION:**

- .1 Tamper switches shall be provided on all control and equipment cabinets such as card reader controllers. Tamper switches shall include provision for future connection to Security System.

## 2.5 **SUBMITTALS AND INSTRUCTION:**

- .1 The following data shall be forwarded upon award of Contract:
  - .1 cable schematic showing card reader controllers, alarm terminals, card readers, power supply locations and all other devices and associated wiring and power
  - .2 Technical specification data sheets of each system component and device.
- .2 Provide complete system documentation at acceptance time, as specified herein.

## 2.6 **READER CONTROLLERS:**

- .1 Controllers to be solid state microprocessor based and shall support and communicate with card readers employing a LCD display. The unit shall grant or deny access while including independent reporting system activity back to the CPU for report generation or alarm initiation.
- .2 Provide battery backup for unit.
- .3 Provide tamper switch alarmed to security console.
- .4 The controller shall be capable of operating, connecting and communicating with proximity type readers

## 2.7 **REMOTE ALARM TERMINALS:**

- .1 Provide wall mounted remote data terminals to be microprocessor based housing circuit modules capable of monitoring and connecting to alarm inputs of zones (ie. door monitor, switches, etc.) as required, power supply unit and standby battery.
- .2 The terminal shall have LED indicators for AC power, alarm and trouble. The unit shall contain automatic self-checking program for processor and memory with self-diagnostics.
- .3 Each remote terminal shall be loaded to 85% of its capacity with the field zone/point circuits. The remaining 15% capacity of circuit modules shall be used for future connections.
- .4 Remote terminals shall have a key locked cabinet with tamper switch alarm to the security terminal if located outside of terminal cabinets.
- .5 Unit to be fed from the nearest emergency power source at 120 V.A.C.

**2.8 POWER SUPPLIES:**

- .1 Provide all necessary power supplies, 24 volt AC and/or DC including transformer and/or rectifiers required for operation of the system. 120 volt AC power circuits will be connected from the nearest emergency power panel.
- .2 Provide battery back-up to prevent loss of memory and loss of power. UPS system shall be retained for a power outage for a minimum of two (2) hours.
- .3 Power supplies shall be in a separate enclosure, secured with a key lock.

**2.9 SYSTEM DEVICES:**

- .1 "Key-Scan" Card Readers
  - .1 Provide flush mounted card readers. The card reader shall detect the code information on the card and shall include provision to transmit the information to the "Key-Scan" Central Security System.
  - .2 Card reader shall include an "EL" indicator lamp.
  - .3 The response time shall be within .5 seconds. The reader shall be mounted to any non-metal surface.
  - .4 Power to the reader and data cables shall be connected to the associated card reader controller.
  - .5 The reader shall be vandal-proof, dirt-proof, weatherproof and shock-resistant.
  - .6 Provide a backbox for mounting of card reader.

**2.10 CONNECTION TO ELECTRIC DOOR HARDWARE:**

- .1 For doors with electric strikes, electric magnetic locks or electric locking devices provide all connections to electric door hardware at a voltage to suit hardware for proper operation.
- .2 Provide transformers and rectifiers for the necessary power supplies (24 volts AC or DC) and sized as required to suit hardware equipment supplied.
- .3 Coordinate with all suppliers of other equipment connected to security system.
- .4 Conduit and wiring will be provided by the Electrical Contractor as specified by the security (card access) system manufacturer.
- .5 The Security System Installer shall provide all door hardware (electric strikes, door monitoring contacts, motion exit device, power supplies etc.) that are to be installed on existing doors.

**2.11 DOOR MONITORING SWITCHES:**

- .1 Door monitoring switches (ie. magnetic contacts) shall be provided.
- .2 Provide the necessary points, wiring, conduits, boxes, and connections to the door monitoring switches for proper operation. Coordinate connections and installation with the door hardware contractor.

**2.12 SECURITY INTERFACING**

- .1 Interface the Security System to the CCTV/ Wandering Patient Systems.



- .2 Security System will receive a dry contact signal from either system to activate the alarm.

## 2.13 MISCELLANEOUS REQUIREMENTS

- .1 Include in the Contract the cost of a qualified technician to test and verify the system and correct all wiring and installation faults. Test and demonstrate the operation of the system to the Owner. This shall include, but not be limited to a detailed test and demonstration of each operable device and a detailed test and demonstration of overall system operation.
- .2 On completion of the installation the manufacturer/supplier shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.
- .3 Provide all back boxes and plates, all wire and cable, complete with terminations if necessary and multi-prong female fittings for the complete installation of the intercom stations in the locations shown.

## PART - 3 EXECUTION

- .1 Provide "Key-Scan" Access Control, Security Systems as shown on Drawings and as specified.
- .2 Install all equipment in accordance with the manufacturer's instructions.
- .3 Readers shall be installed at least 6" away from metal surfaces.
- .4 Readers to be mounted at 47" above finished floor.
- .5 The manufacturer/supplier it to assist the Contractor in the installation and provide technical expertise required. Make final connections.
- .6 Adjust system components as necessary to ensure complete system operation.

## 3.2 WIRING

- .1 All wiring to be installed in conduit.
- .2 All wiring to be in accordance with manufacturer's recommendations.
- .3 All card access cables to be adequately shielded and are not to be run with power cables in same conduit.

## 3.3 SECURITY SYSTEM - WARRANTY, MAINTENANCE, TESTING AND CERTIFICATION

- .1 Provide Warranty and Training as specified.
- .2 Test all components of the system for proper operation as indicated in Specification.
- .3 Acceptance procedures shall be in accordance with General Requirements and the following:
  - .1 Written certification shall be provided, on completion of a thoroughly tested installation, that the system has been pre-tested and is ready for acceptance testing. Written certification shall consist of a check list of operating features has been pre-tested and is functioning satisfactorily.

**END OF SECTION**

## **FIRE ALARM SYSTEM**

### **28 31 13**

#### **PART - 1 GENERAL**

##### **1.1 GENERAL**

- .1 Conform with the requirements of Section 26 05 01 Basic Electrical Requirements.
- .2 The Fire Alarm System in K Wing is somewhat aged and needs some modernization as required for this renovation. Contractor/ Supplier is to include:
  - New Amplifiers if/ as required for the new installation
  - New, current technology Speakers and Strobe Lights

##### **1.2 PROGRAMMING CHANGES**

- .1 Include in the Bid Price for all programming changes required for the duration of the project and as required to obtain final acceptance by the Fire and Building Departments.
- .2 Include in the Bid Price for all costs associated with Up-dating the existing Fire Alarm System Computer Floor Plan Graphics as required by the changes created by this renovation.
- .3 Provide audibility testing of sound levels in each and every room and ensure Code required minimum levels are maintained. Adjust speaker transformer "taps" to ensure minimum/ maximum sound levels are maintained. Provide, in the final Verification Report, an indication of the exact sound pressure levels in each room.
- .4 **The Project Scope includes replacing existing K-2-E & K-2-C fire Alarm components and modernizing the Fire Alarm for these floors. The Scope also includes adding new EVAC Speakers in Patient Bedrooms to ensure audibility. However, there is a strong desire to separate the Paging in the Patient Rooms to ensure that these Speakers sound only Fire Alarms and Emergency Paging for K Wing. To accomplish this the Project Scope also needs to:**  
  
Provide new, separate EVAC System Amplifiers for the Patient Rooms Speakers  
Wire the Patient Room Speakers separately from the Corridor Speakers.  
Revise the System program to only sound the K Wing Alarms and EVAC Paging to the separate Amplifiers as required.
- .5 Care shall be taken when placing detectors to ensure that they are not in the direct air stream of a supply air diffuser. However, the preferred location of a smoke detector within any one bay would be in the air stream of a return air diffuser. Ensure smoke detectors are a minimum of 5'-0" from any supply air diffuser.

##### **1.3 RELATED WORK**

- .1 Sprinkler systems: Section 21 13 13 Wet Pipe Sprinkler Systems
- .2 Wiring: Section 26 05 19 Wires & Cables 0-1000 Volts
- .3 Conduits: Section 26 05 33 Conduits Fastenings and Fittings
- .4 Access Control System: Section 28 23 10 Access Control System

##### **1.4 REFERENCES - CURRENT EDITION OF**

- .1 CAN/ULC-S524 Installation of Fire Alarm Systems
- .2 ULC-S525 Audible Signal Appliances
- .3 CAN/ULC-S527 Control Units
- .4 CAN/ULC-S528 Manual Pull Stations
- .5 CAN/ULC-S529 Smoke Detectors
- .6 CAN/ULC-S530 Heat Actuated Fire Detectors
- .7 CAN/ULC-S536 Inspection and Testing of Fire Alarm Systems
- .8 CAN/ULC-S537 Verification of Fire Alarm Systems
- .9 CAN/ULC-S548 Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems
- .10 CAN/ULC-S533 Egress Door Securing and Releasing Devices
- .11 CAN/ULC-S542 Speakers for Fire Alarm Systems
- .12 CAN/ULC-S526 Visual Signal Appliances

#### 1.5 **REQUIREMENTS REGULATORY AGENCIES**

- .1 System  
Ontario Building Code
- .2 System components: listed by ULC and CSA and complying with applicable provisions of Ontario Building Code, and meeting requirements of local authority having jurisdiction.

#### 1.6 **SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 26 05 01- Electrical General Requirements.
- .2 Include:  
Details for devices.  
Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.  
Battery capacity calculation.
- .3 The Contractor in co-operation with the supplier of the system shall prepare a detailed riser diagram of the complete system showing all major components, devices and necessary interconnecting wiring.  
  
Diagram is to indicate wiring quantities, sizes and colour code and to indicate conduit sizes.  
Riser Diagram is to be produced on AutoCad and is to be submitted as a Shop Drawing.  
Riser Diagram is to be revised 'As-Built' at the completion of the project and submitted with Maintenance Manuals (submit both a copy of the Drawing and an AutoCad disc).

#### 1.7 **OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for fire alarm system for incorporation into manual specified in Section 26 05 01 - Electrical General Requirements.
- .2 Include:  
Instructions for complete fire alarm system to permit effective operation and maintenance.

Technical data - illustrated parts lists with parts catalogue numbers.

Copy of approved shop drawings with corrections completed and marks removed except review stamps.

Copy of verification certificate, verification report and warranty certificates such as for fire alarm system, batteries, ancillary devices, and other similar items, including battery suppliers date coding for batteries.

## 1.8 **MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Section 26 05 01 - Electrical General Requirements.

## 1.9 **TRAINING**

- .1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

## 1.10 **WORK INCLUDED:**

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete Fire Alarm System as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.
- .2 Supply and install an expansion to the existing complete and operating two stage, zoned, fully supervised Fire Alarm System as shown, as specified and as otherwise required.

## 1.11 **DESCRIPTION OF SYSTEM**

- .1 There exists a two stage, zoned complete and operating Fire Alarm System as supplied by Chubb Edwards. Scope of this renovation requires:

Any expansion, modifications to the existing System to incorporate the revised/ added functions shown on the Drawings including:

- .1 adding new detection, alarm sounding devices, strobe lights
- .2 adding new Sprinkler and Pre-Action Sprinkler System alarm and supervisory Zones in the renovated as shown on the Drawings

Provide new Trouble signal devices, Power supply facilities, Manual alarm stations, Automatic alarm initiating devices, connection to sprinkler system flow devices, connection to supervised valves (trouble signal only), Door release for doors with hold-open devices or magnetic locks, Audible signal devices, End-of-line devices, Visual alarm signal devices, Ancillary devices, Door release for doors with hold-open devices or magnetic locks, Fan shutdown,

- .2 Additional Requirements

Necessary circuitry for operation of supervised valves and loss of power alarms for sprinkler system and auxiliary booster or special service pumps.

Smoke detectors installed in Operating Rooms shall be Photoelectric/thermal combination with contact to drive the over the door dome light.

The smoke detectors in corridors shall be of equal numbers of ionization and photoelectric and alternated along the corridor or be combination type detectors.

## 1.12 **SYSTEM OPERATION**

- .1 It is the intent to maintain the operation of the existing Fire Alarm System

## 1.13 **SPARE COMPONENTS**

- .1 **Include in the Bid the following additional components including installation (include an average of 20'0" of wire in conduit for each additional device and connection to an adjacent zone/ circuit). Assume, for bidding purposes, that these devices can be added at any time during construction including at the end of the construction and in any location as directed on site. Any devices not installed shall be turned over to the Hospital:**
  - 2 (two) addressable smoke detectors**
  - 2 (two) speakers**
  - 2 (two) addressable pull stations**
  - 2 (two) strobe lights**
- .2 **Verification and any programming required by the installation of these components shall be included.**

## **PART - 2 PRODUCTS**

### **2.1 INPUT (ALARM INITIATING) CIRCUITS**

- .1 Provide alarm receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors, and water flow switches as indicated on schedules.
- .2 Alarm receiving circuits shall be wired in a Class B, 2 wire configuration.
- .3 All alarm receiving circuits shall be supervised for open, short or ground fault conditions by the use of an end of line resistor.

### **2.2 OUTPUT ALARM CIRCUITS**

- .1 Provide alarm output circuits for polarized audible signals such as speakers, horns and visual indicators as indicated.
- .2 Provide necessary amplifiers and tone generator modules for electronic audible alarm devices as required.
- .3 Alarm output circuits shall be wired in a class B, 2 wire configuration.
- .4 All alarm output circuits shall be supervised for open, short or ground fault conditions by the use of an end of line resistor.

### **2.3 AUXILIARY CIRCUITS**

- .1 Provide contacts for fan shut-down as indicated. They shall be of normally closed type. Fan bypass switches shall be provided for each group of fans as indicated and coordinated on site.
- .2 Provide contacts for pressurization system fans. They shall be arranged to start up the fans and shall be of normally closed type. By-pass switch shall be provided as indicated.
- .3 Provide contacts for magnetic door locks and holders. They shall be arranged to release the doors upon actuation of fire alarm system. By-pass switches shall be provided to prevent doors from being released during test of fire alarm system.
- .4 Provide contacts for smoke vents as indicated. They shall be of the normally closed type and shall release all smoke dampers upon actuation of fire alarm system. By-pass switches shall be provided indicated.
- .5 Provide auxiliary contacts with 120 V AC/24 V DC, 2.5 A @ 0.5 power factor rating.

## 2.4 VOICE COMMUNICATION CIRCUITS

- .1 Provide communication circuits for the 5<sup>th</sup> & 7<sup>th</sup> Floors as required
- .2 All communication circuits shall be supervised for open, short or ground fault conditions.
- .3 Amplifiers shall be solid state type compatible with the existing System
- .4 Provide for interconnection to operate the system as specified.

## 2.5 POWER SUPPLY

- .1 Provide an internal integrated power supplies, including surge suppression and circuitry for the System operation as required.

## 2.6 MANUAL FIRE ALARM STATIONS

- .1 Manual pull stations shall be metal construction, open circuit, pull lever type and finished in red enamel. They shall be mounted in a 101 mm (4 in) square recessed box with plaster ring in finished areas and surface mounted in unfinished areas.
- .2 Manual stations shall be suitable for insertion of an evacuation key.
- .3 Each pull station shall be provided with an additional auxiliary contact(s) to allow direct connection to future magnetic locks {and for two stage operation}.

## 2.7 AUTOMATIC FIRE ALARM DETECTORS (HEAT DETECTORS)

- .1 Automatic detectors shall be of the following types:  
57.2°C (135°F), fixed temperature and -9.4°C (15°F) per minute, rate of rise  
93.3°C (200°F), fixed temperature only
- .2 Detectors shall have suitable mounting plates with finish ring.

## 2.8 END OF LINE RESISTORS

- .1 Where Class B wiring is specified or permitted, the end of line resistors shall be located in outlet box with stainless steel cover plate.

## 2.9 IONIZATION SMOKE DETECTORS

- .1 Ionization type smoke detectors shall be constructed of solid state components and operate on ionization principle to detect visible and/or invisible products of combustion.
- .2 It shall be possible to check and change sensitivity of detectors. Smoke detectors shall be set for approved sensitivity.
- .3 Detectors shall be ULC listed.
- .4 Incorporate an LED or lamp latched circuit to indicate the signal operation of the unit.
- .5 Smoke detectors shall operate on 24 volts DC and be protected against electrical transients and electromagnetic interference.
- .6 Detectors shall be equipped with NO/NC contacts to operate ancillary devices where applicable.
- .7 Detectors shall be equipped with a fine mesh bug screen to prevent contamination of the detection chamber by insects.

- .8 The detector shall be a plug-in/twist lock unit which may be removed from its base with a special installation tool without disconnecting detector wiring.
- .9 The detector shall filter out false alarms caused by intermittent aerosols or cigarette/pipe tobacco smoke.
- .10 Recessed smoke detector shall be complete with necessary shroud and flush mounting hardware.
- .11 Protect automatic smoke detectors during construction with a dust-bag, which shall be removed at the time of verification.

## 2.10 PHOTOELECTRIC SMOKE DETECTORS

- .1 Photoelectric smoke detectors shall operate on the photoelectric (light scattering) principle of operation and be activated by visible or invisible products of combustion. Detectors shall be constructed of solid state components with the infrared light source for the photoelectric sensor emitted from a semiconductor diode.
- .2 Detectors shall be ULC listed.
- .3 Incorporate an LED or lamp latched circuit to indicate the signal operation of the unit.
- .4 Smoke detectors shall operate on 24 volts DC and be protected against electrical transients and electromagnetic interference.
- .5 Detectors shall be equipped with NO/NC contacts to operate ancillary devices where applicable.
- .6 Detectors shall be equipped with a fine mesh bug screen to prevent contamination of the detection chamber by insects.
- .7 The detector shall be a plug-in/twist lock unit which may be removed from its base with a special installation tool without disconnecting detector wiring
- .8 The detector shall filter out false alarms caused by intermittent aerosols or cigarette/pipe tobacco smoke
- .9 Recessed smoke detector shall be complete with necessary shroud and flush mounting hardware.
- .10 Protect automatic smoke detectors during construction with a dust-bag, which shall be removed at the time of verification.

## 2.11 DUCT MOUNTED SMOKE DETECTORS

- .1 Duct-mounted smoke detectors shall consist of an ionization type smoke detector as described above, and an air tight housing assembly, mounted on the side of the duct complete with sampling tubes and supporting framework.
- .2 While fans are running, a continuous cross-sectional sampling of the air flows from the ventilation duct, through the detector, and then returned to the duct. Air stream velocity range from 2.5 m/sec minimum to 18 m/sec maximum be made to monitor, test and reset the detectors under actual air flow conditions. Unit shall be equipped with a test key switch and a reset key switch.

- .3 Remote alarm lamps or LED shall indicate the signal operation of the detector. Install Remote LED in an easily visible location to someone standing on the floor without requiring the use of ladders to see it.
- .4 Protect automatic smoke detectors during construction with a dust-bag, which will be removed at the time of verification.
- .5 Manufacturer shall include site visits to direct detailed locations of duct-mounted smoke detectors.

## 2.12 **PERIPHERAL ALARM INITIATING DEVICES**

- .1 Local control panels, interfaced with other equipment such as pre-action systems, kitchen hood extinguishing systems, or other Control panels, shall be a single zone capable of operating on 120 volt AC, 60 Hz and shall be complete with two isolated Form 'C' contacts and capability to initiate a fire alarm signal.
- .2 Manufacturer shall examine drawings and specifications prior to award of contract to ensure that detectors, control panels and miscellaneous devices being supplied will provide a satisfactory working installation.

## 2.13 **ALARM SIGNAL APPLIANCES**

- .1 Remote smoke detector alarm lamps shall be mounted in a single gang switch box with a brushed stainless steel cover, screw type terminals and electrically connected to heat or smoke detectors that require remote annunciation. Use only high intensity (200 med) LED lamps.
- .2 Alarm strobe lamps shall be ULC listed and operate on 24 V DC. The strobe shall be able to flash at a rate of one flash per second in alarm mode. The words "FIRE" shall appear on the strobe lens. Strobes shall comply with ADA requirements.

## 2.14 **FIRE ALARM SPEAKERS**

- .1 Speakers shall be complete with acoustically treated enclosure, line matching transformer, 203 mm (8 in) diameter, ULC approved permanent magnet type speaker and complete with flat white baked enamel square baffle.
- .2 Speakers shall be flush mounted unless otherwise noted.
- .3 Speakers shall produce a minimum gap flux density of 9500 gauss, have a voice coil impedance of 8 ohms, power rating of 20 watts, RMS according to EIA Standard RS-426A, a uniform frequency range from 80 - 13,000 Hz with minimum axial sensitivity of 94 dB at 4 feet with one watt input. The speakers shall have characteristics to produce a wide dispersion bandwidth in a hemispherical pattern in both horizontal and vertical plane.
- .4 Speakers shall have line matching transformers with 1/4 W, 1/2 W, 1 W and 2 W taps, initially set at 1 W. Verify suitability of sound levels in each area and adjust tap to suit.
- .5 Speaker baffles shall be held in place with approved fasteners.
- .6 Unit shall be complete with hook-up terminals with screw-type connection.
- .7 Speaker enclosures in exterior areas shall be suitable for surface mounting. Speaker enclosures elsewhere shall be suitable for outdoor location.

## 2.15 **RISER DIAGRAM**



- .1 The contractor in co-operation with the supplier shall prepare a riser diagram showing all major system components and inter-connecting wiring requirements. Riser to be submitted as a shop drawing.

## 2.16 **WIRING**

- .1 Wiring shall be as recommended by fire alarm system manufacturer.
- .2 Wiring for speaker circuits shall be twisted pair shielded sized as recommended by the manufacturer and it shall be installed in conduit.
- .3 Wiring within the floor area from detection device to device shall be as recommended by manufacturer, and installed in EMT conduit.
- .4 Provide line isolators where wiring crosses a different fire alarm zone.

## 2.17 **MATERIALS**

- .1 Fire alarm systems and components shall be:

*Standard of Acceptance*  
° Chubb Edwards

## **PART - 3 EXECUTION**

### 3.1 **INSTALLATION**

- .1 Installation of the Fire Alarm system components shall be in accordance with latest edition and all amendments of CAN/ULC-S524-M91 Standard for the Installation of Fire Alarm Systems.
- .2 The system shall be installed and wired by persons qualified and licenced to perform the installation of fire alarm systems.
- .3 Wire alarm initiating, alarm output, auxiliary output and signal devices to local SCP's as indicated in the schedules.
- .4 Wire alarm initiating circuits. Connect detectors and manual stations. Properly arrange and connect circuit wiring to their respective circuits as shown on the drawings.
- .5 Provide a separate class A addressable Loop for each zone as indicated on the drawings, complete with line isolators where the loop enter the zone.
- .6 Connect the pull stations, smoke detectors, flow switches, valves, zone alarm modules etc. to the addressable loops.
- .7 Install wiring for the alarm signal, alarm initiating and speaker circuits in separate raceways.
- .8 Wire signal circuits alternatively such that no two adjacent signal devices are on the same circuit.
- .9 Arrange wiring to the speakers such that no two adjacent speakers are connected to the same circuit.
- .10 Speakers shall be surface mounted in outdoor spaces.
- .11 Equip all raceways with a separate ground conductor.

- .12 Test each automatic detector to ensure correct wiring and zoning by setting off its rate of rise component and sounding the signals or by ringing it out. Test each smoke detector, sprinkler system and standpipe system valves to ensure correct wiring.

### 3.2 **DOOR HOLDERS/CLOSERS AND MAGNETIC LOCKS**

- .1 Connect all door holders into the fire alarm system such that doors close automatically upon actuation of the fire alarm system.
- .2 Connect all magnetic locks so that they are released by the fire alarm system and wire directly to be released by the adjacent pull station on First stage alarm in all area of the hospital except psychiatric areas. Mag locks in psychiatric areas will open on second stage alarm. Confirm this operation with local fire department prior to installation or programming.

### 3.3 **SPRINKLER/STANDPIPE SYSTEM CONNECTIONS**

- .1 Connect contacts of sprinkler flow, supervisory and standpipe system switches to fire alarm zones indicated and verify correct zoning.
- .2 Connect contact voltage sensitive relay of sprinkler pump, auxiliary booster or special service pump to fire alarm zone indicated, for trouble condition.

### 3.4 **WIRING**

- .1 Install wiring in conduit using wire size and type in accordance with manufacturer's recommendations.
- .2 Connect automatic detectors, smoke detectors and manual stations between red and black conductors at each outlet. Cut red and black conductors at each outlet and connect to terminal screws provided, red to red and black to black.
- .3 Install wiring between fire alarm and each diesel-generator control panel to show "running" and "trouble" indications.
- .4 Arrange wiring between existing and new fire alarm control system to achieve operation as specified.
- .5 Entire installation shall be done under supervision of manufacturer. Upon completion of installation, check entire system to approval and correct any malfunction immediately.

### 3.5 **SYSTEM VERIFICATION**

- .1 The fire alarm system shall be verified in accordance to ULC CAN 4-S537 Standard For the Verification Of Fire Alarm Systems.
- .2 The manufacturer of the fire alarm and voice communication system shall make a complete inspection of all components installed for system, such as manual stations, speakers, smoke detectors, annunciators, sprinkler and standpipe valves to ensure the following:

That the system is complete in accordance with Specifications.

That the system is connected in accordance with Manufacturer's recommendations.

That the regulations concerning the supervision of components have been adhered to

That all equipment as part of the system is inspected for visible damage or tampering

That adjacent speakers have been connected to alternate circuits.

That the control functions have been tested for proper supervision, operation and annunciation of fan shutdown and all speaker control circuits

That all speakers are properly zoned.

That all valves are properly connected and displayed correctly on each annunciator.

- That any subsequent changes necessary to conform to the above will be carried out with technical advice supplied by the Manufacturer.
- That all thermal detectors, smoke detectors, manual pull stations and all sprinkler system and standpipe system valves have been operated and are in good working order.
- That all annunciators correctly pin-point the origin of any fire alarm.
- That actual test gas concentrations of sufficient density, have been applied to each new smoke detector to cause the detector to be set off and that the sensitivity of each smoke detector has been set. On completion of test, a letter shall be forwarded stating that tests have been completed and that system is operating correctly.
- All tests required by Local Authorities have been carried out and all existing zones have been verified.
- .3 Verification records shall be maintained with the following minimum requirements:
- verification records shall list each device and show the date on which each device was verified and the initials of the person who verified it.
- verification records shall show the date on which all devices were verified.
- verification records shall show the date of all deficiencies encountered in the control equipment, wiring and field devices.
- verification records shall show the date when deficiencies were corrected and re-verified
- .4 Provide any necessary equipment, test apparatus, ladders and scaffolding as required.
- .5 Adjust system and components as required to ensure complete system operation.
- .6 Only after the testing and verification task is completed, and all deficiencies rectified, notify the Engineers and representatives of the Fire Department and demonstrate the proper functioning of the system

**END OF SECTION**



## **ICN Cabling Standards**

### **Information & Telecommunication Services**

***Revised : January 11, 2017***

#### **General Overview**

Sunnybrook has an extensive Ethernet network extending throughout four campuses:

1. Sunnybrook (SB) – 2075 Bayview Ave. (north of Eglinton)
2. Holland Centre (HC) – 43 Wellesley St. (east of Yonge)
3. St. John Rehab (SJR) - 285 Cummer Avenue (west of Bayview)
4. CNIB - 1929 Bayview Ave. (north of Eglinton)

There are approximately 74 wiring closets cabled with Cat5/5e/6/6a UTP cables across the four campuses, with the majority of 61 at Sunnybrook campus.

The implementation of an Intelligent Campus Network (ICN) began in 1995 at the SB campus. This involved moving from a token-ring to an ethernet wide facility and included the implementation of new hub rooms, backbone fibre and horizontal UTP cabling installed to Nordx/CDT IBDN certification. Backbone fibre type will be type OM4 MMF or SMF where required. Standard horizontal UTP will be Category 6 with any new construction or large area renovation project.

Majority of the hub rooms have their own dedicated pathway which serves those floors assigned to that specific room. The pathway may be either zone and distribution conduit or a J-hook design.

The telephone infrastructure (Cat3) consists of a riser closet or terminal located in every wing on every floor of our buildings. The majority of our terminals follow the industry BIX standard. Some of our terminals are in shared locations with the ICN network hub rooms.

#### **Scope of Work for Data Cabling**

The extent of the MAC work includes but is not limited to the following:

1. Place data cabling in existing horizontal pathway from the offices requiring MAC work to their associated ICN hub room.
2. Terminate both the patch panel or the BIX block and the workstation ends of each cable drop as specified in the EIA/TIA T568A wiring standard.
3. Label both the workstation faceplate and the hub room patch panel as per ICN labeling standards provided by Sunnybrook.

4. Provide a 7 ft stranded patch cord (for the hub room end) and a 10 ft. solid station cord (for the user end) for each new drop.
5. Patch each new data drop into an available switch port in the hub room and document port info. If no available switch port, I.S. is to be notified immediately.
6. Test each cable drop to EIA/TIA TSB67 Category 6/6a standards with a Microtest "PentaScanner" LAN tester or equivalent.
7. Install wire raceway or ceiling access panels if required.

### **Scope of Work for Voice Cabling**

The extent of the MAC work includes but is not limited to the following:

1. Place Voice cabling in existing horizontal pathway from the offices requiring MAC work to their associated terminal.
2. Terminate the BIX block and the jack ends of each cable drop as specified by the BIX wiring standard.
3. Label both the phone jack faceplate and the terminal BIX block (with the next available cable number) as per labeling standards provided by Sunnybrook.
4. Tone each cable drop to BIX to confirm connectivity.
5. Install wire raceway or ceiling access panels if required.

### **Installation Requirements**

#### **Data Cable**

- Cable shall be Belden/CDT IBDN Flex Category 6 or 6a, FT4 or FT6 where required, 4 pair UTP.
- Cables shall not exceed the EIA/TIA T568A wiring standard of maximum 90 meters in length. Every effort has been made to centrally locate the hub rooms to facilitate the length limitations. Any drop that may exceed the 90 meter limit will require I.S. approval.

#### **Voice Cable**

- Cable shall be Belden/CDT IBDN Category 3, FT4 or FT6 where required, 4 pair UTP.
- Cables shall not exceed distance to nearest telephone terminal.

### **Data Jacks**

- Data jacks shall be Belden/CDT MDVO, 8p8w, orange for Category 6 and turquoise for Category 6a.

### **Voice Jacks**

- Voice jacks shall be Belden/CDT MDVO, 8p8w, white for digital phone/FAX, or yellow for emergency phones.

### **Patch Panels and Horizontal Wire Management**

- Belden/CDT 48 Port MDVO and CableTalk 2M Managers (**Empty MDVO panels and wire managers installed as a part of the hub room setup**).

### **Wall Plates / Surface Boxes**

- Belden/CDT MDVO 4-port faceplate (white) with surface box where required (**use alternate port of existing plate where temporary ethernet cables are terminated**). Faceplates and surface boxes shall be mounted using screws.

### **Wire Raceway**

- Panduit, Wiremold or equivalent. Large enough to accommodate 4 – Cat6 or Cat6a UTP cables and white in colour.
- Use existing raceway where possible.

### **Ceiling Access Panels (approved by I.S.)**

- In rooms without T-bar ceilings where distribution conduit has been installed (floors H2, H3, H4 only), the conduit stubs into the room above the solid ceiling. A permanent access panel (18" x 18") shall be strategically installed near the conduit stub to allow for the cable installation to the room.

### **Patch cords**

- 1 Belden/CDT stranded Cat6 (for Cat6 cabling) or Cat6a (for Cat6a cabling) 7 feet wired T568A modular cord for each hub room connection.
- 1 Belden/CDT solid Cat6 (for Cat6 cabling) or Cat6a (for Cat6a cabling) 10 feet wired T568A modular cord for each workstation connection.
- Patch cords for Cat6 shall be orange and for Cat6a shall be light green.

### **Labels**

- All labels shall be mechanically printed permanent self adhesive (**no hand written labels will be accepted**). See the last page for labeling standards.

## **Testing**

- Cable testing shall be to EIA/TIA TSB67 standards and include the following information:
  - a. Cable Identification (Workstation Room # / Hub Room # / Port #)
  - b. Cat6 or Cat6a test parameter results
  - c. Hub Port Identification (Hub I.D. # / Port #)
  - d. Project ID and description, date of installation, company etc.
- All test results shall be submitted to Sunnybrook Information Services Department in an electronic file.

## **Pathway**

An ICN cabling pathway has been installed throughout the SB campus to allow for isolation and management of ICN cable drops.

Most wings have been fitted with a pathway consisting of CaddyCat J-hooks from Erico Industries. The pathway generally follows both sides of each corridor on their respective floors. In areas where ceiling congestion did not allow for j-hook installation, EMT conduit has been installed in sections with gaps to allow for cabling to enter rooms where required.

All cabling in T Wing (OCC – Odette Cancer Centre) should be dropped through the wall. The OCC is a modern building with drywall walls and drop ceiling. All cable drops in the OCC to be set as inside wall drops only (where circumstances allow).

Since each hub room will typically service 3 floors, vertical access to adjacent floors has been done using vertical conduits from the ceiling space of one floor to the ceiling space of the other.

Where a cable or cables leave the pathway to enter a room, a conduit sleeve (3/4" for 1 - 2 cables or 1" for 3 - 6 cables) must be installed to access the room and properly fire stopped after the cabling has been installed.

Several wings or partial wings have had a network of zone and distribution conduit installed for ICN cabling. From the hub room, 2" EMT conduit has been install to a pull box in each predetermined zone. From each pull box there has been installed a 1" EMT pipe to rooms in that specific zone deemed as requiring an ethernet connection. Cabling shall be installed through the proper zone and distribution conduit to each room.

Conduit fill ratios have been considered and should be met. If an exception exists, Information Services is to be notified for consultation.

## **Conditions**

1. No ceiling space shall be accessed without a valid Ceiling Access Permit (CAP) received from the Occupational Health and Safety Coordinator and properly displayed.

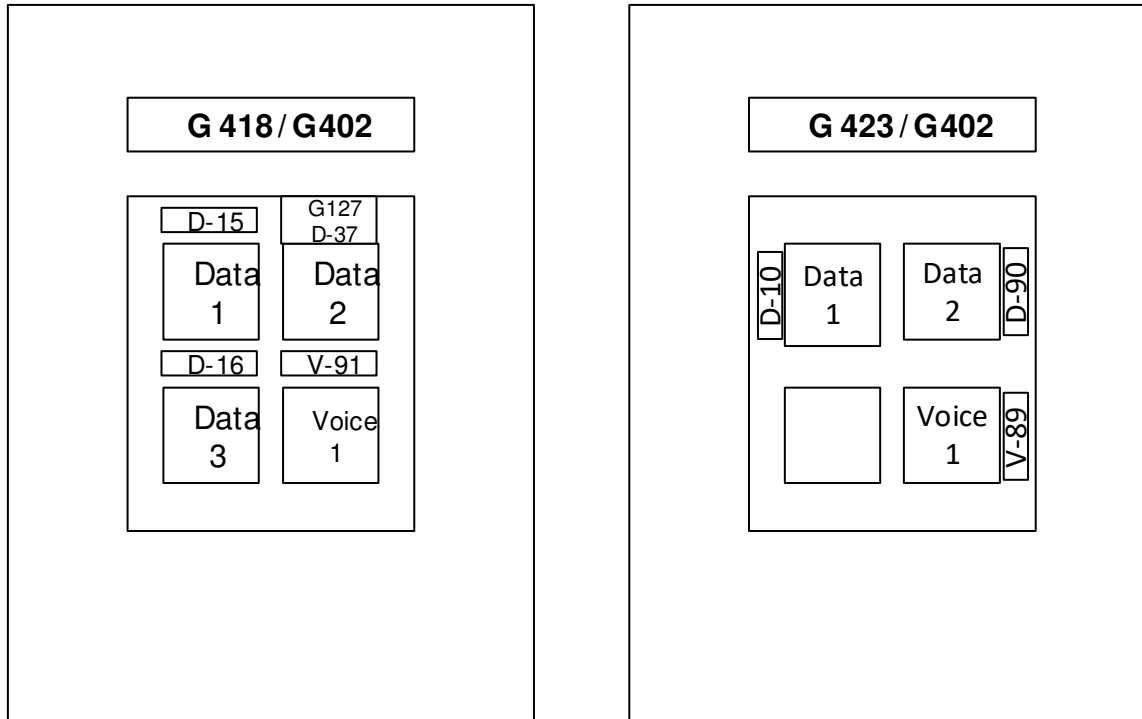
2. Most of the work can be done during normal business hours with the understanding that corridor traffic flow must not be compromised.
3. Access to all locked doors will be through Fire and Security Services. Be prepared to wait at times for access to any given room. All doors **MUST** be locked upon completion of work.
4. All individuals working on the cabling projects must have valid picture I. D. provided by the Fire and Security Department of Sunnybrook.
5. MAC work should be completed within 10 business days from the day of assignment or as scheduled (Projects).
6. Most projects/installations (marked as matrix III and IV) will require medical contamination control due to sensitive areas in the hospital. The cabling vendor should own professional construction equipment/material such as mobile cubicles equipped with hepa vacuum cleaner, asbestos masks and plastic sheets for manual tenting.
7. All persons to be employed as Cable Installers at Sunnybrook are required to attend a minimum ½ day Asbestos Awareness Training Session by an outside consultant. Acceptable training programs are offered by Pinchin Environmental, T. Harris Environmental, Jacques Whitford Environmental, and some labour unions. Certificates of training must be copied and given to the Occupational health and Safety Coordinator at Sunnybrook. The accepted contractor must also meet with the Safety Coordinator to review their work and sensitive asbestos areas prior to starting work. The contractor needs to be aware that they must report unsafe conditions to Occupational Health and Safety Coordinator.
8. All persons to be employed as Cable Installers at Sunnybrook are required to attend awareness session provided by Infection Prevention & Control, hosted on-site at Sunnybrook.



## **Appendix A: Cable Labeling Standard**

The following is the cable labeling standards used at Sunnybrook, for horizontal Cat6/6a UTP cables.

### **Station End Location**



### **Station end wall plates**

The Sunnybrook cable labeling standards requires that the label(s) at the station end wall plate identify the 'station end room number', 'hub room number', and 'device patch panel port number' of where the cable terminates to. The station end wall plate labels comprise of a top label and one or more side labels. If only a port number is listed then it is assumed that the hub room is read from the top label. Otherwise the hub room must be listed in addition to the port number.

#### **Top label      G418 / G402**

- where: - G418 is current station end room location where this wall plate is  
 - G402 is the ICN Hub Room that the cable(s) runs to

#### **Side Labels    D-15   D-16   G127   V-91    D- 37**

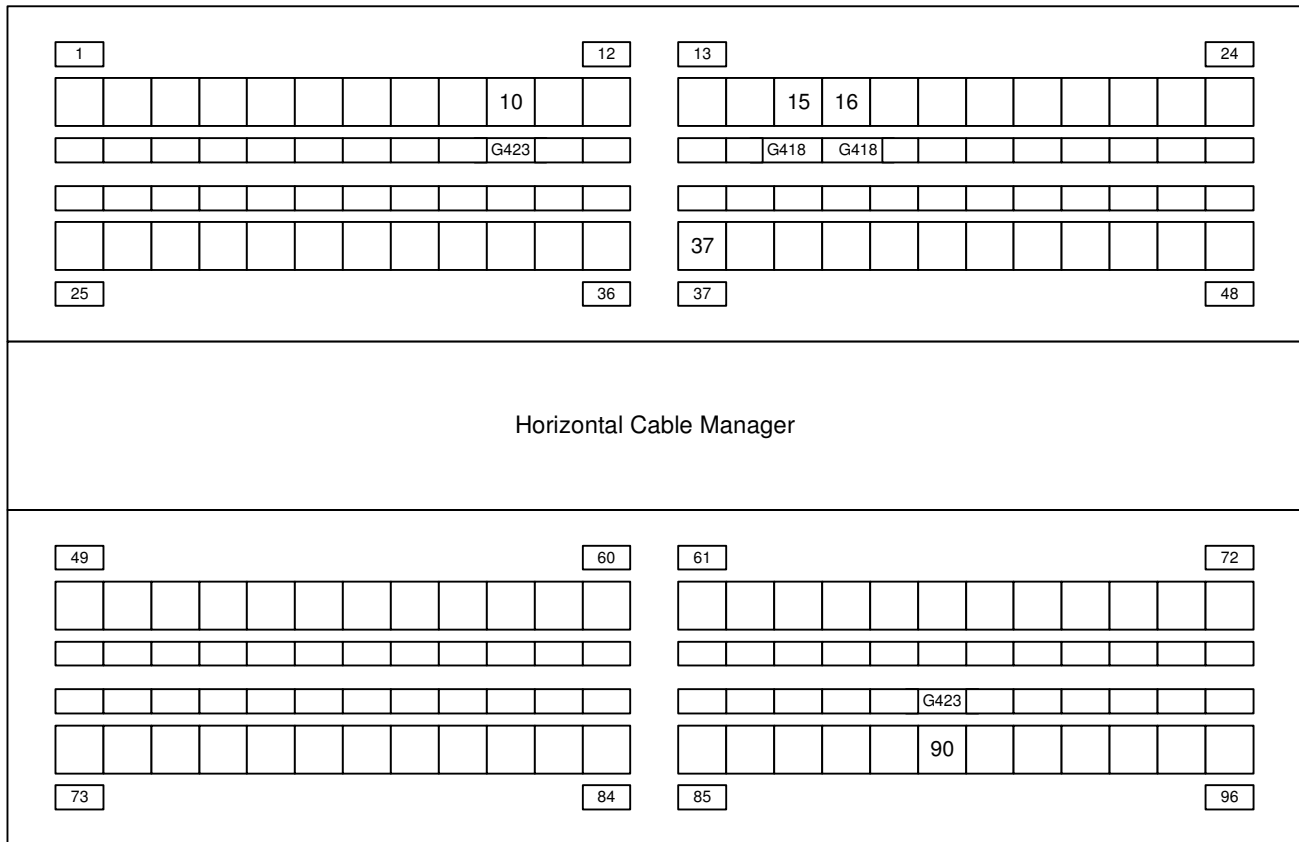
- where - 'D-15' is data cable terminating on patch panel port 15 in hub room G402  
 - 'D-16' is data cable terminating on patch panel port 16 in hub room G402  
 - 'G127 D-37' is data cable terminating on patch panel port 37 in hub room G127  
 (exception cable to a different hub room)

- V-91 is voice cable terminating on BIX panel port 91 in nearest Bell voice closet

Note: if only a number is provided then it is assumed to be a data cable.

## Equipment End Location – ICN Hub Room

Each hub room will have data cables terminated on a patch panel. All patch panel ports will be consecutively numbered such that all ports will be uniquely identified regardless if there are several panels on several network racks. The end ports will be labeled at top/bottom consecutively starting from 1 to nnn as illustrated in the following diagram. The centre labels will indicate the device room number where the cable comes from



## Equipment end Patch Panels - ICN Hub Room G402

## Data Centre and Hub Room Access Policy

<b>Sunnybrook Health Sciences Centre</b>		<b>Policy No:</b>	ICS-025
<b>Title</b>	<b>Data Centre and Hub Room Access Policy</b>	<b>Original:</b> (mm/dd/yyyy)	06/11/2012
<b>Category</b>	<b>Information and Communication Services</b>	<b>Reviewed:</b> (mm/dd/yyyy)	06/11/2012
<b>Sub-Category</b>	<b>Network &amp; Security</b>	<b>Revised:</b> (mm/dd/yyyy)	10/05/2012
<b>Issued By:</b>	IT Operations Committee		
<b>Approved By:</b>	Sam Marafioti		

The Sunnybrook Intranet document is considered the most current.  
Please ensure that you have reviewed all linked documents and other referenced materials within this page.

## Data Centre and Hub Room Access Policy

### Policy

It is Sunnybrook's policy to permit only authorized access to data centre and hub rooms in accordance with Sunnybrook Information Services security policies and procedures in order to ensure the integrity and availability of services dependent on these mission critical resources.

### Definitions

**Agent** means any authorized Sunnybrook person accessing a data centre or hub room.

**Visitor** means any authorized non-Sunnybrook person seeking access to a data centre or hub room.

### Purpose

This policy outlines Information Services standards for access to and maintenance of all Sunnybrook data centres and hub rooms ("facilities"). The policy is intended to enable secure access to facilities and to ensure that these facilities are maintained and operated in a safe, clean and effective manner in order to provide continuous service for dependent systems and infrastructure. All persons accessing data centres or hub rooms must abide by this policy. Failure to comply may result in loss of facility access privileges and/or removal

of equipment.

**Applicability**

This policy applies to:

- All authorized Information Services administrators and their authorized agents who maintain equipment owned and operated by Information Services in a data centre or hub room; and
- Any other Sunnybrook person who owns or maintains equipment housed in or accessed via any Sunnybrook data centre or hub room.
- Any Visitor for any purpose whatsoever.

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**Procedures**

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**1 - Authorized Data Centre and Hub Room Activities**

Hub rooms are intended to be single purpose rooms for accommodating Information Services network systems (network cabling and equipment), servers and storage systems and may include associated cables, monitors, power, air conditioning units, temperature monitoring units, humidity monitoring, tape drives, backup media, etc.

In addition, other Sunnybrook authorized corporate systems or infrastructure services may be housed within or accessible through a data centre or hub room, including patient monitor network systems, Medical Imaging PACS network equipment, Research network equipment, etc. Other rooms may have been built as multipurpose rooms which have other corporate systems installed such as fire alarm panels, Coax video systems, etc.

**Note: installation of any non-IS owned or operated system or service in a data centre or hub room must receive prior written approval from Sunnybrook’s CIO.**

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**2 – Administrator Responsibilities:**

It is the responsibility of each Information Services system administrator to ensure that all data centres and hub rooms and all associated equipment therein are maintained and operated in a safe and effective manner, including the performance of on-going maintenance and monitoring for any unusual conditions, e.g. overheating, flooding, etc.. All non-normal operating conditions must be reported to the Manager of Information Technology at the

earliest opportunity.

- All data centres and hub rooms must be kept in a safe, clean and professional manner at all times. All waste must be immediately disposed of by the respective Administrators and the waste deposited into proper containers.
- All entrances to data centres and hub rooms must be kept clear as per fire/security regulations.
- All non-normal operating conditions must be reported to the Manager of Information Technology at the earliest opportunity.
- Staff failing to adhere to this policy will be reported to Director of Information Technology who will take applicable disciplinary action where required.

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### **3 – Access**

Access to a Sunnybrook data centre or hub room by any person requires

- 1) authorization from Information Services; and
- 2) either an IS escort or a personally issued KeyScan-enabled Sunnybrook ID badge.

- KeyScan-enabled access does not require an Information Services escort. Those persons accessing a data centre or hub room who have not been issued a KeyScan-enabled card must be escorted.
- Escort, where required, must be provided by either an authorized Sunnybrook Information Services or Security Services representative.
- KeyScan-enabled card access will generally be provided to authorized Sunnybrook staff (agents) and 3<sup>rd</sup> parties (visitors) requiring routine, non-escorted access on an individual, case-by-case basis.
- Individuals must only use a personally issued KeyScan-enabled card and all individuals must either scan in or be escorted to enter a room (all tailgating is strictly prohibited).
- Access (whether by escort or KeyScan) will be logged and routinely audited by information Services.

### **Sunnybrook Information Services Purposes**

Sunnybrook agents (IS and non-IS departmental server admins) requiring temporary or permanent access to data centres and hub rooms must send a request to the IS Network team and receive written authorization prior to access.

Temporary access to these rooms will be granted on a short-term basis for 3<sup>rd</sup>

party vendors or other visitors performing work on behalf of Information Services (e.g. for software or hardware installation or maintenance).

**Sunnybrook Non-Information Services Purposes**

Access to data centres and hub rooms for non-IS purposes must be authorized by the Director of Information Technology or designate. Temporary access to these rooms will be granted on a short-term basis for 3<sup>rd</sup> party vendors (visitors) requiring access to service or install non-IS systems in the room (e.g. renovations to the room, service or installation of air conditioning, etc.), including but not limited to:

- Installation or service of any non-IS systems such as Patient Monitor, PACS or Research, fire alarm panels, security system panels, electrical service panels, coax TV systems, etc.
- For construction work near or in these rooms requiring access, including installation of conduit or cables that will pass through the rooms; etc.
- Access by other non-IS Sunnybrook project managers, maintenance and service personnel or their agents (e.g. for Facilities Planning or Maintenance personnel, vendors or contractors) who may require access to these rooms to implement projects, install systems or maintain and service essential systems such as on an ongoing basis or in emergencies.

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**4 - Security:**

**Authorized Access Only**

Access to data centres and hub rooms is absolutely restricted to authorized individuals as documented in this policy and as identified by the Manager, Information Technology in the IS Network Team Data Centre and Hub Room Access access control list.

- All data centres and hub rooms must be kept locked at all times.
- Access to data centres and hub rooms will be logged and audited by the Manager, Information technology
- All persons requesting access will be required to supply identifying information (name, company name or department, room number and phone number/local) and the purpose for entry before being granted access.
- Access is permitted for those activities required for the indicated purpose and under no circumstances shall other activities occur for any other purpose without written approval of the Manager, Information Technology.

- Security badges must be worn at all times.

**Visitors**

- All Visitors must be escorted at all times by an authorized SB Information Services staff or member of Sunnybrook’s Security staff unless they have been issued a KeyScan-enabled Sunnybrook ID badge (see Appendix 1).
- Authorized Visitors who may require continuous access for greater than 5 days may be provided with a temporary Visitors’ badge enabling KeyScan access at their cost or at the cost of their sponsor at the discretion of the Manager, Information Technology.
- Visitors are not permitted to have possession of any data centre or hub room access lock key other than an authorized KeyScan-enabled Sunnybrook ID badge which has been assigned to them personally.

**Enforcement:**

- Any person found to have violated this policy may be subject to disciplinary action, up to and including termination of employment and/or legal action at the sole discretion of Sunnybrook Health Sciences Centre.

**Contact Information:**

George Lee	x4219	page 7308
David Chong	x7232	page 8101
Myles Leicester	x4377	page 8137
Wilfred Yan	x85322	page 5416
IS Help Desk	x4159	
Fire and Security	x4589	

**Appendix 1**

**Requesting Access to ICN Data Centres and Hub Rooms**

The following procedures must be used for requesting access to any Sunnybrook data centres or hub room.

**Requesting access during business hours:**

- 1) Users requiring access to data centres or hub rooms must email the IS Network team for access. The IS Helpdesk can also be called and will, in turn, email and page the ICN Network team. Users are to identify themselves and indicate the reason they require access to this room as well as date and time required.
- 2) The IS Network team will review the request and access may require further management approval without prior notice.

- 3) The IS Network team may personally provide access to the room or submit a request to Sunnybrook Security Services to authorize access.
- 4) The IS Network team will log all access, including identity of user, data centre or hub room number, date, start and stop times and reason for access.

**Requesting access after business hours:**

- 1) Users requiring access to hub room must call the Security office (ext. 4589) to request access. Users must identify themselves and indicate the reason they require access.
- 2) Security will only provide access to persons appearing on a list of pre-approved personnel provided by the IS Network team or based on prior written permission of a member of the IS network Team or the manager, Information Technology.
  - a) If a person is authorized for entry, Security will open the door to permit user access to the room.
  - b) If user is not authorized for entry then Security will deny access and advise the user to contact IS the following day.
    - i) If the user cannot wait then Security may contact the IS Helpdesk for assistance in contacting an authorized IS representative.
    - ii) If Security contacts the IS Helpdesk, the Helpdesk personnel will assess the request and, if necessary, email and page the ICN Network Team for directions.
- 5) Security will log all access, including the identity of user, data centre or hub room number, date, start and stop times and purpose for access.

**Requesting KeyScan Access**

**Note:** Some rooms are equipped with KeyScan access. Visitors may be assigned KeyScan-enabled Sunnybrook ID badge as noted above, however only escorted Visitor access can be granted to rooms without KeyScan pads.

The following procedure is used for requesting KeyScan access to data centres:

1. User submits request by email to IS Helpdesk or IS Network team. Name, department, phone number and pager number of person(s) requiring access, data centre(s) to be accessed and reason for access must be provided. Pre-approved requests may be provided by IS management on behalf of the user.
2. All requests will be forwarded to IS Network team. If the request is questionable then it will be forwarded to IS management for approval. (e.g. to install non-IS systems or allow departmental servers to be installed in the ICN data centres).



3. If a request is approved and accepted then the IS Network team will forward an e-mail to Security to authorize access via KeyScan.

**Note:** Security will not accept requests directly from users and will only accept requests from the IS Network team.

If short term temporary access is requested then the IS Network team will specify the number of days for which access has been granted.

4. Security will create a KeyScan-enabled Sunnybrook ID badge for the approved access and confirm back to ICN Network team and/or directly to the user(s) requiring access. Vendors requiring a temporary ID badge can pick it by visiting the Security office (CG03) only after providing proper identification. Prior email notification of access approval must be received by Security from the IS Network team.

**No person may use a KeyScan-enabled Sunnybrook ID badge which has not been assigned to them personally to access a data centre or hub room.**

5. If temporary access was issued, at the completion of the access period, IS Network team will issue a follow-up email to Security to remove access.
6. If IS Network team is informed of a user leaving the hospital who no longer requires access to a room, IS will issue an email to Security to remove any KeyScan access which may have been previously assigned to that individual.
7. The IS Network team will maintain a spreadsheet of users that have been granted Keyscan access. Date of request and room accesses granted as well as the date of request or access code removal will be recorded.

# POLICY & PROCEDURES

## RE: Code White, Code Blue, and Nurse Call Buttons

Corporate Planning & Development



Date: September 20, 2019  
Issued by: S. Marafioti

### Policy: Code White, Code Blue, and Nurse Call Buttons Installation Policy for Renovation and/or New Construction Projects

#### Procedure for the installation of Code White, Code Blue, and Nurse Call buttons/pull cords in renovation and/or new construction projects

1. During the Design Development phase, the Corporate Planning & Development (CPD) Project Manager (PM) must notify the user group/area stakeholders, representatives from the Occupational Health & Safety, Security, Risk Management, Biomedical Engineering, and Emergency Preparedness departments of any installations and/or replacements of existing Code White, Code Blue, and/or Nurse Call buttons required throughout the hospital.
2. The CPD PM must make note that all new and renovated areas should be considered for security enhancements during the Design Development phase. The potential enhancements are to be further discussed with Security prior to obtaining their approval.
3. The CPD PM must receive approval from all aforementioned stakeholders on the location(s) and specification of the button(s) before proceeding with the install.
4. When installing the **Code White** button, the following pre-determined specifications must be met:
  - a. The Code White button must be a WHITE button with BLACK lettering
  - b. The text must read, "CODE WHITE"
  - c. A name plate noting the function of the button must be placed above the button's location
  - d. A cover plate for the button is to be considered in consultation with the Patient Care Manager of the unit and/or with the aforementioned stakeholders
  - e. After installation, the Code White button will be handed over to the Security department
5. When installing the **Code Blue** button, the following pre-determined specifications must be met:
  - a. The Code Blue button must be a BLUE button with WHITE lettering
  - b. The text must read, "CODE BLUE"
  - c. A name plate noting the function of the button must be placed above the button's location
  - d. A cover plate must be placed on all buttons unless indicated by the Patient Care Manager of the unit and/or the aforementioned stakeholders
  - e. After installation, the Code Blue button will be handed over to the Biomed department
6. When installing the **Nurse Call** button/pull cord, the following pre-determined specifications must be met:
  - a. The CPD PM must receive approval from all aforementioned stakeholders
  - b. After installation, the Nurse Call button/pull cord will be handed over to the Biomed department