HHAngus

Mechanical Specification

FOR

APOTEX BUILDING 5TH FLOOR PILOT UNIT

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1 LIST OF SPECIFICATION SECTIONS

END OF SECTION

MECHANICAL GENERAL REQUIREMENTS
20 01 01

1 GENERAL

1.1 General Contract Documents

.1 Comply with General Conditions of Contract, Supplementary Conditions and Division 1 - General Requirements.

1.2 Work Included

.1 Work to be done under Divisions 20, 21, 22, 23 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.

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)

.2 For clarity, any reference in the Contract Documents to Division 20 includes Divisions 21, 22, and 23.

.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, and 23

.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 or in Specification.

.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 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 list follows a semi-colon (;) the punctuation is for clarity, where 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.

1.7 Examination

.1 Examine any existing buildings, local conditions, building site, 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 Examine work of other Divisions before commencing this work, and report any defect or interference.

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 standard products of approved manufacture.

.4 labeled or listed as required by Code and/or Inspection Authorities,

.5 registered in accordance with the requirements of TSSA Boilers and Pressure Vessels Safety Division Guidelines for the Registration of Non-nuclear Fittings in the Province of Ontario,

.6 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.

.7 identical units of equipment to be of same manufacture.

.8 identical component parts of same manufacture 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.

.1 Where manufacturers or manufacturers products are identified in lists with the phrase "Standard of Acceptance", these are manufacturers and/or products which meet required standards with regard to performance, quality of material and workmanship.

.2 Manufacturers and or products used are to be chosen from these lists.

.4 Select materials and equipment in accordance with manufacturer's recommendations and install in accordance with manufacturer's instructions.

.5 Materials and equipment not satisfying these selection criteria will be condemned.

.6 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 manufacturer 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][Engineer] they made all reasonable efforts to procure the specified product or material in a timely fashion,

.2 the manufacturer must advise the [Consultant][Engineer] 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][Engineer] at no additional costs to the contract,

.4 the [Consultant][Engineer] 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 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 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.

1.11 Owner’s Special Requirements for existing sites

.1 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 Schedule work and meet 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 by the Owner.

.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, allow 48 hours to make appropriate arrangements.

.14 For any fire system isolation requests, 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 unless otherwise approved by the Owner.

.20 At the conclusion of each work day, the Contractor's superintendant 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.]

2 SUBMITTALS

2.1 Shop Drawings and Product Data Sheets

.1 Submit shop drawings, manufacturers and product data and samples in accordance with spec.

.1 Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and imperial measures may be included.

.2 Submitted 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, or, include the same information on the general or trade 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 8.5 x 11 or 11 x 17 size, black and white originals of graphic quality suitable for photocopying. Allow one additional week for processing of shop drawings submitted in hardcopy format.

.2 for each item of equipment.

.4 Manufacturer's letter sized printed data sheets, as black and white originals of graphic quality suitable for photocopying, are acceptable in place of shop drawings for standard production items.

.5 Submit with manufacturers data sheets, typed schedules listing manufacturer's and supplier's name and catalogue model number.

.6 For plumbing fixtures, submit fixture cuts with catalogue numbers for fixtures to be used on job. Identify and arrange fixture cuts in same sequence as specification fixture list.

.7 Shop drawings and product data to show;

(a) dimensioned outlines of equipment
(b) dimensioned details showing service connection points.
(c) elevations illustrating locations of visible equipment such as gauges, pilot lights, breakers and their trip settings, windows, meters, access doors.
(d) description of operation.
(e) single line diagrams.
(f) general routing of bus ducts and connecting services.
(g) mounting and fixing arrangements.
(h) operating and maintenance clearances, and

(i) access door swing spaces.

.8 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.

.9 Shop drawing and data sheet submission is taken as certification;

.1 that units are from Manufacturer's current production and

.2 in compliance with applicable Codes, Standards, and Regulations.

.10 Do not submit drawings showing internal construction details, component assemblies or interior piping and wiring diagrams. These may be necessary to understand correct functioning of equipment and should be submitted with operating and maintenance data.

.11 Check and stamp each shop drawing as being correct before submission. Shop drawings without such stamps will be rejected and returned.

.12 Keep one copy of each reviewed shop drawing and product data sheet on site available for reference purposes.

.13 Where equipment is delivered without reviewed shop drawing available on site, equipment will be condemned and is to be removed from site and replaced with new equipment after shop drawing has been submitted and reviewed.

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.

3 REFERENCE CODES STANDARDS AND REGULATIONS

3.1 Codes, Standards and Regulations

.1 Latest current versions in force at time of Tender.

.2 Where relevant documents applicable to this work exist, follow these criterion, recommendations, and requirements as minimum standards.

.3 In event of conflict between codes, 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 most demanding requirements.

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, Tests and Certificates

.1 Arrange and pay for permits, tests, and Certificates of Inspection required by Authorities having jurisdiction.

.2 Submit applications requiring Owner's signature before commencing work.

.3 Obtain and submit Inspection Certificates.

.4 Certificates to be renewed as to remain in force for guarantee period.

.5 Co-ordinate and perform testing required by Authorities having jurisdiction in accordance with Clause **TESTING** in this Section

4 EQUIPMENT

4.1 Manufacturers Nameplates

.1 Metal nameplate with raised or recessed lettering, mounted on each piece of equipment.

.2 On insulated equipment, mechanically fasten plates on metal stand-off bracket arranged to clear insulation and mount Underwriters Laboratories and/or CSA registration plates on same stand-off brackets.

.3 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.

4.2 Factory Applied Finish Painting

.1 Apply prime and final paint coats to equipment and materials where specifically detailed in Sections of these Divisions.

.2 Apply prime and final paint coats factory to pumps, air moving units, un-insulated pressure vessels and bare metal equipment items in boiler, mechanical and fan rooms.

.3 Use heat resistant paint where conditions require.

.4 Protect factory finished equipment during construction, and clean at completion of work.

4.3 Factory Applied Prime Painting

.1 Have prime paint factory applied to other equipment fabricated from iron or steel including access doors, registers, grilles, diffusers, dampers, metal radiation enclosures and fire hose cabinets.

4.4 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 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:

.1 paint exposed galvanized metal surfaces with one coat of zinc dust galvanized primer and one coat of 100% Alkyd base enamel in an approved colour; and

.2 paint exposed iron or steel work with one coat of chrome oxide phenolic base primer and one coat of 100% Alkyd base enamel in an approved colour.

4.5 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.

5 OFFICE, STORAGE AND TOOLS

5.1 Office and Storage

.1 Provide temporary office and lunchroom facilities, workshop, and tools and material storage space. Facilities may be site trailers or as otherwise approved by the General Contractor/Construction Manager.

.2 Assume responsibility for security of these facilities and provide heat, light and telephone and Internet service

.3 Owners cateteria is off limits.

5.2 Appliances and Tools

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

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.

.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.

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 For details of cutting and patching and Division of Work refer to Division 1.

.2 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. Pay for any resulting costs. Layout such work for approval by the Structural Engineer before undertaking same.

.3 Neatly cut or frill holes required in existing construction to accommodate cable, raceways, bus duct or cabletray.

.4 Division 20 contractor to be responsible for arranging and paying for all cutting and patching as required for own 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 or moisture resistant elements or sight exposed surfaces.

.1 Layout cutting of structural elements, such as floors slabs, walls, columns or beams and obtain approval before starting work. Conduct an electromagnetic scan of reinforcing rods, such as Hilti PS200 Ferroscan, and review with Structural Engineer. Based on these results, arrange and pay for supplemental x-ray examination to locate concrete reinforcement and embedments where required. Submit x-rays and obtain approval before starting work Relocate core drilling location if steel or conduit is found in the proposed location and repeat procedure. Reroute any circuits damaged by core drilling.

7 PROTECTION OF WORK AND PROPERTY

7.1 General

.1 Protect this work and work of other trades from damage.

.2 Cover floors with tarpaulins and provide plywood and other temporary protection.

.3 Assume responsibility for repairing damage to floor and wall surfaces resulting from failure to provide adequate protection.

.4 Protect equipment, pipe and duct openings from dirt, dust and other foreign materials.

8 WORK IN EXISTING BUILDING

8.1 General

.1 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.

.2 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.

.3 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..

.4 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.

.5 Plumbing fixtures, piping, ductwork, conduit and wiring shown to be removed and not shown relocated, to become property of Contractor and to be taken from site.

.6 On completion of relocations, confirm relocated equipment are in proper working order.

.7 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.

8.2 Continuity of Services

.1 Make connections to existing systems 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.

.2 Be responsible for and make good any damages caused to existing systems when making connections.

.3 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.

9 FINAL CLEANING AND ADJUSTMENTS

9.1 General

.1 Conduct final cleaning in accordance with Section 01 74 23 and as specified herein.

.2 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.

.3 Remove tools and waste materials on completion of work and leave work in clean and perfect condition.

.4 Calibrate components and controls and check function and sequencing of systems under operating conditions.

.5 Supply lubricating oils and packing for proper operation of equipment and systems until work has been accepted.

10 RECORD DRAWINGS

10.1 Record drawings

.1 Provide record drawings in accordance with Section 01 78 39 and as specified herein.

.2 A set of design drawings in AutoCad 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 At 50%, 75% and 90% project completion, scan marked-up drawings to Adobe .pdf format and submit copy to the Consultant, or to the project on-line document service if one is used.

10.2 As-built drawings

.1 Prior to testing, balancing and adjusting, transfer site record drawing information to AutoCad (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 Show on mechanical as-built drawings final location of piping, ductwork, switches, starters, Motor Control Centres, thermostats, and equipment.

.4 Show on site services as-built drawings survey information provided by Ontario Land Surveyor (OLS) monitoring services installation.

.5 Identify each drawing in lower right hand corner in letters at least 12 mm (½ in) 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 surveyor attached to note.

.6 Submit one (1) set of white prints of the draft as-built Cad files for Consultants's review.

.7 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.

.8 Submit three (3) sets of white prints and three (3) copies of CAD files with Operating and Maintenance Manuals.

10.3 Operating and Maintenance Manuals

.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 Trade Section; Site services, Plumbing, Fire Protection, Heating and Cooling Plant and Distribution, Air Handling, and Controls and Instrumentation.

.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.

.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 Trade Section identified above, and apply Adobe Bookmarks to create Table of Contents.

.3 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 valves schedule and flow diagram,

.7 service piping identification charts.

.4 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.

.5 Approval procedure

.1 Submit one set of first draft of Operating and Maintenance Manuals for approval.

.2 Make corrections and resubmit as directed.

.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 copies of Operating and Maintenance Manuals to Owner's operating staff and obtain written confirmation of delivery.

10.4 Operating and Maintenance Instructions

.1 Provide instructions 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.

.2 Submit an outline of the training program for review, adjustment and approval by the Owner.

.3 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.

.4 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 session, separated by approximately one week each. Develp the proposed training plan and obain approval from the Owner before commencing training.

.5 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.

.6 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

.7 Keep record of date and duration of each instruction period together with names of persons attending. Submit signed records at completion of instruction.

.8 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 oprating conditions.

.9 Develop and provide training material, including printed documents and electronic presentation aids (eg. MS Powerpoint) for each session. Submit three (3) copies of materials in both hardcopy and electronic format, in accordance with article on Operating and Maintenance Manuals.

.10 Sessions may be videotaped by the Owner as an aid to ongoing training of Owners staff.

11 START-UP AND TESTING

11.1 Care, Operation and Start-up

.1 Arrange and pay for services of manufacturer's factory service technician to supervise start-up of installation, check, adjust, balance and calibrate components.

.2 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.

11.2 TESTING - **General**

.1 Methods to comply with following references:

(a) The Ontario Building Code

.2 Conduct tests, during progress of Work and at its completion to show equipment and systems meet contract. 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, the Inspection Authority and personnel witnessing tests.

.5 Conduct tests before application of external insulation and before any portion of pipes, ducts or equipment is concealed.

.6 Do not subject expansion joints, flexible pipe connections, meters, control valves, convertors, and fixtures, to test pressures, greater than 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.

.7 Should section of pipe or duct fail under test, replace faulty fittings or duct with new fittings, pipe or duct, repair and retest. Do not repair screwed joints by caulking nor welded joints by peening. Repeat tests until results are satisfactory.

.8 Where it is necessary to test portions of duct or piping system before system is complete, overlap successive tests so that no joint or section of duct or pipe is missed in testing.

.9 Upon completion of work and testing of same, submit logs to demonstrate that tests have been carried out satisfactorily. Repeat any tests if requested.

11.3 Testing - Potable Water Piping

.1 Test potable water systems with water or air as required by The Ontario Building Code, Part 7.

.2 For water service pipes 100mm (4") and larger, disinfect the pipe with chlorine from the street valve to the first shut-off valve inside the building. Provide testing laboratory certificate confirming water contaminates are below the threshold values in O.Reg. 248/06.

11.4 Testing - Ventilation

.1 Test low pressure ductwork with an air pressure of 1 Kpa (4 in wg for 10 minutes.

.2 Test medium pressure ductwork with an air pressure of 2 Kpa (8 in wg) for 10 minutes.

.3 Test high pressure ductwork with an air pressure of 3 Kpa (12 in wg) for 10 minutes.

.4 Examine construction joints for damage or weakening. Reduce pressure to maximum working pressure or 1 Kpa (4 in wg), whichever is larger, and check joints for audible leaks. Mark each leak and repair after pressure is released. Retest repaired section of duct.]

12 TEMPORARY AND TRIAL USAGE

12.1 General

.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 guarantee.

13 CONSULTANT REVIEWS

13.1 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 authourity have jurisdiction.

13.2 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.

13.3 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.

13.4 Final Review

.1 At project completion submit written request for final review of mechanical and electrical systems.

.1 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 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.

14 CORRECTION AFTER COMPLETION

14.1 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.

15 ATTACHEMENTS

15.1 Shop Drawing Submittal Form

.1 Attached sample of shop drawings submittal form.

HHAngus

1127 Leslie Street
Toronto, Ontario
M3C 2J6 Canada

T 416 443 8200
F 416 443 8290
hhangus.com

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: **[Client/Architect name]**

Project Name: **[Project name]**

HHA Project No: **[HHA Project No]**

Contract: **General**

Contractor to complete the following for each submission.

Date: _____

Contractor Name: _____ Ref No:_____

Manufacturer Name: _____

Product Type: _____

Specification Section No: _____

Contractor Trade:

☐ Mechanical ☐ Electrical ☐ Elevators ☐ General Trades

If this is a resubmission, check here: ☐

Previous submission HHA reference no.: _____

HHA distribution - for internal use only:	
Mechanical review:	[Mechanical designer name]
Electrical review:	[Electrical designer name]
Elevators review:	[Elevator designer name]

Document1

END OF SECTION

QUALIFICATIONS AND AUTHORITIES - ONTARIO
20 01 02

1 GENERAL

1.1 Scope

.1 Qualification requirements for tradesmen in the province of Ontario.

.2 Registration and inspection of systems.

2 QUALIFICATIONS

2.1 Trades Qualification and Apprenticeship Act

.1 Tradesmen to hold certification of applicable trades:

.1 Construction Millwright, O.Reg. 1048

.2 Electrician, O.Reg. 1051

.3 Plumber, O.Reg. 1073

.4 Sheet metal worker, O.Reg. 1077

.5 Sprinkler and fire protection installer, O.Reg. 1078

2.2 Technical Standards and Safety Authority Act 2000

.1 Manufacturers and installers of regulated pressure piping parts and systems regulated to hold certificates of authorization under *Boilers and Pressure Vessels* O.Reg. 220/01, for;

.1 pressure piping systems, CSA B51 Boiler, Pressure Vessel and Pressure Piping Code

.2 refrigeration piping systems, CSA B52 *Mechanical Refrigeration Code*

3 AUTHOURITIES, REGISTRATION AND INSPECTION

3.1 Ontario Building Code

.1 Submit and pay for building permit, and arrange and coordinate for inspections as required under the Ontario Building Code.

3.2 Technical Standards and Safety Authority

.1 Arrange, provide documentation, and pay for registration and inspection of the following systems:

.1 Boiler, pressure vessel and pressure piping

.2 Arrange, provide documentation, and pay for variance approvals and field inspections of the following systems:

.1 Fuel safety, gas and/or oil, where Variance approval is required.

END OF SECTION

BASIC MATERIALS AND METHODS
20 05 01

1 GENERAL

1.1 Scope

.1 Articles that are of a general nature, applicable to each Section of Division 20 [][and 26].

2 ACCESS DOORS

.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.

.2 Access is required at;

.1 dampers,

.2 fire dampers,

.3 air terminal units,

.4 isolation and control valves ,

.5 heating or cooling coils,

.6 control wiring junction boxes.

.3 Submit shop drawings showing access door size, type and location.

.4 Construction:

.1 constructed of steel, prime coated,.

.2 flush mounted with 180E opening door, round safety corners, concealed hinges, plaster lock and anchor straps

.3 600 mm x 600 mm (24 in x 24 in) for personnel entry,

.4 300 mm x 450 mm (12 in x 18 in) for hand entry, and

.5 constructed of stainless steel in areas finished with tile or marble surfaces

.6 constructed of stainless steel with neoprene gasketed door in damp and high humidity areas

.7 generally fitted with screwdriver operated latches, except in areas subject to security risks (Public Corridors, Psychiatric Patient Areas, Public Washrooms). In these areas doors to be fitted with keyed cylinder locks with similar keys.

Standard of Acceptance

- Baird - ABCO
- Stelpro - Type 700
- Williams Brothers - GP
- LeHage
- Acudor Acorn
- Mifab

.5 Installation:

.1 Supply access doors and make arrangements and pay for installation by Division in whose work they occur.

.2 Size and locate access doors in applied tile, block or in glazed or unglazed structural tile to suit joint patterns.

.3 Access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive tile insert.

.4 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.

.5 At time of instruction of owners operating staff, hand-over and obtain signed receipt for 4 sets of each type of key used to lock access doors in secure areas.

3 DIELECTRIC COUPLINGS

.1 Provide dielectric isolation between pipes of dissimilar metals with suitable couplings, insulating dielectric unions, 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.

.2 Insulating unions for pipe sizes NPS 2 and under

Standard of Acceptance
- Epco - Dielectric
- Watts

.3 Insulating flanges for pipe or tube from NPS 2 to NPS 4

Standard of Acceptance
- Watts No. 3100 or 3200

.4 Insulating gaskets for flanges NPS 5 and over:

.1 compatible with pressure and temperature service,

.2 flange bolts run in insulating sleeves with insulating washers under nuts.

4 SLEEVES

4.1 General

.1 Sleeve pipes, ducts and conduits passing through masonry walls, concrete floors, and fire rated gypsum board ceilings and partitions.

.2 Maintain fire rating integrity where pipes and ducts pass through fire rated walls, floors and partitions.

4.2 Floor and Wall Sleeves

.1 Sleeves in fire separations:

.1 sized to suit fire stopping methods employed for bare pipes, conduits, insulated pipes, and bare and insulated ducts without fire dampers, and

.2 sized to suit conditions of approval given in manufacturers installation instructions for fire and smoke dampers.

.2 Sleeves in other construction:

.1 sized to clear insulated pipes and ducts by 13 mm (2 in) all round, and

.2 sized to clear conduits, bare pipes, and bare ducts by 6 mm (3 in) all round.

.3 Sleeves for pipes, conduits and ducts smaller than 0.4 m5 (4 sq ft) through solid walls and floors:

.1 Schedule 40 steel pipe or 1 mm (20 ga) (minimum) sheet metal, lapped and spot welded.

.2 Sleeves for pipes, conduits and ducts smaller than 0.4 m5 (4 sq ft) through gypsum board partitions:

(a) 1 mm (20 ga) minimum sheet metal, lapped and spot welded with 20 mm (: in) lip flange at one and.

.4 Sleeves for ducts 0.4 m5 (4 sq ft) and larger through walls and floors:

.1 1.6 mm (16 ga) minimum sheet metal, lapped and spot welded with 20 mm (: in) lip flange at one end.

4.3 Waterproof sleeves

.1 Applications:

.1 where pipes and ducts pass through floors in areas subject to water, in mechanical rooms, in kitchens, in washing areas and in slabs over electric and telephone rooms.

.2 Waterproof sleeves for pipes and conduits:

.1 Schedule 40 pipe, with 75 mm (3 in) wide annular fin continuously welded at midpoint, hot dip galvanized after fabrication.

.3 Waterproof sleeves for ducts less than 0.4 m5 (4 sq ft):

.1 1 mm (20 ga) galvanized steel, with 40 mm (12 in) flange at midpoint.

.4 Waterproof sleeves for ducts 0.4 m5 (4 sq ft) and larger and openings with multiple ducts:

.1 1.6 mm (16 ga) galvanized steel, with 40 mm (12 in) flange at midpoint, or,

.2 form opening with wood (removed after concrete is set) and trim opening with welded steel angle frame 75 mm (3 in) high , bolted to slab and caulked, or,

.3 trim opening with 75 mm x 75 mm (3 in x 3 in) continuous concrete curb doweled to slab.

.5 Modifications for existing construction:

.1 annular fins and flanges attached to sleeve at point equivalent to surrounding floor level or curb.

4.4 Installation

.1 Place and secure sleeves in concrete form work.

.2 Supply sleeves to be set in concrete and masonry walls with installation detail drawings.

.3 Regular sleeves;

.1 terminate flush with surfaces of concrete and masonry walls.

.4 Waterproof sleeves in new construction;

.1 extend 75 mm (3 in) above finished floor.

.2 with flange embedded within concrete floor.

.5 Sleeves in existing concrete and masonry walls and floors;

.1 installed in neatly cut or drilled holes in existing construction,

.2 cutting and drilling of structural elements, such as floors, slabs, walls, columns, or beams to be carried out in accordance with procedure set out in Article ACutting and Patching@ below.

.3 terminate sleeves flush with surfaces of concrete and masonry walls,

.4 extend waterproof sleeves 75 mm (3 in) above finished floor with flange, countersunk, and bolted down flush into floor surface,

.5 fill opening between sleeve and wall or floor with 2 hour fire rated fire-stopping sealant with water barrier.

.6 Fill future-use sleeves with weak concrete, gypsum plaster or similar material.

.7 Coat exposed exterior surfaces of un-galvanized ferrous sleeves with heavy application of zinc rich paint

.8 At fire separations and smoke seperations, pack and seal void between sleeve and pipe, duct without fire damper, conduit, or insulation in accordance with Article "Fire Stopping and Smoke Seals" in this Section.

.9 At other locations, pack void between sleeve and pipe, conduit, duct or insulation for full depth of sleeve, with mineral wool and seal with silicone-free caulking compound.

.10 Install fire dampers in accordance with conditions of approval given in manufacturer's instructions.

5 FIRE STOPPING AND SMOKE SEALS

5.1 General

.1 Provide fire stopping and smoke seals where ducts, pipes or conduits penetrate fire separations. Materials to be supplied, worker training to be arranged, and installation to be supervised, by a specialist firm with an established reputation in this field.

.2 Fire stop materials to be impervious to water when installed in a horizontal separation, including waterproof service sleeves.

5.2 Products

.1 Materials to form ULC listed or cUL listed/classified assemblies.

Standard of Acceptance
- 3M
- Nelson Firestop Products
- Hilti Firestop Systems
- Eastern Wire + Conduit (Royal Quickstop)

.2 Other manufacturers having products with explicitly similar characteristics, listings or classifications and approvals are acceptable.

5.3 Installation

.1 Seal space between penetrating service and sleeve or opening in slab with firestop and smoke sealing system in strict accordance with terms and conditions of original ULC or cUL listing and manufacturers recommended procedures.

.2 Select thickness and arrangement of back-up materials to suit size of service, length of sleeve and anticipated movement.

.3 Select firestopping system to allow insulation and vapour barrier to pass un-broken through assembly.

.4 Surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint and foreign materials at time of application of materials

.5 Do not apply fire stopping materials to fire or smoke dampers.

6 WALL AND FLOOR PLATES

.1 Fit pipes passing through walls, floors and ceilings in finished areas with escutcheon, wall or floor plates.

.2 Plates:

.1 at floor; chrome plated two piece split type with hinge.

.2 at walls and ceilings; similar to floor plate but with set screw to fasten plate to pipe.

6.2 Installation

.1 Plates:

.1 sized to cover sleeves

.2 secured tight against finished surfaces, and

.3 fitted to cover sleeve extensions where sleeves extend above finished floor.

END OF SECTION

VALVES
20 05 23

1 GENERAL

1.1 Scope

.1 Provide valves in piping systems throughout project for shut-off service, manual balancing, and check-stops.

.2 Refer to relevant specification sections for specialty and control valves.

1.2 Applicable Codes and Standards

.1 Temperature and pressure ratings, material composition, and manufacturer's testing procedures conforming to latest specifications from:

.1 Manufacturers Standardization Society of Valve and Fittings Industry (MSS), and

.2 ASTM A216 Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service, or

.3 British Standards Institution (BSI) Kitemarks, or

.4 supplied by manufacturer operating with ISO 9001 certification.

.2 Valves subject to registration in pressure piping service to have current Canadian Registration Numbers (CRN) in accordance with:

.1 TSSA Act, O.Reg. 220/01][local boiler inspection authority,

.2 CSA B51 Boiler, Pressure Vessel, and Piping Code.

1.3 Quality and Equivalence

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

.2 Companies, and/or trade names listed below are acceptable for various valve types, where products offered are essentially similar to those identified by manufacturer or model number under “Standard of Acceptance” designation.

.1 Specific duty valves are specified in each piping service article.

.2 for gate, globe, angle, and check valves

Standard of Acceptance

- Kitz
- Crane
- Newman Hattersley
- Jenkins
- Bonney Forge
- Dahl Bros
- Neo Valves
- Nibco
- Trueline
- Toyo Valves (Red &White)
- S.A. Armstrong
- Velan

- Watts
- A-Chem Valves & Controls

.3 for double regulating valves

- S.A. Armstrong
- Tour & Anderson
- Preso
- Newman Hattersley

.4 for silent check valves

Standard of Acceptance

- Valmatic
- APCO
- Durabla
- Nibco
- Mueller

.5 for butterfly valves

Standard of Acceptance

- Crane Centreline
- Crane Flowseal
- Kitz
- Mueller
- Crane
- Keystone
- Demco
- Newman Hattersley
- Grinnell
- DeZurik
- Apollo
- Milwaukee Valve
- Bray
- Jenkins
- Nibco
- Watts
- Challenger
- Velan
- A-Chem Valves & Controls
- Sure Seal

.6 for plug valves (with CGA approval when used in gas service)

Standard of Acceptance

- Mueller
- Nordstrom
- Newman Hattersley

.7 for ball valves

Standard of Acceptance

- American Valve
- Kitz
- Crane
- Newman Hattersley

- Jenkins
- Apollo
- Dahl Bros
- Neo Valves
- Milwaukee Valve
- Nibco
- Canadian Worcester Controls
- Toyo Valve (Red&White)
- Watts
- Velan
- A-Chem Valves & Controls
- Trueline

.8 for grooved piping valve products

Standard of Acceptance

- Victaulic
- Nibco
- Gruvlok
- Couplox
- Mueller
- Shurjoint

2 PRODUCTS

2.1 Selection criteria

.1 Valves to be line size, selected as follows

.1 for shut-off or isolating service, valves to be

(a) Gate
(b) Butterfly
(c) Ball or
(d) Plug

.2 for flow balancing and shut-off service valves to be

(a) Double regulating, or
(b) Plug and
(c) to incorporate adjustable limit stops.

.3 at discharge of pumps check valves to be silent or spring assisted or combination check and flow control valves.

.2 On mains and risers, drain valves to be selected as follows

.1 On mains NPS 4 and under

(a) NPS ¾ brass threaded ball valve of appropriate pressure rating with hose thread, cap and chain.

.2 On mains NPS 5 and over

(a) NPS 1 brass threaded ball valve of appropriate pressure rating with hose thread, cap and chain.

.3 Gate valves NPS 2 and under, soldered

.1 1000 kPa (150 psi),to MSS SP-80, Class 150,bronze body, solid wedge bronze disc, rising stem, screw in, or union bonnet.

Standard of Acceptance
- Kitz 43
- Crane 1334
- Jenkins 813J
- Newman Hattersley T608 with NPT to copper adapters
- Nibco S-131

.4 Gate valves NPS 2 and under, threaded

.1 1000 kPa (150 psi), to MSS SP-80, Class 150, bronze body, solid wedge disc, rising stem, screw in, or union bonnet.

Standard of Acceptance
- Kitz 42
- Crane 431
- Jenkins 281OJ
- Newman Hattersley T608
- Nibco T-131

.2 1000 kPa (150 psi) to 2000 kPa (300 psi), to MSS SP-80,Class 300, bronze body, solid wedge disc, rising stem, union or screw in bonnet.

Standard of Acceptance
- Kitz 37
- Crane 634E
- Jenkins 228OUJ
- Newman Hattersley #C1174
- Nibco T-174A

.5 Gate valves NPS 2½ and over flanged

.1 850 kPa (125 psi), to MSS SP-70,Class 125, cast iron body with flat faced flange, bronze or bronze faced solid wedge disc with bronze seat rings, rising stem, OS & Y, bolted bonnet.

Standard of Acceptance
- Kitz 72
- Crane 465 ½
- Jenkins 454J
- Newman Hattersley #504
- Nibco F-617-O

.2 1000 kPa (150 psi), to ASTM A216 grade WCB, Class 150, cast steel body with raised faced flange, flexible Type 416 stainless steel disc and hard faced seat rings, rising stem, OS & Y, bolted bonnet.

Standard of Acceptance
- Kitz 150 SCLS
- Crane 47XUT
- Jenkins J1009B8F
- Newman Hattersley #C1481

.3 1000 kPa (150 psi) to 2000 kPa (300 psi), to ASTM A216 grade WCB, Class 300, cast steel body with raised faced flange, flexible Type 416 stainless steel disc and hard faced seat rings, rising stem, OS & Y, bolted bonnet.

Standard of Acceptance
- Kitz 300 SCLS

- Crane 33½ XU-F
- Newman Hattersley #C1482

.6 Globe valves NPS 2 and under, soldered

.1 850 kPa (125 psi),to MSS SP-80, 300 CWP, bronze body, renewable composition PTFE disc, threaded over bonnet., lock shield handles as indicated.

Standard of Acceptance
- Kitz 10
- Crane 1334/1320
- Jenkins 813J
- Newman Hattersley 13 with NPT copper adaptors
- Nibco S-235-Y

.7 Globe valves NPS 2 and under, threaded

.1 1000 kPa (150 psi),to MSS SP-80, Class 150, bronze body, renewable composition PTFE disc, union bonnet, lock shield handles as indicated.

Standard of Acceptance
- Kitz 09
- Crane7TF
- Jenkins 106BJ
- Newman Hattersley 13
- Nibco T-235-Y

.8 Butterfly valves NPS 2 to NPS 12, flanged

.1 1378 kPa (200 psi) to MSS-SP-67, cast iron lug body style with holes drilled and tapped for ANSI 125/150 flange pattern;

(a) 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.
(b) ANSI 150 temperature and pressure rating and suitable for working pressures up to 1378 kPa (200 psi) at 100°C (212°F), factory tested to minimum of 2067 kPa (300 Psi) at 37.8EC (100EF)
(c) with locking handles up to NPS 4 and gear operators for NPS 6 and over.

Standard of Acceptance
- Crane Center Line - Series 200
- Kitz - 6122E
- Colton - CILB Series
- Nibco LC-2000
- Challenger #20CN4E
- DeZurik BOS
- Watts BF
- SureSeal 600

.2 1720 kPa (250 psi) to MSS-SP-67, cast iron lug body style with holes drilled and tapped for ANSI 125/150 flange pattern;

(a) stainless steel shaft, aluminum bronze or T316 stainless steel 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.

(b) ANSI 150 temperature and pressure rated and suitable for working pressures up to 1720 kPa (250 psi) at 37.8EC (100EF), factory tested to minimum of 2067 kPa (300 Psi) at 37.8EC (100EF).
(c) with locking handles up to NPS 4 and gear operators for NPS 6 and over.

Standard of Acceptance
- Crane Center Line – Series 225
- Kitz – 6123E
- Nibco – LD-3010

.3 High performance type for working pressures up to 4800 kPa (740 psi), ANSI B16.34 temperature and pressure rated carbon steel lug body with holes drilled and tapped for ANSI Class 300 flange pattern.

(a) 316 or 17-4 stainless steel disc and shaft, Teflon 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.
(b) with locking handles up to NPS 4 and gear operators for NPS 6 and over.
(c) ANSI 300 temperature and pressure rated and suitable for working pressures up to 4823 kPa (740 psi) at 37.8EC (100EF), factory tested to minimum of 4823 kPa (740 psi) at 37.8EC (100EF)

Standard of Acceptance
- Crane Flowseal
- DeZurik BHP Series
- Keystone K-Lok Series
- Mueller
- SureSeal

.9 Butterfly valves NPS 2 to NPS 12, for roll grooved piping

.1 2000 kPa (300 psi), Class 300, Iron body, grade E dual seal disc, with lever handle up to NPS 3 and gear operators NPS 4 and up.

.2 Suitable for mounting motorized control actuators.

Standard of Acceptance
- Victaulic - Vic 300 Master seal for steel pipe
- Gruvlok - 7700 for steel pipe
- Nibco GD-4765 for steel pipe
- Victaulic - Vic 608 for copper pipe
- Gruvlok - 7721 for copper pipe
- Mueller - 59G

.10 Butterfly valves NPS 14 to NPS 24, for roll grooved piping

.1 1200 kPa (175 psi), Class 175, Iron body, grade E dual seal disc, with gear operator.

Standard of Acceptance
- Victaulic - Vic 709, Series W709 AGS

.11 Swing check valves NPS 2 and under, soldered

.1 850 kPa (125 psi),to MSS SP-80, bronze body, bronze swing disc, regrindable seat, screw-in cap,

Standard of Acceptance
- Kitz 23

- Crane 1342
- Jenkins4093J
- Newman Hattersley 47 with NPT copper adaptors
- Nibco S-413

.12 Swing check valves NPS 2 and under, threaded

.1 850 kPa (125 psi), to MSS SP-80, Class 125, bronze body, bronze swing disc, regrindable seat, screw-in cap

Standard of Acceptance
- Kitz 22
- Crane 37
- Jenkins 4073J
- Newman Hattersley 47
- Nibco T-413

.13 Swing checks NPS 2 ½ and over, flanged

.1 850 kPa (125 psi), to MSS SP-71, Class 125, cast iron body with flat faced flange, renewable bronze seat rings, bronze faced iron or bronze disc, bolted cap.

Standard of Acceptance
- Kitz 78
- Crane 373
- Jenkins 587J
- Newman Hattersley 651
- Nibco F-918

.14 Swing check valves NPS 2 and over, grooved:

.1 2065 kPa (300 psig), ductile iron body with spring-assisted disc.

Standard of Acceptance
- Victaulic series 719, NPS 2 ½ to 4
- Victaulic series 779, NPS 4 to 14

.15 Ball valves up to NPS 2:

.1 1000 kPa (150 psi), two piece bronze body and chrome plated bronze ball, PTFE seat rings, solder joint or NPT to copper adapters, full port.

.2 handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.

Standard of Acceptance
- Kitz 59(soldered)
- Kitz 58 (threaded)
- Crane 9322 (soldered)
- Crane 9302 (threaded)
- Jenkins 202J (soldered)
- Jenkins 201J (threaded)
- Newman Hattersley 1999 (soldered)
- Newman Hattersley 1969F (threaded)
- Nibco S-FP-600 (soldered)
- Nibco T-FP-600 (threaded)
- Victaulic 722 (threaded)
- Anvil Fig 171N (threaded)

.16 Double regulating valves (DRV), NPS 2 and under, threaded

.1 1000 kPa (150 psi) Copper alloy body, plug type stem with flow measurement ports and tamper-proof setting.

Standard of Acceptance

- S.A. Armstong CBV
- Tour & Anderson STAD
- Newman Hattersley #1700
- Preso B-PLUS

.17 Double regulating valves (DRV), NPS 2½ and over, flanged

.1 860 psi (125 psi), cast or ductile iron body, raised face flanges, copper alloy trim, with flow measurement ports, tamper-proof setting.

Standard of Acceptance

- S.A. Armstrong CBV II
- Tour & Anderson series 787
- Newman Hattersley #737
- Preso B-PLUS

END OF SECTION

HANGERS AND SUPPORTS
20 05 29

1 GENERAL

1.1 Scope

.1 Provide hangers and supports for piping and conduits.

1.3 Related Work

.1 Ductwork hangers: to section 23 31 13

1.4 Shop drawings

.1 Product data to show:
- .1 upper attachment.
- .2 hanger rods.
- .3 pipe attachment.
- .4 riser clamps.
- .5 shields and saddles.
- .6 inserts.

.2 Submit details for supports, guides, and anchors for glass, fibre-reinforced plastic, and plastic piping systems.

.3 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.

1.5 Applicable Codes and Standards;

.1 ASME B31.9 Building Service Piping

.2 Manufacturers Standardization Society of Valve and Fittings Industry (MSS)
- .1 MSS SP-58 Pipe Hangers and Supports - Materials Design and Manufacture
- .2 MSS SP-69 Pipe Hangers and Supports - Selection and Application
- .3 MSS SP-77 Guidelines for Pipe Support Contractual Relationships
- .4 MSS SP-90 Guidelines for Terminology for Pipe Hangers and Supports

.3 The Ontario Building Code

2 PRODUCTS

2.1 General

.1 Hangers, supports, sway braces, to be made up from stock or production parts, manufactured and fabricated in accordance with ASME B31.1 and MSS SP-58, SP-69, and SP-90.

.2 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, by change of momentum in fluid flow.

2.2 Product identification

.1 Pipe support products to be selected from manufacturers standard product line

Standard of Acceptance
- Anvil
- Unistrut
- Myatt
- Hunt Erico
- Taylor
- National Concrete Accessories - Acrow Richmond
- Pipe Shields
- Portable Pipe Hangers
- Hilti

.2 Model designations from these manufacturer's catalogue are used to establish quality standards and construction details to permit assessment of products from other manufacturers.

2.3 Upper attachments

.1 Cast-in-place concrete:

.1 single or double pipe runs up to and including 300 mm (12 in) diameter:

(a) galvanized wedge inserts to MSS SP-58, type 18.
(b) ULC listed for pipe NPS ¾ through NPS 8.

Standard of Acceptance
- Anvil - Model 281
- Unistrut - Model P-3245

.2 pipe runs of three or more pipes:

(a) multiple inserts, spaced to suit smallest pipe in group.

Standard of Acceptance
- Unistrut of Canada Limited

.2 Surface mount on concrete:

.1 carbon steel plate with clevis and malleable iron socket and expansion case and bolt with minimum of two expansion cases and bolts for each hanger.

Standard of Acceptance
- Anvil plate, Fig. 49 socket, Fig. 290 expansion case, Fig. 117

- Myatt cut plate, double angle clip, Fig. 535 socket, Fig. 480 expansion case, Fig. 485[][for existing concrete

.2 Do not use explosive drive pins in any section of Work without obtaining prior approval.

.3 Piping or equipment supported from existing concrete construction:

.1 drill and install threaded inserts.

Standard of Acceptance
- Hilti - HDI, Kwick Bolt, HSL

.4 Steel framed construction:

.1 steel beam (bottom flange) and cold piping NPS 2 and under:

(a) beam clamp to MSS SP-58, type 30, ULC listed.

Standard of Acceptance
- Anvil Fig. 218
- Myatt Fig. 500

.2 steel beam (bottom flange) and cold piping NPS 2½ and larger and hot piping:

(a) heavy beam clamp assembly to MSS SP-58, type 28 or 29, or
(b) fabricated equivalent, ULC listed.

Standard of Acceptance
- Anvil Fig. 228 or 292
- Myatt Fig. 510 X-HEAVY, or 511 X-HEAVY.

.3 steel beam (top flange) and cold piping and hot piping NPS 2 and under:

(a) steel jaw, hook rod with nut, spring washer and plain washer, to MSS SP-58, type 25, ULC listed.

Standard of Acceptance
- Anvil Fig. 227
- Myatt Fig. 506

.4 steel joists and cold piping NPS 2 and under:

(a) steel washer plate with double locking nuts.

Standard of Acceptance
- Anvil Fig. 60
- Myatt Fig. 545

.5 steel joists and cold piping NPS 2½ and larger and hot piping:

(a) steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.

Standard of Acceptance
- Anvil washer plate - Fig. 60, clevis - Fig. 66, socket - Fig. 290.
- Myatt washer plate - Fig. 545, clevis - Fig. 530, socket - Fig. 480.

2.4 Hanger rod

.1 Carbon steel threaded rod;

.1 electro-galvanized finish in mechanical rooms and outdoors.

.2 black steel finish in other areas.

Standard of Acceptance
- Anvil Fig. 146
- Myatt Fig. 432

2.5 Horizontal pipe support - suspended

.1 Hot or cold suspended piping, including conduits, where horizontal movement is 25 mm (1 in) or less and hanger rod is longer than 300 mm (12 in).

.1 steel or cast iron piping:

(a) adjustable clevis to MSS SP-58, type 1, ULC listed, sized for outside dimension of pipe and insulation.

Standard of Acceptance
- Anvil Fig. 260
- Myatt Fig. 124
-

(b) opening clevis, ULC listed, sized for outside dimension of pipe and insulation.

Standard of Acceptance
- Hilti SLC Speed Lock]

.2 copper piping:

(a) adjustable clevis to MSS SP-58, type 1, copper plated.

Standard of Acceptance
- Anvil Fig CT-65
- Myatt 151 CT

.2 Suspended hot steel or copper piping having horizontal movement in excess of 25 mm (1 in) or hot steel piping with hanger rod 300 mm (12 in) or less:

.1 trapeze or yoke style pipe roller to MSS SP-58, type 43.

Standard of Acceptance
- Anvil Fig. 171 or fig. 181
- Myatt Fig. 261 or fig. 258

2.6 Horizontal pipe support - bottom supported

.1 Hot and cold steel and copper piping:

.1 adjustable pipe roller stand to MSS SP-58, type 44.

Standard of Acceptance
- Anvil Fig. 177
- Myatt Fig. 262

2.7 Vertical pipe supports:

.1 Steel or cast iron pipe:

.1 floor supported,[black][galvanized] carbon steel riser clamps to MSS SP-58, type 42, ULC listed, field-welded pipe lugs.

Standard of Acceptance

- Anvil Fig. 261
- Myatt Fig. 182 or 183

.2 suspended, [black][galvanized] carbon steel riser clamps to MSS SP-58, type 42, ULC listed, 4 or 6 bolt pattern, field-welded pipe lugs.

Standard of Acceptance
- Anvil fig. 40
- Myatt fig. 190 or 191

.2 Copper pipe:

.1 carbon steel, copper finished, riser clamps to MSS SP-58, type 8.

Standard of Acceptance
- Anvil Fig. CT-121
- Myatt Fig. 150CT

2.8 Variable load supports

.1 Performance:

.1 Selected for piping loads and estimated travel under service conditions.

.2 Construction:

.1 carbon steel housing and spring,

.2 precommressed spring,

.3 load indicator,

.4 welding to ASME Section IX

.5 welded attachement points

.6 finish: semi gloss primer coat.

Standard of Acceptance
- Anvil – Fig 82, 268, 98

2.9 Constant load supports

.1 Performance:

.1 maintains constant support load under variable hanger displacements.

.2 selected for piping loads and estimated travel under service conditions, with a minimum safety factor of 25 mm (1 in) extra travel or 20% of total travel, whichever is greater.

.2 Construction:

.1 to WW-H-171E, ANSI/MSS SP-69 and 58

.2 carbon steel housing and spring,

.3 combination hanger moment arm and balancing spring design,

.4 horizontal and vertical arrangements,

.5 load adjustment and load indicator scale,

.6 factory set for load and travel,

.7 welding to ASME Section IX

.8 welded attachement points

.9 finish: semi gloss primer coat.

Standard of Acceptance
- Anvil – Fig R 80-V, 81-H

2.10 Roding for mechanical joint pipe

.1 Plain end cast iron and asbestos cement drain waste and vent pipe, NPS 5 and over,

.1 bell clamps and rodding at each joint

Standard of Acceptance
- Myatt Fig. 175 in configuration Fig. 176
- Anvil Fig. 595 with Fig. 594 washers
- Taylor Fig. 35

.2 bell clamp and rodding at each tee branch
- Myatt Fig. 175 in configuration Fig. 180
- Anvil Fig. 595 with Fig. 594 washers
- Taylor Fig. 35

2.11 Saddles and shields at pipe supports

.1 Cold piping insulation shields:

.1 provided for steel, copper, stainless, glass and plastic piping, all sizes,

.2 galvanized steel protection shield.

Standard of Acceptance
- Anvil Fig. 167 (up to NPS 24)
- Anvil Fig. 168 - Riblok (up to NPS 8)
- Myatt Fig. 251

.2 Hot piping insulation shields:

.1 provided for steel piping NPS 1-1/4 and smaller,

.2 provided for copper tubing, all sizes,

.3 galvanized steel protection shield.

Standard of Acceptance
- Anvil Fig. 167 (up to NPS 24)
- Anvil Fig. 168 - Riblok (up to NPS 8)
- Myatt Fig. 251

.3 Hot piping saddles:

.1 provided for steel piping, NPS 1½ and larger:

.2 protective saddle welded to pipe with insulation inserted between saddle and pipe.

Standard of Acceptance
- Anvil Fig. 160 to 166
- Myatt Fig. 210 to 240

3 EXECUTION

3.1 Coordination with concrete work

.1 Supply and deliver inserts to site in ample time to be built into work.

.2 Set and correctly locate inserts for pipes and equipment hangers. Secure inserts firmly to formwork before concrete is poured.

3.2 Hanger installation

.1 Support piping and conduit directly from or on structural building elements. Do not support pipe or conduit directly from other services except as described below.

.2 The hanger rod size and spacing in the following articles is based on supporting a single pipe directly from the structure.

.1 If multi-level pipe or conduit supports are proposed, such as trapeze or roller hanger supports, submit shop drawings designed and sealed by a professional engineer licensed as a consulting engineer in the province of the project location and include details for each support system including load calculations.

.2 Coordinate with the structural engineer for point load connections to the building structure.

.3 Install hangers for steel pipe with spacing and hanger rod diameter in accordance with table 1.

.1 Exception: fuel oil, natural gas, propane, and medical gas piping.

.4 Install hangers for copper pipe with spacing and hanger rod diameter in accordance with table 2.

.1 Exception: fuel oil, natural gas, propane, and medical gas piping.

.5 Install hangers for cast iron soil pipe with hanger spacing and hanger rod diameter in accordance with table 3 and as follows:

.1 provide at least one pipe hanger for each length of pipe, located at or within 300 mm (12 in) of each hub or mechanical joint,

.2 provide a hanger at or adjacent to each fitting hub or mechanical joint except where multiple joints occur within a 1200 mm (4 ft) developed pipe length then;

(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, a 1.6 mm (16 ga) galvanized steel half sleeve may be used underneath the pipe and fittings and supported with a hanger at each end of the sleeve.

.3 for mechanical joints, if the spacing between adjacent joints is 300 mm (12 in) or less, reduce the support spacing to a maximum of 1000 mm (39 in),

Table 1 : Hanger Spacing for Steel Piping

Pipe Size NPS	Rod Diameter	Maximum Spacing
½	10 mm (3/8 in)	1.8 m (6 ft)
3/4 to 1¼	10 mm (3/8 in)	2.1 m (7 ft)
1½	10 mm (3/8 in)	2.7 m (9 ft)
2	10 mm (3/8 in)	3.0 m (10 ft)
2½	13 mm (½ in)	3.3 m (11 ft)
3	13 mm (½ in)	3.3 m (12 ft)
4	16 mm (5/8 in)	4.2 m (14 ft)
6	16 mm (3/4 in)	5.1 m (17 ft)
8	22 mm (3/4 in)	5.7 m (19 ft)
10	22 mm (7/8 in)	6.7 m (22 ft)
12	22 mm (7/8 in)	7.0 m (23 ft)
14	25 mm (1 in)	7.5 m (25 ft)
16	25 mm (1 in)	8.0 m (27 ft)
18	25 mm (1 in)	8.4 m (28 ft)
20	30 mm (1-1/4 in)	9.0 m (30 ft)
24	30 mm (1-1/4 in)	9.6 m (32 ft)

Table 2 : Hanger Spacing for Copper Piping

Pipe Size NPS	Rod Diameter	Maximum Spacing (Copper)
½	10 mm (3/8 in)	1.5 m (5 ft)
3/4 to 1¼	10 mm (3/8 in)	1.8 m (6 ft)
1½	10 mm (3/8 in)	2.4 m (8 ft)
2	10 mm (3/8 in)	2.7 m (9 ft)
2½	13 mm (½ in)	3.0 m (10 ft)
3	13 mm (½ in)	3.0 m (10 ft)
4	16 mm (5/8 in)	3.0 m (10 ft)

Table 3: Hanger Spacing for Cast Iron Soil Piping

Pipe Size NPS	Rod Diameter	Maximum Spacing (CI soil pipe)
3	13 mm (½ in)	3 m (9.8 ft)
4	16 mm (5/8 in)	3 m (9.8 ft)
6	16 mm (3/4 in)	3 m (9.8 ft)
8	22 mm (3/4 in)	3 m (9.8 ft)
10	22 mm (7/8 in)	3 m (9.8 ft}

.6 Hanger spacing and hanger rod diameter for steel or copper flexible joint roll groove pipe to be as shown in table above for appropriate pipe material with not less than one hanger between joints and with anchors and guides located to maintain piping true to line and grade.

.7 In steel framed construction, support piping from structural members. Where structural members are not suitably located for upper hanger attachments and inserts of adequate capacity can not be installed in floor slabs over, 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,

.3 mechanically fasten supplementary steel to structural steel.

.8 Offset hangers so that rods are vertical in operating position.

.9 Provide hanger within 300 mm (12 in) of each horizontal elbow and tee.

.10 Riser clamps:

.1 Weld lugs onto steel piping.

.2 Solder copper pipe to copper riser clamps.

3.3 Variable load supports

.1 Size, select and install variable load supports for piping in mechanical rooms at first three load points from a shaft penetration.

3.4 Constant load supports

.1 Size, select and install constant load supports at the following locations;

.1 pipe risers, located at the top of the riser, and intermediate riser locations,

3.5 Saddles and shields

.1 On cold insulated piping, provide insulation shields between insulation and pipe support.

.2 On hot insulated piping, weld protective saddles to pipe at pipe support locations.

.3 No saddles or shields are required on un-insulated piping.

3.6 Load nut retention requirements

.1 Adhere fastening nuts, including top and bottom load nuts, and clevis bolt nuts, to threaded rods or fittings with Loctite 266.

3.7 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.

END OF SECTION

DUCTWORK INSULATION
20 07 16

1 GENERAL

1.1 Scope

.1 Insulate and finish ducts, casing, and plenums;

.1 provide insulation, sealer coatings, finishes, and mechanical protection.

.2 insulation is not required on factory insulated and/or and acoustically lined ductwork except as otherwise shown.

1.2 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.

1.3 Qualifications

.1 Provide insulation and covering by recognized specialist applicator with an established reputation for this type of work.

Standard of Acceptance
- Custom Insulation Systems
- Guaranteed Insulation Ltd
- White & Greer Co Ltd
- Dewpoint Insulation Systems

1.4 Material test criteria

.1 Insulation, adhesives, coatings, finishes, sealers, and tapes:

.1 maximum flame spread rating of 25 to CAN/ULC-S102,

.2 maximum smoke developed rating of 50 to CAN/ULC-S102.

.3 Exception: vapor barrier mastics installed outside of building.

1.5 Applicable codes and standards

.1 Material and method of application to comply with or be tested in accordance with following Standards;

.1 Thermal Insulation Association of Canada (TIAC) National Insulation Standard, excluding section 12

.2 NFPA 90-A Installation of Air-Conditioning and Ventilating Systems

.3 ASHRAE/IES 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings

.4 NFPA 255 Test of Surface Burning Characteristics of Building Materials

.5 CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering, and Miscellaneous Materials and Assemblies

.6 ASTM C411 Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation

.7 ASTM C518 Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flo Meter Apparatus

.8 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

.9 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

.10 ASTM C552 Standard Specification for Cellular Glass Thermal Insulation

.11 ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

.12 ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation

.13 ASTM C1126 (Gr.1) Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation

.14 CGSB 51-GP-52MA Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation.

.15 CGSB 51.53-95 Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels and Round Ducts.

1.6 Definitions

.1 In this Section;

.1 “**Ambient”** : as applied to temperatures means outdoor design temperature.

.2 "**Concealed**" : as applied to mechanical services and equipment located in space above opaque suspended ceilings, and within trenches not in boiler rooms, pipe and/or duct shafts, and non-accessible chases and furred spaces.

.3 “**Ductwork”** as applied to this section includes ducts, fans, supply unit casings, and plenums.

.4 "**Exposed"** : as applied to remainder of mechanical services and equipment which are not "concealed" as defined above. For greater certainty, the following locations are Exposed:

(a) Services in tunnels,
(b) Services in space beneath raised floors,
(c) Trenches located in boiler rooms,
(d) Outdoors.

.5 “**Conditioned air**” : air supplied from air handling units which heats, cools, dehumidifies, or humidifies the air.

.6 “**Unconditioned space**” : rooms or spaces that are not supplied with conditioned air, including ceiling spaces which are not part of a ceiling return plenum system

.7 “**Outdoor**” : mechanical services and equipment located outside of the building envelope including services located beneath overhangs and soffits, and exposed to any outdoor condition including temperature, sun exposure, or precipitation.

.8 “**Mastic**” : heavy-consistency waterproof compound for outdoor applications used in conjunction with reinforcing fabric, that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish to insulation.

.9 “**Coating**” : light-consistency compound for indoor applications used in conjunction with reinforcing fabric, to provide either a breathable or vapour barrier finish to insulation.

.10 **“Finish Jacket”** : final finish protective layer for insulation, including lagging fabric, PVC, metal, and adhesive films; that provides weather-protective finish depending on application.

.11 “**Service temperature”** : for purpose of ductwork temperature, is equal to the design operating temperature.

2 PRODUCTS

2.1 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 - No. 220-05
- Foster – Drion 85-75

.2 Adhesive for flexible closed cell foam insulation:

.1 Volatile Organic Content: maximum 80 g/L.

Standard of Acceptance
- Armaflex 520BLV
- Armaflex Low VOC Spray Contact Adhesive
- Rubatex R-373

.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 220-05
- Childers CHIL-STIX FRN CP-82

.4 Fibrous insulation adhesive:

.1 Volatile Organic Content: maximum 250 g/L.

Standard of Acceptance
- Childers CHIL-STIX FRN CP-82
- Foster No. 85-70

.5 Vapour barrier tape:

.1 colour matched and foil faced

.2 UL 181A listed.

Standard of Acceptance
- Johns Manville - Zeston Z-Tape
- MacTac Canada Limited - Vinyl Scrim or Foil Scrim Kraft
- Compac Corp.
- Fattal Canvas Inc. - Insultape

.6 Weld Pins, Studs and Clips

Standard of Acceptance
- Midwest Fasteners
- Continental 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 jackets (outdoor use only)

.1 fast-drying, aluminum colour finish, flexible butyl elastomer based vapour barrier sealant.

Standard of Acceptance.
° Foster 95-44

2.2 Coatings and Membranes

.1 Reinforcing Membrane:

.1 synthetic fibre:

(a) Leno weave,
(b) indoor and outdoor use.

Standard of Acceptance
° Foster Mast-A-Fab

.2 glass-fibre fabric:

(a) indoor use.

Standard of Acceptance
° Childers Chil-Glas #5/#10

.3 glass-fibre fabric for use with elastomeric closed cell foam:

(a) indoor use.

Standard of Acceptance
° Childers 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 CP-50A HV2
° Foster 30-36

Standard of Acceptance
° Childers Vi-Cryl CP-10/11
° Foster 35-00 / 45-00
° Bakor 120-10

.3 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,

.3

(a) permeance rating 0.02 perms maximum,
(b) white in colour

Standard of Acceptance
- Childers Chil Perm CP-34/35
- Foster 30-80, 30-90

.4 for use with elastomeric closed cell foam.

Standard of Acceptance
- Childers CHIL-SPRAY WB CP-56 Adhesive

2.3 Field Applied Finishes

.1 Fabric finish jacket:

.1 ULC listed plain weave cotton fabric at 220 g/m2 (6 oz/sq yd), treated with fire retardant lagging adhesive, or

.2 re-wetable fiberglass lagging fabric with water activated self-adhesive.

.3 suitable for field painting.

Standard of Acceptance
- Fattal's Thermocanvas
- Alpha-Maritex 3451-RW
- Clairmont Diplag 60
- Glass-Cell FR
- Newtex - Zetex Rewettable

2.4 Ductwork Insulation

.1 Type D-1 glass fibre blanket:

.1 to ASTM C1290

.2 service temperature: up to 121°C (250 F)

.3 flexible blanket,

.4 FSK jacket of kraft bonded to aluminum foil reinforced with glass fibre yarn, maximum 0.02 perms to ASTM E96 Procedure A.

.5 noncombustible,

.6 thermal performance: R = 0.74 m^2 °C/W @ 24 C (4.2 btu ft^2 F /Btu @ 75 F)

.7 density: 12 kg/m^3 (0.75 pcf)

.8 vapor transmission : maximum 0.02 perms

Standard of Acceptance
- John Manville Microlite XG Duct Wrap
- Owens Corning SOFTR Duct Wrap
- Knauf Fibreglass Friendly Feel Duct Wrap

.2 Type D-2 glass fibre board :

.1 to ASTM C612,

.2 service temperature: up to jacket surface temperature (air contact) up to 66 C (150 F) and un-jacketed surface temperature (equipment contact) up to 232 C (450 F).

.3 rigid for flat surfaces or,

.4 scored board for curved surfaces 250 mm (10 in) dia and over,

.5 jacket of kraft bonded to aluminum foil reinforced with glass fibre yarn,

.6 thermal performance: 0.033 W/m/C @ 24 C (0.23 btu/hr/in/sq ft/F @ 75 F),

.7 vapor transmission: maximum 0.02 perms

.8 density: 48 kg/m3 (3.0 lb/cu ft),

.9 suitable for jacket surface temperature (air contact) up to 66 C (150 F) and un-jacketed surface temperature (equipment contact) up to 232 C (450 F).

Standard of Acceptance
- Johns Manville - Manville 814 Spin-Glas
- Owens Corning - 703 Board
- Knauf Fiberglass - Insulating Board

.3 Type D-3 flexible elastomeric closed cell foam:

.1 to ASTM C534,

.2 service temperature: up to 82 C (180 F).

.3 sheet self-adhering, roll type,

.4 thermal performance: 0.04 W/m/C @ 24 C (0.28 btu/hr/in/sq ft/F @ 75 F),

.5 manufacturer specific sealer/adhesive.

Standard of Acceptance
- Armstrong - AP Armaflex Self-Adhering Sheet Insulation
- Rubatex

.4 Type D-4 low temperature phenolic board:

.1 to ASTM C1126 (Gr.1),

.2 service temperature: -73ºC to+121 ºC (-100ºF to 250ºF).

.3 rigid for flat surfaces,

.4 meeting 25/50 flame spread/smoke development when tested to ASTM E84,

.5 thermal performance: 0.021 W/m/Cº@ 10ºC (0.145 btu/hr/in/sq ftº @ 50ºF),

.6 density: 37 kg/m3 (2.3 Ib/cuft),

Standard of Acceptance
- Kingspan - Koolphen K

3 EXECUTION

3.1 Insulation Limits

.1 Externally insulate air handling system components:

.1 Conditioned air with cooling coils : supply unit casings and plenums, and free standing supply fans for both recirculating and non recirculating type systems,

.2 Conditioned air with heating only: supply unit casing and plenums, free-standing supply fans, and supply air ducts and plenums up to the space served but not in the space itself,

.3 Conditioned air supply ducts including downstream of reheat coils,

.4 un-conditioned supply air ducts and plenums that pass through unheated rooms or spaces,

.5 the first 300 mm (12 in) length of acoustically lined ductwork,

.6 return air ducts and plenums in unheated spaces,

.7 exhaust air ducts and plenums in unheated spaces,

.8 exhaust air ducts between exhaust air damper and point of discharge to outside of building,

.9 outside air intake ducts and plenums;

(a) for non-recirculating type ventilation systems without cooling coils, terminate plenum or casing insulation 300 mm (12 in) downstream of final heating coil,

.10 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,

.11 sheet metal blank-off plates behind unused sections of air intake louvres.

.2 Externally insulate ductwork located outdoors:

.1 supply ducts.

.2 conditioned supply ducts.

.3 return ducts,

.4 exhaust ducts,

(a) excluding fan discharge duct,

.5 kitchen exhaust ducts with more than 3 m (10 ft) length of duct on roof.

(a) excluding fan discharge duct.

.3 External insulation is not required on:

.1 casings, ducts or plenums which have been lined with acoustic insulation, except as described above,

.2 free standing unconditioned supply fans, supply ducts and plenums,

.3 portions of intake ducts or plenums, unit casings and conditioned air plenums which are of double wall insulated construction,

.4 pre-insulated flexible ducts.

.5 factory insulated air handling units.

3.2 General Requirements

.1 Insulate ductwork in accordance with Table 1 at the end of this section.

.2 Store and use adhesives, mastics, and insulation cements at ambient temperatures and conditions recommended by product manufacturers.

.3 Surfaces to be clean and dry before application of insulation. Apply insulation after pressure and leakage testing is completed and accepted.

.4 Place insulation with joints staggered and tightly butted, with no visible gaps.

.5 Neatly finish insulation at supports, protrusions, and interruptions.

.6 Seal exposed insulation with reinforced vapor barrier or breather coating/mastic as shown.

.7 Finish ductwork with field installed finish jackets as shown.

3.3 Application

.1 Rigid insulation - fans, ducts, and casing:

.1 overlap horizontal boards over vertical boards, and butt edges tightly together.

.2 impale insulation on weld pins, studs, and clips at 300 mm (12 in) centres in both directions, with not less than 2 rows per side and bottom.

.3 secure insulation laps with mechanical fasteners (staples).

.2 Rigid insulation - outside air duct and plenums - glass fibre:

.1 as above for fans, ducts, and casings, and;

(a) apply first layer of insulation without integral vapour barrier,
(b) apply second layer of insulation with integral vapour barrier with staggered joints.

.3 Rigid insulation - outside air duct and plenum - phenolic board:

.1 as above for fans, ducts, and casings, but with only one layer of insulation board.

.4 Rigid insulation - exhaust air plenums:

.1 as above for fans, ducts, and casings.

.5 Flexible insulation:

.1 overlap insulation 50 mm (2 in) on each lap joint, and butt end edges tightly together,

.2 on rectangular ducts 600 mm (24 in) and wider, and round ducts 450 mm (18 in) and wider;

(a) secure insulation to the underside of duct with weld pins, studs, and clips at 300 mm (12 in) centres in both directions, with not less than 2 rows per side and bottom,
(b) secure insulation laps with mechanical fasteners (staples),
(c) for round ductwork, the underside of duct is measured as being half the circumference of the duct.

.6 Flexible elastomeric:

.1 wrap tightly onto ductwork and drain pans, and secure with 100% adhesive coverage.

.2 on round ducts, overlap insulation 50 mm (2 in) on each lap joint, and butt end edges tightly together,

.7 Cover angles or standing seams on the outside of plenums, casings and ducts which extend beyond face of applied rigid insulation;

.1 with same material and thickness as adjacent ductwork,

.2 extend this insulation 75 mm (3 in) on each side of the angle and place tight around the projecting leg of the angle.

.3 apply rigid insulation overlapping edge of flexible insulation on angle so that outstanding part of insulated angle projects through work.

.8 Cut and mitre rigid insulation at elbows and fittings and attach to ductwork with 50% coverage of adhesive, and mechanical fasteners with weld pins, speed clips and washers.

.9 Attach speed washers when insulation has been placed on metal pins and cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape.

.10 At junctions between external insulation and acoustic insulation, overlap external insulation 300 mm (12 in) over acoustic lining.

.11 Outdoor rectangular and flat-oval ductwork:

.1 build-up and slope insulation on top of ductwork to provide a 1:100 drainage slope,

.2 where width of ductwork exceeds 600 mm (24 in), slope insulation in both directions.

3.4 Sealing Insulation

.1 Hot ducts, casings, and plenums - Indoors:

.1 service temperature: 20°C to 65°C (70 F - 150 F)

.2 apply vapour barrier tape to butt joints, overlapping my minimum 50 mm (2 in) each side,

.3 do not tape lap joints.

.2 Cold or dual temperature ducts, casings, and plenums - Indoors:

.1 service temperature: Ambient to 20°C (Ambient to 70 F)

.2 apply reinforced vapor barrier coating and/or vapour barrier tape to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side,

.3 cover mechanical fastener (staple) penetrations with reinforced vapour barrier coating and/or vapor barrier tape,

.4 insulate flanges and standing seams with overlapping strips of flexible insulation, and cover with reinforced vapour barrier coating.

.3 Apply mastics and coatings when ambient temperature is above 4°C (40 F), unless manufacturer's instructions permit colder ambient installation conditions.

3.5 Insulation Finish

.1 Install protective finish on insulation in accordance with Table 2 at the end of this Section, after breather and vapor barrier sealing is completed.

.2 Install finish jacket materials used for covering to allow 50 mm to 100 mm (2 in to 4 in) overlap on longitudinal and circumferential edges.

.3 Fabric:

.1 Cotton lagging:

(a) apply cotton lagging with minimum two coatings of breather or vapor barrier coating adhesive as applicable to the duct 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 Hot or Cold/Dual temperature ducting systems.

.2 Fibreglass lagging:

(a) apply re-wetable figreglass lagging in accordance with manufacturer instructions. Finish to provide a smooth surface free of wrinkles and sags.

(b) where re-wetable fiberglass lagging is used this satisfies the requirements of a breather sealer coating for Hot piping systems.

3.6 Mechanical Damage Protection - Indoors

.1 Protect exposed insulated ductwork from floor level up to 1200 mm (4 ft) above floor with 1.2 mm (18 ga) stainless steel jacket, secured to floor slab.

.2 Do not overlap fire damper slip joint with protective sheeting.

3.7 Field Quality Control

.1 The Consultant reserves the right to have protective finish coverings removed on up to 5% of all fittings and flanges to review the sealing of the insulation, at no change in cost.

.2 If insulation sealing is found to be incorrect at any one location, remove the protective finish on all fittings and flanges for review.

.3 Repair defective sealing and replace protective coverings at no change in cost.

3.8 Insulating and Finishes Tables

.1 Tables 1, and 2 follows.

Table 1 : Ductwork and Plenum Insulation Type and Thickness mm (in)

Nominal Surface Temperature	Equipment Description	Insulation Type	Insulation Thickness
5°C to 65°C (40F to 150F)	Supply unit casings and plenums Free standing supply fans Rectangular, exposed Rectangular, concealed	D-2	25 (1)
	Rectangular, concealed Round and Oval, exposed Round and Oval, concealed	D-1	38 (1-1/2) *note (1)*
Ambient to 65°C (Ambient to 150F)	Plenums and Casings - Air Intake	D2	Two layers each 50 (2)
		D4	75 (3)
	Plenums and Casings - Exhaust	D2	50 (2)
		D4	38 (1-1/2)
	Rectangular - Outdoor - Supply	D2	50 (2)
	Rectangular - Outdoor - Return Rectangular - Outdoor - Exhaust	D2	38 (1-1/2)
	Round - Outdoor	D3	Two layers each 25 (1)
	Drain pans	D3	20 (3/4)

Note (1) : thickness is “out of box” before installation.

Table 2 : Ductwork Insulation Protective Finishes			
Location	**Weather Exposure**	**System/Space**	**Finish**
Concealed	Indoors	All	None
Exposed	Indoors	Service Rooms	Fabric
	Indoors	Public Spaces	Metal

END OF SECTION

PIPING INSULATION
20 07 19

1 GENERAL

1.1 Scope

.1 Insulate and finish piping, valves, fittings, and pipeline accessories.

.1 provide insulation, coatings, finishes, and mechanical protection.

1.2 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.

1.3 Qualifications

.1 Provide insulation and covering by recognized specialist applicator with an established reputation for this type of work.

Standard of Acceptance
- Custom Insulation Systems
- Guaranteed Insulation Ltd
- White & Greer Co Ltd
- Dewpoint Insulation Systems

1.4 Material test criteria

.1 Insulation, adhesives, coatings, finishes, sealers, and tapes:

.1 maximum flame spread rating of 25 to CAN/ULC-S102,

.2 maximum smoke developed rating of 50 to CAN/ULC-S102..

.2 Exception: vapor barrier mastics installed outside of building.

1.5 Applicable codes and standards

.1 Material and method of application to comply with or be tested in accordance with following Standards;

.1 Thermal Insulation Association of Canada (TIAC) National Insulation Standard, excluding section 12

.2 NFPA 90-A Installation of Air-Conditioning and Ventilating Systems

.3 ASHRAE/IES 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings

.4 NFPA 255 Test of Surface Burning Characteristics of Building Materials

.5 CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering, and Miscellaneous Materials and Assemblies

.6 ASTM C411 Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation

.7 ASTM C518 Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flo Meter Apparatus

.8 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

.9 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

.10 ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation

.11 ASTM C552 Standard Specification for Cellular Glass Thermal Insulation

.12 ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

.13 ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation

.14 ASTM C795 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel

.15 ASTM C1126 (Gr.1) Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation

.16 CGSB 51-GP-52MA Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation.

.17 CGSB 51.53-95 Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels and Round Ducts.

1.6 Definitions

.1 In this Section;

.1 “**Ambient”** : as applied to temperatures means outdoor design temperature.

.2 "**Concealed**" : as applied to mechanical services and equipment located in space above opaque suspended ceilings, and within trenches not in boiler rooms, pipe and/or duct shafts, and non-accessible chases and furred spaces.

.3 "**Exposed"** : as applied to remainder of mechanical services and equipment which are not "concealed" as defined above. For greater certainty, the following locations are Exposed:

(a) Services in tunnels,
(b) Services in space beneath raised floors.
(c) Trenches located in boiler rooms.

.4 “**Conditioned air**” : air supplied from air handling units which heats, cools, dehumidifies, or humidifies the air.

.5 “**Unconditioned space**” : rooms or spaces that are not supplied with conditioned air, including ceiling spaces which are not part of a ceiling return plenum system

.6 “**Outdoor**” : mechanical services and equipment located outside of the building envelope including services located beneath overhangs and soffits, and exposed to any outdoor condition including temperature, sun exposure, or precipitation.

.7 “**Mastic**” : heavy-consistency waterproof compound for outdoor applications used in conjunction with reinforcing fabric, that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish to insulation.

.8 “**Coating**” : light-consistency compound for indoor applications used in conjunction with reinforcing fabric, to provide either a breathable or vapour barrier finish to insulation.

.9 **“Finish Jacket”** : final finish protective layer for insulation, including lagging fabric, PVC, metal, and adhesive films; that provides weather-protective finish depending on application.

.10 “**Service temperature”** : for purpose of piping temperature, is equal to the gas or vapour design operating temperature, or the liquid supply operating temperature.

.11 "**Pure water"** ; water which 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.

SPEC NOTE: INCLUDE THE FOLLOWING FOR LEED PROJECTS.

2 PRODUCTS

2.1 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 - No. 220-05
- Foster – Drion 85-75

.2 Adhesive for flexible closed cell foam insulation:

.1 Volatile Organic Content: maximum 80 g/L.

Standard of Acceptance
- Armaflex 520 BLV
- 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 220-05
- Childers CHIL-STIX FRN CP-82

.4 Fibrous insulation adhesive:

.1 Volatile Organic Content: maximum 250 g/L

Standard of Acceptance
- Childers CHIL-STIX FRN CP-82
- Foster No. 85-70

.5 Vapour barrier tape:

.1 colour matched and foil faced

.2 UL 181A listed.

Standard of Acceptance
- Johns Manville - Zeston Z-Tape
- MacTac Canada Limited - Vinyl Scrim or Foil Scrim Kraft
- Compac Corp.
- Fattal Canvas Inc. - Insultape

.6 Weld Pins, Studs and Clips:

Standard of Acceptance
- Midwest Fasteners
- Continental 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 jackets (outdoor use only)

.1 fast-drying, aluminum colour finish, flexible butyl elastomer based vapour barrier sealant.

Standard of Acceptance.
- Foster 95-44

2.2 Coatings and Membranes

.1 Reinforcing Membrane:

.1 synthetic fibre:

(a) Leno weave,
(b) indoor and outdoor use.

Standard of Acceptance
- Foster Mast-A-Fab

.2 glass-fibre fabric:

(a) indoor use.

Standard of Acceptance
- Childers Chil-Glas #5/#10

.3 glass-fibre fabric for use with elastomeric closed cell foam:

(a) indoor use.

Standard of Acceptance
- Childers 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 CP-50A HV2
- Foster 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 Vi-Cryl CP-10/11
- Foster 35-00 / 45-00
- Bakor 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 Chil Perm CP-34/35
- Foster 30-80, 30-90

.3 for use with elastomeric closed cell foam.

Standard of Acceptance
- Childers CHIL-SPRAY WB CP-56 Adhesive
-

2.3 Field Applied Finishes

.1 PVC (Polyvinyl Chloride) finish jacket:

.1 minimum 20 mil thickness with permeability not more than 0.09 perms,

.2 fitting covers, one or two piece, pre moulded,

.3 glass-fibre insulation inserts for elbows, tees, valves, end-caps, mechanical pipe couplings,

.4 self sealing longitudinal joints.

Standard of Acceptance
- Johns Manville - Manville Zeston 2000
- ACWIL Insulations
- Sure Fit Systems
- Proto PVC - LoSMOKE

.5 pressure sensitive, colour matching vinyl tape.

2.4 Pipe Insulation

.1 Type P-1 molded glass fibre:

.1 to ASTM C547,

.2 pipe size application: up to and including NPS 24:

.3 service temperature: -18°C (0 F) to jacket surface temperature (air contact) of 66 C (150 F) and un-jacketed surface temperature (equipment contact) up to 232 C (450 F).

.4 factory molded rigid pipe insulation,

.5 ASJ jacket of kraft bonded to aluminum foil reinforced with glass fibre yarn, maximum 0.02 perms to ASTM E96 Procedure A.

.6 self sealing longitudinal jacket with integral vapour barrier, and matching butt joint sealer strips.

.7 noncombustible,

.8 thermal performance: 0.033 W/m/C @ 24 C (0.23 btu/hr/in/sq ft/F @ 75 F)____

.9 vapor transmission : maximum 0.02 perms

.10 reduced environmental impact feature of either: bio-based binders, 25% minimum recycled glass content, and/or paper-free ASJ jacket material.

Standard of Acceptance

- John Manville Micro-Lok HP (25% recycled content)
- Owens Corning Fiberglas Evolution (paper-free ASJ)
- Knauf Fiberglass Redi-Klad 1000 Ecose (bio-based binders)

.2 Type P-2 glass fibre semi-rigid board:

.1 to ASTM C795,

.2 pipe size application: NPS 16 and larger:

.3 service temperature: up to 454°C (850 F)

.4 scored and folded board,

.5 ASJ jacket of kraft bonded to aluminum foil reinforced with glass fibre yarn, maximum 0.02 perms to ASTM E96 Procedure A.

.6 noncombustible,

.7 thermal performance: 0.050 W/m/C @ 93 C (0.35 btu/hr/in/sq ft/F @ 200 F)___

.8 vapor transmission : maximum 0.02 perms

Standard of Acceptance

- John Manville Spin-Glas 813
- Owens Corning Pipe and Tank
- Knauf Fibreglass Pipe and Tank

.3 Type P-3 flexible elastomeric closed cell foam:

.1 to ASTM C534,

.2 pipe size application: up to and including NPS 1-1/2

.3 service temperature: -183°C (-297 F) to 82°C (183 F)

.4 tubular with self sealing seams,

.5 thermal performance: 0.04 W/m/C @ 24 C (0.28 btu/hr/in/sq ft/F @ 75 F),

.6 manufacturer specific sealer/adhesive.

Standard of Acceptance

- ARMACELL - AP Armaflex SS Pipe Insulation
- Rubatex

.4 Type P-4 molded phenolic rigid:

.1 to ASTM C1126 (Gr.1),

.2 pipe size application: up to and including NPS 16

.3 service temperature: -73ºC to+121 ºC (-100ºF to 250ºF).

.4 molded pipe, fitting, and hanger supports,

.5 meeting 25/50 flame spread/smoke developed when tested to ASTM E84,

.6 thermal performance: 0.019 W/m/Cº@ 24ºC (0.13 btu/hr/in/sq ft/Fº @ 75ºF),

Standard of Acceptance
- Kingspan - Kooltherm K/Kooltherm

.5 Type P-5 cellular glass :

.1 to ASTM C552,

.2 pipe size application: up to and including NPS 16

.3 service temperature: -268°C (-450 F) to 480 C (900 F)

.4 density 120 kg/m3 (7.5 lb/cu ft),

.5 molded or block type,

.6 thermal performance: 0.043 W/m/C @ 0 C (0.32 btu/hr/in/sq ft/F @ 75 F).

Standard of Acceptance
- Pittsburgh Corning Foamglas

.6 Type P-6 calcium silicate:

.1 to ASTM C533,

.2 pipe size application: up to and including NPS 16

.3 service temperature: to 649 C (1200 F).

.4 density 232 kg/m3 (14.5 lb/cu ft),

.5 molded or block type,

.6 asbestos-free,

.7 thermal performance: 0.058 W/m/C @ 149 C (0.40 btu/hr/in/sq ft/F @ 300 F),

Standard of Acceptance
- Industrial Insulation Group - Thermo-12/Blue

.7 Type P-7 molded mineral wool fibre:

.1 to ASTM C547,

.2 pipe size application: up to and including NPS 30,

.3 service temperature: up to 650°C (1200 F),

.4 rigid molded type,

.5 thermal performance: 0.04 W/m/C @ 50 C (0.25 btu/hr/in/sq ft/F @ 100 F),

Standard of Acceptance
- Roxul Techton 1200
- Fibrex Coreplus 1200 Pipe Insulation

.8 Type P-8 molded mineral wool fibre high temperature:

.1 to ASTM C547,

.2 pipe size application: up to and including NPS 30

.3 service temperature: up to 730°C (1350 F),

.4 rigid moulded type,

.5 thermal performance: 0.04 W/m/C @ 50 C (0.25 btu/hr/in/sq ft/F @ 100 F),

Standard of Acceptance

- Roxul SturdiRock
- Fibrex Dura K Pipe Insulation

3 EXECUTION

3.1 General Requirements

.1 Apply insulation after pressure and leakage testing is completed and accepted, and heat tracing 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 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 stamps.

.6 Neatly finish insulation at supports, protrusions, and interruptions.

.7 Seal exposed insulation with reinforced vapor barrier or breather coating or mastic.

.8 Finish piping with field installed finish jackets as specified herein.

3.2 Hot Piping Systems Insulation

.1 Insulate hot piping systems including pipe, valves, fittings, and pipeline accessories in accordance with Table 1 at the end of this Section.

.2 Insulate Condensate piping to the same criteria as its associated steam system.

.3 Insulate Safety Relief valve piping located between floor or elevated worksurface and up to 2400 mm (8 ft) above same, and passing within 1200 mm (4 ft) of a floor or elevated work surface.

3.3 Cold and Dual Temperature Piping Systems Insulation

.1 Insulate cold and dual temperature piping systems including pipe, valves, fittings, and pipeline accessories in accordance with Table 2 at the end of this Section..

.2 For drainage systems insulate:

.1 sanitary piping in the following locations,

(a) horizontal sanitary drainage piping NPS 3 and larger in ceiling spaces,
(b) exposed sanitary drainage piping in wet areas including sterile processing, dishwashing, cart-washing
(c) exposed sanitary drainage piping in IT/Data rooms,
(d) exposed sanitary drainage piping in service tunnels
(e) exposed sanitary drainage piping serving spaces located above a parking garage open to the outdoors,
(f) and where shown on drawings

.3 For greater clarity, domestic hot water, domestic hot water recirculating, non-potable hot water, and non-potable hot water recirculating piping systems are treated as “cold and dual temperature” for the purpose of application of vapor barriers to both hot and cold domestic and non-potable water piping.

3.4 Piping

.1 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn each butt joint.

.2 Secure insulation at centre of each section, at each end, and at not more than 600 mm (2 ft) intervals with:

.1 vapor barrier tape in addition to jackets with self-adhering lap joints for type P1 and P2 insulation on Cold and Dual Temperature piping,

.2 mechanical fastened (stapled) or jackets with self adhering lap joints on type P1 and P2 insulation on Hot piping,

.3 bands or wire for type P4 to P8 insulation,

.4 self-adhered or provide 100% coverage of contact adhesive for type P3 insulation,

.5 in accordance with listing requirements for type P10 insulation.

3.5 Fittings, Flanges, Couplings, and Strainers

.1 Insulate fittings including elbows and tees:

.1 NPS 1 ½ and smaller:

(a) mitre cut insulation to create tight fit,
(b) for PVC cover, trim backside of insulation on elbows to suit cover but do not reduce total thickness less than that of adjacent pipe insulation.

.2 NPS 2 and larger:

(a) use matching preformed insulation inserts, or fabricate mitred insulation segments made from same material as pipe insulation,
(b) number of mitred segments to be sufficient to maintain thickness of insulation around throat of elbow,
(c) secure inserts and fabricated segments with wire prior to application of coatings or finishes.

.2 Insulate flanges and grooved joint couplings:

.1 Insulate with preformed inserts or build-up insulation with same material as on adjacent pipe:

(a) butt pipe insulation to each side of flange, coupling, valve, or strainer,
(b) build up rigid insulation blocking on each side of fitting, coupling, valve or strainer, with a width dimension same as pipe insulation thickness, and
(c) apply insulation layer over outside of flange, coupling, valve or strainer to a thickness equal to pipe insulation thickness.
(d) provide removable insulation section on strainer head.

.2 Where phenolic insulation is used;

(a) same as above except use factory made insulation inserts, or fabricate inserts to suit fixture.

.3 Where elastomeric insulation is used;

(a) same as above except adhere insulation to flange, coupling, or strainer with full coverage of °C adhesive,
(b) 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.

3.6 Pipeline Accessories

.1 Insulate pipeline accessories:

.1 valves

.2 Insulate accessories for Hot Piping systems with design temperatures greater than 93°C (200 F):

.1 where located within 2100 mm (7 ft) above a floor or work surface

.2 with type P-9 removable fitted insulation covers,

.3 allow free movement of valve actuator.

.3 No insulation is required on pipeline accessories for Hot Piping systems with design temperatures of 93°C (200 F) or less.

.4 Insulate accessories for all other Cold and Dual Temperature Piping systems:

.1 insulate with flexible blanket of same material and thickness of adjacent piping and seal with reinforced vapor barrier sealer.

.2 at locations requiring access including valve handles, valve actuators, drain valves, etc, cut-back insulation and seal exposed edges.

3.7 Cold and Dual Temperature Pipe Insulation Systems - Additional Requirements

.1 Insulate pipe anchor plates and frames with flexible elastomeric closed cell foam insulation blanket of type P-3 insulation and seal with vapour barrier coating.

.2 Extend insulation along anchor steel a minimum distance of 150 mm (6 in) outside the piping insulation thickness.

3.8 Hangers and Supports

.1 Provide insulation protection in accordance with Table 3 at the end of this Section, based on pipe size and service process temperature.

.2 Pipe saddle insulation protection:

.1 insulate the interior void spaces of pipe saddles, of same material as adjacent pipe insulation,

.2 butt insulation up to sides and end of pipe saddle, and leave bottom surface of saddle exposed for direct contact with pipe support.

.3 Pipe shield insulation protection:

.1 install insulation shield between outside of insulation and pipe support; pipe support is sized for outside dimension of insulation.

.2 in accordance with pipe size, provide high density insulation insert of same thickness as adjacent pipeline material, fabricated from:

(a) cold and dual temperature piping: type P-11 (phenolic),
(b) hot piping: type P-11 (phenolic),.
(c) 300 mm (12") long for pipe size up to NPS 3, and
(d) 450 mm (18") long for pipe sizes NPS 4 and larger.

3.9 Floor and Wall Sleeves

.1 Extend pipe insulation including coatings and finishes through floor and wall sleeves.

.2 For penetrations through fire rated separations, provide finishes in accordance with fire stopping manufacturer's listing requirements.

.3 For outdoor piping passing through exterior walls or roof, terminate mastic lagging at outside face of sleeve and protected by storm flashing, caulked to lagging and to building structure.

3.10 Sealing Insulation

.1 Apply coatings and mastic in accordance with manufacturer requirements.

.1 Hot piping: breather coating/mastic

.2 Cold and Dual Temperature piping: vapor barrier coating/mastic

.2 Only use mastics on outdoor installations.

.3 Apply mastics and coatings when ambient temperature is above 4°C (40 F), unless manufacturer's instructions permit colder ambient installation conditions.

.4 Hot Piping;

.1 seal lap joints with self-adhesive lap joint, reinforced breather coat, or vapour barrier tape,

.2 seal butt joints with matching vapour barrier tape.

.5 Cold and Dual Temperature Piping;

.1 tightly seal insulation with factory applied all-purpose jacket using self-adhering or field applied adhesive on longitudinal laps and butt joint.

(a) where sealing strips are damaged, apply secondary layer of colour matched vapor barrier tape.

.2 seal insulation without factory applied jackets with 100% coverage of vapor barrier coating/mastic as applicable complete with reinforcing membrane.

.3 seal insulation butt ends with vapor barrier coating every four (4) lengths of insulation but not to exceed 2400 mm (8 ft) of pipe length.

.6 Hanger high-density insulation inserts:

.1 seal inserts with reinforced breather or vapour barrier coating as applicable, overlapping adjacent insulation a minimum of 50 mm (2 in).

.7 Elbows, tees, flanges, and fittings;

.1 Apply applicable breather or vapor barrier coating/mastic with reinforcing membrane over fitting insulation and overlap 50 mm (2 in) onto adjacent pipe insulation.

(a) for greater clarity, use of vapor barrier tape to seal insulation is not permitted.

.2 Apply coating/mastic and reinforcing membrane regardless of final finish application.

.8 Maintain integrity of vapor barrier through sleeves, around fittings and at hangers and supports.

3.11 Insulation Finish Coverings

.1 Install protective finish coverings on insulation in accordance with Table 4 at the end of this Section, after breather and vapor barrier sealing is completed.

.2 Cut finish jacket materials used for covering to allow 50 mm to 100 mm (2 in to 4 in) longitudinal overlap and similar circumferential overlap onto adjacent sheets.

.1 On vertical pipes arrange circumferential overlap on adjacent sheets outside of sheet below and under sheet above.

.3 PVC sheeting :

.1 Hot piping:

(a) overlap longitudinal edges and adjacent sheets by minimum of 50 mm (2 in) and staple fasten the sheets.
(b) secure sheeting with colour matched tape around circumference, at least two places per section of sheet, and by stapling longitudional and circumferential edges.
(c) do not seal edges with vapour barrier tape.
(d) seal PVC fitting covers at throat and heel seams by stapling and secure over insulation by banding or taping ends to adjacent pipe finish covering with colour matched tape.

.2 Cold and Dual Temperature piping:

(a) overlap longitudinal edges and adjacent sheets by minimum of 50 mm (2 in) and seal longitudinal edges with vapor barrier coating adhesive for full depth and 100% coverage of overlap,
(b) seal circumferential 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/mastic overlapping adjacent pipe insulation a minimum of 50 mm (2 in).

3.12 Mechanical Damage Protection - Indoors

.1 Protect exposed pipe insulation extending up through a floor sleeve at floor line with 1.2 mm (18 ga) stainless steel jacket approximately 100 mm (4 in) high, secured to floor slab. Conceal fastenings by floor plate.

.2 For piping systems using metal finishes, this protection cover replaces a portion of the specified pipe cover.

.3 For piping systems using other finishes, this protection cover is in addition to the specified pipe cover.

3.13 Field Quality Control

.1 The Consultant reserves the right to have protective finish coverings removed on up to 5% of all fittings, flanges, couplings, valves, and pipeline accessories to review the sealing of the insulation, at no change in cost.

.2 If insulation sealing is found to be incorrect at any one location, remove the protective finish on all fittings, flanges, couplings, valves, and pipeline accessories for review.

.3 Repair defective sealing and replace protective coverings at no change in cost.

3.14 Insulating and Finishes Tables

.1 Table 1, 2 and 3 follows.

Table 1 : Hot Piping Systems, Insulation Type and Thickness mm (in)

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)				
High temperature hot water heating	94 to 121 (201 to 250)	P-1 P-2 P-7	38 (1½)	38 1(½)	50 (2)	50 (2)	90 (3½)
		P-4	20 (3/4)	20 (3/4)	25 (1)	38 (1½)	38 (1½)
Hot Water Heating Glycol Heating Pumped Condensate	61 to 93 (141 to 200)	P-1 P-7	38 (1½)	38 (1½)	38 (1½)	38 (1½)	38 (1½)
		P-4	20 (3/4)	25 (1)	25 (1)	25 (1)	25 (1)
Pure Water (during heat sanitization)	50 to 93 (122 to 200)	P-1 P-7	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)
Low Temperature Hot Water Heating Low Temperature Glycol Heating	40 to 60 (105 to 140)	P-1	25 (1)	25 (1)	25 (1)	38 (1½)	38 (1½)
		P-4	20 (3/4)	20 (3/4)	20 (3/4)	25 (1)	25 (1)
Condenser Water (outdoors)	26 to 39 (80 to 104)	P-1 P-5	25 (1)	25 (1)	25 (1)	38 (1½)	38 (1½)

Table 2 : Cold and Dual Temperature Piping Systems, Insulation Type and Thickness mm (in)

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)				
Dual Temperature Heating/Cooling	4.4 to 93 (40 to 200)	P-1	38 (1½)	38 (1½)	38 (1½)	38 (1½)	38 (1½)

Table 2 : Cold and Dual Temperature Piping Systems, Insulation Type and Thickness mm (in)

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)				
Domestic Hot Water Domestic Hot Water Recirculation Not-Potable Hot Water Non-Portable Hot Water Recirculation	40.5 to 60 (105 to 140)	P-1	25 (1)	25 (1)	38 (1 ½)	38 (1 ½)	38 (1 ½)
Domestic Cold Water Non-potable Water Drainage	4.4 to 16 (40 to 60)	P-1	25 (1)	25 (1)	38 (1 ½)	38 (1 ½)	50 (2)
		P-4	---	---	---	25 (1)	25 (1)
Equipment Drains	4.4 to 16 (40 to 60)	P-3	13 (1/2)	20 (3/4)	25 (1)	---	---
Chilled Water Dual Temperature Heating/Cooling	4.4 to 16 (40 to 60)	P-1	25 (1)	25 (1)	38 (1 ½)	38 (1 ½)	50 (2)
		P-4	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)
Refrigerant Suction	< 4.4 (< 40)	P-3	25 (1)	25 (1)	25 (1)	---	---
		P-4	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)

Table 3 : Insulation Hanger Protection				
Process Temperature °C (F)	Pipe Size NPS	Pipe Saddle	Insulation Shield	High-Density Insert
> 93 (200)	≥ 1-1/2	●	---	---
	≤ 1-1/4		●	---
61 to 93 (141 to 200)	> 6	●	---	---
	≥ 1-1/2 and ≤ 6	---	●	●
	≤ 1-1/4	---	●	---
26 to 60 (80 to 140)	≥ 1-1/2	---	●	●
	≤ 1-1/4	---	●	---
Cold & Dual Temp	≥ 1-1/2	---	●	●
	≤ 1-1/4	---	●	---

Table 4 : Piping Insulation Protective Finishes			
Location	Weather Exposure	Piping System	Finish
Concealed	Indoors	All	None
Exposed	Indoors	All except steam over 860 kPa (125 psig)	PVC

END OF SECTION

TESTING ADJUSTING AND BALANCING
20 08 05

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.

1.2 Qualifications and performance standards

.1 Balancing to be performed under supervision of recognized expert with an established reputation in this field.

.1 TAB contractor to be a member of AABC or NEBB .

.2 Perform testing and balancing in accordance with:

.1 SMACNA Testing, Adjusting and Balancing guidelines,

.2 Associated Air Balancing Council standards for Total System Balance.

1.3 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.

.3 Confirm proper placement of thermometer wells, test ports, pressure gauge cocks, balancing valves, balancing dampers and splitter dampers, and access doors.

.4 Submit TAB schedule, with descriptive data outlining procedures and sample forms showing method of data presentation, three months before start of TAB work on site.

.5 Provide details of specific procedures to be used for determining test parameters from test measurements and criteria proposed to establish compliance with specification requirements.

.6 List instruments to be used, method of instrument application (by sketch) and correction factors.

.7 Calibrate instruments in accordance with recognized standards, and submit calibration curves not more than three months before commencement of TAB.

.8 TAB measurements to commence when building is “closed in” and work is sufficiently advanced to include;

.1 Installation of ceilings, doors and windows.

.2 Application of sealing, caulking, and weather stripping.

.3 Normal operation of mechanical systems.

1.4 Systems, equipment and related controls requiring TAB

.1 Air handling systems.

.2 Hydronic systems including

.1 Domestic water equipment and cold, hot and recirculation hot water piping systems.

2 AIR MOVING SYSTEMS

2.1 Parameters

.1 Listed below is an outline of the information to be established in the TAB process:

.1 Air flow related;

(a) Air velocity
(b) Flow cross sectional area.
(c) Static pressure.
(d) Velocity pressure.

.2 Measurement are required to characterize system performance;

.1 at main ducts.

.2 at branch ducts.

.3 at sub-branch ducts.

.4 at each supply, exhaust and return air inlet and outlet.

.5 in each thermostatically controlled zone.

2.2 Terminal box supply system balancing procedure

.1 Set system to operate with 100% return air, set room thermostats at indoor design temperature and set fan discharge temperature at design value.

.2 Set thermostat in most remote zone to full cooling and adjust fan inlet guide vane static pressure controller to maintain manufacturer's specified minimum static pressure at box inlet.

.3 Check air quantity delivered by box and adjust volume regulators to obtain design value.

.4 Reset room thermostat to full heating and check performance of regulator.

.5 Reset thermostat to design temperature and repeat procedure for remaining terminal boxes.

.6 If inlet static pressure at a subsequent box is less than manufacturer's specified minimum, reset inlet guide vane static pressure controller to suit.

.7 Open balancing dampers and adjust fan inlet static pressure controllers, or fan speed to obtain design air quantity at most remote outlet.

.8 Balance remaining outlets by adjusting dampers.

.9 If air quantity at some outlet other than the most remote outlet is less than design, re-adjust fan and rebalance previously adjusted outlets.

.10 Measure fan performance and adjust fan speeds and inlet guide vane controllers so that return air quantity is equal to supply air quantity less fixed exhaust air quantities, with a 10 percent allowance for pressurization.

2.3 Fresh air adjustment procedure

.1 After adjustment of supply, return and related exhaust fans, adjust minimum fresh air damper position to obtain design fresh air quantity.

.2 Damper position to be determined by measurement of outside return and mixed air temperatures and confirming calculations to be included in balance report.

.3 Where duct space permits, include airflow measurement of supply, and recirculation or outdoor air, to verify results.

2.4 Branch air quantity measurement procedure

.1 Branch air quantities to be determined using pitot tube traverses in accordance with the procedures outlined in "Testing, Balancing and Adjusting of Environmental Systems" by William G. Eads, P.E., issued by SMACNA.

.2 Measurements to be taken at each riser as it is connected to fan discharge or suction header and at each floor where branches are taken from the riser. Measurement to be repeated until sum of branch air quantities is within 10% of fan delivery.

3 HYDRONIC SYSTEMS

3.1 Parameters

.1 Listed below is an outline of the information to be established in the TAB process;

.1 Flow.

.2 Pressure.

.3 Temperature.

3.2 General criteria

.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 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, and checked against 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.

.4 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing.

.5 Perform balancing by measurement of temperature differential in conjunction with air balancing.

.6 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.

.7 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.

4 REPORT PRESENTATION AND VERIFICATION

4.1 Required reports

.1 Provide the following reports:

.1 Air and water balancing report

4.2 Report format

.1 Reports to incorporate approved standard forms, with values expressed in SI and (Imperial) units.

.2 Include "as-built" system schematics showing flow quantities and measurement points. Use as-built drawings and ventilating line diagrams for references.

.3 Submit four hard copies of TAB reports, with index tabs, in "D" ring binders, for verification.

.4 Submit two soft copies of TAB reports in Adobe Acrobat V7 PDF format.

4.3 Accuracy

.1 Adjust systems until operating values within plus or minus 5% of design values are achieved.

.2 Measurements to be accurate to within plus or minus 2% of actual values.

4.4 Spot checks

.1 After review of the Draft Report by the Consultant and at the Consultants direction, retest up to 30% of all measurements in locations as directed by the Consultant, at no cost extra to the contract.

.2 If results indicate unusual testing inaccuracy, omissions, or incomplete balancing/adjustment, in the opinion of the Consultant, re-balance entire affected system(s) at no increase in Contract Price.

4.5 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 Double Regulating Valves:

.1 Remove valve handle or other protective device, and set memory stop to limit valve open travel. Replace valve handle or protective cover.

4.6 Record keeping

.1 Keep records of trial and final balance and submit preliminary report as each system is completed.

.2 Make spot checks as requested and repeat balancing of system if actual spot check quantities do not agree with preliminary report figures.

4.7 Verification

.1 Reported measurements will be verified.

.2 Provide instrumentation and manpower to verify results of up to 30% of reported measurements.

.3 Number and location of verification measurements to be at discretion of Engineer.

.4 Where discrepancies are encountered repeat TAB, and resubmit reports.

4.8 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 total performance of the Mechanical Subcontract (Contract) will not be considered reached until the alternate season testing and balancing is completed and the final report submitted and accepted by the Consultant.

END OF SECTION

PROJECT CLOSE-OUT MECHANICAL
20 08 19

1 GENERAL

1.1 Scope

.1 Provide documentation deliverables at completion of the Work.

1.2 Occupancy Permit

.1 Submit the reviewed final Life Safety and Fire Protection Commissioning report two weeks prior to application for occupancy permit.

1.3 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.

1.4 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.
- ☐ Building department inspection reports.
- ☐ TSSA pressure piping inspection reports (if applicable)
- ☐ TSSA fuel system field inspection reports (if applicable)
- ☐ ESA field inspection reports.
- ☐ Sprinkler installation certification report to NFPA 13.
- ☐ Air and Water Balancing reports (Interim).
- ☐ Clean-up completed.
- ☐ Warranty certificates
- ☐ Operating and Maintenance Manuals, draft, submitted.
- ☐ As-built drawings submitted
- ☐ Training completed and attendance logs submitted.

Consultant Review		
Status:	☐ Reviewed	☐ Incomplete or deficient - resubmit
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.
☐ Air and water balancing - final versions including alternate season testing completed and submitted.
☐ 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: .

Consultant Review	
Status:	□ Reviewed □ Incomplete or deficient - resubmit
Signed:	
Date:	

End of Section

FIRE PROTECTION - GENERAL
21 05 01

1.1 GENERAL

1.2 Scope

.1 Fire protection work includes;

.1 Commissioning of fire protection systems,

.2 Wet Pipe Sprinkler System

1.3 Applicable Codes and Standards

.1 Fire Protection Work to conform to Standards of National Fire Prevention Association (NFPA) and relevant sections of The Ontario Building Code.

2 PRODUCTS

2.1 Pipe, hangers and gaskets

.1 Pipe:

.1 ASTM A53 Grade B, Schedule 40 continuous weld steel to up to NPS 2, grooved or screwed.

(a) Galvanized where specified.

.2 ASTM A53-63R Grade B, Schedule 40 electric resistance weld steel for NPS 2 ½ to NPS 10, welded.

.3 NPS 2½ and over ASTM A53-72A Schedule 10 thin wall, rolled grooved.

.2 Pipe hangers:

.1 UL/ULC listed for fire protection, and

.2 swivel ring hanger type or

.3 as specified in Section 20 05 29 Hangers and Supports.

.3 Gaskets for flanged joints:

.1 Red rubber sheet 1.6 mm (1/16 in) thick.

Standard of Acceptance
- Chesterton 100
- Beldam Red Rubber

2.2 Fittings, and valves up to 1200 kpa (175 psi) working pressure

.1 Fittings:

.1 1035 kPa (150 #) black malleable iron screwed up to NPS 2.

.2 Forged steel, butt welding Schedule 40 for NPS 2½ and over.

.2 Unions:

.1 1035 kPa (150 #) black malleable ground joint union, bronze to iron seat up to NPS 2.

.3 Flanges:

.1 1035 kPa (150 #) forged steel, slip-on or weld neck, raised face style.

.4 Valves:

.1 ULC and FM listed for fire protection service.

.2 as specified in Section 20 10 00 Valves.

2.3 Fittings for grooved pipe to 1200 kpa (175 psi)

.1 Couplings:

.1 Malleable or ductile iron NPS 2½ and over.

.2 Fittings:

.1 Malleable iron or ductile iron to NPS 2½ to NPS 12.[][

.2 Fabricated steel NPS 14 and over.]

.3 Flanges:

.1 Cast iron, raised face flange with coupling groove NPS 2½ and over.

.4 Gaskets for grooved couplings:

.1 EPDM Grade "E", dry lubricated.

3 EXECUTION

3.1 Piping Installation

.1 General layout of mains, risers, run-outs and connection details of piping systems are shown.

.2 Provide bends, expansion loops, hoses or joints to compensate for pipe seismic movement.

.3 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.

.4 Erect piping so that gravity forces and thrust from changes in direction do not stress connections to apparatus.

.5 Separate copper pipe and fitting materials from contact with ferrous material with di-electric couplings.

.6 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.

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 licences in the province of Ontario.

1.2 Qualified Subcontractors

.1 Sprinkler work to be undertaken by specialist automatic sprinkler installation firm with an established reputation in this field.

1.3 Applicable codes and standards

.1 National Fire Protection Association (NFPA) 13 - Standard for the Installation of Sprinkler Systems

.2 NFPA 25 - Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems

.3 Factory Mutual Engineering Division (FM) Data Sheets.

.4 Canadian Industrial Risks Insurers (CIRI), Interpretive Guide.

.5 Ontario Building Code

.6 Ontario Fire Code

.7 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-dipped, Zinc-coated, Welded and Seamless

1.4 Shop drawings and product data

.1 Prepare shop drawings and forward three copies with hydraulic calculations 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 for review in accordance with Division 1 procedures.

1.5 Samples

.1 Submit samples of;

.1 sprinkler heads,

.2 signs.

1.6 Design criteria

.1 System is designed to NFPA 13 using hydraulic method for hazard classification shown with design densities and design areas for each zone as detailed.

.2 Hydraulic calculations are based on water supply test results, down-rated in accordance with requirements of Authorities having jurisdiction as shown. Hydraulic calculations establishing pipe sizing as shown on drawings are available upon request.

.3 Changes to pipe sizes or head layouts accompanied with modified hydraulic calculations, may be submitted for approval.

1.7 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, hangers and gaskets

.1 To section 21 05 01.

2.2 Sprinkler heads

.1 Ratings:

.1 ULC and FM listed 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.

.2 Selection:

.1 indicated by type in accordance with following:

(a) TYPE U-1 upright bronze body with 12 mm (½ in) diameter orifice or 13 mm (17/32 in) diameter orifice as shown.
(b) TYPE P-2 pendent, flush, concealed with fusible chrome or white cover plate, glass bulb type.

Standard of Acceptance

- Viking
- Tyco
- Reliable
- Victaulic

3 EXECUTION

3.1 General

.1 Extend piping and connect to sprinklers.

.2 Provide additional sprinkler heads with associated piping for sprinkler protection 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.

3.2 Sprinkler selection

.1 Use 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.

3.3 Testing and approvals

.1 Test sprinkler systems in accordance with requirements of NFPA.

.2 In existing buildings, for new additions to an existing sprinkler system: in addition to the NFPA requirements for pressure testing, conduct an initial pressure test:

- .1 isolate the new piping from the existing system,
- .2 pressure test the new piping at 350 kPa (50 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 Schedule testing to give at least two weeks notice to following authorities:

- .1 Local Building/Plumbing Inspector,
- .2 Local Fire Department Representative,
- .3 Insurer's Representative,
- .4 Owner, and
- .5 Consultant.

.4 Prior to testing, ensure that valves, flow switches, pressure switches, supervisory switches and other devices are functioning.

.5 Provide Contractor's Material and Test Certificate for above ground piping.

.6 Distribute copies of Certificates as per shop drawing requirements.

.7 On completion of project obtain Certificate of Approval showing that work is in accordance with rules and regulations of National Fire Protection Association.

END OF SECTION

PLUMBING GENERAL
22 05 01

1 GENERAL

1.1 Scope

.1 Provide labour, materials and equipment for installation, testing and putting into operation plumbing and drainage systems.

1.2 Qualified tradesmen

.1 Work to be done by qualified and recognized firm with an established reputation in this field using tradesmen holding certificates of competency.

1.3 Applicable codes and standards

.1 Ontario Building Code

.2 Regulations of Province, City, or local authority having jurisdiction.

.3 CSA B272 Pre-Fabricated Self Sealing Roof Vent Flashings

2 PRODUCTS

2.1 n/a

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 Provide/Extend existing domestic cold water system with

.1 distribution pipe and fittings,

.2 valves,

.3 zone or equipment backflow protection.

.2 Provide valved connections from supply system, to fixtures and other equipment requiring cold water.

3.3 Domestic hot water system distribution

.1 Provide/Extend existing domestic hot water system with

.1 distribution pipe and fittings

.2 valves

.3 zone or equipment backflow protection.

.2 Provide valved connections from hot water supply system to fixtures and other equipment requiring hot water.

3.4 Domestic hot water recirculation system

.1 Provide/Extend existing] domestic hot water recirculation system with

.1 distribution pipe and fittings

.2 valves

.2 Install recirculation piping as shown.

3.5 Drainage

.1 Provide waste and vent connections to plumbing fixtures and equipment.

.2 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 gasketted access cover and plug, with cleanout body cast in floor slab above.

.6 Drainage fittings to match connected piping for quality and wall thickness.

3.6 Special water and waste connections

.1 Provide hot and cold water, waste and vent connections to equipment.

.2 Provide vacuum breakers and backflow preventers on equipment connections, and hose bibbs, 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 apparatus and brass trap 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.

.6 Provide similarly sized connections for items marked N.I.M.C. (Not in Mechanical Contract) and S.B.O. (Supplied by Owner).

.7 For these items:

.1 N.I.M.C. Do not make final connections but provide services.

.2 S.B.O. Make final connections including traps, screwdriver stops and accessories.

3.7 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.

3.8 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.

.6 When flushing has been completed to satisfaction of Consultant, introduce strong solution of chlorine into watermain and ensure that it is distributed throughout entire system:

.1 Drain down system to remove flushing water,

.2 Introduce Chlorine close to point of re-filling of system, and evenly add to water as system is refilling, to provide an initial concentration of 50 mg/L

.3 Operate valves, hydrants, and appurtenances while main contains chlorine solution.

.4 Flush line to remove chlorine solution after 24 hours contact time.

.5 Arrange and pay for laboratory testing of water samples taken from newly disinfected main.

.6 Where samples do not meet laboratory test standard for potable water, disinfection procedure and testing is to be repeated until satisfactory results are achieved.

END OF SECTION

PLUMBING SPECIALTIES & ACCESSORIES
22 05 23

1 GENERAL

1.1 Scope

.1 Provide plumbing specialties and accessories.

1.2 Product data

.1 Submit product data sheets for;

.1 cleanouts, water hammer arresters, back flow preventers, strainers, traps.

1.3 Applicable codes and standards

.1 CSA-B125 Plumbing Fittings.

.2 CSA B.64.1.1 Vacuum Breakers, Atmospheric Type

.3 CSA B.64.4 Backflow Preventers, Reduced Pressure Principle Type

.4 CSA B64.10 Manual for the Selection and Installation of Backflow Prevention Devices/Manual for the Maintenance and Field Testing of Backflow Prevention Devices

.5 CSA B79 Floor, Area, and Shower Drains and Cleanouts for Residential Construction

.6 Plumbing and Drainage Institute (PDI) Standard PDI-WH201.Water Hammer Arresters

.7 PDI-G101 Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data.

2 PRODUCTS

2.1 General

.1 Floor, area, combination and roof drains and cleanouts to conform to CSA B79 and to be products of one manufacturer.

Standard of Acceptance
- Jay R. Smith
- Mifab
- Zurn

2.2 Cleanouts

.1 In floors:

.1 line size for NPS 2, NPS 3 and NPS 4 and NPS 4 in larger lines.

.2 seal and test plug

.3 cast iron body with clamp and collar,

.4 in unfinished floor areas,

(a) cast iron frame heavy duty scoriated cast iron round or square tractor cover and internal plug, and

.5 in finished flor areas,

(a) nickel bronze frame and round or square nickel bronze adjustable access cover,
(b) recessed for tile infill in tiled areas,
(c) recessed for carpet infill in carpeted areas,
(d) deeply recessed for terrazzo infill in terrazzo finished areas, and with
(e) extended flange around frame in areas with monolithic floor finishes.

Standard of Acceptance
- Jay R. Smith 4000 series
- Mifab C1100 series
- Zurn Z-1400 series

.2 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.
-

2.3 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.

Standard of Acceptance
- Jay R. Smith Hydrotrol 5000 series
- Mifab WHB series
- Zurn Shocktrol Z-1700 series]

2.4 Trap seal primers

.1 Serving 1 or 2 drains:

.1 diaphragm operated primer with distribution unit,

.2 automatically operated by a pressure drop of 35 to 70 kPa (5 to 10 psi) in supply line to fixture.

Standard of Acceptance
- Precision Plumbing Products Model PO-500
- Mifab M-500 with MI-DU

2.5 Back-flow preventers - Reduced Pressure Principle (RP)

.1 Conforming to CSA B.64.4

.2 NPS 3/4 and larger:

.1 two independent check valves with intermediate relief valve,

.2 OS&Y ULC listed resilient seated gate valves,

.3 ball test cocks, and

.4 air gap drain.

Standard of Acceptance
- Watts No.909 series

- Cla-val Company Model RP-1
- Conbraco 40200 & 40100 Series

.3 NPS ¼ and ½:

.1 two independent check valves with intermediate relief valve,

.2 quarter turn full port resilient seated ball valves,

.3 inlet strainer,

.4 ball test cocks, and

.5 air gap drain.

Standard of Acceptance
- Watts No.909QT series

2.6 Vacuum breakers

.1 Conforming to CSA B.64.1.1.

.1 NPS ¼ to 3:

(a) atmospheric type (AVB), with single float and disc, and
(b) large atmospheric port.

Standard of Acceptance
- Watts No.288A series
- Cash Acme Type V-101

.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 No.800 series

.2 Conforming to CSA B.64.2

.1 NPS ¾,

(a) Hose connection type (HCVB) with non-removable single check , and
(b) atmospheric vent vacuum breaker.

Standard of Acceptance
- Watts No.8A
- A.W.Cash Valve Type V-3

2.7 Strainers

.1 "Y" pattern with ;

.1 bronze, cast iron or steel bodies ,

.2 screwed or flanged to match pressure class and size restrictions specified for globe valves in section of piping system where strainer is to be installed,

.3 stainless steel baskets with;

(a) 0.8 mm (1/32 in) diameter perforations for strainers up to NPS 3 size and
(b) 3.2 mm (c in) diameter perforations for strainers NPS 4 and larger.

(c) Baskets with 3.2 mm (c in) diameter perforations to be made from 0.9 mm (0.037 in) stock reinforced with 13 mm x 0.9 mm (½ in x 0.037 in) bands of the same material spot welded to baskets

3 EXECUTION

3.1 Installation general

.1 Install to conform with Canadian Plumbing Code, provincial codes, and local authority having jurisdiction.

3.2 Cleanouts

.1 Install at base of soil and waste stacks, and rainwater leaders and at changes in direction .

.2 Extend cleanouts flush to wall or finished floor unless serviceable from below floor.

.3 Install cleanouts located in floors clear of obstructions.

3.3 Water Hammer Arresters

.1 Select and install in accordance with PDI-WH 201 on branch supplies to each fixture or group of fixtures.

3.4 Trap seal primers

.1 Select and install to prime floor and funnel drain traps.

3.5 Back-flow preventers and vacuum breakers

.1 Install in accordance with CSA B64.10.

.2 Install backflow preventers horizontally, in accordance with manufacturers reccomendations, but not less than 300mm (12") and not greater than 1500mm (60") above the floor.

.3 Pipe discharge from backflow preventer, with air gap, to nearest drain or service sink.

3.6 Strainers

.1 Install with sufficient space to remove basket.

END OF SECTION

DOMESTIC WATER SUPPLY PIPING - COPPER
22 11 16

1 GENERAL

1.1 Scope

.1 Provide copper pipe and fittings for potable domestic water piping, above ground.

1.2 Applicable codes and standards

.1 ASTM B88 Standard Specification for Seamless Copper Water Tube

.2 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250

.3 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings

.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 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

.7 CSA B242 Groove and Shouldered Type Mechanical Couplings

.8 AWS A5.8 Brazing Filler Metal.

.9 AWWA C606 Grooved and Shouldered Joints

.10 AWWA C111/ ANSIA21.11 Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

.11 ASTM A307 Standard Specification for Carbon Steel Bolts and Studs 60,000PSI Tensile Strength

.12 ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts

.13 ASTM B-32 Specification for Solder Metal

2 PRODUCTS

2.1 Domestic hot, cold and recirculating piping, within building

.1 Copper tube: to ASTM B88.

.1 Hard drawn, type L above ground.

.2 Tube 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 Roll groove full flow standard radius cast bronze fittings for sizes NPS 2 1/2 and larger: to AWWA C606.

2.3 Joints

.1 Flanged joints:

.1 made up with rubber gaskets 1.6 mm ($^{1}/_{16}$ in) thick to AWWA C111 and

.2 heavy series bolts, hexagonal head pattern to ASTM A307, nuts to ASTM 563, and washers.

.2 Solder : tin antimony solder, 95:5 to ASTM B-32 .

.3 Silver brazing alloy AWS Classification BCUP-5

Standard of Acceptance
- Handy Harman "SIL-FOS"
- All-State Welding Alloys "SILFLO 15"

.4 Roll grooved piping:

.1 made up with roll groove positive clamp gasketted couplings or roll groove flange adapters for copper piping to CSA B242 or AWWA C606.

Standard of Acceptance
- Victaulic
- Gruvlock
- Couplox
- Shurjoint

2.4 Valves

.1 Valves: to Section 20 05 23 Valves.

3 EXECUTION

3.1 Installation

.1 Isolate equipment, fixtures and branches with gate, ball or butterfly valves.

.2 Use globe, DRVs, ball or butterfly valves for throttling service.

.3 Install piping close to building structure to minimize furring and conserve headroom. Group piping and run parallel to walls and ceilings.

.4 Cut tube square, ream tube ends and clean tubing and tube ends before joint assembly.

.5 Prepare roll groove joints in shop or field using groove rolling machine.

.6 Assemble roll groove joints using dry lubricated gaskets.

.7 Anchors, guide and support roll grooved piping in accordance with coupling manufacturers instructions.

.8 Before assembling 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 flux.

.9 Solder or braze joints with blow torch or oxy-acetylene flame.

.10 Joint construction, buried:

.1 All sizes: brazed.

.11 Joint construction, above ground:

.1 Up to NPS 2½: soldered in all locations

.2 NPS 3 and larger: brazed in all locations

.3 NPS 3 and larger: grooved joint in exposed areas only.

(a) for greater clarity, “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.

3.2 Testing and Balancing

.1 Pressure test piping before insulation is applied. Cut-out and replace leaking soldered or brazed fittings and retest.

.2 Balance supply systems and recirculation systems using lock shield globe valves or DVR.

END OF SECTION

DRAINAGE AND VENT PIPING – CAST IRON AND COPPER
22 13 16

1 GENERAL

1.1 Scope

.1 Provide cast iron pipe and fittings and/or copper tube and fittings for drain, waste and vent services.

.1 For aboveground services.

1.2 Applicable codes and standards

.1 Standards:

.1 CSA B70 Cast Iron Soil Pipe, Fittings, and Means of Joining

.2 CSA-B125 Plumbing Fittings.

.3 CSA B158.1 Cast Brass Solder Joint Drainage, Waste, and Vent Fittings

.4 CSA B602 Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

.5 ASTM A74 Standard Specification for Cast Iron Soil Pipe and Fittings

.6 ASTM A888 Standard Specification for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications

.7 ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV

.8 ASTM B32 Specification for Solder Metal

.9 ASTM B306 Standard Specification for Copper Drainage Tube (DWV)

.10 ASTM C564- Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.11 ASTM C1540 Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.

.12 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

.13 Canadian Pipe Institute Standard Specification

.14 Cast Iron Soil Pipe Institute (CISPI) Technical Manual

.15 CISPI 301 Standard Specification for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications

.16 CISPI 310 Specification for Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications

2 PRODUCTS

2.1 Copper drain waste and vent pipe and fittings, within building

.1 Pipe:

.1 Copper DWV tube, to ASTM B306

.2 Certification markings made by testing agency accredited by Standards Council of Canada.

.2 Fittings

.1 Cast brass to CSA B158.1

.2 Wrought copper to ANSI B16.29

.3 Solder

.1 Tin-antimony 95/5, to ASTM B32 alloy Sb5.

2.2 Cast iron pipe and fittings for drain waste and vent services

.1 Pipe and fittings:

.1 Cast to CSA B70, ASTM A74 or ASTM A888

.2 with heavy bituminous coating for buried service.

.2 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.

.3 Tie-rods:

.1 fabricated by double bolted riser clamps and 10mm (3/8 in) carbon steel rods, with riser clamp placed on each side of joint.

3 EXECUTION

3.1 Installation General

.1 Install suspended piping to grade, parallel and close to walls and ceilings to conserve headroom and space.

.2 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 For suspended piping, provide hangers within 450 mm (18 in) of each joint, at each change of direction, and within 450 mm (18 in) of the terminal end of each pipe run.

.3 Assemble and tighten mechanical sleeve joints to coupling manufacturers recommended torque value with torque wrench.

.4 Provide braces or tie-rods on horizontal piping NPS 5 and larger:

.1 at each branch opening or change of direction,

.2 at each pipe run coupling.

.5 Provide sway bracing on all horizontal piping where the hanger length is greater than 450 mm (18 in) from the top of the pipe to the connecting point on the structure.

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 Testing

.1 Test before piping is concealed.

.2 Cut-out and replace leaking soldered fittings, remake joints in cast iron piping, and retest.

END OF SECTION

PLUMBING FIXTURES & TRIM
22 42 13

1 GENERAL

1.1 Scope

.1 Provide plumbing fixtures and trim.

1.2 Applicable codes and standards

.1 CSA-B45 Series, Plumbing Fixtures.

.2 CSA-B125 Plumbing Fittings.

.3 CSA Z317.1 Special Requirements for Plumbing Installations in Health Care Facilities.

.4 CSA Z318.3 Commissioning of Plumbing Systems in Health Care Facilities

.5 UL 1951 Electrical Plumbing Accessories

.6 ASME A112.6.1 Supports for Off-the-Floor Plumbing Fixtures for Public Use

1.3 Fixture count

.1 Determine number and location of fixtures from Architectural drawings. In the absence of architectural drawings, refer to Mechanical drawings.

1.4 Fixture quality standards

.1 Fixtures and trim of same type to be product of one manufacturer.

.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: chrome plated.

.4 Water supply faucet spouts fitted with aerators.

.5 Floor mounted water closets fitted with china bolt caps.

.6 Where fixtures and trim are identified by manufacturers' catalogue designation these references are to establish quality standards. 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

- Eljer
- American Standard
- Crane
- Kohler
- Symmons Valve
- Waltec
- Delta Commercial
- Emco

- Beneke
- Centoco
- Kindred
- Waltec
- Architectural Metals

2 PRODUCTS

2.1 Stainless Steel Sink Type "S-1"

.1 Sink: single bowl countertop mounted sink, round, 18-1/8” dia. x 8" deep, 18-10 type 302 18 GA stainless steel. Slef-rimming, no ledge, bright mirror finish rim, satin finish bowls. Fully undercoatd to reduce condensation and resonance, mounting kit. 3-1/2” crumb cup strainer with NPS 1½ tailpiece.

Standard of Acceptance

- Kindred
- Kohler

.2 Supply Fitting: C.P, 8” centerset, lead free bronze construction with one piece concealed rough body. Swing gooseneck spout with vandal-resistant 1.5 GPM laminar. 4” metal color indexed vandal resistant blade handles.

Standard of Acceptance

- Chicago Faucets Model 786-E36V-ABCP Two handle faucet

.3 Trap: C.P. polished heavy cast brass adjustable body, 1-1/2" (38 mm) with cleanout plub. Seamless brass wall bend and escutcheon.

Standard of Acceptance

- McGuire 8912CB

.4 Supplies, C.P., polished brass, rigid horizontal nipples 3/8" x 3" long I.P.S., heavy all brass angle stops with V.P. loose key, escutcheons, and flexible copper risers.

Standard of Acceptance

- McGuire Model LFH165LKN3

.5 Thermostatic Water mixing valve (TMV): Provide tempered water to hot side of valve from “TMV” installed in ceiling space. Nickel plated bronze body, temperature adjustable spindle, 3/8” inlets and outlet FNPT connections, integral checks. Set valve temperature at 115 deg F.

Standard of Acceptance

- Lawler

2.2 Stainless Steel Sink Type "S-2"

.1 Sink: single compartment, 2-hole, overall dimension 15”x15”x 9" (deep), countertop mounted, back ledge, 18 GA. type 304 stainless steel, bright mirror finish rim, satin finished bowl. Self rimming, full undercoated for condensation and sound deadening, bottom blow rack and mounting kit. 3-1/2” crumb cup strainer with NPS 1½ tailpiece.

Standard of Acceptance

- Kohler K-3840

.2 Supply Fitting: chrome plated, 4” centerset, deck mounted faucet with swing gooseneck spout, non-aerating laminar flow, 1.0 GPM flow outlet, 4” metal vandal proof wristblade handles with blue and red index buttons.

Standard of Acceptance

- Chicago Faucet 895-317-GN2A-E2805-5ABCP
- Delta

.3 Trap: C.P. polished cast brass adjustable body, 1-1/2" (38 mm) with cleanout plub. Seamless brass wall bend and escutcheon.

Standard of Acceptance

- McGuire
- OS&B

.4 Supplies, C.P., polished brass, rigid horizontal nipples 3/8" x 3" long I.P.S., heavy all brass angle stops with V.P. loose key, escutcheons, and flexible copper risers.

Standard of Acceptance

- Delta Teck
- McGuire

.5 Thermostatic Water mixing valve (TMV): Provide tempered water to hot side of valve from “TMV” installed in ceiling or below counter. Nickel plated bronze body, temperature adjustable spindle, 3/8” inlets and outlet FNPT connections, integral checks. Set valve temperature at 115 deg F.

Standard of Acceptance

- Delta Teck
- Lawler

2.3 Sealant between fixture and wall finish:

.1 One part acetoxy silicone sealant

.2 White or clear colour

.3 Formulated with fungicide

Standard of Acceptance

- Tremco Tremsil 200
- Dow Corning
- GE

3 EXECUTION

3.1 Fixture installation

.1 Support fixtures level and square and connect with supplies, drains, traps and vents.

.2 Hot water faucets to be on left.

.3 Fixtures on outside walls to have water supplies from floor, other fixtures to be served from walls.

.4 Mounting heights for wall hung fixtures and showers to be measured from finished floor.

.5 Provide field installed in-line brass bodied swing check valves on the hot and cold water supplies to each TMV unit. For greater certainty, if the TMV unit is supplied with integral check valves they are deemed not to meet this requirement.

3.2 Protection

.1 Plumbing fixtures and trim to be covered 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.

3.3 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 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.

.7 Floor mounted water closet bowls to be set in mastic.

3.4 Hot Water Temperature Limits

.1 Test, adjust and set high temperature limit stops on shower fixtures to supply a maximum water temperature of 49°C (120°F).

.2 Test, adjust and set temperature control on thermostatic mixing valves to supply a maximum water temperature of:

.1 49°C (120°F) for group showers, and

.2 29°C (85°F) for emergency showers.

.3 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.

.4 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.

END OF SECTION

HEATING AND COOLING PIPING SYSTEMS GENERAL
23 05 01

1 GENERAL

1.1 Scope

.1 Provide heating and cooling piping systems.

1.2 Hot water heating system

.1 Piping design code:

.1 to ASME B31.9 Building Service Piping

.2 System design criteria.

.1 Constant temperature system:

(a)	Supply temperature:	180 °F
(b)	Return temperature:	160 °F
(c)	Maximum working pressure:	125 psi
(d)	Design pressure:	150 psi

2 PRODUCTS

2.1 n/a

3 EXECUTION

3.1 Pipe installation

.1 General layout of mains, risers, run-outs and connection details of piping systems are shown.

.2 Provide bends, expansion loops, hoses or joints to compensate for pipe expansion and contraction.

.3 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.

.4 Erect piping so that expansion forces, gravity forces and thrust from changes in direction do not stress connections to apparatus.

.5 Mechanical grooved pipe, couplings, fittings and valves may be used for water and glycol piping systems in place of welded, flanged or threaded pipe jointing methods, where operating temperature conditions are in range -30°C through 110°C

.6 Separate copper pipe and fitting materials from contact with ferrous material with di-electric couplings.

.7 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.

END OF SECTION

STEEL PIPE AND FITTINGS - HEATING AND COOLING
23 21 13

1 GENERAL

1.1 Scope

.1 Provide steel pipe and fittings for systems where working temperatures are in range of -10°C to 120°C (14°F to 248°F) and working pressure is less than 860 kPa (125 psi).

1.2 Shop drawings

.1 Submit shop drawings where pipe assemblies with fittings, elbows and flanges are shop fabricated.

1.3 Applicable codes and standards;

.1 Provide materials to:

- .1 ASTM A47 Standard Specificatin for Ferritic Malleable Iron Castings.
- .2 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- .3 ASTM A106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
- .4 ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High-Pressure or High-Temperature Service, or Both.
- .5 ASTM A536 Standard Specification for Ductile Iron Castings.
- .6 ANSI A21.11 Rubber Gasket joints for Ductile-Iron Pressure Pipe and Fittings
- .7 ANSI B1.20.1 Pipe Threads, General Purpose (inch)
- .8 ANSI/ASME B16.1 Cast Iron Pipe Flanges And Flanged Fittings
- .9 ANSI/ASME B16.3 Malleable Iron Threaded Fittings.
- .10 ANSI/ASME B16.5 Pipe Flanges and Flanged Fittings
- .11 ANSI/ASME B16.9 Factory Made Wrought Steel Buttwelding Fittings
- .12 ANSI/ASME B16.20 Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed.
- .13 ANSI/ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges.
- .14 ANSI/ASME B18.2.1 Square and Hex Bolts and Screws,
- .15 ANSI/ASME B18.2.2 Square and Hex Nuts
- .16 CSA B242 Groove and Shoulder Type Mechanical Pipe Couplings
- .17 CSA W47.1 Certification of Companies for Fusion Welding of Steel.

.2 Install piping to:

- .1 AMSI/ASME B31.9 Building Service Piping

2 PRODUCTS

2.1 Steel pipe for heating and cooling water and glycol service

.1 Hydronic piping service, carbon steel:

.1 NPS 1/2 to 10:

(a) ASTM A106 Gr B, schedule 40 seamless, or
(b) ASTM A53 Gr B, schedule 40 Electric Resistance Weld (ERW).

2.2 Pipe joints for sizes NPS 2 and under

.1 Threaded:

.1 threaded malleable iron fittings, Class 150 to ANSI B16.3

.2 1030 kPa (Class 150) black malleable iron, bronze face, ground joint unions.

Standard of Acceptance
° Anvil

2.3 Pipe joints for sizes NPS 2 ½ and over

.1 Welding fittings:

.1 wall thickness to match pipe

.2 butt weld type to ANSI B16.9

.2 Flanges:

.1 raised face style to CSA W47.1

.2 cast iron Class 150 to ANSI B16.1.

.3 forged steel, 1035 kPa (150 #) to ANSI B16.5, weld neck with wall thickness to match pipe, or slip on type.

.4 studs, bolts and nuts to ANSI B18.2.1, ANSI 18.2.2 and ASTM A194, “high strength” type.

.5 gaskets to ANSI B16.21, ANSI B16.20 or ANSI A21.11 of red rubber sheet 1.6 mm ($^{1}/_{16}$ in) thick

Standard of Acceptance
° Chesterton 100
° Beldam Red Rubber

.3 Rolled or cut grooved standard or rigid fittings and couplings:

.1 to CSA B242 with dry lubricated EPDM gaskets,

.2 malleable iron to ASTM A47 or ductile iron to ASTM A536 for grooved piping in sizes NPS 2 ½ to 12,

.3 fabricated steel in sizes NPS 14 and over

.4 maximum working temperature is less than 100EC (210EF)

Standard of Acceptance
° Victaulic
° Gruvlock

- Couplox
- Shurjoint

3 EXECUTION

3.1 Piping installation

.1 Pipe joints:

.1 Piping NPS 2 and smaller: tapered pipe threads to ANSI B1.20.1and teflon tape or pipe thread sealant similar to Masters Pro-Dope

.2 Piping NPS 2½ and larger: welded with butt weld fittings or made up with grooved pipe and couplings.

.2 Equipment connections:

.1 NPS 2 and smaller: unions and threaded fittings

.2 NPS 2 ½ and larger: flanged connections.

.3 Install concealed pipes close to building structure to keep furring spaces to minimum and minimize obstruction to other services in ceiling spaces.

.4 Run exposed piping parallel to walls and conserve headroom and space. Group piping wherever practical.

.5 Slope main piping up in direction of flow 1:1000.

.1 Branch piping to have greater slope.

.6 Use eccentric reducers at pipe size changes arranged flat on bottom to assist venting.

.7 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.8 Ream pipe after cutting to length and clean off scale and dirt inside and outside of pipe before threading grooving or welding.

.9 Cap ends during construction to prevent entry of foreign matter.

.10 Branches may be welded directly into main provided main is more than NPS 4 and branch is at least 2 pipe sizes smaller than main. Cut openings in main true and beveled. Branch pipes are not to project inside main pipe. Openings to be sized to prevent entry of welding metal and slag into pipes.

.11 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.

3.2 Groove joint piping

.1 Make pipe ends clean and free of indentations, projections and roll marks, between the end of the pipe and the groove.

.2 Verify gasket style and material grade with supplier for use with intended service.

.3 Provide for manufacturers' service representative to conduct on-site training prior to piping rough-in and installation.

3.3 Flushing and cleaning

.1 After hydraulic pressure test, flush to drain with clean water for minimum of four hours.

.2 Isolate system from other piping systems. Drain and fill with solution of water and non-foaming, phosphate free detergent, 3% by weight. Provide temporary pump for additions to existing systems and circulate solution for minimum of eight hours.

.3 Flush to drain with clean water for four hours. Remove and clean strainers.

.4 Drain and refill system with clean water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

END OF SECTION

COPPER PIPE AND FITTINGS - HEATING AND COOLING
23 21 14

1 GENERAL

1.1 Scope

.1 Provide copper pipe and fittings for systems where working temperatures are in range of -10°C to 120°C (14°F to 248°F), working pressures are less than 1035 kPa (150 psi), and maximum pipe size is NPS 4.

1.2 Applicable codes and standards

.1 ASTM B88 Standard Specification for Seamless Copper Water Tube

.2 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250

.3 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings

.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 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

.7 AWWA C111/ ANSI A21.11 Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

.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 B32 Specification for Solder Metal

2 PRODUCTS

2.1 Copper pipe

.1 Type K hard drawn copper tubing to ASTM B88.

2.2 Fittings

.1 Cast bronze to ANSI B16.18.

.2 Wrought copper and bronze to ANSI B16.22.

2.3 Flanges

.1 Brass or bronze to ANSI B16.15.

2.4 Solder

.1 95:5 tin: antimony solder to ANSI B16.18 and ASTM B32

3 EXECUTION

3.1 Application

.1 Copper piping to be used for;

.1 Hot water and low temperature heating system,

.2 Exterior zone heating and cooling system,

3.2 Piping installation

.1 Connect to equipment with flanged connections where pipe size is NPS 2 ½ and larger and with unions and screwed fittings where connections are NPS 2 and smaller.

.2 Install concealed pipes close to building structure to keep furring spaces to minimum and minimise obstruction to other services in ceiling spaces.

.3 Run exposed piping parallel to walls and conserve headroom and space. Group piping wherever practical.

.4 Slope main piping up in direction of flow 1:1000. Branch piping to have greater slope.

.5 Use eccentric reducers at pipe size changes arranged flat on bottom to assist venting.

.6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.7 Ream pipes and clean scale and dirt from both inside and outside before assembly.

.8 Isolate steel pipe and equipment from copper pipe with di-electric fittings or bronze adapters manufactured for this purpose.

.1 Bronze body valves may be used for di-electric isolation.

3.3 Flushing and cleaning

.1 After pressure test, flush to drain with clean water for minimum of four hours.

.2 Isolate system from other piping systems. drain and fill with solution of water and non-foaming, phosphate free detergent, 3% by weight. Provide temporary pump for additions to existing systems and circulate solution for minimum of eight hours.

.3 Flush to drain with clean water for four hours. Remove and clean strainers.

.4 Drain and refill system with clean water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

.5 Drain and refill system with clean water adding water treatment chemicals.

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

1.2 Qualified tradesmen

.1 Work to be done by qualified tradesmen holding certificates of competency.

1.3 Applicable standards

.1 The Ontario Building Code

.2 Regulations of Province, City, or local authority having jurisdiction.

2 PRODUCTS

2.1 Not Used

3 EXECUTION

3.1 Ductwork

.1 Ductwork system routing is shown diagrammatically. Drawings are not considered to be 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 absorb thrust.

3.2 Air supply equipment

.1 Install and connect air handling units, and air conditioning units, 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 devices

.1 Locate and install terminal boxes, registers, diffusers, and grilles

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

DUCTWORK
23 31 13

1 GENERAL

1.1 Scope

.1 Provide metal ductwork systems as shown.

1.2 Applicable Codes and Standards

.1 Installation standards and codes

.1	NFPA 90A	Installation of air conditioning and ventilating systems.
.2	NFPA 90B	Installation of warm air heating and air conditioning systems.
.3	ASHRAE	Letter and number designations, shown as “CR3-16" etc., are taken from ASHRAE Duct Fitting Data Base.(DFDB)
.4	ANSI/SMACNA	HVAC Duct Construction Standards - Metal and Flexible (2005 edition)

.2 Product standards:

.1	ASTM A90/M	Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
.2	ASTM A653/M	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
.3	ASTM A924/M	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
.4	ASTM A1011/M	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
.5	ASTM A283/M	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
.6	ASTM A36/M	Standard Specification for Carbon Structural Steel
.7	ASTM A480/M	Specification for General requirements for Flat Rolled Plate, Sheet, and Strip
.8	ASTM A463/M	Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
.9	ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

1.3 Shop Drawings and Application Details

.1 Submit manufacturer's catalogue literature for;

.1 Proprietary joints,

.2 Hardware.

.2 Submit field/fabrication drawings at 1:50 (¼ inch=1 foot) or larger scale, with piping, ductwork, and fittings in double line format, to show;

.1 arrangements in congested areas,

.2 where installation proposed deviates substantially from layout shown, and

.3 where installation requires joints for field assembly in welded duct construction.

.3 For greater clarity, do not submit field/fabrication drawings for other areas of the Work.

.4 Submit schedules and details to show;

.1 fabrication details of

(a) connections to risers in duct shafts
(b) balancing damper construction,
(c) fittings where geometry contemplated is different from that specified.

.2 in chart form

(a) duct system pressure class,
(b) duct sheet gauges,
(c) joint types and application criteria,
(d) location criteria and dimensions for bracing, stiffeners and balancing dampers
(e) duct leakage class, and
(f) extent of sealing.

1.4 Record Drawings

.1 As work progresses, mark-up field drawings and submit as part of record of “As-Built” conditions.

1.5 Qualifications

.1 Ductwork systems to be provided by firm having an established reputation in this field.

2 PRODUCTS

2.1 Basic material

.1 Galvanized steel:

.1 Ducts and connectors: lock forming quality to ASTM A653 or ASTM A924,

(a) Z275(G90) for indoor ductwork,

.2 Miscellaneous pipe, angles, strips and threaded rod in contact with ductwork: galvanized with a minimum thickness equal to ASTM A653 - Z180 (G60).

2.2 Joints

.1 Flanged duct joints:

.1 proprietary roll-formed flanges, corner pieces, integral edge seals, gaskets and cleats.

.2 material to match that of ductwork being joined.

Standard of Acceptance
- Ductmate – System 25/35/45
- Carlisle Canada - Nexus

2.3 Sealant and tape

.1 To section 23 33 05 Duct Accessories.

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 Seismic supports and restraints to Section 20 05 49 Seismic Restraint

2.5 Duct access doors

.1 To section 23 33 05 Duct Accessories.

3 EXECUTION

3.1 Construction

.1 Construction details, sheet gauges, reinforcing, and bracing to be taken from SMACNA HVAC Duct Construction Standards - Metal and Flexible except as otherwise shown.

.2 Rectangular ductwork:

.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 sealing requirements.

.3 Round ductwork, 500 Pa (2 in wg) pressure class and higher:

.1 spiral flat type longitudinal seam, button punched.

3.2 Pressure classification and seal class

.1 Low pressure ductwork construction classification:

Table 1: Duct Pressure Classification

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)

Table 1: Duct Pressure Classification			
Pressure class Pa (in wg)	Operating pressure Pa (in wg)	Velocity m/s (fpm)	Leakage Test Pressure Pa (in wg)
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 2.

.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 2: Duct System Pressure and Seal Class				
No.	Ductwork System	Static pressure construction class Pa (in.wg.)	Seal class	Sealing requirements (1)(2)(3)(4)
1	Induction unit supply from fan discharge to unit plenum box inlet.	+1000 (4) and up	A	Transverse joints, longitudinal seams, ductwall penetrations, and other connections
2	Supply risers in vertical service space (duct shafts).	+1000 (4)	B	Transverse joints, longitudinal seams, and other connections
3	Supply air ductwork from discharge side of fan to inlet of terminal box or reheat coil in healthcare and laboratory facilities.	+1000 (4)		
4	Return/exhaust air ductwork between HEPA filters and suction side of fan.	-1000 (4)		
5	Return/exhaust air ductwork between a Heat Recovery Wheel and suction side of fan.	-1000 (4)		
6	Autopsy exhaust ductwork.	-1000 (4)		

Table 2: Duct System Pressure and Seal Class

No.	Ductwork System	Static pressure construction class Pa (in.wg.)	Seal class	Sealing requirements (1)(2)(3)(4)
7	Supply air ductwork from discharge side of fan to inlet of terminal box or reheat coil; Return air ductwork on discharge side of fan.	+750 (3)		
8	Return/Exhaust risers in mechanical rooms and vertical service spaces (duct shafts).	-750 (3)		
9	Supply air ductwork upstream of HEPA filters, including diffusers with integral HEPA filters.(5)	+750 (3)		
10	Return and/or exhaust air ductwork on suction side of fans other than in mechanical rooms and vertical service spaces.	-500 (2)	C	Transverse joints and other connections
11	Supply air ductwork on downstream side of terminal units or reheat coil; Exhaust air ductwork on discharge side of fan; Fan coil units, suction and discharge.	250 (1)	C	Transverse joints only
12	Supply air and return air ductwork from roof top air conditioning units, 5 tons or less	125 (½)	D	No sealing

Notes for table 2:

(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 box or reheat coil which serve diffusers with integral HEPA filters.

3.3 Fittings - Rectangular 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 descending order as listed in table 3.

(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 3: 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 Unvaned elbow	1.5	≤ 300 (12)	---	Default
			1.0	> 300 (12)	---	
2	CR3-3	Smooth radius Vaned elbow	0.75	≤ 900 (36)	150 (6)	One full radius single thickness splitter vane
	CR3-4	Smooth radius Vaned elbow	0.75	> 900 (36) ≤ 1500 (60)	150 (6)	Two full radius single thickness splitter vane
	CR3-5	Smooth radius Vaned elbow	0.75	> 1500 (60)	150 (6)	Three full radius single thickness splitter vane
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.
4	CR3-2	Radius Heel Sharp Throat	0.5	---	---	Double thickness turning vanes as per CR3-3, 4 or 5 depending on duct width

.2 First elbow on discharge side of fan:

(a) fitting CR3-1, unvaned 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 4.

Table 4 : Rectangular Duct, Wye and Tee Branch Fittings - Supply Air Systems

Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
1	For 750 Pa (3 in.w.g) pressure class and above: branch take-off from ducts in shafts, and ducts	Smooth radius wye; diverging	SR5-1

Table 4 : Rectangular Duct, Wye and Tee Branch Fittings - Supply Air Systems			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
	upstream of terminal boxes, filters and reheat coils	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 5.

Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Return/Exhaust Air Systems

Ref. No.	Return/Exhaust Ductwork System	Fitting Type	ASHRAE Fitting No
1	All pressure classes including branch connections at duct shafts	Smooth radius wye; converging	ER5-1
		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 ductside and direction of flow,

.2 diverging: maximum 15° angle between ductside 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.

3.4 Fittings - Round Ductwork

.1 Refer to Annex A at the end of this Section for illustrations of referenced fitting types.To

.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
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.

Table 7 : Round Duct, Wye and Tee Branch Fittings

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

Table 7 : Round Duct, Wye and Tee Branch Fittings			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
5	Return or exhaust duct branches; smaller branch size.	Tee, tapering, with 45° elbow	SD5-12

3.5 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.

3.6 Finishing, fastening and supports

.1 Hammer edges and slips to leave smooth finished surface inside duct.

.2 Support vertical ducts with angles rivetted to duct and bearing on building structure.

.3 Hangers;

.1 Duct side up to maximum 500 mm (20") supported with strap hangers of same material as duct but one sheet metal thickness heavier.

.2 Extend strap hangers down duct side and turn under 50 mm (2") fastening securely to side and underside of duct.

.3 Duct side greater than 500 mm (20") supported with trapeze hangers constructed from galvanized steel angle with steel rods in accordance with table 8;

Table 8 : Duct Hangers		
Duct size mm (in)	Angle size mm (in)	Rod size mm (in)
up to 750 (up to 30)	25x25x3 (1x1x⅛)	6 (¼)
750 to 1050 (30 to 40)	40x40x3 (1½x1½x⅛)	6 (¼)
1050 to 1500 (40 to 60)	40x40x3 (1½x1½x⅛)	10 (⅜)
1500 to 2400 (60 to 90)	50x50x3 (2x2x⅛)	10 (⅜)
2400 and over (90 and over)	50x50x6 (2x2x¼)	10 (⅜)

.4 Maximum hanger spacing: 2.4 m (8 ft) on centre.

.5 Seismic restraints: to Section 20 05 49 *Seismic Restraints*.

3.7 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") thick filter media secured with tape. Maintain media until dust producing finishing operations are completed.

3.8 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 9.

Table 9 : Access Door Sizes

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)

3.9 Leak testing

.1 Test air duct systems for leaks at 1.00 times pressure specified for class as follows;

.1 between supply air handling units and terminal units

.2 between supply air handling units and air supply outlets on supply systems without terminal units

.3 between inlet grilles and exhaust/return fan inlet, and fan outlet and exhaust or mixing plenum, on return/exhaust systems,

.4 following parts of system are exempt from pressure testing;

(a) short duct runs of 15 metres (45 feet) or less, operating at 37 Pa (1/8 in) SP or less.
(b) ductwork installed downstream of terminal boxes and fan coil units.

.2 Conduct test in accordance with Associated Air Balance Council (AABC) recommended procedures.

.3 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.

.4 Allowable ductwork leakage to be lesser of,

.1 1% of system airflow, or

.2 value calculated from following formula;

$$F = K \times C_L \times P^{0.65}$$

$$L = (A \times F) / 100, \text{ or}$$

$$L = (A \times K \times C_L \times P^{0.65}) / 100$$

Table 10: Flow Measurement Units

	Term	Flow Measurement		
		m^3/s	l/s	CFM
F	leakage coefficient	m^3/s per $100m^2$	l/s per m^2	CFM per 100 ft^2
C_L	leakage coefficient	Refer to table 11 below		
P	test pressure	kPa	kPa	in.wc.
L	Allowable leakage	m^3/s	L/s	CFM
A	Duct surface area	m^2	m^2	ft^2
K	unit conversion	1.24×10^{-2}	1	1

Table 11: Leakage Coefficient, C_L

Duct Type	Seal Class		
	C	B	A
Rectangular metal	24	12	6
Round Metal	12	6	3
Unsealed rectangular metal duct	48	48	48
Unsealed round or oval metal duct	30	30	30

.5 Calculate duct surface area for each test section and determine allowable leakage in accordance with formulae above. Test duct at pressure for specified class for 15 minutes. If leakage rate exceeds allowable value, caulk and seal joints, and repeat testing caulking and sealing process until measured leakage rate is less than calculated allowable value for section under test.

.6 Maintain 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 TAB Agent, identifying each segment of duct system tested, showing calculation of allowable leakage, test pressure and leakage value measured under test, and certifying that leakage testing has been satisfactorily completed.

3.10 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.

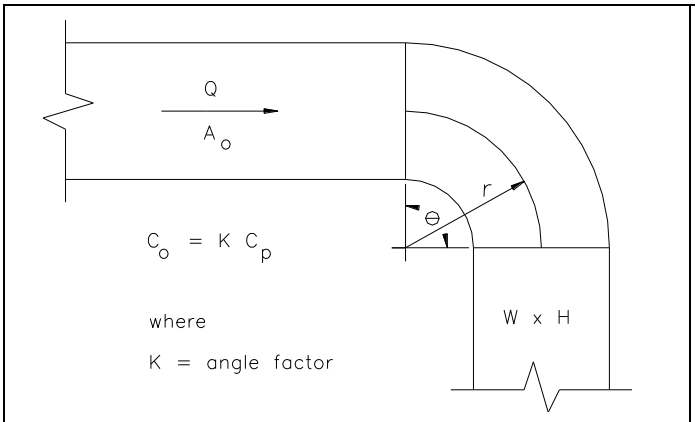
.6 Submit a written report, verified by TAB Agent, identifying extent of duct system cleaning and certifying that NADCA standards have been met.

3.11 Fitting Illustrations

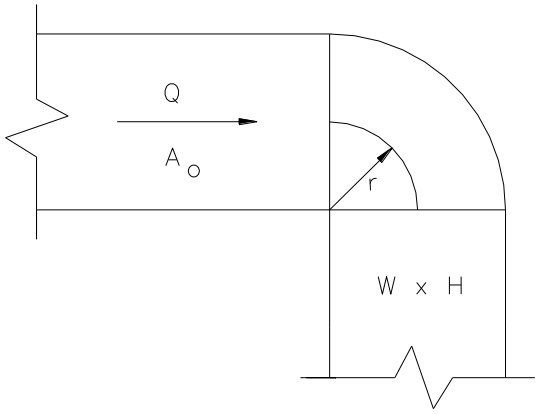
.1 Illustrations of fitting referenced in this specification follows in Annex A.

Annex A – Illustration of Referenced Fittings

Rectangular Elbows (see Table 3)



CR3-1



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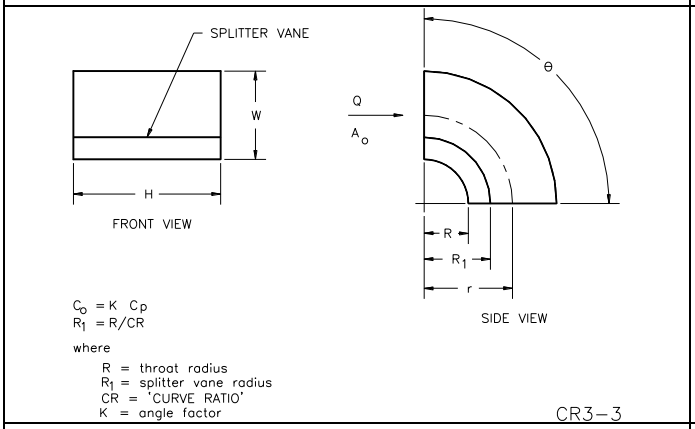

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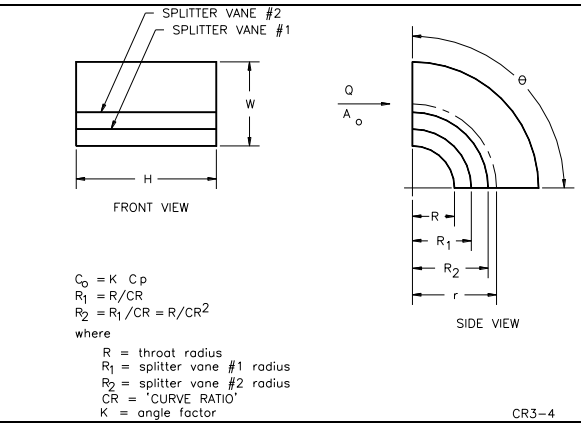

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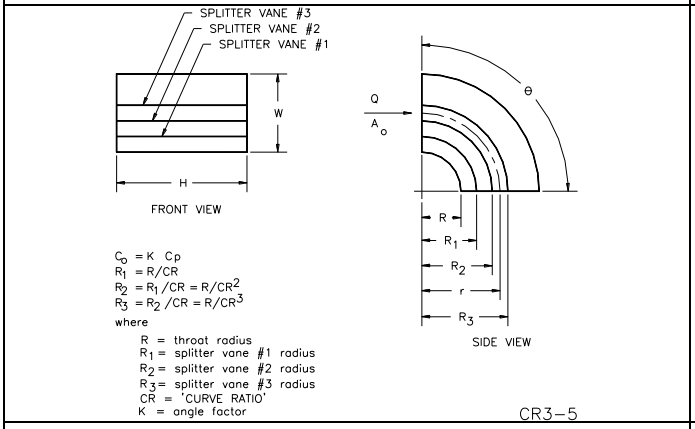

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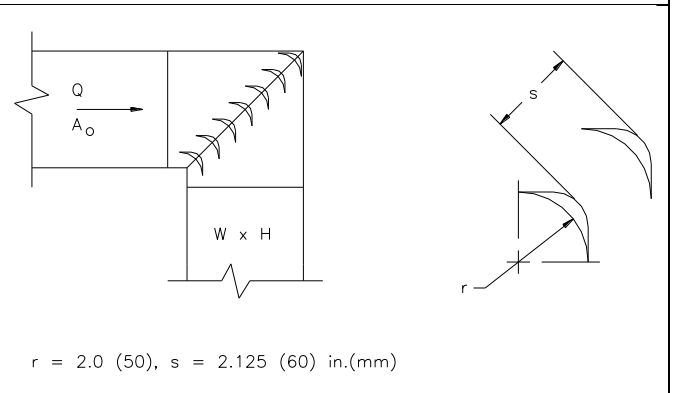
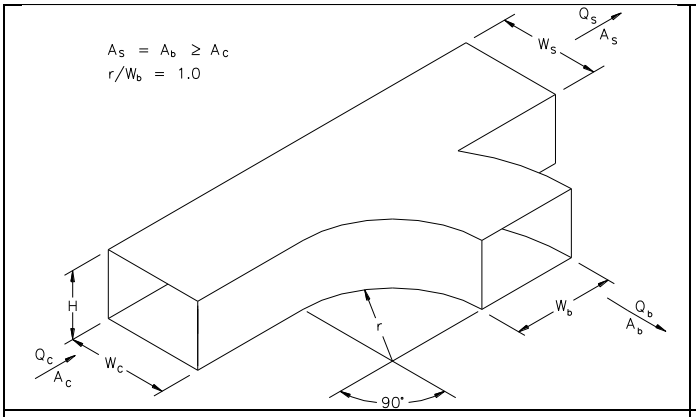
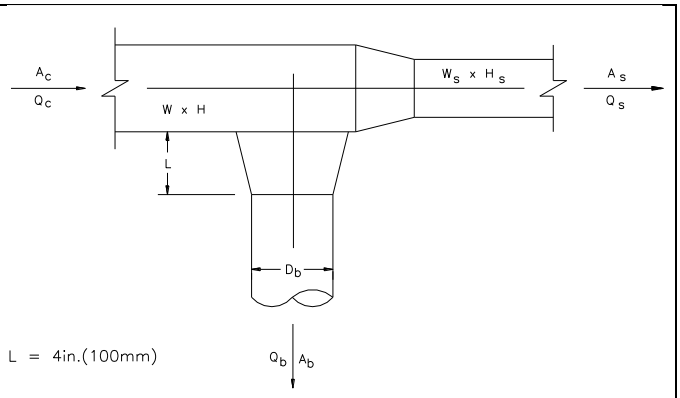


CR3-15

Rectangular Wyes and Tee's – Supply Ductwork (see Table 4)



SR5-1



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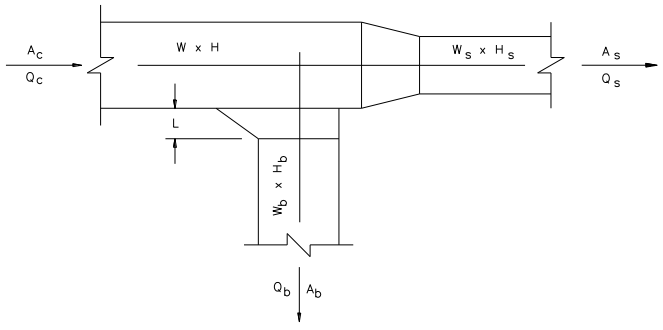

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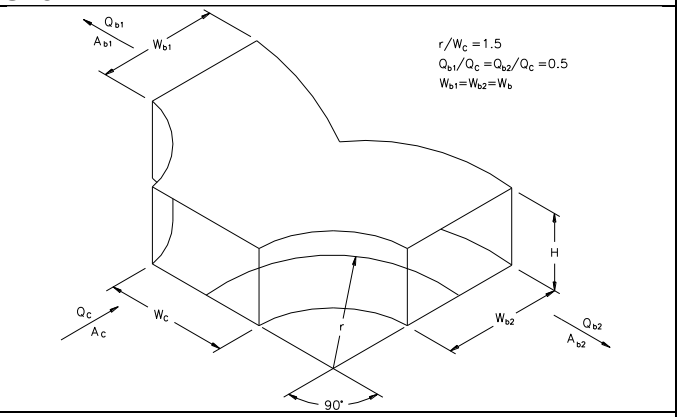
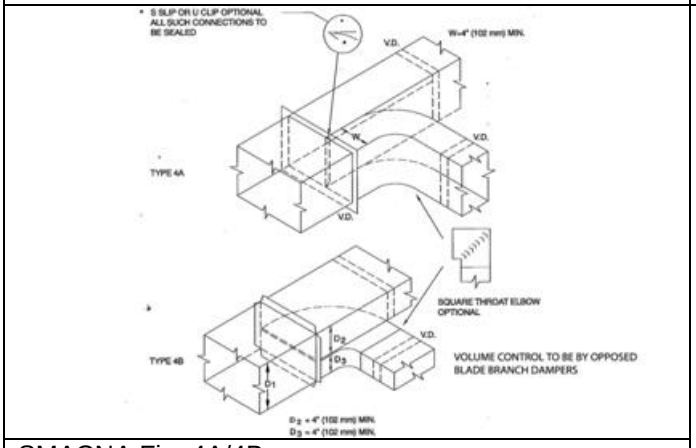
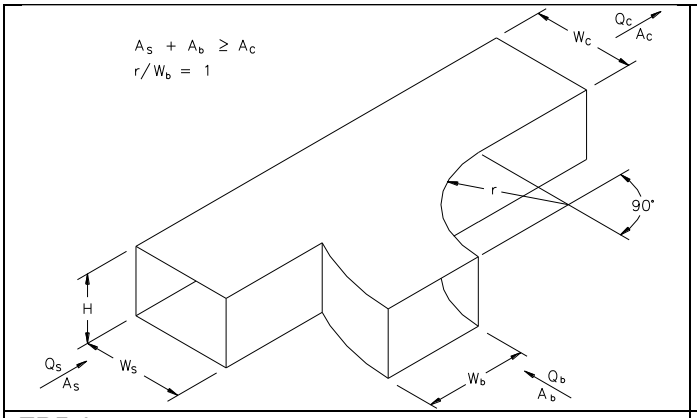


SR5-14

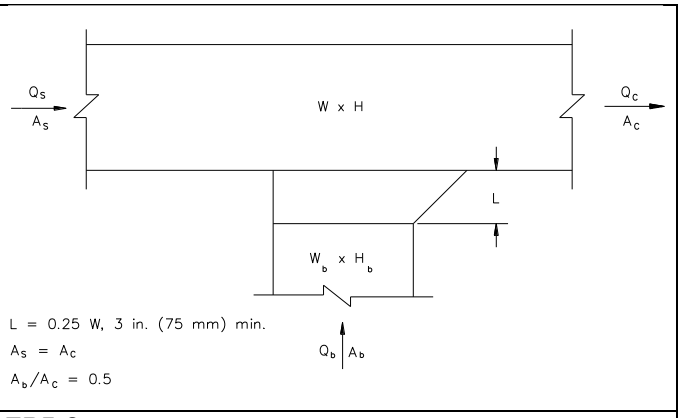


SMACNA Fig. 4A/4B

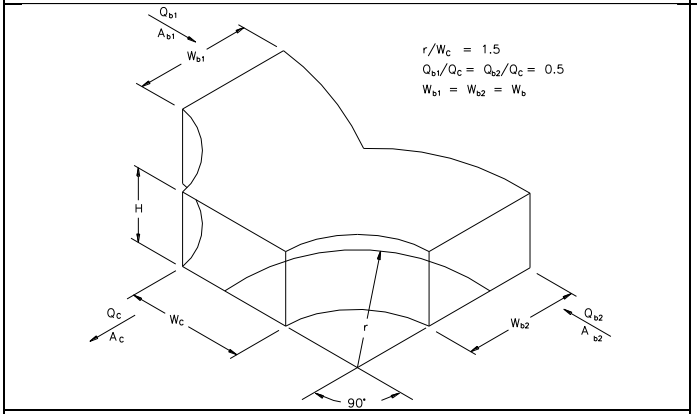
Rectangular Wyes and Tee's – Return/Exhaust Ductwork (see Table 5)



ER5-1

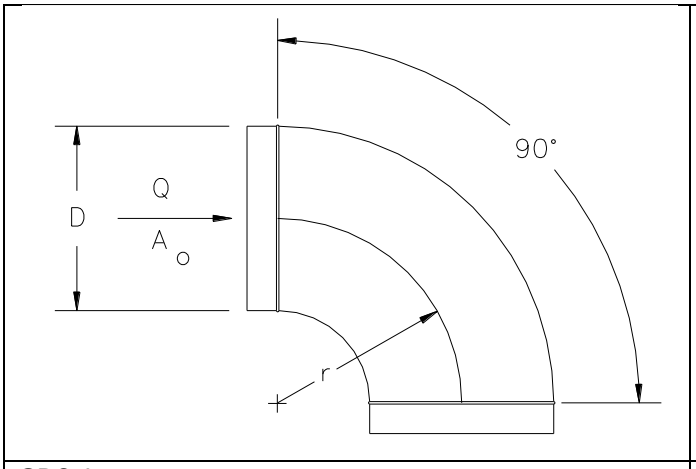


ER5-3

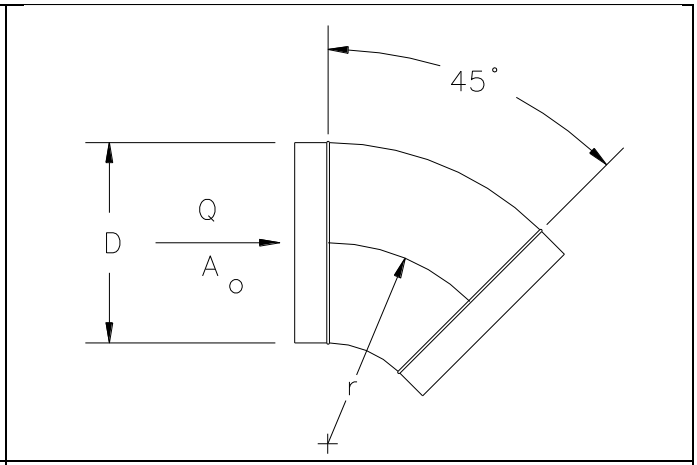


ER5-4

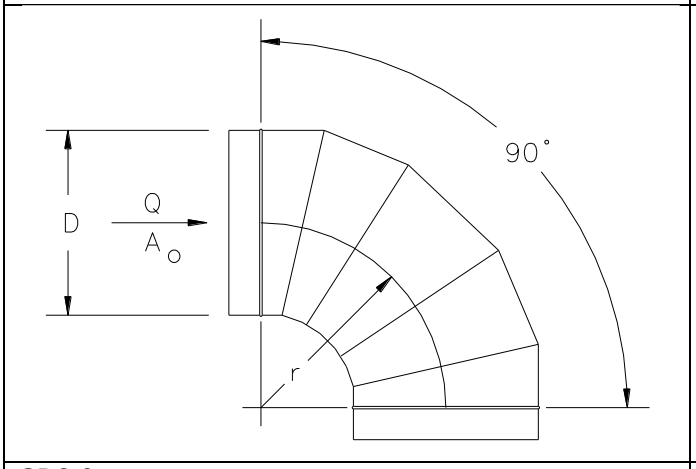
Round Elbows (see Table 6)



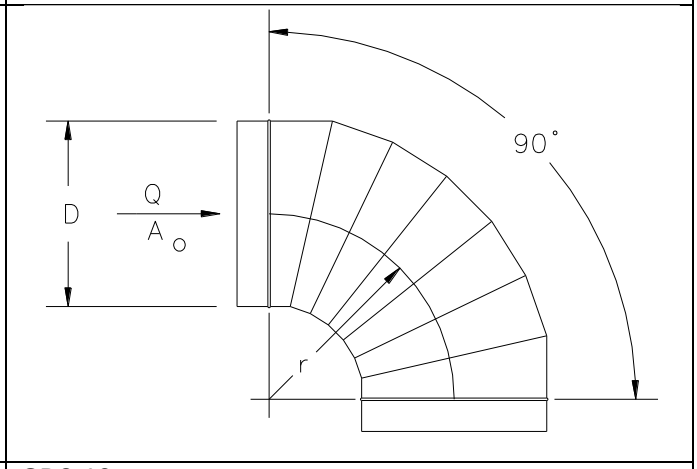
CD3-1



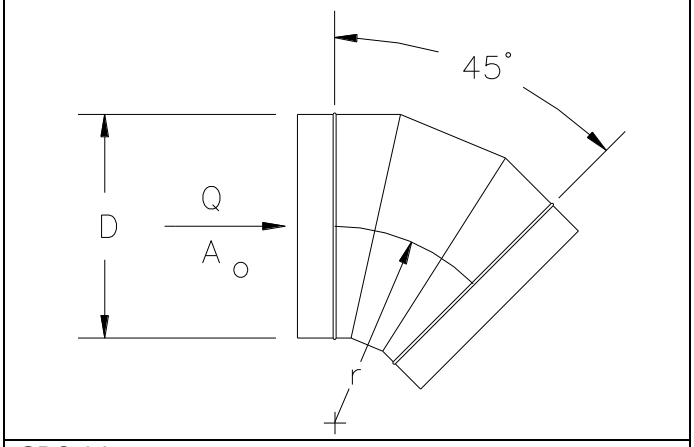
CD3-3



CD3-9

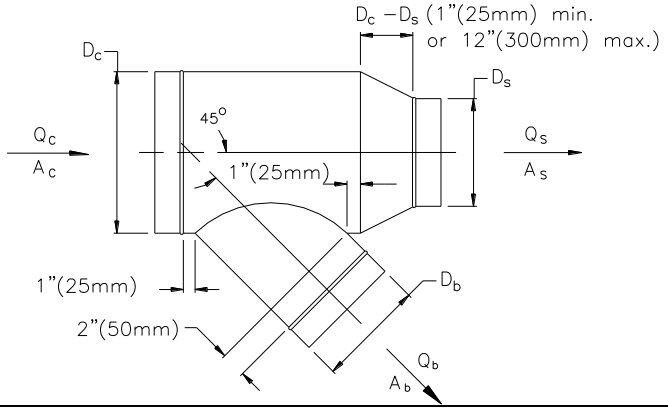


CD3-10

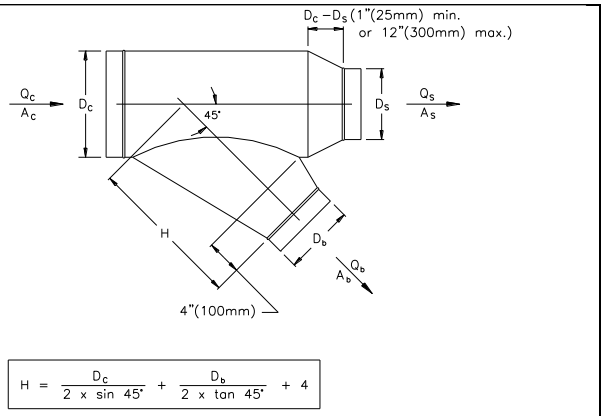


CD3-14

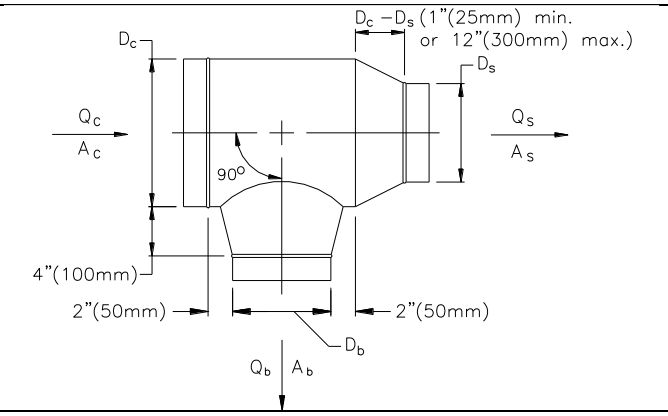
Round Wyes and Tees (see Table 7)



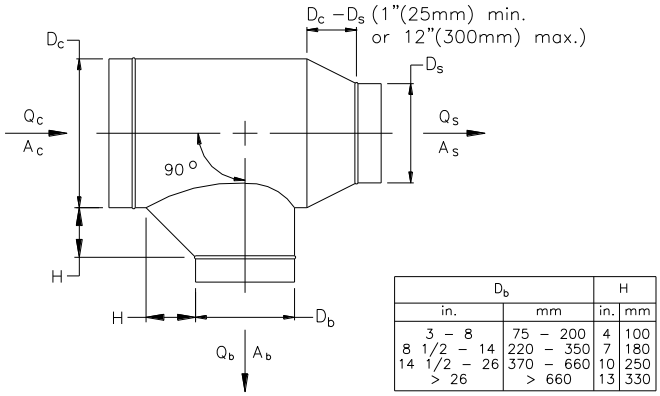
SD5-1



SD5-2

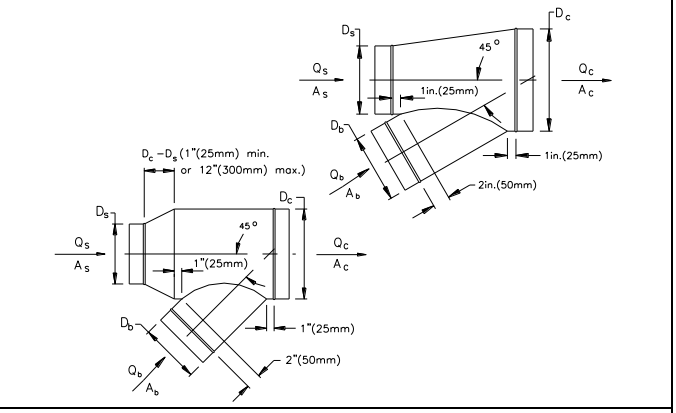


SD5-10



Db		H	
in.	mm	in.	mm
3 – 8	75 – 200	4	100
8 1/2 – 14	220 – 350	7	180
14 1/2 – 26	370 – 660	10	250
> 26	> 660	13	330

SD5-12



ED5-2

END OF SECTION

DUCT ACCESSORIES
23 33 05

1 GENERAL

1.1 Scope

.1 Provide duct accessories as shown.

1.2 Shop drawings

.1 Submit product data sheets for:

.1 sealants

.2 tapes

.3 duct access doors and hardware

.4 instrument test ports

2 PRODUCTS

2.1 Sealant

.1 water based polymer emulsion type flame resistant duct sealing compound.

.2 operating temperature range: -29EC to 93EC (-20EF to 200EF).

Standard of Acceptance
- Bakor 530 - 14
- RCD #6
- 3M Fastbond 900
- Childers CP-145a & CP-146
- United Duct Sealer (water based)
- Duro Dyne DWN (water based)

2.2 Tape

.1 polyvinyl treated open weave glass fibre tape, 50mm (2") wide.

Standard of Acceptance
- Duro-Dyne FT-2

2.3 Duct access doors

.1 Construction - uninsulated duct or plenum:

.1 shop or field fabricated from same material as duct, one sheet metal thickness heavier but not less than 0.6mm (26ga.) thick,

.2 with gasketed sheet metal angle frame.

.2 Construction - insulated duct or plenum:

.1 shop fabricated as double wall insulated sandwich, of same material as duct, one sheet metal thickness heavier but not less than 0.6mm (26ga) thick,

.2 with gasketed sheet metal angle frame and 25 mm (1") thick rigid glass fibre insulation.

.3 gasketed with neoprene or foam rubber.

.4 fitted with hardware as follows; two sash locks for doors up to 300mm x 300mm (12" x 12").

.1 four sash locks for doors up to 301mm x 450mm (13" x 18").

.2 piano hinge and minimum 2 sash locks for doors up to 451mm x 1000mm (19" x 40")

.3 piano hinge and 2 handles operable from both sides for doors over 1000mm (40") in height.

Standard of Acceptance

° Duro-Dyne SP-21 for door handles

2.4 Instrument test ports

.1 Construction:

.1 1.6mm (16ga.) thick steel body zinc plated after manufacture,

.2 chain secured neoprene expansion plug with cam lock handle,

.3 28mm (1") minimum inside diameter, length to suit insulation thickness,

.4 Neoprene mounting gasket: flat for rectangular duct and moulded for round duct.

Standard of Acceptance

° Duro-Dyne IP1 or IP2

3 EXECUTION

3.1 Sealant and tape

.1 Apply to ductwork joints and seams as detailed in other sections.

3.2 Access doors

.1 Install in ductwork;

.1 before and after reheat coils, and at

.2 fire dampers,

.3 duct smoke detectors,

.4 volume control devices, and

.5 control elements.

.2 Weld door frames in place for plenums, casings, and high velocity ductwork.

.3 Door sizes:

.1 as large as possible, with 1:1.5 aspect ratio, for duct sides up to and including 360 mm (14"),

.2 300 mm x 380 mm (12 in x 15") for duct sides 380 mm (15") and larger,

.3 1500 mm (60") high by 450 mm (18") wide in casings and plenums.

3.3 Instrument test ports

.1 Install for duct velocity traverse readings and for duct air temperature readings.

.2 Locat across duct or plenum at right angles to flow, at not more than 250 mm (10") intervals for traverses and at not more than 500 mm (20") for temperature measurements.

.3 Install for velocity traverses;

.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 where branch serves more than one outlet. Ports in main to be upstream of branch in both diverging and converging flow.

.4 Install 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

DAMPERS - BALANCING
22 33 13

1 GENERAL

1.1 Scope

.1 Provide balancing dampers as shown.

2 PRODUCTS

2.1 Splitter dampers

.1 Construction:

.1 single thickness construction, of same material as duct but one sheet metal thickness heavier where both dimensions of damper blade are less than 300 mm (12 in),

.2 double thickness construction, one metal thickness lighter than duct, where either dimension of damper blade is 300 mm (12 in) or larger,

.3 of 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 Construction:

.1 shop fabricated of same material and sheet metal thickness as duct, stiffened with longitudinal V-grooves.

.2 maximum aspect ratio: 3:1,

.3 maximum blade height: 250 mm (10 in).

.4 fitted with locking quadrant and inside and outside bearings.

2.3 Multi-blade dampers in rectangular ductwork

.1 Construction:

.1 shop fabricated of same material and sheet metal thickness as duct, stiffened with longitudinal V-grooves.

.2 opposed blade configuration

.3 channel frame with angle blade stop..

.4 maximum blade height: 100 mm (4 in),

.5 maximum blade length: 1200 mm (48 in).

.6 bearings with bronze bushings.

.7 shaft extension with locking quadrant.

2.4 Single blade dampers in round ductwork

.1 Construction:

.1 shop fabricated butterfly type with round edged 3.5 mm (10 ga) disk set in round sheet metal housing, fitting snugly when closed, 10 degrees from vertical,

.2 fitted with rubber packing glands, shaft extension, wing nuts, and indexing device to indicate disk position.

3 EXECUTION

3.1 Manual dampers

.1 Install dampers:

.1 where branch serving more than two outlets is taken from main supply duct, use splitter damper in take-off fitting, or single or multiple blade damper in branch.

.2 where branch joins main return or exhaust duct use single or multiple blade damper in branch .

.2 Install splitter dampers and single or multiple blade dampers where branches are taken from or feed into main ducts as specified above.

.3 Provide other manual dampers as shown.

3.2 Access for adjustment

.1 Locate dampers to allow adjustment of blade position and locking of quadrant.

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 Shop drawings

.1 Submit manufacturer's data sheets with equipment model numbers, performance and design data, outline dimensions, support recommendations and connection details.

2 PRODUCTS

2.1 General

.1 Grilles, registers and diffusers:

.1 product of one manufacturer where same model or type identification is used.

.2 standard catalogue products selected to meet capacity, throw, and noise level.

.3 prime coated, stamped or cold rolled steel material with mitred corners and exposed joints welded and ground smooth.

.4 extruded satin finish, clear anodized aluminum material with mitred corners and mechanical fasteners.

.5 Frames with full perimeter gaskets, plaster stops where set into plaster or gypsum board, and concealed fasteners.

2.2 Type designations

.1 Diffuser, register and grille schedule identifies model or type identifiers used on floor plans with model numbers taken from listed manufacturer's catalogue.

.2 Where several manufacturer's model numbers are given, these are acceptable alternatives.

.3 Where only one manufacturer's model number is given, provide designated item.

Standard of Acceptance
- E.H. Price
- Tuttle & Bailey
- Titus
- Hart & Cooley
- Carnes
- Nailor
- MetalAire

2.3 Supply registers

.1 double deflection style with face bars vertical and rear bars horizontal,

.2 perimeter border with gasket,

.3 opposed blade dampers (OPD) with concealed manual operator,

.4 of steel or aluminum material.

2.4 Return and exhaust grilles

.1 single deflection type, with horizontal face bars, 20 maximum turn up,

.2 perimeter border with gasket,

.3 opposed blade damper with concealed operator,

.4 of steel or aluminum material.

2.5 Diffusers

.1 circular or square multiple cone or perforated face type, with adjustable pattern control,

.2 of steel or aluminum material.

2.6 Linear grilles

.1 aluminum bar core type with margin as indicated, pattern adjustment, plaster frames, sealing strips, end caps, mitred corners and alignment key strips for multiple sections.

.2 capable of supporting {90kg}{200lb} point loads where installed as floor grilles.

2.7 VAV diffusers

.1 variable geometry thermostatically controlled type, with [electric][self-contained][pneumatically] operator.

Standard of Acceptance
- Acutherm
- Titus
- Warren

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 reflected ceiling drawings and select trim to suit ceiling materials listed in Finish Schedules.

3.2 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 In gymnasium provide safety chain on each diffuser face and core and bolt diffuser in place.

.3 For laminar flow diffusers, with or without HEPA filters, support diffuser from the building structure with steel cable, independent of ceiling system and ductwork.

.4 For security grilles and diffusers, and other grilles and diffusers exceeding 5 kg (12 lbs) weight, mechanically fasten grille/diffuser to ceiling or wall structure, independent of ductwork connection or support.

3.3 Installation of grilles and registers

.1 Install supply registers with face bars vertical and exhaust and return registers with face bars horizontal.

.2 Install registers and grilles with oval head cadmium plated screws in countersunk holes where fastenings are visible.

3.4 Installation of diffusers

.1 Diffusers to be installed with concealed fastenings.

.2 Round, square and rectangular diffusers to be provided with equalizing deflectors, mounted in neck, accessible from diffuser face, with blades oriented at right angles to direction from which air is flowing.

.3 Except for last diffuser on branch, each diffuser installed in underside of supply duct to have extract volume control damper.

END OF SECTION