

***MECHANICAL
SPECIFICATIONS***

for

***AQUAVISTA CONDOMINIUM
EAST BAYSIDE
TORONTO, ONTARIO***

prepared for

Tridel Development Corporation

***Issued for Tender
October 15, 2015***

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.

1.02 APPLICATION

- .1 This Section applies to and is part of all Sections of Division 15.
- .2 Perform All Work specified herein by experienced and licensed personnel.

1.03 DEFINITIONS

- .1 Wherever the term "The Consultant" is used in the Division 15 Drawings and Specifications it means MCW Consultants Limited, 207 Queen's Quay West, Suite 615, Toronto, Ontario, M5J 1A7. Tel. No. (416) 598-2920.
- .2 Wherever the term "install" (and tenses of "install") is used in the Division 15 Drawings and Specifications it means install and connect complete.
- .3 Wherever the term "supply" is used in the Division 15 Drawings and Specifications it means supply only for installation by other subtrades or under separate contract.
- .4 Wherever the terms "Provide" or "Provision of" are used in relationship to equipment, piping, other materials and systems specified for the Work of Division 15, it means "Supply, Install and Connect and make operable to specified performance". Wherever the terms "Provide" or "Provision of" are used in connection with services such as testing, balancing, start-up, preparation of Drawings and commissioning for any part of the Work of Division 15, it means procure, prepare, supervise, take responsibility and pay for these services.
- .5 Wherever "Drawings and Specifications" are referred to, it means "the Contract Documents".
- .6 Wherever the terms "Authorities" or "Authorities having jurisdiction" are used in the Division 15 Drawings and Specifications it means any and all agencies that enforce the applicable laws, ordinances, rules, regulations or codes of The City of Toronto. Refer to Division One.
- .7 Wherever the term "Work" is used in the Division 15 Drawings and Specifications it means all equipment, permits, materials, labour and Services to provide a complete Mechanical installation as described and detailed on the Drawings and in the Specifications.
- .8 Wherever the term "Performance" is used in the Division 15 Drawings and Specifications in relation to specified equipment, it means the specified capacity of that equipment as it applies to provide air, steam or water flow, heating and/or cooling within the specified conditions of operation including air, steam and water pressures, physical space limitations and noise levels.
- .9 Wherever the term "Acceptable" is used in the Division 15 Drawings and Specifications it means acceptable to the Consultant.

1.04 WORK INCLUDED

- .1 Sections of Division 15 are not intended to delegate functions nor to delegate Work and supply to any specific trade. The Work of Division 15 includes all labour, materials,

equipment, permits and tools required for a complete and working installation as described in the Division 15 Specifications and Drawings and is not necessarily limited to items in the following Sections:

15010	Mechanical General Requirements
15050	Mechanical Basic Materials and Methods
15100	Vibration Isolation and Noise Control
15180	Insulation
15200	Water Treatment
15400	Plumbing
15500	Fire Protection
15700	Heating and Cooling
15725	Variable Speed Drives
15800	Air Distribution
15900	Controls

- .2 This project will be undertaken to allow for LEED® Certification. Division 15 Contractor must carefully review the LEED scope of work in preparing their Bid for this Project and the successful Division 15 Contractor must follow the requirements and bear all costs associated with services required to meet these requirements:
- .3 A commissioning agent will be appointed to fully commission the mechanical systems for this project. The commissioning agent will be involved in design stage, construction stage, performance testing stage, including seasonal performance testing, training stage and operations and maintenance documentation stage. Division 15 Contractor must carefully review the LEED scope of work in preparing their Bid for this Project and the successful Division 15 Contractor must follow the requirements of this Section and bear all costs associated with services required to assist commissioning agent.

1.05 REGULATORY REQUIREMENTS

- .1 Comply with requirements of all Municipal, Provincial and Federal Bylaws and Ordinances as well as requirements of Utilities such as Ontario Gas Utilization Code and The Ontario Electrical Safety Code.
- .2 Do not reduce quality of any part of the Work specified and/or shown on the Drawings by following regulatory requirements.
- .3 In general and as applicable, perform all Work of Division 15 to comply with physical and chemical properties, characteristics and performance requirements of recognized associations and agencies as listed herein and in the following:

ACCGH	- American Conference of Governmental Industrial Hygienists
AMCA	- Air Moving & Conditioning Association
ADC	- Air Diffusion Council
ANSI	- American National Standards Institute
ARI	- Air Conditioning & Refrigeration Institute
ASCII	- American Standard Communication Information Interchange
ASHRAE	- American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	- American Society of Mechanical Engineers
ASTM	- American Society for Testing and Materials
AWWA	- American Water Works Association
CGA	- Canadian Gas Association
CGSB	- Canadian General Standards Board
CIRI	- Canadian Industrial Risk Insurers

CSA	- Canadian Standards Association
CTI	- Cooling Tower Institute
EIA	- Electronic Industry Association
FCC	- Fire Commissioner of Canada
ISA	- Instrument Society of America
IAO	- Insurers Advisory Organization
MTC	- Ministry of Transportation and Communication
NBCC	- National Building Code of Canada
NFPA	- National Fire Protection Association
OBC	- Provincial Ontario Building Code
OFM	- Local Fire Codes or Standards Ontario Fire Marshall
MOEE	- Ontario Ministry of Environment and Energy
OML	- Ministry of Labour and Workmen's Compensation Requirements
OWRA	- Ontario Plumbing Code
TSSA	- Technical Standards & Safety Authority
UL	- Underwriter's Laboratories Inc.
ULC	- Underwriter's Laboratories of Canada

1.06 STANDARDS

- .1 Provide new materials and equipment of proven design and quality. Provide current models of specified equipment with published ratings certified by recognized North American testing and standards agencies.
- .2 Comply with ASHRAE/IES 90.1, 2001 Standards in the supply and installation of all parts of the Work.
- .3 Comply with Regulations Amending the Energy Efficiency Regulations P.C. 2004-965 1 September 2004 for the following equipments:
 - .1 Water Chiller - To meet the requirements of CSA C743.
 - .2 Electric Water Heater - To meet the requirements of CAN/CSA C191-00.
 - .3 Gas Fired Water Heater - To meet the requirements of CSA – P.3-04.
- .4 Conform to the best modern practices of workmanship and installation methods and employ only skilled tradesmen working under the direction of fully qualified personnel.

1.07 PERMITS, FEES & INSPECTIONS

- .1 Apply for, obtain, and pay for all permits, licences, inspections, examinations and fees required for Work of Division 15. Also submit, if required by the Authorities, information such as heat loss calculations, and other data that may be obtained from the Consultant. Should the Authorities require the information on specific forms, fill in these forms by transcribing thereto the information as provided by the Consultant.

If the municipality is structured as a "single permit jurisdiction", the Contractor will apply, pay for and obtain the municipal building permit. In this case, the Division 15 Subcontractor has no financial obligation for permit application except for permits not covered in the "single permit".

- .2 Arrange for inspection of all Work by the Authorities having jurisdiction over the Work. On completion of the Work, present to the Consultant the final unconditional certificate of acceptance of the inspecting Authorities.

- .3 Arrange and pay for inspection of all Work by TSSA for Gas, Fuel and Oil Piping Systems. On completion of the Work, present to the Consultant the final unconditional certificate of acceptance of the inspecting Authorities.
- .4 In case of conflict, codes and regulations take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the Drawings and Specifications by applying any of the codes referred to herein.
- .5 Before starting any work, submit the required number of copies of Drawings and Specifications to the Authorities for their approval and comments. Comply with any changes requested as part of the contract, but notify the Consultant immediately of such changes. Prepare and submit any additional drawings, details or information as may be required.

1.08 CONTRACT DRAWINGS

- .1 The Drawings for Mechanical Work are performance drawings, diagrammatic, intended to convey the scope of work and indicate general arrangement and approximate location of apparatus, fixtures and pipe runs. The Drawings do not intend to show Architectural and Structural details.
- .2 Do not scale Drawings. Obtain information involving accurate dimensions from dimensions shown on Architectural and Structural Drawings, and by site measurement.
- .3 Make, at no additional cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (pipes or ducts around beams and columns and other structural elements).
- .4 Alter, at no additional cost, the locations of materials and/or equipment as directed that do not necessitate additional material.
- .5 Install ceiling mounted or exposed components (e.g. diffusers, sprinkler heads, grilles) in accordance with reflected ceiling drawings or floor plans.
- .6 Confirm on the site the exact location and mounting elevation of outlets and fixtures as related to Architectural and Structural details.

1.09 EXAMINATION OF THE SITE AND DOCUMENTATION

- 1. Prior to submitting tender, carefully examine conditions at the site which could affect the Work of this Division. Refer to and examine all Contract Documents.
- 2. Verify that materials and equipment can be delivered to the Place of the Work and that sufficient space and access is available to permit installation thereof in locations shown on the Drawings.
- 3. Verify location and elevation of existing services (water, electrical, sanitary, storm sewers, equipment, ductwork and piping) which may affect the Tender and Work of this Division. Repair any damage to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.
- 4. Refer also to room finish schedules to determine finished, partially finished and unfinished areas of the building.

1.10 CO-ORDINATION DRAWINGS

- .1 Prepare drawings in conjunction with all trades concerned, showing sleeves and openings for passage through structure, and all inserts, equipment bases, sumps, pits and supports, and relate these to suitable grid lines and elevation datum.
- .2 Prepare interference and co-ordination drawings for all areas where the work of this Division could conflict with and/or obstruct the work of other trades and/or other Sections of this Division. Submit drawings for acceptance by the Consultant.

1.11 SHOP DRAWINGS

- .1 Submit shop drawings for items and equipment specified in the sections of Division 15.
- .2 Present a schedule of shop drawings two (2) weeks after the award of contract indicating drawings submission and equipment delivery dates.
- .3 In addition to project identification, date, etc., the form of stamp used in drawings review will contain the following format.

Drawing:	Reviewed	()
	Reviewed As Modified	()
	Revise and Re-Submit	()
	Not Reviewed	()

This stamp to be applied by the Consultant to each and every shop drawing.

- .4 This review by the Consultant is for the sole purpose of ascertaining conformance with the design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which to remain with the Contractor, and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or responsibility for meeting all requirements of the contract documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of the work of other interfacing Trades as well as compliance with codes and requirements of Authorities.
- .5 For equipment, provide performance, physical and operating data as described in the Specifications and listed in equipment schedules. Provide performance curves for all pumps and for any fans as described in Section 15800. Include sound power data for any equipment such as fans and chillers where this data is included in the specification or listed on equipment schedule.
- .6 Identify the equipment by system name and number, e.g., "S1, second floor, air supply", "P1, chilled water pump", etc.
- .7 Provide dimensions and mounting details for all items of equipment, and weight and support point loads of equipment weighing in excess of 14 kg (30 lbs.).
- .8 All dimensions, weights and performance characteristics to be in the same units used in the Specifications and shown on the Drawings (SI or Imperial). Drawings submitted not in conformance with the foregoing will be rejected.
- .9 Where equipment is specified with control panels or electrical control components such as float switches, control valves, level controllers, relays and the like, provide wiring diagrams and component descriptions that are specific to the item. General data covering a wide range of similar devices or components is not acceptable.

- .10 Bind one complete set of checked shop drawings in each operating and maintenance instruction manual.

1.12 RECORD DRAWINGS

- .1 The drawings for this Project have been prepared using REVIT. The consultant will produce record (as-built) drawings from information shown on the contractor mark-up prints from site.
- .2 Obtain a set of white prints and as the job progresses, mark this set to accurately indicate installed work. Show location by dimension from walls or columns for all buried services as well as invert depths. Have these white prints available for inspection at the site at all times and present for scrutiny at each job meeting.

1.13 PRODUCT STANDARDS AND ALTERNATIVES

- .1 Provide new material and equipment as specified and to acceptance of the Consultant. Manufacturers' names are listed to set a standard of quality, performance, capacity, appearance and serviceability. Acceptable alternative Manufacturers are also listed, and their products may be used in the Work subject to conditions stipulated in paragraph .3 of this Article.
- .2 Where no other acceptable Manufacturers are indicated, provide only as specified. Requests for acceptance of manufacturers not listed must be submitted not less than seven working days prior to closing date of the tender. Submissions must bear proof of acceptance by the Consultant.
- .3 Assume full responsibility for ensuring that when providing acceptable alternative Manufacturers, all performance, space, weight, connections (mechanical and electrical), power and wiring requirements, are within the scope of the item specified, and costs for any variances therefore are included in the tender. Equipment requiring greater than specified energy requirements and greater installation and service space requirements will not be accepted.
- .4 All electrically operated equipment and electrical materials to bear the label of approval of CSA or be so stamped or have special approval of the Authorities. All material, wiring and devices to conform to the Canadian Electrical Code for the purpose for which they are to be used. All electrical equipment to be designed and manufactured in accordance with applicable EEMAC and ANSI specifications.
- .5 All gas fired equipment to bear the label of the CGA or be so stamped.
- .6 All plumbing products such as fixtures, faucets, flush valves and shower heads to bear the label of approval of the CSA or be so stamped.

1.14 PATENTS

- .1 Pay all royalties and licence fees, and defend all suits or claims for infringement of any patent rights, and save the Owner and Consultant harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters patent or rights.

1.15 RIGHTS RESERVED

- .1 Rights are reserved to issue any additional Detail Drawings, which in the judgement of the Consultant may be necessary to clarify the Work, and such Drawings shall form a part of the Contract.

1.16 EQUIPMENT NAMEPLATES

- .1 Provide apparatus (including electric motors) with proper nameplates affixed thereto, showing the size, name of equipment, serial number and all information usually provided, which also includes voltage, cycle, phase and horsepower of motors and the name and address of the Manufacturer.

1.17 EXPEDITING AND DELIVERIES

- .1 Continuously check and expedite delivery of equipment and materials. If necessary, inspect at the source of manufacture.
- .2 Ensure that materials and equipment are delivered to the site at the proper time and in such assemblies and sizes so as to enter into the building and to be moved into the spaces where they are to be located without difficulty. Perform any cutting and patching involved in getting assemblies into place.
- .3 Continuously check and expedite the flow of necessary information to and from all parties involved.
- .4 Immediately inform the Consultant of any difficulties in delivery of equipment.
- .5 Provide delivery records updated monthly.

1.18 SUPERINTENDENCE

- .1 Maintain at this job site, at all times, qualified personnel and supporting staff with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.

1.19 TRIAL USAGE, TESTS AND COMMISSIONING

- .1 Include, as part of the Work, trial usage of Mechanical Systems and equipment for the purpose of testing and commissioning and assisting Owner's staff in learning operational and maintenance procedures.
- .2 Assist in trial usage over a length of time sufficient to confirm specified equipment capacities and operating characteristics. Maintain full responsibility for all mechanical equipment and systems required to temporarily operate during trial usage. Warranty period commencement for any equipment operated during trial usage will not occur until all Mechanical Work is substantially complete.
- .2 Provide all testing required on Mechanical System components and equipment where, in the opinion of the Consultant, specified performance is not being achieved.

1.20 SPECIAL CLEANING

- .1 Vacuum clean and remove debris from the inside of air handling systems, fans, ducts, coils and terminal units.

- .2 Clean exposed surfaces of Mechanical equipment, ductwork and piping. Polish plated work.
- .3 Comb all bent fins to proper configuration on all coils in air handling units, fan coil units, entrance heaters and on finned radiation elements.

1.21 COMPLETION

- .1 After successful completion of tests and adjustments, remove temporary covers, and strainers, and obstructions to flow. Drain, flush and refill piping systems as often as required until all piping is clear of all debris.
- .2 Provide a clean set of filters on each air handling system, fan coil unit and unitary heater.
- .3 Provide new filter elements in pump seal filters.
- .4 Leave Mechanical work in specified working order.
- .5 Provide spare components as specified in Section 15500 and Section 15900.

1.22 WARRANTIES

- .1 Provide warranties on specified products, equipment and components as well as on the installation of these items. Include for all costs for cutting and patching, removal of equipment and restoration materials and work and repairs to other equipment affected in performance of warranty work.
- .2 Provide warranty certificates, wherever given or required, that are in excess of the normal warranty period showing the name of the firm giving the warranty, dated and acknowledged, on specific equipment and systems.
- .3 Warranty periods for chillers, variable speed drives, boilers and temperature controls to start on the date of verification of acceptance issued in writing by the Consultant.

The date of verification of acceptance is independent of Substantial Performance of the Work and may occur after certification of Substantial Performance.

Chillers and boilers will be accepted after start-up, a minimum of six hours of logged operation and submission of written verification of same by manufacturer's representative. Refer to Section 15725 for requirements for acceptance of variable speed drives. The Consultant must also witness a portion of any of these this procedure.

- .4 Include verification of acceptance certificates with the maintenance and operating manuals in the appropriate sections.

1.23 INSTRUCTIONS TO OWNER'S STAFF

- .1 Instruct the Owner's designated staff on all aspects of the operation of systems and equipment. Advise the Consultant at least one week in advance of the schedules of all instruction sessions.
- .2 Obtain the services of Subtrade and Manufacturers' representatives to provide information and instructions on each part of the Mechanical Work and on items of equipment.

1.24 DOCUMENTATION AND SYSTEMS ACCEPTANCE

- .1 Provide the following on substantial performance of the work:
 - .1 One set of valve charts set in glazed frames mounted on the project as directed by the Consultant.
 - .2 Air and water balancing report. (The Work of Division 15 will not be considered totally performed until acceptance by the Consultant of the air and water balancing report notwithstanding that the air and water balancing may be undertaken under separate contract.)
 - .3 As constructed drawings including temperature control drawings.
 - .4 Three manuals assembled in three ring binders with index tabs, each containing:
 - .1 This Subcontractor's name, address and telephone/fax numbers
 - .2 Suppliers and Subtrades names and telephone numbers
 - .3 Equipment data sheets (dimensions, capacities, electrical characteristics)
 - .4 Maintenance, operating and lubricating instructions for each item of equipment
 - .5 Wiring diagrams for each item of equipment
 - .6 Copies of valve charts for the project
 - .7 A complete set of checked shop drawings for all equipment provided by this Division.
 - .8 Certificates for:
 - .1 Boiler start-up and commissioning
 - .2 Chiller and refrigeration system start-up and commissioning
 - .3 Water treatment
 - .4 Rooftop HVAC Equipment start-up and commissioning
 - .5 Rooftop Heating and Ventilation Equipment start-up and commissioning
 - .6 Control and Building Automation Systems commissioning
 - .7 Variable speed electric drives commissioning
 - .8 Piping pressure tests (domestic water, fire protection heating/cooling piping) certifying system tested, pressure held, time of test and date and certification by the commissioning agent.

1.25 MECHANICAL LIST OF MANUFACTURERS, SUBTRADES & PRICES

- .1 Submit with the tender the List of Manufacturers, Subtrades and prices appended to the Division 15 Specifications.
- .2 At the time of tender closing, list the names of Manufacturers and subtrades (one per item) carried as well as the total cost of Mechanical Work and any separate, unit and alternative prices where indicated.

.3 If specified or acceptable alternative Manufacturers are not listed or more than one Manufacturer per item is listed, or Manufacturers not specified are listed, the Consultant will have the option of making the selection of the Manufacturers.

.4 Substitution of listed Manufacturers or Subtrades after close of Tender will not be accepted.

1.26 UTILITY SERVICES

.1 Coordinate, arrange, and pay for all required utility connections (natural gas) as shown on the Drawings, complete with all required metering. Install all metering equipment as well as service connections in accordance with municipal and utility requirements. Pay for all inspection fees arising out of the installation of these services.

.2 Bear all costs and co-ordinate with Enbridge Consumers Gas to provide a natural gas service from the nearest street main into the building. Pay for all inspection fees, metering devices and any work performed by Enbridge Consumers Gas.

PART 2 - PRODUCTS

NIL

PART 3 - EXECUTION

NIL

END OF SECTION 15010

PART 1 - GENERAL

1.01 DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Section 15010 Mechanical General Requirements.

1.02 SUBMITTALS

- .1 Submit shop drawings on access doors, valves, strainers, expansion tanks, thermometers and gauges, expansion compensators, grooved end components and motor starters.

PART 2 - PRODUCTS

2.01 ACCESS DOORS

- .1 Provide rounded safety corners hinged access doors as constructed of primed 16 gauge steel as manufactured by William Brothers or Acudor equal to fire rating of wall or ceiling in which installed.
- .2 Provide doors with minimum size of 300mm x 300mm (12" x 12"). Access doors to be sized of adequate size to permit service of equipment and/or resetting dampers. Provide minimum size of 600mm x 460mm (24" x 18") where personnel entry is required.
- .3 Provide for plaster surfaces recessed 16 ga. prime painted steel door and welded metal lath, ready to take plaster. Provide with concealed hinge and stainless steel studs with brass sleeves.
- .4 Provide for tiled surfaces, recessed type 16 ga. primed steel (stainless steel for ceramic tile and shower areas) doors to suit type and dimension of tile used. Size door to be as close as possible to 300mm x 300mm (12" x 12") by fitting to single or multiple tile dimensions. Provide with concealed hinges and stainless steel studs with brass sleeves.
- .5 Provide, to suit wall surface or type of construction, other factory prime coated access doors of welded 16 gauge steel, flush type with concealed hinges, lock and anchor straps.
- .6 Lay-in type ceiling tiles, properly marked, may serve as access panels.
- .7 Access doors in fire rated construction shall be ULC listed and labelled, meeting the requirements of Authorities having jurisdiction and rated to maintain the fire separation integrity.

2.02 PIPE AND FITTINGS

- .1 Corrosion Prevention
 - .1 Provide V-line insulating couplings as supplied by H & G Specialities Limited, or accepted alternative dielectric couplings, for prevention of galvanic corrosion at specific points where connections are required between copper, brass or bronze and black or galvanized steel piping.
 - .2 Other acceptable manufacturers EPCO, Watts.

- .2 All fittings 50mm (2") and below connecting to equipment: Use unions, extra heavy duty pattern, having ground joints, brass seats and diagonal screws.
- .3 Connections to equipment 65mm (2 1/2") and above: Flanged, standard weight provided with ring gaskets.
- .4 Cooling coil condensate: drainage grade copper tubing with copper drainage fittings with 50-50 solder.
- .5 Chilled water, condenser water, glycol solution circuits, compressed air and Heating:
 - .1 Schedule 40 ASTM specification A53 wrought steel black pipe with heavy cast iron or standard black malleable steel threaded fittings rated at 1725 kPa (250 psi WOG) for pipe sizes up to and including 50mm (2"). Use extra heavy cast iron fittings for steam applications.
 - .2 Schedule 40 ASTM specification A53 wrought steel black pipe with standard black steel welding fittings rated at 1725 kPa (250 psi WOG) for pipe sizes 65mm (2 1/2") and over.
 - .3 Type L copper to ASTM B88-83 with 95/5 soldered wrought copper pressure fittings to ANSI B22.18-1973 (not applicable to fuel oil and stand-by generator exhaust).
- .6 Sanitary Drainage - Internal:
 - .1 Buried:
 - .1 Cast iron pipe and fittings to CSA B70-M1978.
 - .2 Where buried and accepted by Authorities: PVC or ABS pipe and fittings to CSA CAN 3-B181.1-M85 (ABS) CAN 3-B181.2-M85 (PVC) B182.1-M1983, B182.2-M1983, (large diameter PSM PVC). B182.3-M1983, (large diameter IPS PVC).
 - .2 Suspended:
 - .1 Cast iron pipe and fittings to CSA B70-M1978.
 - .2 DWV copper to ASTM B306-76 with 50-50 soldered cast brass drainage fittings to CSA B158.1-1976 or wrought copper fittings to ANSI B16-29-1973.
- .7 Sanitary Drainage - External:
 - .1 Cast iron or approved ABS or PVC with solvent weld or ring gasket joints as specified for internal buried pipe.
 - .2 Concrete to CSA Standard A257-M1982.
- .8 Vent Piping: DWV Grade copper to ASTM B306-76 with 50-50 soldered cast brass or wrought copper drainage fittings to CSA B158.1-1976 and ANSI B16-29-1973 respectively or cast iron pipe and fittings to CSA B70-M1978.
- .9 Domestic Water:
 - .1 Type L copper marked certified for compliance with ASTM B88-83 Standard with wrought copper or cast bronze pressure solder fittings to ANSI B22.18-1973 and ANSI B16.18-73 respectively. Buried piping: soft temper type K with soldered fittings to the previously mentioned standards.
 - .2 Domestic water located within suites will be in-slab plastic piping by Wirsbro. Refer to drawings for manifold locations and installation details.

- .3 IPEX AquaRise hot and cold water distribution piping in compliance with CSA B137.6, NSF 61, CAN/ULC-S102.2 and in conformance with ASTM F442 will be an equal alternate to type L copper.
- .10 Building Water Service:
 - .1 Building water service 100mm (4") and larger: Ductile iron ANSI Class 2 cement lined with Tyton joints: Approved PVC with ring gasket joints class 150 to CSA B137.3 - M1981.
 - .2 75mm (3") and smaller: Type K copper soft temper to ASTM B88-83 with soldered pressure fittings to ANSI B22.18-1973 or ANSI B16.18-73: (If more economical, use oversized Ductile Iron or PVC as previously specified).
 - .3 Where suspended between building entry point and water meter: Type L copper with wrought copper soldered fittings to ANSI B22.18-1973. Use brass flanges, nuts and bolts at equipment connections.
- .11 Soldered Fittings in Potable Water Systems: Provide lead, antimony, cadmium and zinc free solders composed of tin/copper/silver or nickel components that are acceptable to Authorities having jurisdiction.
- .12 Sewage and sump pump discharge piping: Schedule 40 ASTM A53 hot dipped galvanized steel pipe with hot dipped galvanized cast iron drainage fittings, or copper Type L to ASTM B88-83 with pressure fittings to ANSI B22.18-1973 or ANSI B16.18-73 with 50-50 solder. Where buried, use PVC class 150 to CSA B137.3.
- .13 Storm drainage piping:
 - .1 Cast iron pipe and fittings to CSA B70-M1978 where buried or suspended.
 - .2 Where buried and accepted by Authorities: PVC or ABS with solvent weld or ring gasket joints to CSA B182.1 and B182.2.
 - .3 Where external to the building, Concrete to CSA Standard A257-M1982. Where acceptable to the Jurisdiction having authority, IPEX PVC Ultra Rib pipe and fittings to CSA Standard B182.4 with maximum long term deflection of 7.5%.
- .14 Natural gas piping: Provide as required by the Authorities having jurisdiction as follows:
 - .1 ASTM A53 Schedule 40 seamless wrought steel with standard threaded malleable fittings to ANSI standard B16.3; welded in concealed areas and X-rayed if required by Authorities having jurisdiction.
 - .2 ASTM A53 Schedule 40 wrought steel seamless with standard wrought steel butt welding fittings to ANSI B16.9. Welding procedures to comply with standards as required by the Authorities having jurisdiction.
 - .3 Connections to equipment: provide extra heavy duty pattern unions with ground joints, brass seats and threads to ANSI B1.20.1. Where flanges are required, provide standard weight type to ANSI B16.1 with neoprene gaskets.
- .15 Victaulic couplings to CSA Standard B242-M1980 for fire protection, domestic hot and cold water, heating, chilled water and condenser water is acceptable provided that this application meets the approval of the Municipal Authorities who have jurisdiction at the place of the Work.
 - .1 Couplings - Victaulic housing styles 75 or FIT plain end: Malleable iron to specification A-47 or ductile iron to specification A536. In mechanical rooms use grooved couplings to be designed with angle bolt pads to provide a rigid joint. Victaulic style 07.

- .2 Gaskets: Water Services - EPDM Grade "E", with green colour code identification, conforming to ASTM D-200 for water services up to 110°C (230°F).
 - .3 Fittings - Victaulic full flow fittings manufactured of malleable iron to ASTM A-47 Grade 32510 or 35018 of ductile iron to ASTM A-536 Grade 65-4-12.
 - .4 Subject to the approval by the Engineer, Victaulic flexible couplings Style 75/77 three coupling arrangement may be used in lieu of braided flex connectors at certain equipment connections to provide vibration & attenuation.
 - .5 Acceptable Alternative: Gruvlok (Entire system by one manufacturer)
- .16 Victaulic products for domestic water services (hot and cold), to be rated for operating conditions of -34°C to +110°C (-29.2°F to 230°F) and 2067 kPa (300 psi).
- .1 Couplings: ductile iron coated with copper alkyd enamel to ASTM A - 536. Flanges to be copper alkyd enamel coated to ANSI class 125 for cast iron and class 150 for steel. Couplings shall be designed with angle bolt pads to provide a rigid joint, complete with EPDM Flush-seal gasket. Victaulic Style 606.
 - .2 Fittings: grooved copper to ASTM B-75 and grooved bronze castings to ASTM B-584-87.
 - .3 Gaskets: grade E EPDM to ASTM D-2000.
 - .4 Acceptable Alternative: Gruvlok (Entire system by one manufacturer)

2.03 VALVES

- .1 All valves to have minimum certified rating of 1725 kPa (250 psi) WOG. Refer to Section 15500 for fire protection service valves.
- .2 Gate valves:
 - .1 50mm (2") and smaller with bronze body and rising stem: Jenkins #810, Crane #428, Newman Hattersley #T607, Red and White #293.
 - .2 Valves for copper ends: Jenkins #813J, Crane #1334, Grinnell #3000, Toyo 299 or Newman Hattersley #T607, Kitz #44.
 - .3 Gate valves 65mm (2 1/2") and up: Iron body, bronze trim, OS&Y, rising stem, Jenkins #454J, Crane #4652, Toyo #421A, Grinnell #6060A or Newman Hattersley #504, Kitz #72.
 - .4 For valves 150 mm (6") and greater where mounted overhead, provide O. S. & Y. valves with chainwheel operation - length of chain to be determined on site.
- .3 Globe valves:
 - .1 50mm (2") and smaller: Grinnell #3240, Jenkins 106B, Crane #7, Toyo #221, or Newman Hattersley #13, Kitz #9.
 - .2 Valves 50mm (2") and smaller for copper ends: Grinnell #3240SJ, Jenkins #1068AP, Crane #1312, Red and White #212, Newman Hattersley Fig. 13 with adapters, Kitz #10.
 - .3 Valves 22" and greater, iron body, bronze seat and disc: Jenkins #234J, Crane #351, Red & White #400A, Newman Hattersley #731.

- .4 Swing check valves - other than at pump discharge:
 - .1 50mm (2") and smaller: Grinnell #3320, Jenkins #4092, Crane #37, Toyo #236, Newman Hattersley #47, Victaulic Series 712, Kitz #22.
 - .2 65mm (2 1/2") and larger: Iron body, brass trim, flanged: Grinnell #6300A, Jenkins #587, Crane #373, Toyo #435JA, Newman Hattersley #651, Kitz #78.
 - .3 At pump discharge use wafer type check valve as manufactured by Grinnell #300, Victaulic, Streamflo, Checkrite or M & G #1515WM5S with 316 stainless steel disc.
- .5 Balancing cocks: 50mm (2") and smaller: DeZurick series 425. 65mm (2 1/2") and larger: Flanged DeZurick Series 100. Both types to be complete with memory stops.
- .6 Gas valves, CGA approved - lubricated plug type: 12 to 50 mm (1/2" to 2"): Newman Hattersley 70M. 65mm (2 1/2") and greater, flanged: Newman Hattersley #171M.
- .7 It is preferable that ball valves be used in place of gate valves for sizes 12 to 50 mm (1/2" to 2") provided they are as follows:
 - .1 Full port bronze or brass body with chrome plated bronze ball, P.T.F.E. Teflon seat blow-out proof stem rated at 400 WOG.
 - .2 Acceptable Manufacturers: Crane, Jenkins, Toyo, Watts, Grinnell, Apollo, Newman Hattersley and Nibco.
- .8 It is preferable, except for gas and steam services, that butterfly valves be used in place of gate valves for sizes 65mm (2 1/2") and greater provided they are as follows:
 - .1 Constructed of enamelled cast iron body with stainless steel disc, bronze bushings, 304 stainless steel stem, EPDM rubber resilient seat with temperature range of -40°C to 120°C (-40°F to 248°F), tight shut-off to 1100 kPa (150 psi), full lug type body tapped for 1100 kPa (150 psi) ASA drilling. Handles and operators: up to and including 100mm (4") - Lever with infinite adjustment. 150mm (6") and over: wheel/gear operated. Provide chain operator where mounted overhead.
 - .2 Grooved end butterfly valves 50 – 300mm (2 – 12") shall be rated to 2068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, electroless nickel coated ductile iron disc, EPDM seat for water service with temperature range of -34C to +110C (-30F to 230F). Victaulic Vic-300 MasterSeal.
 - .3 As manufactured by Challenger, Centerline, Keystone, DeZurick, Crane, Jenkins, Bray or Grinnell.
- .9 Corporation stops and site service valves:
 - .1 Corporation Stops : 1/2" to 12": Cambridge Brass "Century" brass body ball valve with connections to suit piping. Ball to be stainless steel with teflon seats. Provide cast iron housing with threaded cover to suit depth of bury.
 - .2 Valves 2" to 12" FM, UL and ULC approved: Kennedy Valve mod. 4701 to AWWA standard C509. flanged epoxy coated cast iron body, non rising stem, 2" operating nut and post plate complete with Clow Canada Series 900-S/900-C adaptor

flange/restrainer where connection to PVC pipe is required. Provide extension stem and cast iron housing complete with cover to suit depth of bury. Valves as manufactured by Clow are also acceptable.

- .10 Balancing Valves:
 - .1 Where specified at items of equipment and where shown on schematic piping diagrams, provide S.A. Armstrong Ltd. Model CBV1 and CBV11 circuit balancing valves. Each valve to have features as follows:
 - .2 Screwed or flanged bronze or cast iron 1725 kPa (250 psi) bodies with maximum operating temperature of 121°C (249.8°F) with tamperproof balance setting, positive shut-off and drain.
 - .3 Other acceptable Manufacturers: Tour and Anderson, ITT and Newman-Hattersley.
- .11 Pump Discharge Control Valves: Unless stated otherwise, provide S.A. Armstrong Ltd. Flo-Trex combinations check, balancing and shut-off valves at discharge of pumps. Newman Hattersley, Watts and Grinnell valves are also acceptable.

2.04 HANGERS AND PIPING SUPPORTS

- .1 Hangers:
 - .1 Provide adjustable Clevis type equal to Grinnell Fig. 65 for pipe sizes up to and including 65mm (2.5"). For pipe sizes 75mm (3") and over, provide adjustable Clevis type equal to Grinnell Fig. 260. Use rod sizes as recommended by the manufacturer. Provide Grinnell FM approved Fig. 104 split swivel or Fig. 69 swivel type hangers on fire protection piping. On copper piping, provide copper plated type hanger or separate piping from hanger with an approved insulating tape or plastic coating. Grinnell adjustable ring type fig. 97 and fig. 97c (coated) are acceptable on copper piping up to 65 mm (2.5"). Where insulation covers hanger, refer to Section 15180.
 - .2 Provide oversized hangers to pass over insulation on all cold water piping. Refer to detail drawings and Section 15180.
 - .3 Acceptable alternative: Unistrut.
- .2 Piping supports:
 - .1 For roof mounted piping, provide pipe roller supports with clamps as manufactured by Portable Pipe Hangers installed to Manufacturer's specifications. Use PPH model SS-8R or PP10 with roller for piping up to 65mm (2.5") and use model PS-1-2 for pipes over 75mm (3") and up to 200mm (8"). For refrigeration piping and conduits, use PPH model PS1-2. For pipes over 75mm (3"), use PPH-RB18 with clamps, base and all other applicable support. Supports to be aluminium with stainless steel clamps and rollers. Membrane pads to be close-cell extruded polystyrene insulation equal to Dow Chemical Roofmate.

Acceptable alternative meeting the above requirement: Unistrut.
 - .2 For roof mounted gas piping: On stable flat bed roof, use pipe supports by Quick Block with oversized stainless steel clamps for roof mounted gas piping up to 125mm (5"). Supports for gas piping must be CGA certified & listed and meeting the requirement of gas code B149.1.00.

- .3 For pipe risers, provide supports equal to Grinnell Fig. 40, black carbon steel, sized to carry the operating weight of the piping.

2.05 INSERTS

- .1 Use only factory made, threaded or toggle type inserts as required for supports, and anchors, properly sized for the load to be carried.
- .2 Use factory made expansion shields where inserts cannot be placed, but only as accepted by the Consultant and for light weights.
- .3 Do not use explosive activated tools except with written acceptance of the Consultant.

2.06 SLEEVES

- .1 Piping: Machine cut schedule 40 steel pipe, medium cast iron or 18 gauge galvanized steel; refer to detail drawings.
- .2 Ductwork: At fire dampers refer to detail drawings: Other locations - formed to accommodate duct size or access opening as required.

2.07 AIR VENTS

- .1 Provide air vents as manufactured by Maid-O-Mist No. 7 series or Braukmann. Where system pressure exceeds 345 kPa (50 psig) provide air vents with 1035 kPa (150 psig) rating.

2.08 EXPANSION TANKS

- .1 Provide in sizes as shown pre-pressurized diaphragm type expansion tanks meeting current ASME and CSA code requirements designed for a maximum working pressure of 1000 kPa (150 psi) constructed of mild steel with prime painted finish and complete with sight glass and all necessary tapings in combination with Filtrol valve and automatic vent.
- .2 Acceptable Manufacturers: O'Connor, Clemmer, Amtrol, Expanflex.

2.09 EXPANSION COMPENSATORS

- .1 Provide expansion compensators where indicated on the Drawings and for all main vertical pipe risers.
- .2 For pipe sizes 75mm (3") and under and operating pressures up to 1380 kPa (200 psi) provide shrouded compensators with 2-ply stainless steel bellows, anti torque device, limit stops and internal guides.
- .3 For operating pressure up to 585 kPa (85 psi) provide compensators with 2-ply phosphor bronze stainless bellows and brass protective shroud.
- .4 For pipe sizes over 75mm (3") provide corrugated controlled flexing expansion joints with cast steel rings and stainless steel pressure carrier.
- .5 Expansion compensators are not required on piping systems utilizing Victaulic couplings provided they are installed to Manufacturer's requirements to offset expansion. Provide Manufacturer's design data for acceptance by the Consultant. If Zero Flex style couplings are

used, expansion compensators are required to the same conditions as specified for welded steel pipe.

2.10 STRAINERS

- .1 Provide where shown on the drawings, strainers as manufactured by Mueller, Streamflo or Sarco, rated at 860 KPa (125 psi).
- .2 Unless noted otherwise, provide an integral strainer for pressure relief valves, pressure regulating valves and backflow preventers.
- .3 Strainer baskets: Type 304 stainless steel or Monel, 1.13mm (.045") perforations. For pump suction service provide 3.175mm (.125") perforations.
- .4 Combination strainers and pump inlet diffusers with screens as specified above manufactured by S.A. Armstrong Ltd. (Suction Guide), Victaulic (Style 731) or Taco Model SDO are also acceptable.

2.11 THERMOMETERS AND GAUGES

- .1 Pressure Gauges: Gauges where indicated on the drawings - Winters model 100-4S to ANSI B40.1 grade "A" level with SI and Imperial scales 115mm (4 1/2") complete with ball valves and PSN-B snubbers. Scale: 0-1725 kPa (0-250 psi).
- .2 Thermometers: Provide bi-metal dial type thermometers complete with brass separable wells as shown on the Drawings and as manufactured by Trend (Winters). Model 32 adjustable angle 75mm (3") diameter with external reset. Range: 0°C to 50°C (32°F to 122°F) for chilled and condenser water and 10°C to 150°C (50°F to 302°F) for hot water with both Celsius and Fahrenheit scales.
- .3 Gauges and thermometers as manufactured by Trerice and Ashcroft will also be accepted.

2.12 WIRING

- .1 Electric power wiring for equipment (connection of motors through starters and disconnects) provided by mechanical trades is specified in Division 16. Electrically operated equipment: to CSA Standard and bear Certification label.
- .2 Provide motor control wiring (at any required voltage) between starter panels and control components to all requirements specified for similar wiring in Division 16.
- .3 Provide wiring of items supplied by equipment manufacturers such as filter advance motors and control, high level alarms, low water cut-offs, anti vibration lock-outs, flow switches, remote and local thermostats for unitary heating equipment and rooftop HVAC units, sump pump alternators, level controllers, water treatment equipment, and oil/grease interceptor alarms, and control wiring between starters and control panels (e.g., air cooled condensers, cooling towers and condensing units). Also provide wiring for communications interface panels, sensors, oil pumps, purge pumps and oil heaters supplied with water chillers. Refer also to Section 15900.

2.13 ELECTRIC MOTORS

- .1 CSA labelled, and except where specifically noted, all motors below 560 Watt (: HP): 120 volt, single phase, 60 cycle. 560 Watt (: HP) and over: 575volt 3 phase, 60 cycle - refer to Electrical Drawings and Mechanical Equipment Schedules for exact details. Motors to meet NEMA standards for maximum sound level ratings under full load. Service factor on all motors to be 1.15.
- .2 Motor bearings: to be permanently lubricated ball type for motors up to and including 3725 W (5 hp). Bearings for all motors over 3725 W to be self aligning greaseable ball bearings sized to provide life of at least 50,000 hours under belt driven service.
- .3 Single Phase Motors: Provide permanent split capacitor type. Motors 14.9 kW (20 hp) and greater: Provide thermistor over temperature protection for each winding, wire in series, with leads terminated in the motor junction box.
- .4 All motors over 186 W (3 HP) to be TEFC. All motors over 1 HP to be high efficiency type with ratings based on statistically valid Quality Control procedures conforming to ANSI/IEEE 112-1984 (Ref. 10), Test Method B (dynamometer), using NEMA MG1-1987 (MG1-12.54 and MG1-12.55) (Ref.11), and be approved under the Canadian Electrical Safety Code.
- .5 Acceptable electric motor manufacturers: Westinghouse, CGE, Reliance, Brook-Crompton, Marathon, US Motors, WEG and Siemens.
- .6 For motors used with variable frequency drives, provide Class H motor winding insulation and be inverter duty type manufactured to NEMA Standard MG-1 part 31 "Definite purpose inverter-fed motors". Ensure that drive Manufacturer reviews motor shop drawings prior to releasing order

2.14 MOTOR STARTERS

- .1 Provide CSA labelled motor starters for all motorized mechanical equipment, except where delineated as an integral part or accessory of specified equipment as follows:
 - .1 Motor starters and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of EEMAC and CSA.
 - .2 Submit Shop drawings showing the following information:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.
 - .3 The specifications are based on Allen Bradley Canada Ltd. Acceptable alternatives are Klockner Moeller, Telemecanique, Siemens, Square D, Cutler-Hammer and General Electric.
 - .4 Motor starters for motorized mechanical equipment shall be in accordance with the following specification and the M/E schedules on the drawings.
 - .5 Unless otherwise noted, starters for 3-phase motors shall be combination, "quick-make" and "quick break" disconnects with full voltage non-reversing magnetic starters for across-the-line service. Full protection of each phase shall be provided in the starters by means of one (1) overload relay per phase per starter. Undervoltage protection shall be provided by the starter coil which shall disengage on 65% of rated

voltage unless otherwise noted, for refrigerant machine etc. starters. All starters shall come equipped with:

- .1 Selector Switch either hand/off/automatic or start/stop.
- .2 'ON' pilot light (two lights for reversing or two speed starters) complete with required interlocks.
- 3 2 N.O. and 2 N.C. electrical interlocks.

These requirements are a minimum for all starters. Extra accessories shall be provided as indicated on the drawings.

- .6 Motors 20 HP and larger, as well as smaller motors, but with longer than 10 seconds duration to reach full speed will be equipped with inherent overheating protection, which shall consist of thermistors, one for each phase, embedded in the stator windings. The wires of the thermistor shall be brought out to the motor conduit box, ready for field wiring into the starter holding coil circuit.
The motor tripping device shall be equal to Westinghouse type 3 UN7 c/w latching relay, pilot light and alarm contacts.
- .7 The motor tripping device shall be housed in the individual starters.
- .8 Field install in starters, the tripping devices supplied by the motor manufacturers for field wiring connection to thermistor wires. Supply and install auxiliary relay in starter, if holding coil rating exceeds capacity of tripping device.
- .9 Supply and install timing relays in starters equipped with hand-off-automatic or on-off switches, and which serve motors larger than 30 HP. Set timers as instructed to provide sequenced starting of motors after power outage.
- .10 Two speed starters shall be provided with an adjustable time delay relay to provide a time delay on transfer of motor from high to low speeds.
- .11 Reduced voltage starters shall be provided where indicated on the drawings. They shall be as described in paragraph .2 above, but shall be Star Delta closed circuit transition type.
- .12 Unless otherwise noted, starters, for single phase motors, shall be Bulletin 600, 115 volt, thermal overload protected manual starting switches with and "ON/OFF" toggle switch, a neon pilot light and a surface or flush mounting NEMA enclosure to suit the application. If, in certain cases, automatic or remote operation is required, magnetic starters as specified above for 3 phase motors shall be provided but single phase with unfused disconnects.
- .13 Disconnects shall be heavy duty, CSA approved, front operated with a handle suitable for padlocking in the "OFF" position and arranged so that the enclosure cover cannot be opened while the handle is in the "ON" position. Operating mechanisms shall be "quick-break" positive acting with visible blades and a line terminal shield. Fusible units shall be complete with fuse clips and suitable for HRC fuses unless otherwise noted. Each unit shall be equipped with solderless lugs and a front cover nameplate identifying the catalogue number and electrical characteristics. Enclosures for disconnects mounted indoors and not exposed to the weather shall be unless otherwise, noted CEMA 1 general purpose enclosures.
- .14 Enclosures for disconnects mounted outdoors or in locations exposed to the weather shall be CEMA 3 rain tight, number of poles and fuse requirements be as indicated on the drawings.
- .15 Unless otherwise indicated, fuses shall be Gould Shawmut HRCI-J type CJ for constant running equipment and type AJT time delay type for equipment that cycles ON and OFF.
- .16 Installation:
 - .1 Install starters, connect power and control as indicated.
 - .2 Ensure correct fuses and overload devices elements installed.
 - .3 Operate switches, contractors to verify correct functioning.
 - .4 Perform starting and stopping sequences of contractors and relays.
 - .5 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

- .1 Install equipment, ductwork, conduit and piping in a workmanlike manner to present a neat appearance and to function properly to the acceptance of the Consultant. Install ducts and pipes parallel and perpendicular to building planes. Install piping and ductwork concealed in chases, behind furring, or above ceiling. Install exposed systems grouped to present a neat appearance. Comply with manufacturer's installation instructions.
- .2 Install gauges and thermometers to permit easy observance from floor level.
- .3 Install all equipment and apparatus with adequate space allowance for wiring, maintenance, adjustment and eventual replacement.
- .4 Install control devices to guarantee proper sensing. Shield elements from direct radiation and avoid placing them behind obstructions.
- .5 Include in the Work all requirements of Manufacturers shown on shop drawings.
- .6 Install all ceiling mounted components (Diffusers, Grilles,) in accordance with reflected ceiling Drawings.
- .7 Leave space clear and install all work to accommodate future materials and/or equipment and to accommodate equipment and/or materials supplied by other trades. Verify spaces in which work is to be installed. Install pipe and ductwork runs to maintain maximum headroom and clearances and to conserve space in shaft and ceiling spaces.
- .8 Confirm on the site the exact location of equipment and fixtures. Confirm location of equipment supplied by other trades and mechanical requirements thereof.
- .9 Where FMP "flow measurement port" is shown on the Drawings, make installation as described on the Detail Drawings and in a location as shown on the schematic piping drawings. Install the flow measurement port in straight run of pipe at least 3 m (10 ft. +/-) downstream from any valve, thermometer, tee, elbow or any other pipeline device.

3.02 EQUIPMENT CONNECTIONS

- .1 Install piping connections to pumps and all other equipment without strain at the pipe connections. Remove, where requested by the Consultant, bolts in flanged connections or disconnect piping after the installation is complete to demonstrate that the piping has been so connected.
- .2 Provide shut-off valves on supply and return piping connections on all items of equipment.
- .3 Provide flexible connectors on supply and return piping connections on all based mounted pumps.
- .4 Corrosion Prevention: Install dielectric couplings as specified in Part I at:
 - .1 Connections to copper/aluminium perimeter convectors, radiant ceiling panels and coils with copper connections in steel piping systems.
 - .2 Connections between copper and steel pipe.
 - .3 Connections to cooling coil condensate drains.

- .4 Steel Valves used in a copper or copper alloy piping system. In this case, use brass or bronze valves whenever possible.
 - .5 Connections to expansion tanks and domestic hot water tanks in copper piping systems.
 - .6 In either steel or copper piping systems, do not put short black steel nipples and individual black steel fittings between brass or bronze components such as valves - use only copper, brass or bronze components. Use a minimum of eight times the mass of steel pipe or components between any two brass, bronze or copper fittings or components.
 - .7 Do not use copper alloy (brass and bronze) fittings and valves in place of specified dielectric couplings.
-
- .5 Hot water boilers: Connections to the boilers are to be swing joints. Provide a minimum of 600mm (24") piping for swing joints.
 - .6 Stand-by generator: Install and connect the flexible piping and muffler supplied by Division 16. Make installation in accordance with detail drawing.

3.03 DRAINS

- .1 Pipe all discharge from relief valves and drains from equipment, outside air plenum/louvre, chemical pot feeders and tanks to nearest floor drain or suitable receptacle.
- .2 Provide 20mm (3/4") ball valves with hose ends, caps and chains at strainers, all piping system low points, pumps, coils and at each piece of equipment.
- .3 Provide deep seal traps (150mm trap seal) on all air handling equipment condensate drains and on floor drains located within air handling unit plenums. Provide trap seal primers on all floor drain traps and gang traps.

3.04 PIPING SYSTEM INSTALLATION

- .1 Install all piping in accordance with the best practices of the trade.
- .2 The piping shown on the drawings is diagrammatic for clearness in indicating the general run and connections and may or may not be, in all instances, shown in its true position. Take responsibility for the proper erection of systems of piping in every respect suitable for the work intended and as described herein.
- .3 Keep plugged or capped all openings in pipe or fittings during installation.
- .4 Install piping to avoid any interference with the installation or removal of equipment, other piping and ducts.
- .5 Install all valves, strainers and specialties to permit easy operation and access. On horizontal piping, install valves in an upright position. Where there are space constraints mount valves at a 45 deg. off vertical maximum. Install strainers to provide easy strainer basket removal.
- .6 Install systems to provide thorough drainage and air elimination.
- .7 During welding or soldering procedures, provide a fire retardant cloth, mat or blanket to protect the structure, and adequate fire protection equipment at all locations where work is being done. Close off shaft or confined areas with a fire retardant mat or cloth to prevent sparks or pieces of hot metal from falling down the shaft or area way.

- .8 Provide long turn pipe fittings having not less than pipe wall thickness. Provide line size tees. Where branch lines are more than two sizes smaller than the main, weldolets may be used.
- .9 Where steel piping is required to be buried, apply two coats of Densopaste (Denso of Canada Ltd.) primer to all buried surfaces after assembly and testing. Hot or cold applied tape as manufactured by Tapecoat, selected for the application and applied to manufacturer's instructions, is also acceptable.
- .10 Where it is necessary to offset piping to avoid obstructions, use 45 degree rather than 90 degree elbows.
- .11 Provide suitable clean-outs on every other change in direction and slope all condensate drip drains.
- .12 Make all threaded pipe joints on water piping using a thread paste or teflon tape suitable for the service for which the pipe is to be used. Use of hemp or similar materials on threaded joints will not be permitted.
- .13 For Victaulic Fittings:
 - .1 Comply with manufacturer's installation instructions for all products. Ensure that grooved pipes are in compliance with the current Victaulic specifications and recommendations.
 - .2 Ensure that the "A" dimension, i.e. the area from the pipe end to the front edge of the groove is free from indentations, scores, seams, projections or roll marks.
 - .3 Use only lubricants which are non-toxic and non-injurious to the gasket material.
 - .4 Upon completion of assembly, the bolt pads of each coupling must be fully drawn together, except for HP-70 couplings in sizes to 100mm (4").
- .14 Natural Gas Piping: Install in accordance to relevant Codes. Provide vents to atmosphere for all safety switches and regulators as required by Code. Provide approved type pipe supports under roof mounted piping and install all supports according to Code and manufacturer's instruction. Refer to the Gas Code for spacing requirements.
- .15 Compressed air piping: slope piping in direction of air flow. Provide drip points at all low points in the piping system consisting of a line size or 25mm (1") minimum diameter 300mm (12") long down leg with a reducer to a 12mm (2") ball valve with nipple and cap.
- .16 Install all piping requiring insulation with sufficient clearance to apply, seal and finish the insulation.
- .17 Provide sufficient space between piping to install valves arranged in straight rows or equally spaced steps. Valve wheels, handles and operators to be easily accessible and operable.
- .18 Do not install horizontal piping within masonry walls. Any piping installed in this manner will not be accepted.
- .19 Use only non-ferrous metals in high humidity areas.
- .20 Do not suspend any equipment, piping, ducting or any other mechanical components from formed hollow steel decking.

- .21 Underground sanitary and storm piping: Underground sanitary and storm piping required to be hung under structure slab are to be cast iron piping meeting the requirements of the Authorities having jurisdiction.

3.05 CONTROL COMPONENTS

- .1 Install all pipe line devices required by the Section 15900 sub-contractor such as flow switches, valves and separable wells for temperature controllers and sensors.

3.06 DIRT ACCUMULATION IN CONTROL VALVES

- .1 Remove any dirt accumulated under seats of automatic control valves during the first year's operation. Replace damaged valve parts at no additional cost to the Owner.

3.07 FIELD WELDING

- .1 Only persons holding current welding certificates for the applications required for the Work to be permitted to do any welding. Perform all welding to Standards specified by Authorities. Do not weld to structural members of the building.

3.08 HANGERS

- .1 Hanger rods may be attached to beam or joist clamps, brackets, or concrete inserts. Explosive actuated tools are not permitted. Do not weld to structural steel unless accepted by the Consultant.
- .2 Install hangers to the following table.

STEEL PIPE

<u>Nominal Pipe Size</u>	<u>Distance Between Supports</u>
Up to 32mm (13")	2,400mm (8 ft.)
40mm (12") - 65mm (222")	3,000mm (10 ft.)
75mm (3") and over	3,600mm (12 ft.)

COPPER TUBING

<u>Nominal Pipe Size</u>	<u>Distance Between Supports</u>
Up to 20mm (3/4")	1,800mm (6 ft.)
20mm (3/4")-25mm (1")	2,400mm (8 ft.)
32mm (1 1/4")-50mm (2")	3,000mm (10 ft.)
65mm (2 1/2") and over	3,600mm (12 ft.)

3.09 AIR VENTS

- .1 Provide air vents on water piping at all high points in the system and at each piece of equipment. Provide ball valves on automatic vents.
- .2 Provide automatic air vents on piping mains except where a possibility from water damage would occur, in which case, use manual vents.
- .3 Provide manual air vents at each piece of equipment.

- .4 For all vents, except for screw driver operated type at convectors and unitary heating equipment, provide 9mm (3/8") copper drains to nearest floor drain.

3.10 EXPANSION JOINTS

- .1 Install expansion loops, joints and compensators in accordance with the Drawings and manufacturer's instructions in regard to proper length, anchoring and guiding, pre-compression, removal of spacers and testing. All main building pipe risers are to have expansion compensators.

3.11 PROTECTION

- .1 Cover openings in equipment and cover equipment where damage may occur from weather. Cover temporary openings in ducts and pipes with polyethylene sheets, until final connection is made. Cover all items cast into concrete floors or walls such as floor drains and cleanouts prior to pour, with heavy plastic tape or duct tape.

Cover and seal, with polyethylene sheeting, all equipment, coils and motors in place during construction to prevent entry of dust, paint and debris.

3.12 RIGGING OF EQUIPMENT

- .1 Provide all rigging, hoisting and handling of equipment as necessary in order to place the equipment in the designated area in the building.
- .2 Direct this work by qualified personnel normally engaged in rigging, hoisting and handling of equipment.

3.13 CONCRETE

- .1 Except as specifically indicated on the Mechanical Drawings or where indicated on the Architectural or Structural Drawings as provided by other Sections, provide all concrete work required for mechanical work (bases, curbs, anchors, thrust blocks, manholes, catch basins) in accordance with requirements of Division 3. Provide reinforced concrete housekeeping pads (equipment bases) at least 100mm (4") high under all floor mounted equipment. Provide 150mm (6") high bases under equipment with cooling coils to provide sufficient clearance for deep seal condensate traps.
- .2 Provide in good time, all inserts, sump frames, anchors etc., required to be built into forming for mechanical services.

3.14 METALS

- .1 Steel construction required solely for the work of Mechanical trades and not shown on Architectural or Structural Drawings: Provided by Division 15 to the acceptance of the Consultant. Prepare and submit installation drawings on any steel construction for acceptance of the Consultant. Provide one coat of primer on all steel supports located outdoors.

3.15 CUTTING AND PATCHING

- .1 Provide all cutting and patching for mechanical services penetrating walls, floors and roofs as shown on the Drawings. Cut only to suit dimensions required and for minimum clearances.

- .2 Seal around services passing through cut openings with materials commensurate with the fire rating of the wall, floor or roof. Ensure sealing is weatherproof for openings through exterior walls and roofs. Before sealing, provide prime coat of paint on all repaired surfaces.

3.16 LINTELS

- .1 Lintels for openings in masonry to conform to requirements given on structural drawings and as required by By-laws.
- .2 Pay all costs for lintels over openings required solely by the mechanical trades.

3.17 IDENTIFICATION OF EQUIPMENT AND PIPING

- .1 Identify all automatic control devices and motor driven equipment with 3mm (1/4") lamacoid plastic plates with bevelled edges having engraved white letter on black background giving the nature of equipment service and its number, i.e., "Washroom Exhaust E1", "Condenser Pump P1" Fix to equipment using sheet metal screws. Also provide:
 - .1 12mm (2") lettering for motor starters and 75mm (3") lettering for equipment.
 - .2 Where equipment is locally switched (e.g., room exhaust fans) provide identification plate at switch.
- .2 Co-ordinate with controls Section 15900 subcontractor and obtain list of automatically operated equipment and provide warning identification on lamacoid plate for each item as follows:

"Warning: This equipment may start at any time. Do not service without disconnecting power."
- .3 Provide all major valves with brass or plated plastic numbered tags, 18mm (3/4") diameter with stamped numbers. Secure by brass chains to the valve. Valves adjacent to plumbing fixtures, convectors, unit heaters and entrance heaters need not be tagged. Prepare an approved list detailing the valve location, tag numbers and purpose. Mount one (1) copy of this list in a glazed frame where advised by the Owner and provide additional copies for the manuals.
- .4 Identify the following piping as to service and direction of flow using stencils and black lettering behind each access door, in each room, and/or every 12m (40 ft.)
 - Domestic water: hot, cold, recirculation
 - Heating system supply and return
 - Chilled water supply and return
 - Condenser water
 - Gas (identify to code requirements)
 - Sprinkler system
 - Standpipe system
 - Glycol

3.18 FLASHING

- .1 Flash all mechanical parts passing through or built into an outside wall, roof or a waterproof floor.
- .2 Provide copper flashing for sleeves passing through exterior walls or water proof floors.

- .3 Provide counter flashing on stacks, ducts and pipes passing through roofs to fit over flashing or curb. Supply flashing for roof drains and vents to Division 7 Subcontractor for installation.

3.19 INSTALLATION OF ROOF MOUNTED EQUIPMENT

- .1 Flashing of equipment bases and curbed openings for ductwork or roof mounted fans and flashing of roof drains and plumbing vents is specified in Section 07555. Equipment bases and curbs for openings to be supplied and set in place by Division 15.

3.20 INSERTS, SLEEVES AND ESCUTCHEONS

- .1 Provide all sleeves required for ductwork, piping and access openings unless they are specifically shown on Architectural and Structural Drawings.
- .2 Place inserts only in portion of the main structure and not in any finishing material.
- .3 Supply and locate all inserts, holes, anchor bolts and sleeves in time when walls, floors and roof are erected.
- .4 Provide the following for pipe sleeves:
 - .1 Through interior walls, exterior walls above grade, interior non-waterproof floors: Machine cut schedule 40 steel pipe, medium cast iron or 18 gauge galvanized steel.
 - .2 Through walls below grade, waterproof floors, floors in janitors' closets, equipment rooms, and kitchens: machine cut medium cast iron, DWV copper or copper sheet extended 100mm (4") above the floor and cut flush with the underside.
- .5 Provide the following for ductwork:
 - .1 Where fire dampers are not required in poured walls; removable wood box out of required size. In block or brick walls; masonry to be built around ducting.
 - .2 Where fire dampers are required; 18 gauge galvanized steel or heavier sleeves complete with steel angle framing both sides installed in accordance with requirements of Authorities. See also detail drawings.
 - .3 Through Equipment Room floors, provide 100mm (4") high concrete curbs for ductwork and any piping so spaced that sleeving is impractical.
- .6 Seal all sleeves as follows:
 - .1 Through fire rated walls and floors and within mechanical assemblies (ducts): Stop insulation flush with all wall and floor surfaces and seal space between duct or pipe and sleeve with ULC approved and listed fire stopping material as manufactured by Double AD Distributors Ltd. (416) 292-2361 or M. W. McGill and Associates Ltd. "Fire-Bloc" (416) 291-8393 or Dow RTV Silicon Foam or "Metacaulk" as distributed by EMCO Ltd. (416) 742-6220.
 - .2 Through all non fire rated walls and floors stop insulation, where applicable, at wall and floor surfaces. Ram-pack ULC labelled mineral wool materials around piping and ductwork. Apply an approved caulking compound over the ram packed material on both sides.

- .3 Through foundation walls: Use either of the two following methods:
 - .1 Co-operate with the Waterproofing trade and apply an approved caulking compound over ram-packed mineral wool on both sides. Over this, on both sides, apply a layer of glassfab tape embedded in two coats of an approved mastic compound.
 - .2 Provide Link-Seal Model S mechanical seal mechanism with stainless steel bolting, EPDM seal element and composite pressure plates as supplied by Power Plant Supply Company (905) 845-7951. Follow Manufacturer's instructions in all aspects of installation procedure.
- .7 Cover sleeves and openings around exposed piping in all finished areas with chrome plated escutcheons. Cover exposed duct sleeves in finished areas with an 18 gauge galvanized steel collar fixed to wall or floor.

3.21 ACCESS PANELS AND DOORS

- .1 Install all concealed Mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels and doors. Install systems and components to result in a minimum number of access panels.
- .2 Access doors are required in walls, ceilings and ductwork for the following:
 - .1 Fire dampers and motorized dampers (for inspection, repair and resetting). Provide access doors on both upstream and downstream sides of automatic dampers.
 - .2 Duct mounted coils (duct access upstream and downstream sides for cleaning).
 - .3 Fan inlets and outlets (for inspection of impellers and vanes).
 - .4 Duct mounted smoke detectors (for inspection of in-duct sensors).
 - .5 Control valves and temperature control components.
- .3 Indicate access panels on "As built" drawings and note at each location the items (i.e., equipment or valve no.) that access is being provided for.
- .4 Supply the Division 9 Subtrade with panels, doors or the frames therefore, complete with all pertinent information for installation.
- .5 Prepare detail drawings showing location and type of all access doors in co-ordination with other trades before proceeding with installation and submit for review.
- .6 Size access doors to provide adequate access and be commensurate with type of structure and architectural finish.
- .7 Ensure proper rating of doors in fire separations.
- .8 Provide lamaroid labels (white on black), screwed in place, on all access doors and access tiles listing items or equipment which access is being provided for.

3.22 EXCAVATION AND BACKFILL

- .1 Perform all excavation, bedding, backfill and related work within the perimeter foundation walls required for mechanical Work. Ensure all services are buried a minimum of 5 ft. (1.5m) where piping is located outside the building perimeter walls.
- .2 Grade the bottom of the pipe trench excavation as required.
- .3 In firm undisturbed soil, lay pipes directly on the soil and shape soil to fit the lower α segment of all pipes and pipe bells. Ensure even bearing along the barrels.
- .4 In rock and shale excavate to 150mm (6") below and a minimum of 200mm (8") to either side of the pipe. Fill back with a bedding of 10mm (0.4") crushed stone or granular 'A' gravel.
- .5 Prepare new bedding under pipe in unstable soil, in fill, and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, at manholes and catch basins. Compact to maximum possible density and support the pipe by 200mm (8") thick concrete cradle, spanning full length between firm supports. Install reinforcing steel in cradle and construct piers every 2400mm (8 ft.) or closer, down to solid load bearing strata. Provide a minimum of one pier per length of pipe. Use the same method where pipes cross.
- .6 Where excavation is necessary in proximity to and below the level of any footing, bed with 14,000 kPa (2000 psi) concrete to the level of the highest adjacent footing. Proximity is determined by the angle of repose as established by the Consultant.
- .7 Provide support over at least the bottom one third segment of the pipe in all bedding methods.
- .8 Do not open trench ahead of pipe laying and bedding more than weather will permit. Break up rocks and boulders and remove by drilling and wedging. Do not use blasting unless specifically approved by the Consultant.
- .9 Perform all, or required portions of backfilling in 150mm (6") layers with clean selected materials acceptable to the Consultant.

Backfill and compact to the following standard Proctor percentages:

Sodded area	85%
Under paving	95%
Under Floor slabs	100%

- .10 Dispose of excavated material as directed by the Contractor.

3.23 PAINTING

- .1 Provide all exposed ferrous metal work on equipment with at least one factory prime coat, or paint one prime coat on job. Clean up or wire brush all equipment before painting. This Division is not required to prime coat or paint ductwork or piping. Except to apply two coats of Densopaste primer to cooling tower piping and steel support structures exposed to outdoors and casings of chilled water and domestic water booster pumps. Also paint ductwork internally at grilles - refer to Section 15800.

Co-ordinate with Division 9 Subcontractor and provide all required assistance in identifying all piping circuits requiring colour coding in addition to natural gas, propane and fire protection piping.

- .2 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

3.24 EXPOSED WORK

- .1 Wherever any mechanical work (plumbing, heating and sprinkler piping, ductwork, and associated thermal insulation) is exposed in finished areas, co-ordinate the work with the Consultant prior to installation. If unsatisfactory installation results due to not following this procedure, perform remedial work to the Consultant's acceptance.
- .2 For purposes of the foregoing, finished areas do not include parking garages and equipment rooms.

3.25 PIPING SYSTEM TESTS

- .1 Do not insulate piping systems until completed, perfected, and proven tight.
- .2 Should leaks develop in any part of the piping system, remove and replace defective sections, fittings and equipment.
- .3 Test piping system in sections as required by the progress of work.
- .4 Test all heating and chilled water [condenser water] and domestic water piping hydraulically to a minimum pressure of 1100 kPa (150 psi) or 1.5 times the normal working pressure, whichever is the greater, and prove tight for a period of 8 hours. Testing with nitrogen is also acceptable provided a pressure of 1.25 times values specified previously is used. Test fuel oil and natural gas piping as required by codes and authorities.
- .5 All plumbing, heating and cooling mains and branches are to be flushed and cleaned without fixtures and appliances connected.
- .6 All tests must be recorded. Submit recorded data to the Consultant.

3.26 AIR AND WATER BALANCING AND TESTING

- .1 Costs to perform air and water balancing to be included in the Tender for the Work of Division 15.
- .2 Provide the services of an independent firm specialising in air and water balancing, acceptable to the Consultant, to undertake this work as follows:
 - .1 Provide personnel to review working drawings, make site visits, prepare reports and take responsibility for measuring and adjusting all air supply, exhaust, return and transfer systems and water and other fluid pumping systems operate in accordance with specified requirements with tolerance of plus or minus 10%.
 - .2 Review and check working drawings to ensure that modifications, if required, are implemented prior to execution of work.
 - .3 Provide inspections during the course of construction and issue reports making whatever recommendations are necessary in the interests of achieving specified pumping, heat transfer and air balance.

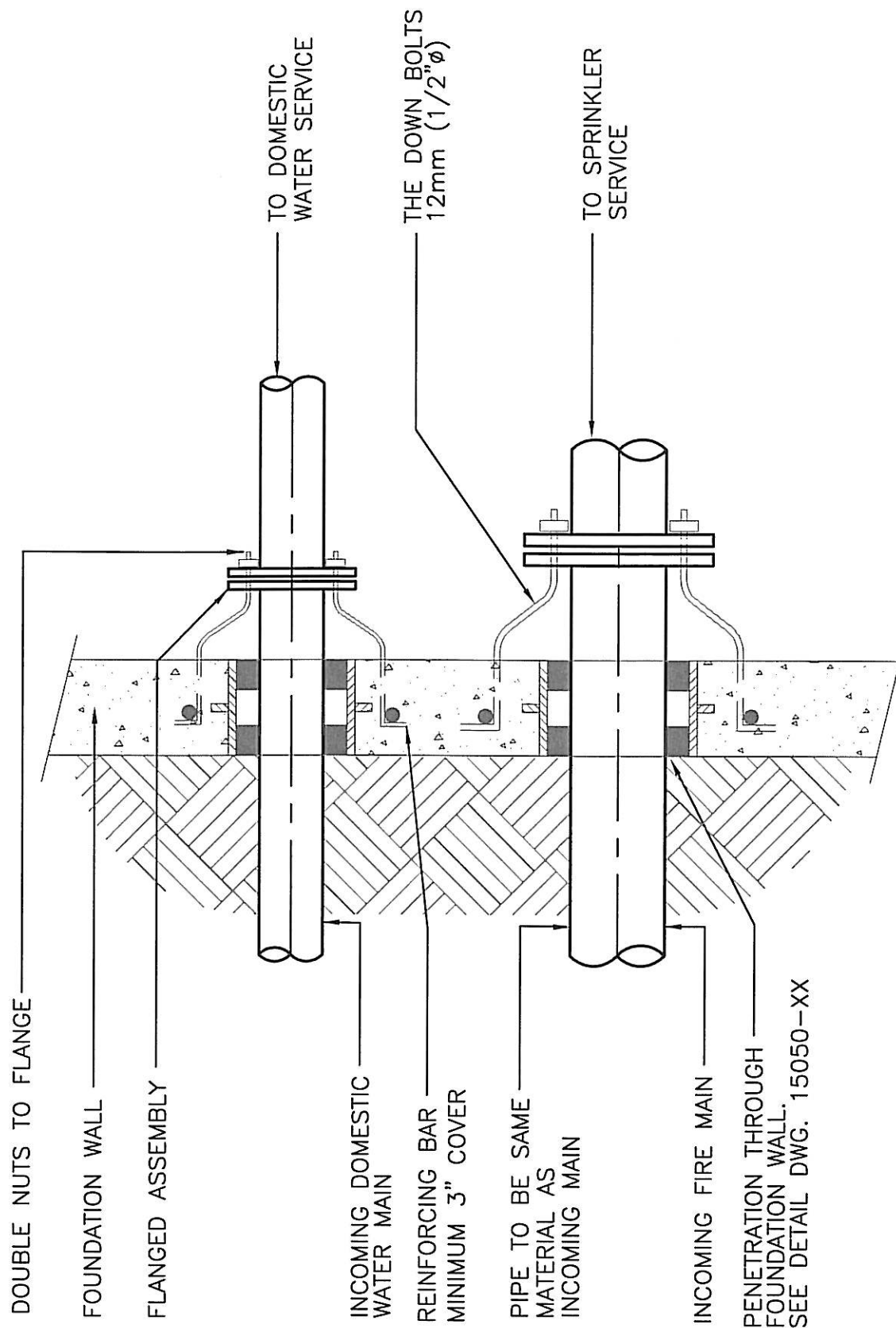
- .4 When the work is adequately completed, inspect, check and test all pump and fan systems. Also co-operate with controls systems Subcontractor to achieve required air quantities where modulating dampers etc., are installed.
 - .5 Provide assistance to the Consultant for on-site spot verification of air and water balance report.
- .3 Air Balancing
- .1 Perform air balancing in accordance with current NBCTA, NEBB or AACB procedural standards by adjusting fan speed. Use damper throttling only in systems where fan motor is less than 1 HP or where throttling results in no greater than one additional fan HP over a reduced RPM condition.
 - .2 Where ductwork is subject to static pressure in excess of 75mm (3 in.) WC, leak test 25% minimum of total installed duct area of all representative sections of the total system. All testing to conform to requirements of HVAC Duct Leakage Test Manual, 1985, Sections 5 and 6 and tested duct leakage class at a test pressure equal to the design duct pressure class rating to be equal to or less than leakage Class 6 as defined in 4.1 of Ref. 35.
 - .3 Provide Dial 1000 or Dial 2000 or acceptable alternative, duct pilot tube test opening enclosures for installation by the Section 15800 Subtrade. Provide all required test opening locations and installation instructions to the Section 15800 Subtrade.
 - .4 After inspection and tests, report all required replacement of sheaves and belts and all required adjustments and ductwork modifications to achieve system performance as specified.
 - .5 After deficient items have been rectified, retest and issue a final report and certificate covering the following:
 - .1 Specified and achieved total air quantities per system supported by curves for all fans over 150 l/s (300 cfm) capacity.
 - .2 Specified and achieved individual air quantities per outlet with supporting schematic diagrams showing test points.
 - .3 Nameplate and actual motor loading in amperes at actual voltage and installed overload heater size and manufacturer.
 - .4 Specified and actual fan total static pressures with breakdown showing inlet and discharge pressures with data shown on fan curves.
 - .5 Shelve and belt sizes and quantities per unit.
- .4 Water Balancing
- .1 Perform hydronic system balancing by minor throttling for pumps that are less than 7.45 kW (10 HP) provided this results in a power draw of no greater than 10% of that required if the impeller were trimmed. For pumps greater than 7.45 kW (10 HP), the same limit applies but in no case is it to exceed 2.23 kW (3 HP). In either case where these limits are exceeded by throttling, the impeller is to be trimmed or replaced.

- .2 Make adjustments to achieve specified temperature drops across all finned radiation sections and flows through chillers and coils. Also report all pump data such as suction, and discharge pressure, current draw at tested voltage and starter OL heater sizes and pump motor nameplate ratings.
 - .3 Provide pump curves indicating the operating point with superimposed power draw, RPM, impeller size, etc.
 - .4 Instruct piping system installers on proper locations of flow measurement ports.
 - .5 Report any required pump impeller adjustments to achieve specified performance.
 - .6 After adjustments, retest systems and issue final report confirming systems are operating in compliance with design.
- .5 Acceptable Air and Water Balancing Contractors:
- .1 Aerodynamics Inspecting Consultants Ltd.
 - .2 Designtest & Balancing Co. Ltd.
 - .3 Dynamic Flow Balancing Ltd.
 - .4 National Air Balance
 - .5 VPG Associates Ltd.

3.27 DETAIL DRAWINGS, LEGENDS AND EQUIPMENT SCHEDULES

- .1 Refer to legends and equipment schedules on the drawings and detail drawings bound in at the end of this Section of the Specifications. Comply with requirements of the detail drawings. Refer also to the appropriate Sections of this Division for additional information and requirements on scheduled equipment.

END OF SECTION 15050



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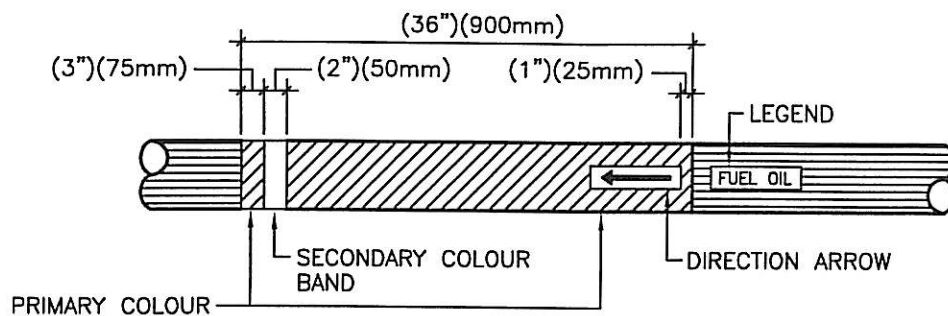
DETAIL DRAWING:

INCOMING WATER SERVICE
PIPE ENTRY DETAIL
N.T.S.

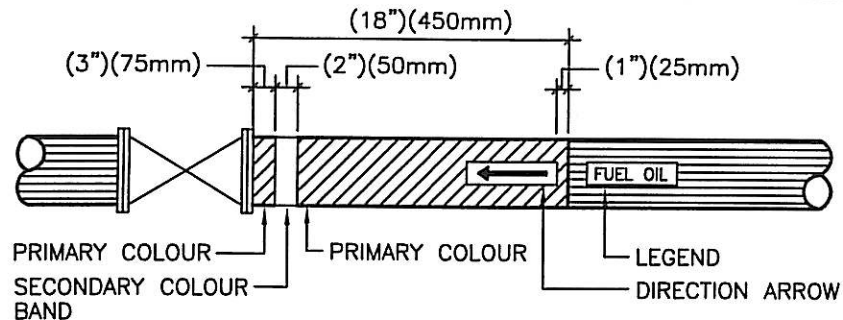
DETAIL No.

15050-002

APRIL 28/04



IDENTIFICATION FOR STRAIGHT PIPE RUNS



IDENTIFICATION AT VALVES AND EQUIPMENT

MATERIAL CLASSIFICATION	PRIMARY COLOUR
DANGEROUS MATERIALS	YELLOW, 505-101
SAFE MATERIALS	GREEN, 505-107
PROTECTIVE MATERIALS	BLUE, 202-101
FIRE PROTECTION MATERIALS	RED, 509-102
MATERIAL CLASSIFICATION	SECONDARY COLOUR
DANGEROUS MATERIALS FLAMMABLE POISONOUS OR RADIOACTIVE PHYSICALLY DANGEROUS	ORANGE, 508-102 PURPLE, 511-101 BLACK, 512-101
SAFE MATERIALS	NO SECONDARY COLOUR REQUIRED
PROTECTIVE MATERIALS HAZARDOUS NON-HAZARDOUS	YELLOW, 505-101 WHITE, 513-101
FIRE PROTECTION MATERIALS HAZARDOUS NON-HAZARDOUS	YELLOW, 505-101 WHITE, 513-101



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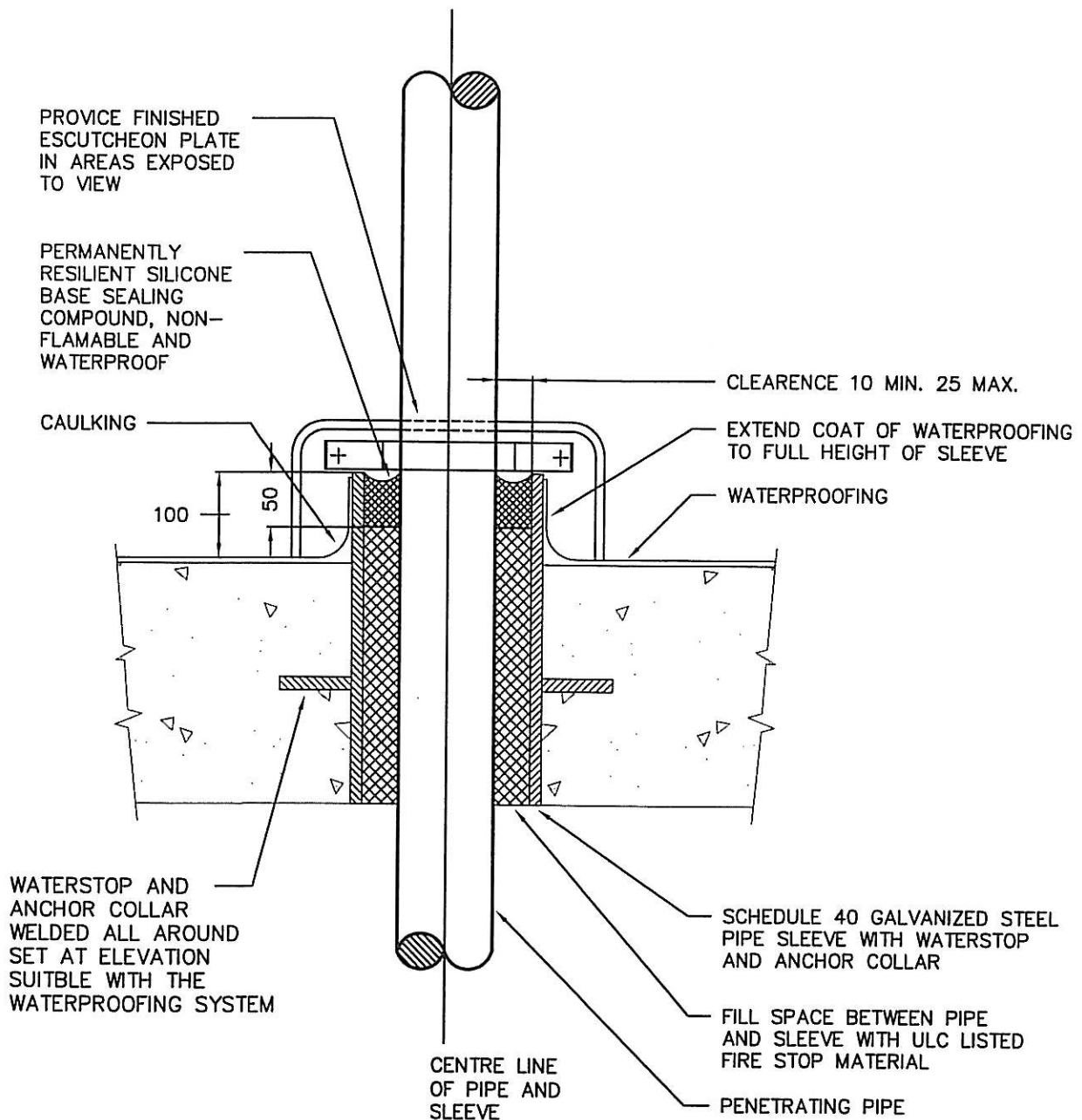
DETAIL DRAWING:

PIPE IDENTIFICATION

DETAIL No.

15050-003

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NOTE

THIS TYPE OF SLEEVE SHALL BE USED THROUGH ALL WATERPROOF FLOORS, JANITOR CLOSETS, MECHANICAL ROOMS, KITCHEN AND THROUGH ROOF.



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DETAIL DRAWING:

**TYPICAL RISER CLAMP DETAIL
FOR DRY AREAS**

DETAIL No.

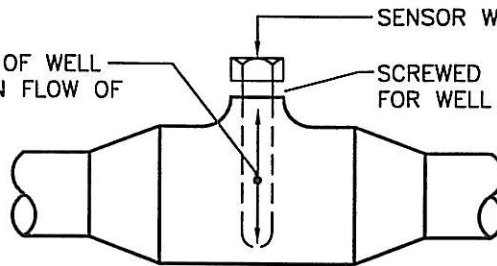
15050-004

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MINIMUM 75% OF WELL
TO BE IN MAIN FLOW OF
FLUID

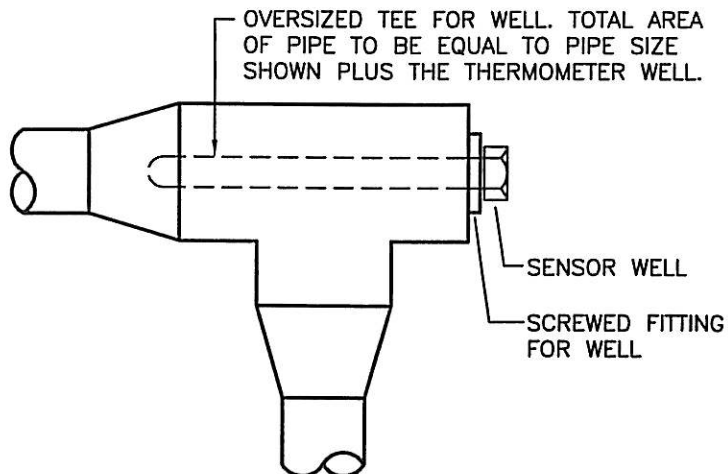
SENSOR WELL

SCREWED FITTING
FOR WELL



OVERSIZED SECTION OF PIPE TO SUIT THE
THERMOMETER WELL. MIN. SIZE TO BE
EQUAL TO PIPE SIZE SHOWN PLUS THE
THERMOMETER WELL.

OVERSIZED TEE FOR WELL. TOTAL AREA
OF PIPE TO BE EQUAL TO PIPE SIZE
SHOWN PLUS THE THERMOMETER WELL.



NOTES:

1. OVERSIZED SECTIONS OF PIPE TO BE USED
WHERE WELL AREA EXCEEDS 25% OF PIPE AREA.
2. DEPENDING UPON SIZE OF PIPE SENSOR WELL
SHALL BE INSTALLED IN PIPE OR TEE.



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DETAIL DRAWING:

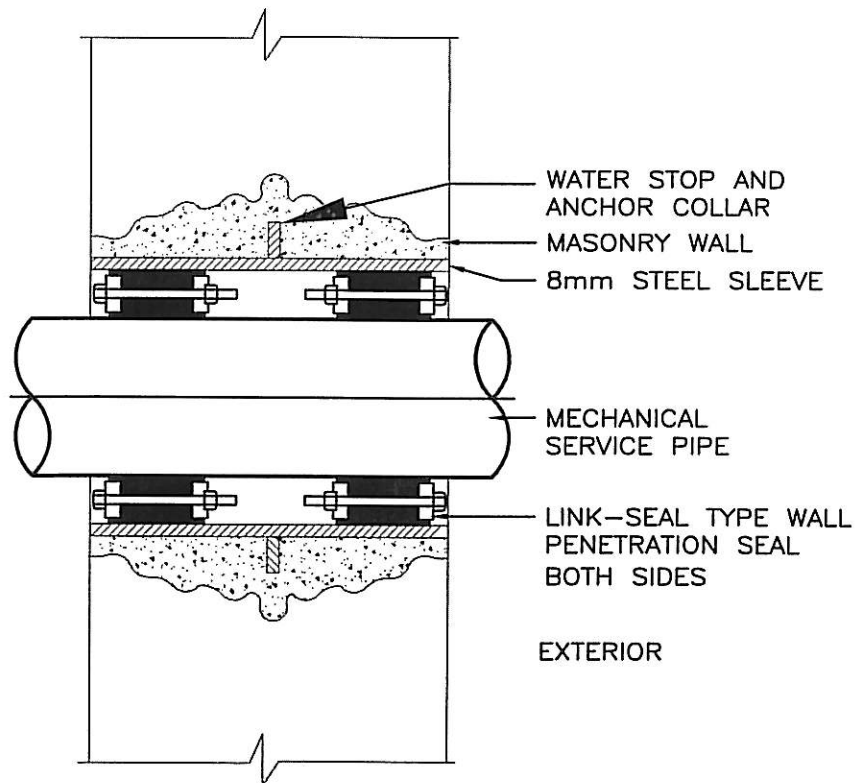
PIPE TEMPERATURE SENSOR WELLS

DETAIL No.

15050-005

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INTERIOR



WATER STOP AND
ANCHOR COLLAR
MASONRY WALL
8mm STEEL SLEEVE

MECHANICAL
SERVICE PIPE

LINK-SEAL TYPE WALL
PENETRATION SEAL
BOTH SIDES

EXTERIOR



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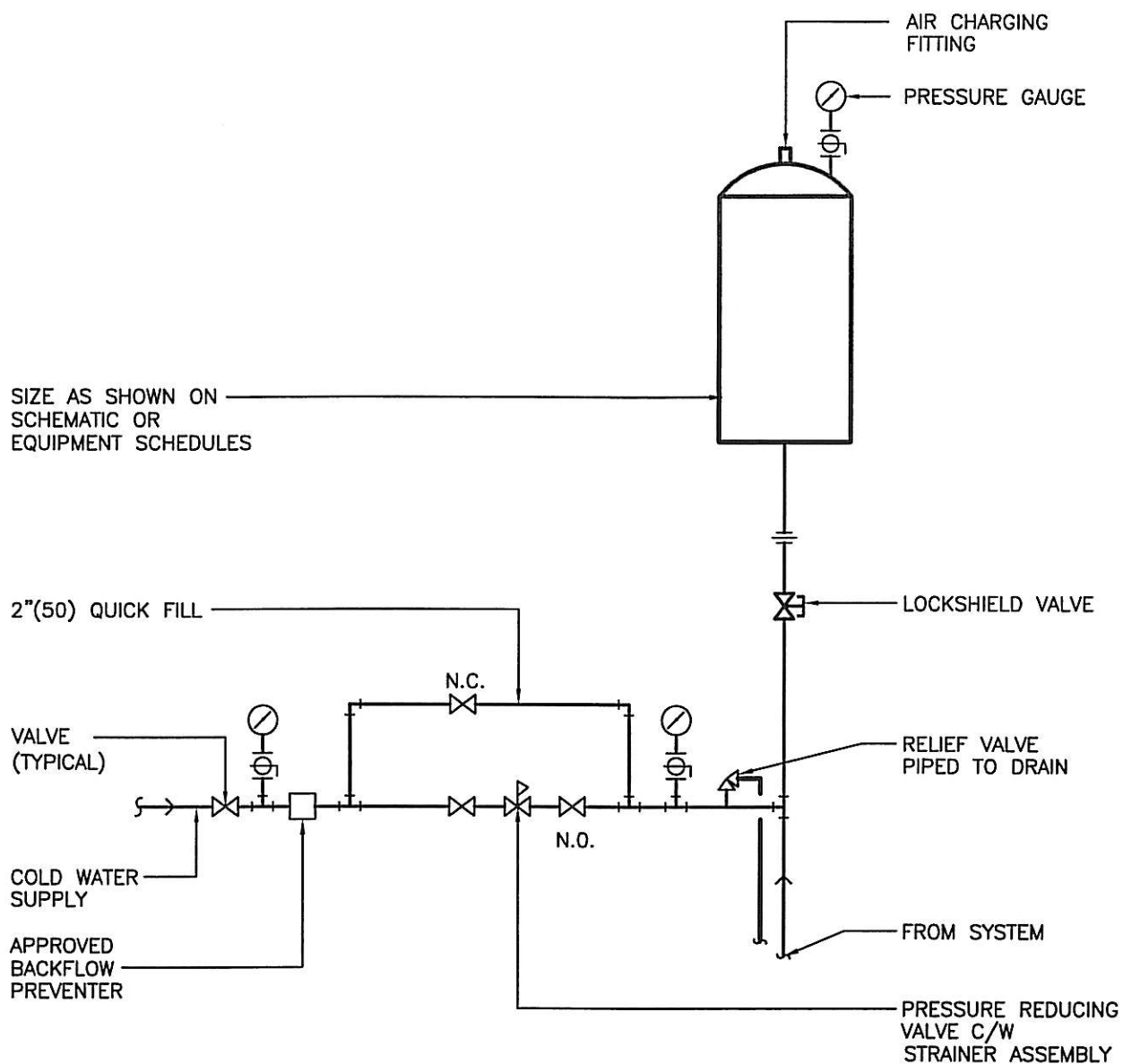
DETAIL DRAWING:

TYPICAL PENETRATION THROUGH
FOUNDATION WALL
N.T.S.

DETAIL No.

15050-006

APRIL 28/04



1. PIPE SIZES AS SHOWN ON SCHEMATIC DRAWING



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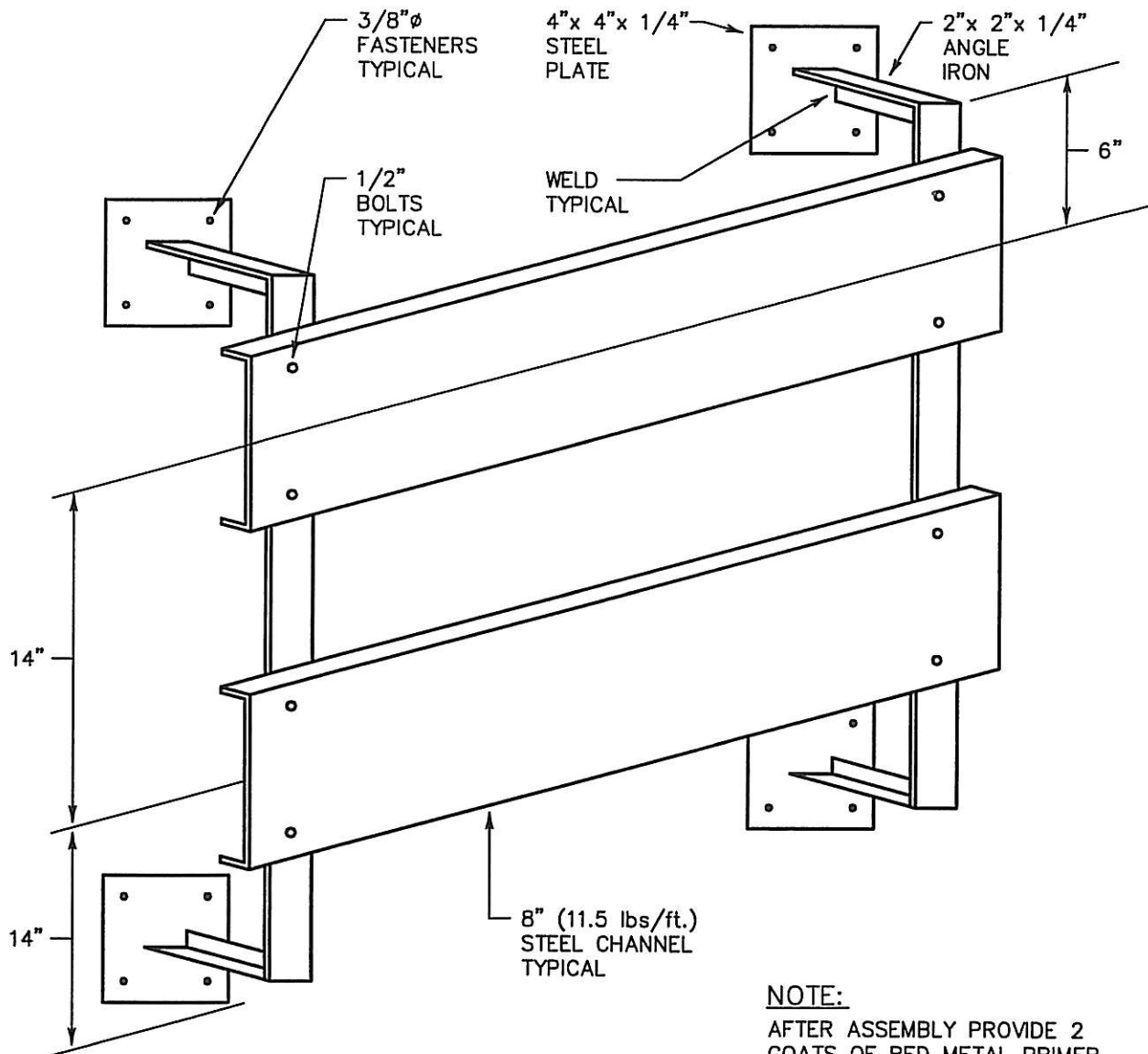
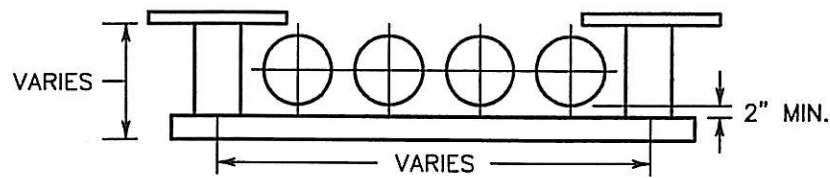
DETAIL DRAWING:

DIAPHRAGM EXPANSION TANK
PIPING SCHEMATIC

DETAIL No.

15050-007

APRIL 28/04



NOTE:
AFTER ASSEMBLY PROVIDE 2
COATS OF RED METAL PRIMER.



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DETAIL DRAWING:

PIPING PROTECTION

DETAIL No.

15050-008

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(2925)	10 (3200)	4 - #7 (7/8" ϕ) (22 ϕ)
10'-7" (3225)	AND OVER	SPECIAL: CONSULT WITH ARCH.

BASEMENT FLOOR

SEE DETAIL 15050-XXX FOR WALL SEAL

2" (50)

9" (225)

3-1/2" (13) x 28" (700) BENT DOWELS REINFORCING STEEL (SEE TABLE ABOVE)

2" (50)

4" (100)

SPAN (SEE TABLE ABOVE)

2'-0" (600) MIN

UNDISTURBED SOIL

INSIDE

OUTSIDE

FOUNDATION WALL

ELEVATION

Technical drawing of a foundation wall cross-section. The drawing shows a vertical wall with a horizontal concrete pad at the base. A pipe sleeve is shown passing through the wall, with a pocket provided in the foundation wall beyond the sleeve to provide a key for support. The concrete pad is labeled "2250lb (1135kg) CONCRETE PAD". Dimensions are given in feet and inches, with equivalent values in parentheses: 1'-6" (450) for the total width, 9" (225) for the total height, and 2" (50) for the sleeve diameter and the concrete pad thickness. A dashed line indicates the location of the pocket in the foundation wall.

PIPE SLEEVE

PROVIDE POCKET IN FOUNDATION WALL BEYOND TO PROVIDE KEY FOR SUPPORT.

2250lb (1135kg) CONCRETE PAD

2" (50)

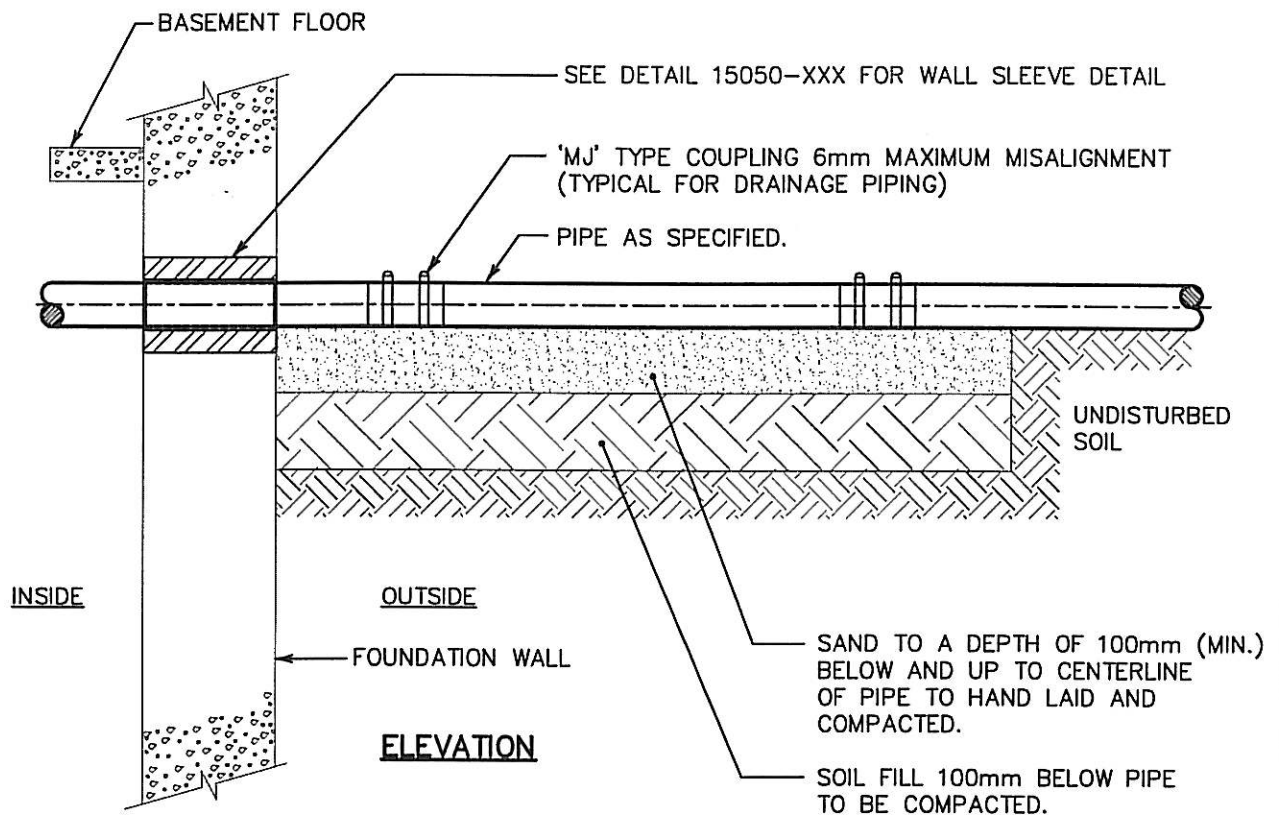
9" (225)

2" (50)

1'-6" (450)

NOTES :

- 1) SET PIPE SLEEVE WHERE REQUIRED AND COORDINATE IN FOUNDATION WALLS TO SUIT PIPE BRIDGE SUPPORT AS DETAILED.
- 2) THIS DETAIL APPLIES TO ALL SERVICE PIPING PASSING THROUGH FOUNDATION WALLS OR OVER EXCAVATED AREAS SUCH AS SEWER LINES, WATER MAINS, NATURAL GAS MAINS, OIL LINES & ANY OTHER SERVICES SHOWN ON THE DRAWINGS.
- 3) METRIC DIMENSIONS (mm)



NOTES :

- 1) SET PIPE SLEEVE WHERE REQUIRED AND COORDINATE WITH OTHER SUB-TRADES TO LOCATE IN FOUNDATION WALLS TO SUIT PIPE BRIDGE SUPPORT AS DETAILED.



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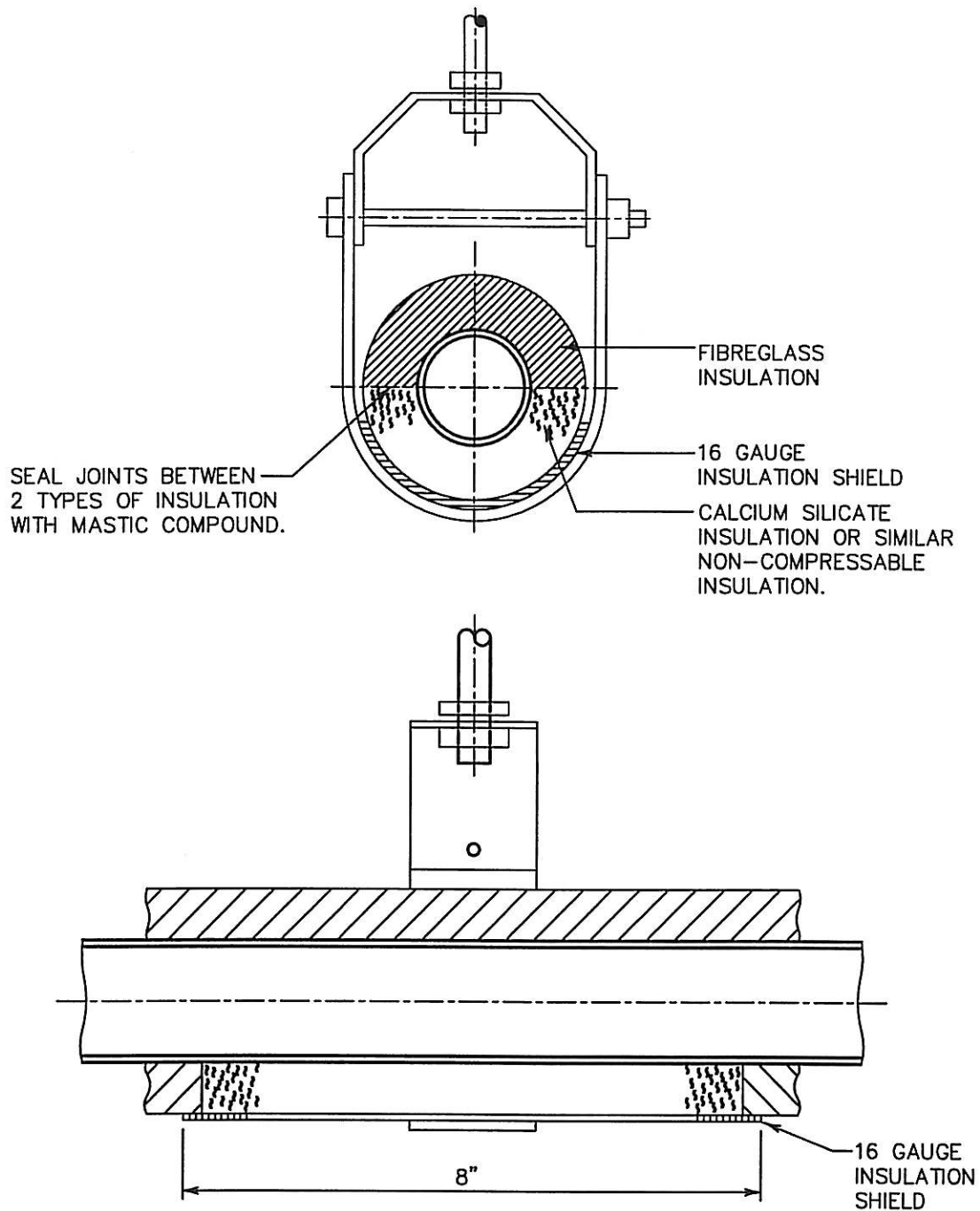
DETAIL DRAWING:

**DRAINAGE PIPE SUPPORT
THROUGH FOUNDATION WALL
N.T.S.**

DETAIL No.

15050-009A

APRIL 22/04



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DETAIL DRAWING:

PIPE HANGER
(CHILLED & COLD WATER)
N.T.S.

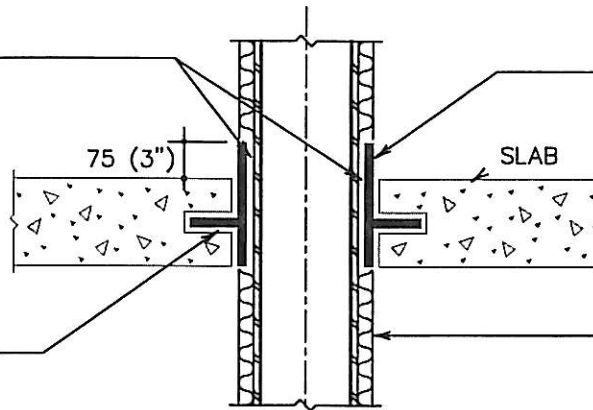
DETAIL No.

15050-013

APRIL 22/04

PACK VOID BETWEEN
SLEEVE & RISER WITH
FIRE STOPPING MATERIAL
& FINISH WITH A MASTIC
COMPOUND FROM THE
TOP & BOTTOM (TYPICAL)

PUDDLE
FLANGE



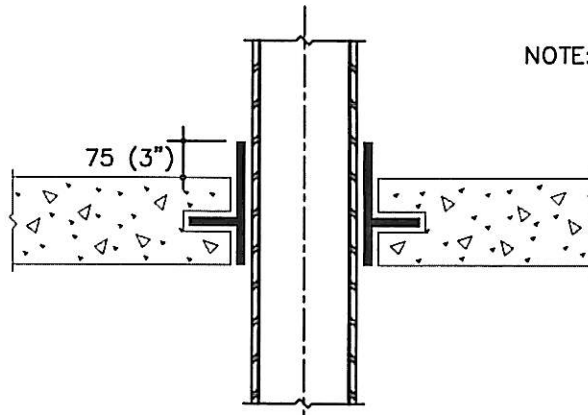
PIPE SLEEVE WITH
WATERPROOFING
FLANGE (TYPICAL)

SLAB

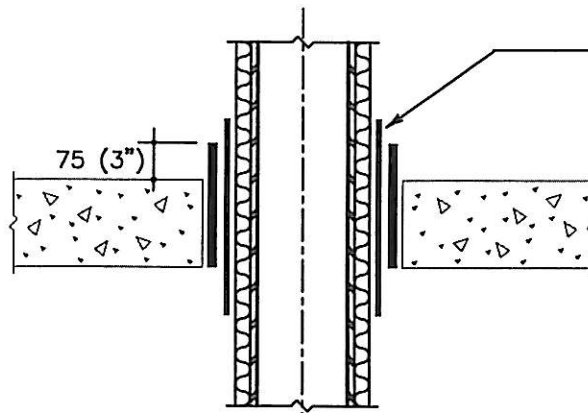
INSULATION

INSULATED HOT RISERS

NOTE: METRIC DIMENSIONS (mm)



UNINSULATED RISERS



20 GAUGE SHEET METAL
THIMBLE OVER INSULATION

C.W., SECONDARY OR CHILLED WATER RISERS



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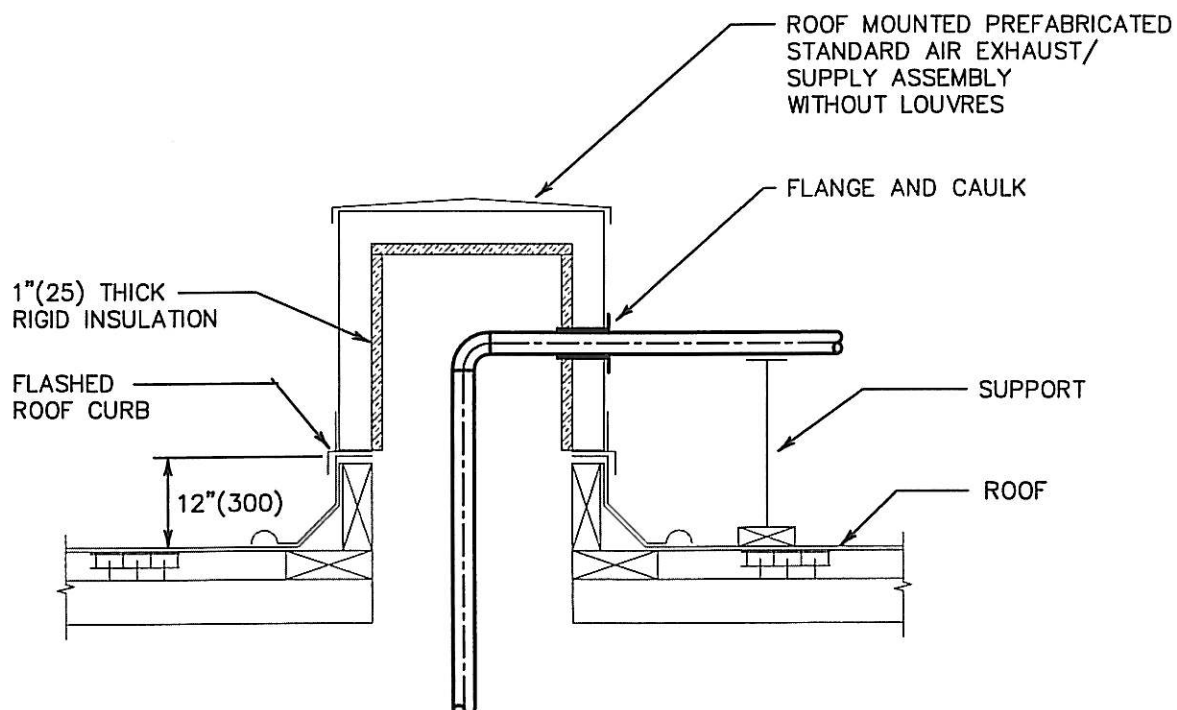
DETAIL DRAWING:

METHOD OF PASSING PIPES THROUGH
CONCRETE SALBS OF MECHANICAL OR
EQUIPMENT ROOM FLOORS N.T.S.

DETAIL No.

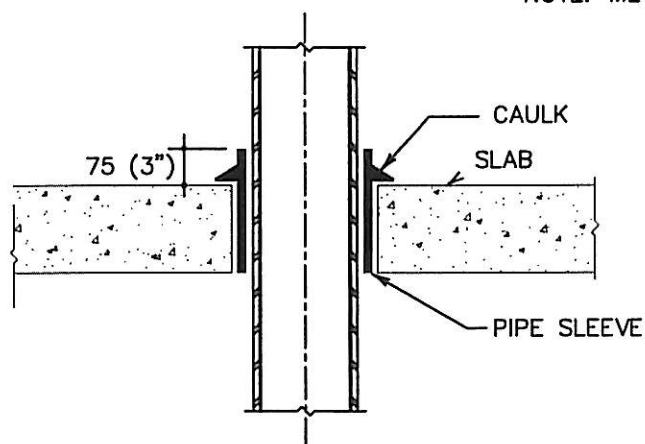
15050-014

APRIL 22/04



PIPE ENCLOSURE

NOTE: METRIC DIMENSIONS (mm)



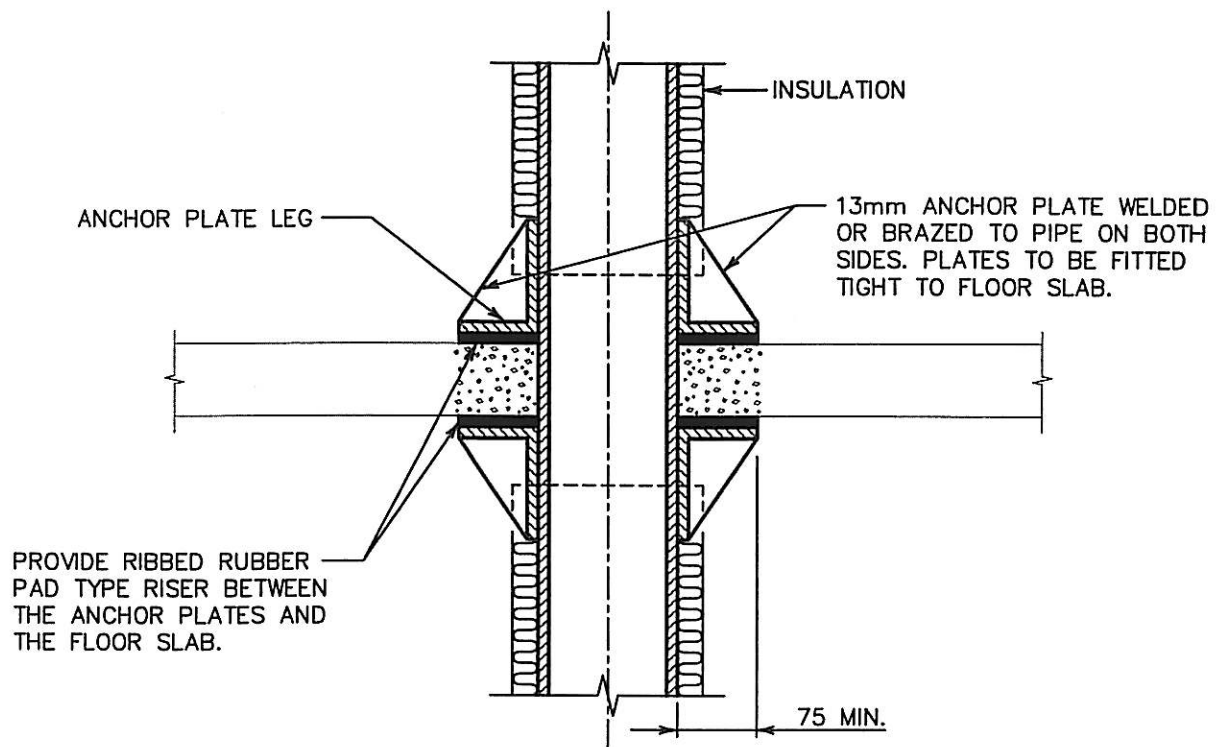
UNINSULATED RISERS



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DETAIL DRAWING:
METHOD OF PASSING PIPES THROUGH
CONCRETE SLABS AND ROOF
N.T.S.

DETAIL No.
15050-014A
APRIL 22/04



NOTE :

- 1) METRIC DIMENSIONS (mm)
- 2) WHERE ANCHORS ARE PROVIDED FOR CHILLED WATER LINES, INSULATE THE ANCHORS.



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DETAIL DRAWING:

METHOD OF ANCHORING RISERS
N.T.S.

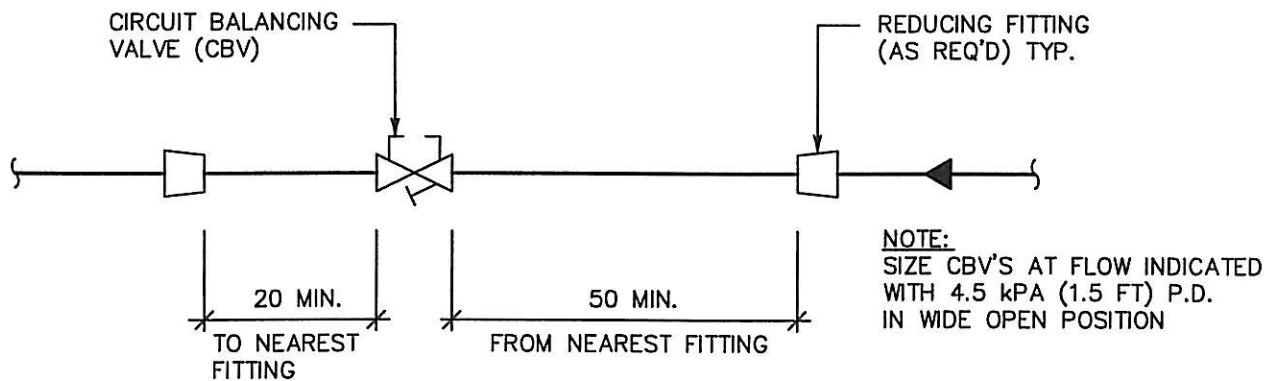
DETAIL No.

15050-015

APRIL 22/04

VALVE SELECTION GUIDE
(BASED ON 'TOUR & ANDERSSON')

NOM. SIZE (imperial)	NOM. SIZE (mm)	NOM. FLOW (GPM)		NOM. FLOW (l/s)	
1/2"	12	UP TO	3.1	UP TO	0.20
3/4"	20	3	6.9	0.19	0.44
1"	25	6.8	10.1	0.43	0.64
1-1/4"	32	10.2	16.2	0.64	1.02
1-1/2"	40	15	24	0.95	1.51
2"	50	25	40	1.58	2.52
2-1/2"	65	40	100	2.52	6.3
3"	75	95	145	5.99	9.1
4"	100	145	235	9.15	15
5"	125	230	320	14.51	20
6"	150	320	700	20.19	44
8"	200	500	1250	31.55	79



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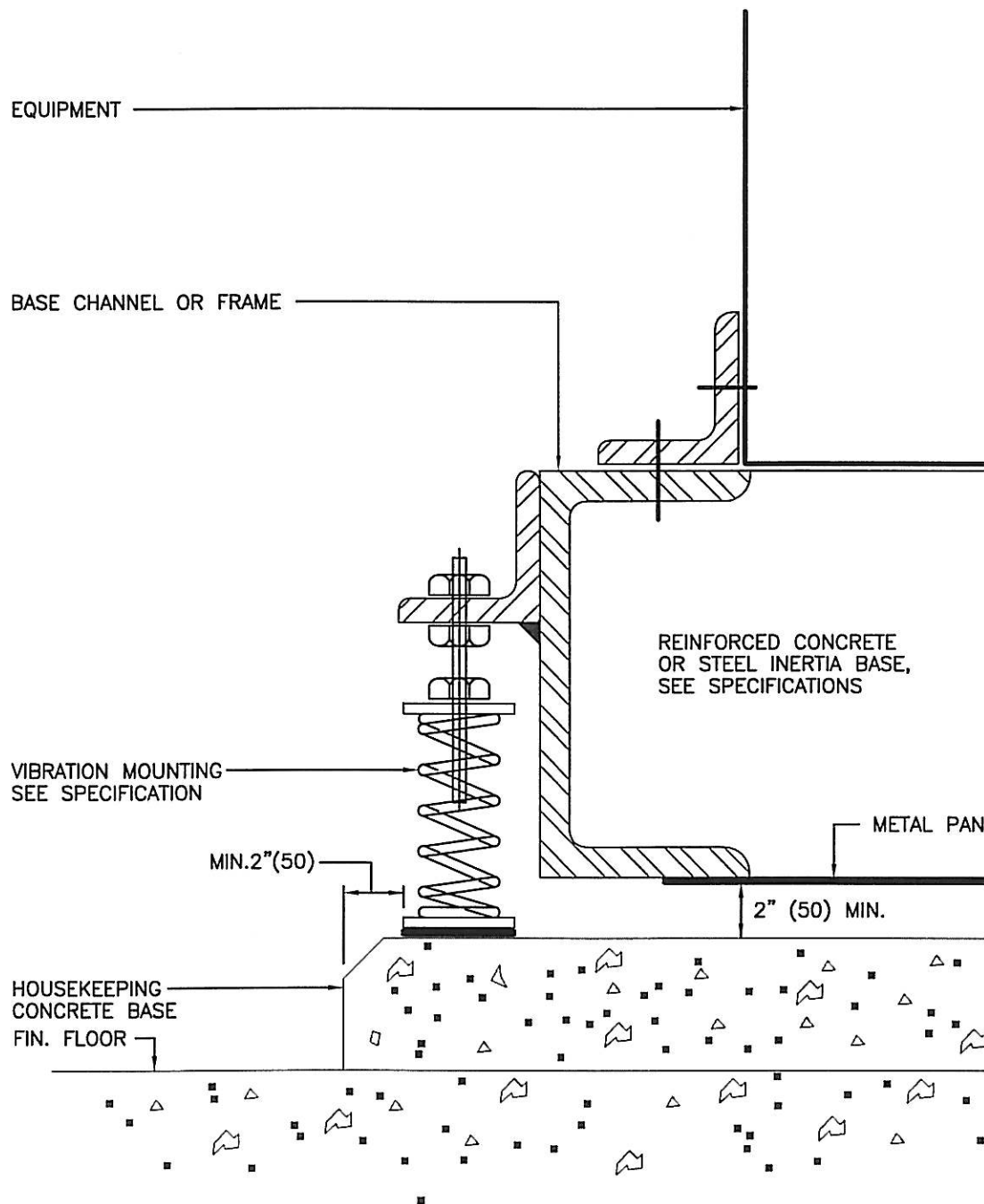
DETAIL DRAWING:

TYPICAL CIRCUIT BALANCING VALVE
DETAIL

DETAIL No.

15050-016A

APRIL 22/04



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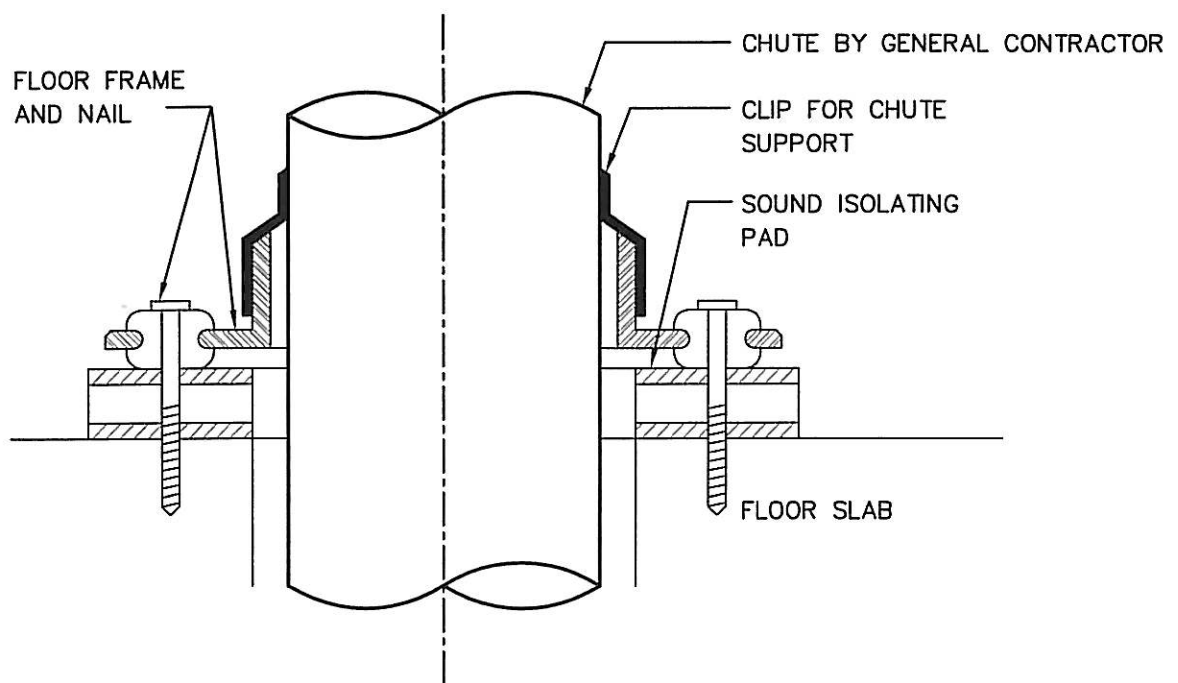
DETAIL DRAWING:

TYPICAL UNIT BASE WITH
VIBRATION ISOLATORS

DETAIL No.

15100-003

APRIL 28/04



MCW Consultants Ltd.

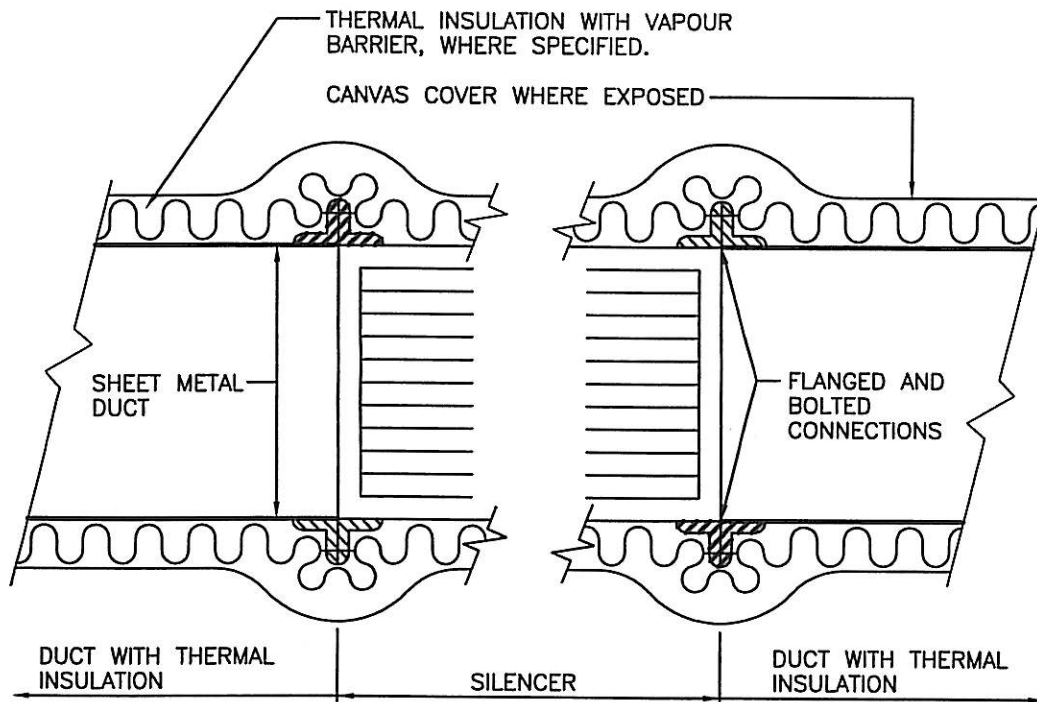
DETAIL DRAWING:

SOUND ISOLATING CHUTE SUPPORT
N.T.S.

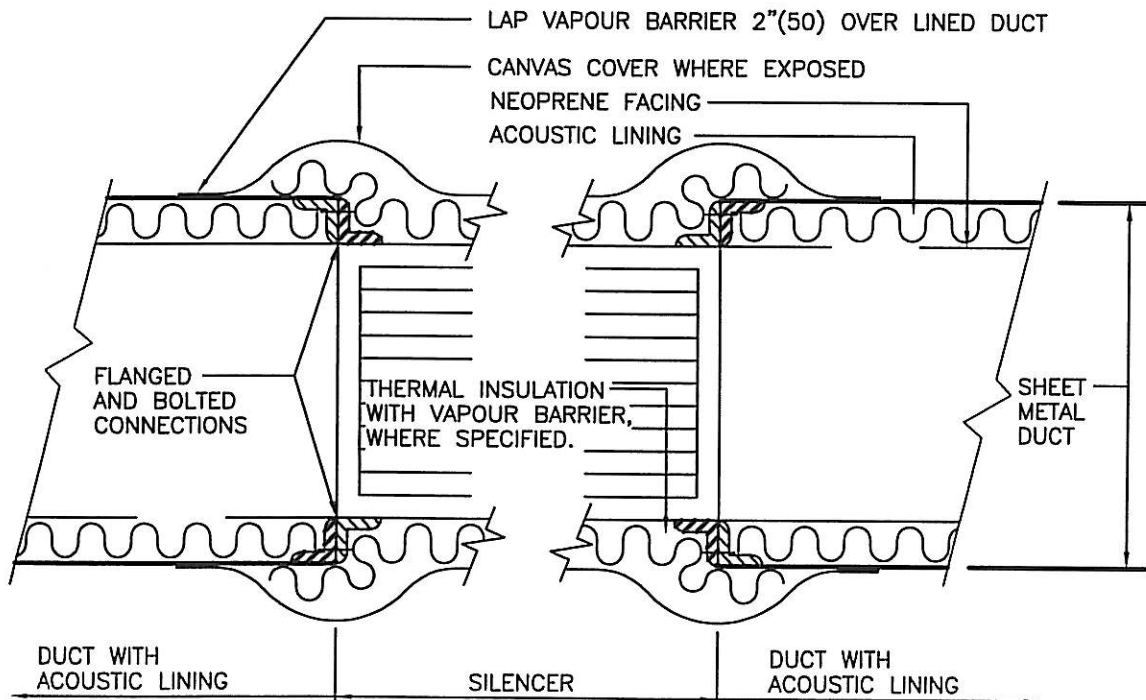
DETAIL No.

15100-004

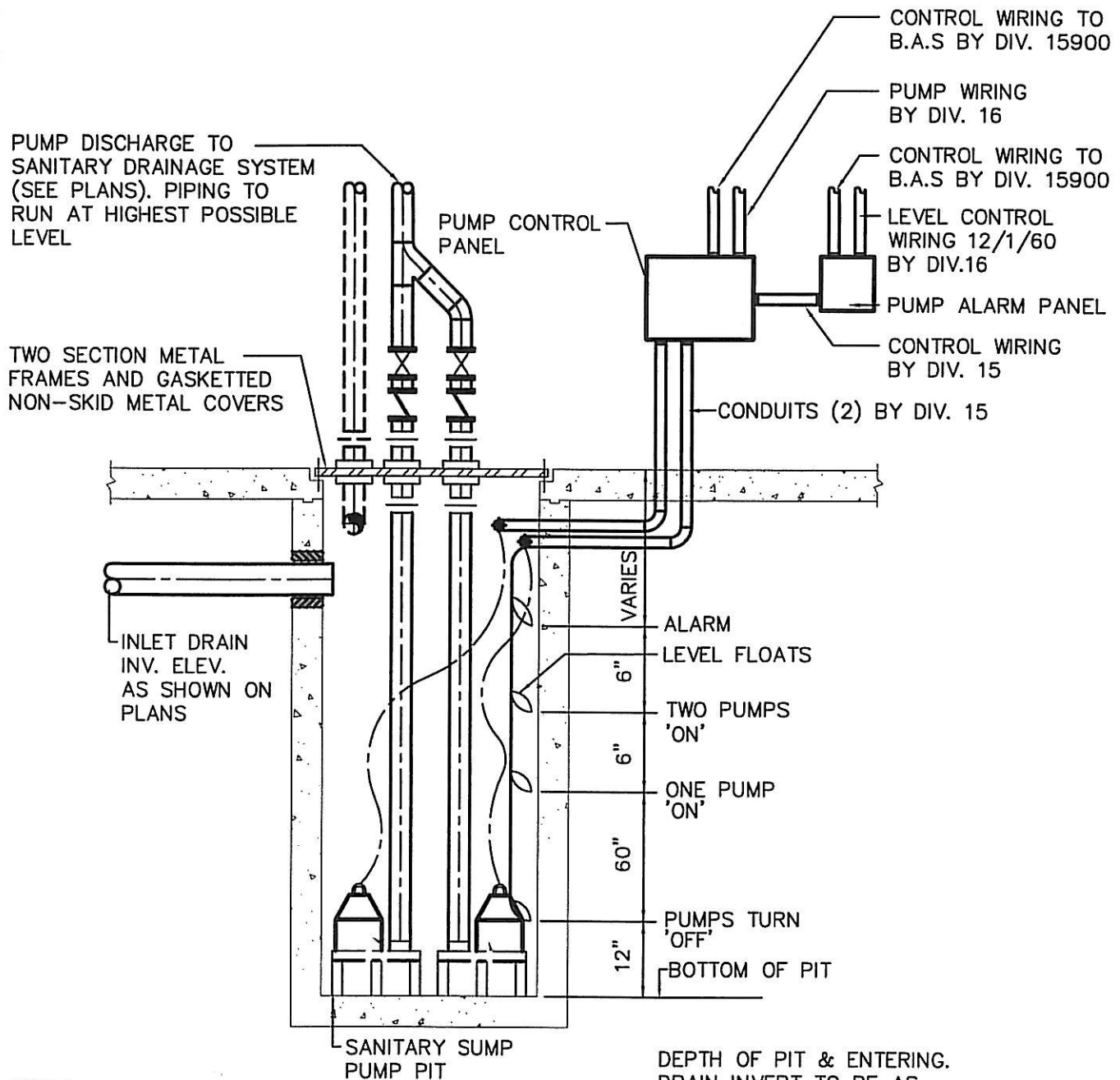
APRIL 22/04



THERMAL INSULATION



ACOUSTIC LINING



NOTE:

ALARM LEVEL FLOAT SWITCH
TO BE AT SAME LEVEL AS
INLET DRAIN INVERT.

DEPTH OF PIT & ENTERING.
DRAIN INVERT TO BE AS
SHOWN ON PLANS

(SIMPLEX PUMP. SIMILAR WITH
PUMP 'OFF', ONE PUMP 'ON' FLOAT,
& ALARM FLOAT ONLY)



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DETAIL DRAWING:

SANITARY SUMP PUMP (DUPLEX)
AND PIT DETAIL
N.T.S.

DETAIL No.

15400-001

APRIL 28/04

OPTIONAL PUMP OUT ARRANGEMENT
WITH SHUT OFF VALVE, CHECK VALVE
AND UNION. (RUN UP THROUGH FLOOR
BEYOND PIT)

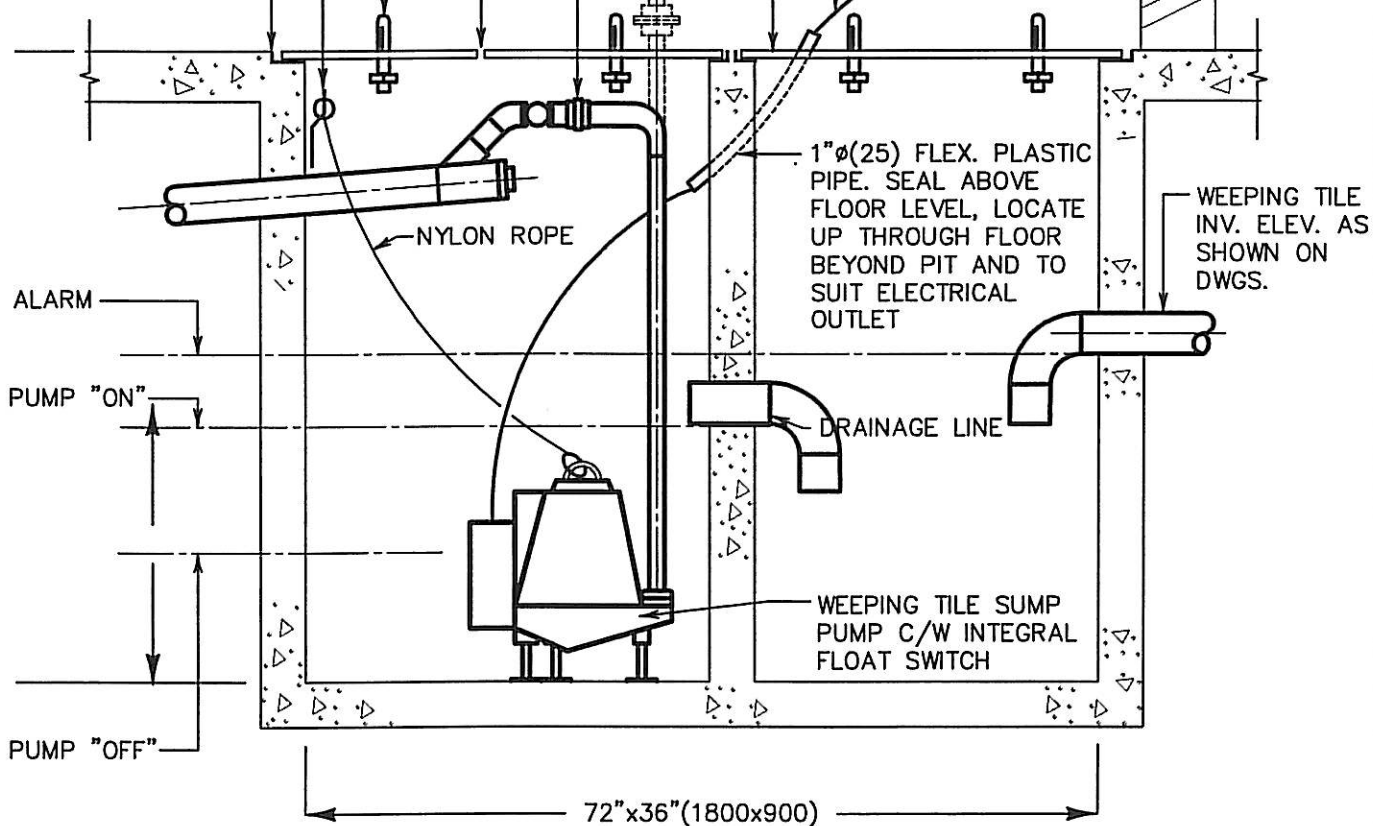
PUMP OUT ARRANGEMENT
WITH CHECK VALVE AND UNION

SPLIT COVER

DROP HANDLES

HOOK 1/4"(8 ϕ)
STEEL ROD

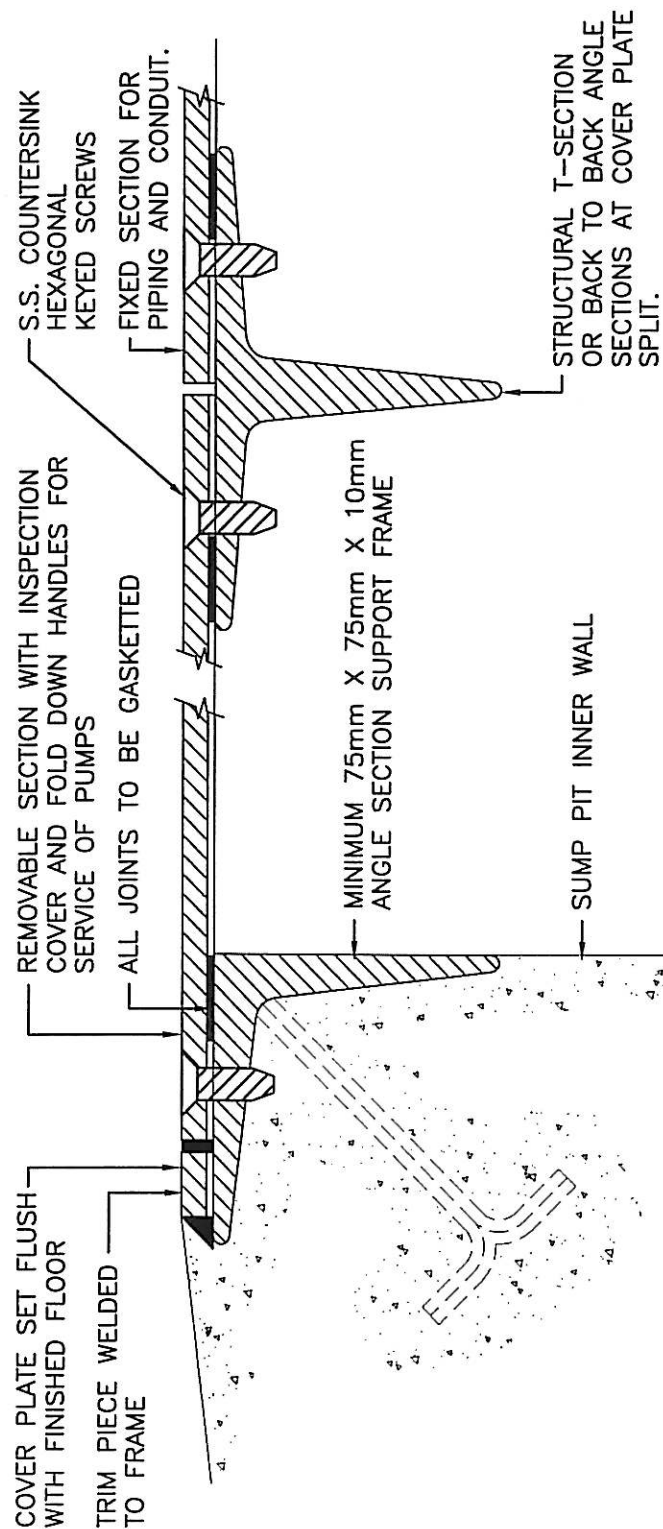
1 1/4"(32)X2"(50)
X 3/16"(6) ANGLE
FRAME C/W
ANCHORS



NOTE: METRIC DIMENSIONS(mm)

NOTE

ALARM LEVEL FLOAT SWITCH TO
BE AT SAME LEVEL AS INLET
WEeping TILE INVERT



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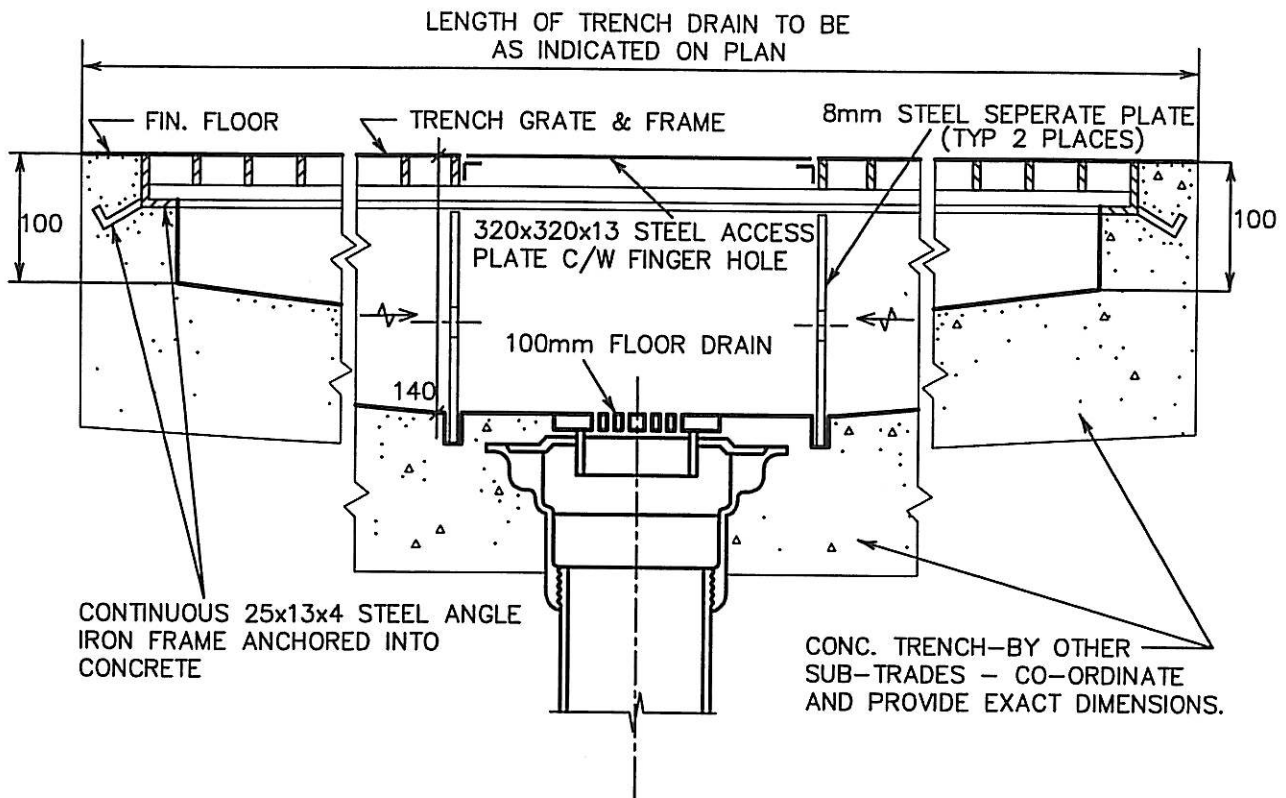
DETAIL DRAWING:

SUMP PIT COVER
DETAIL

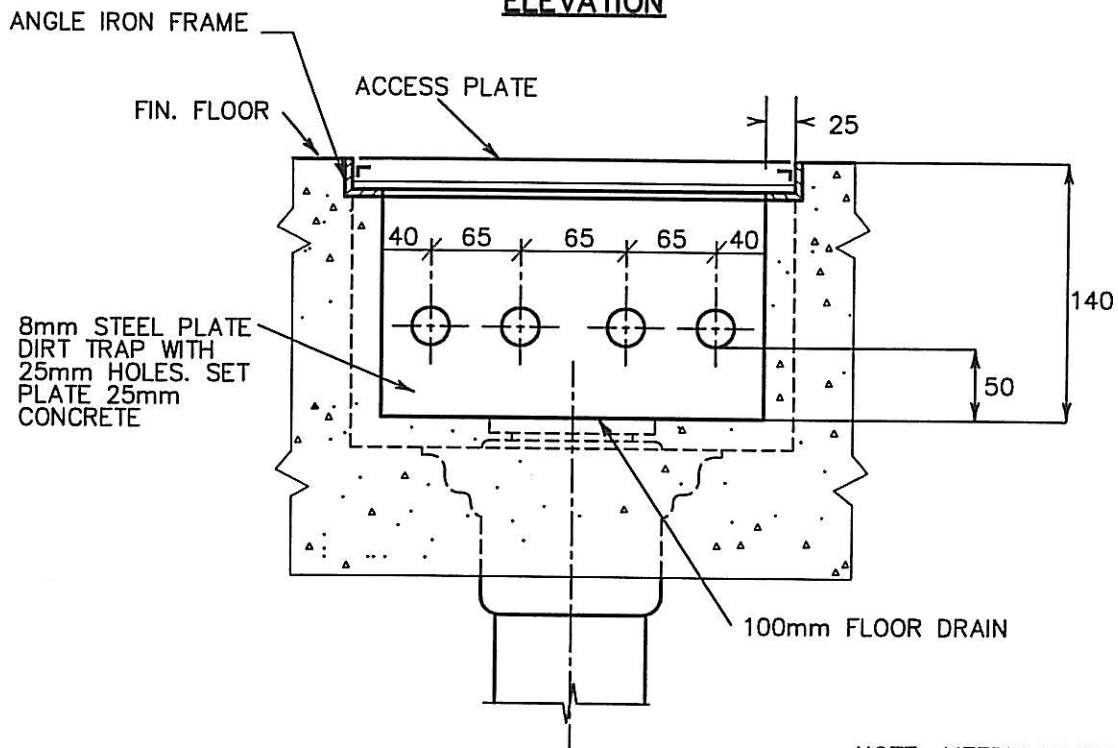
DETAIL No.

15400-003

APRIL 28/04



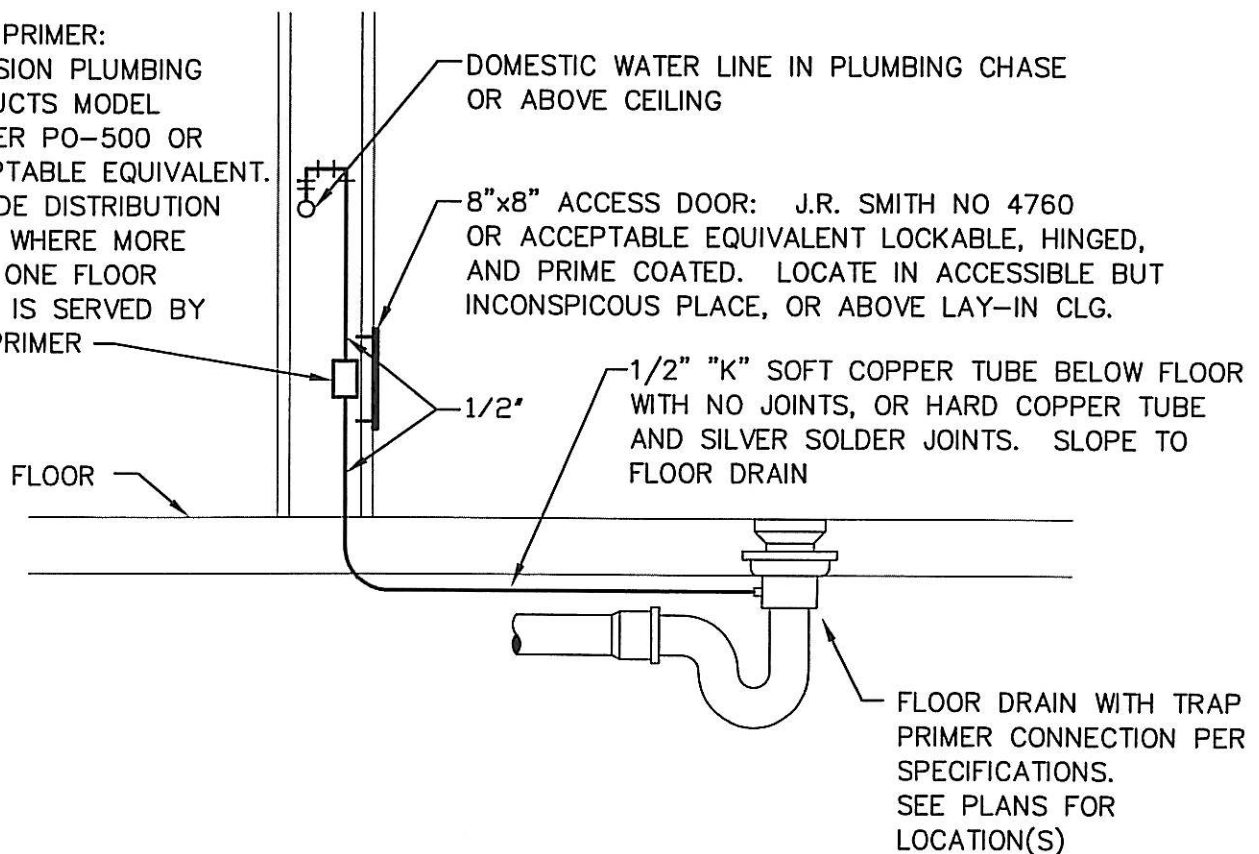
ELEVATION

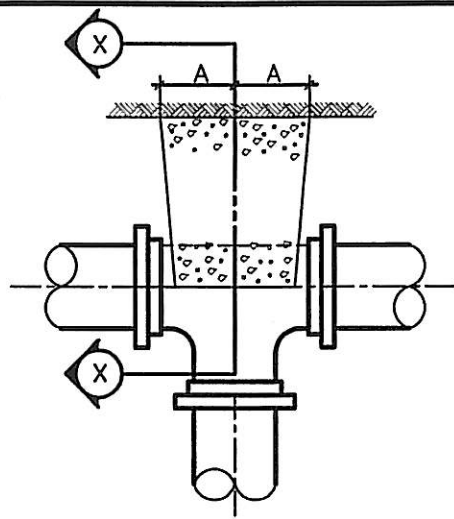


SECTION

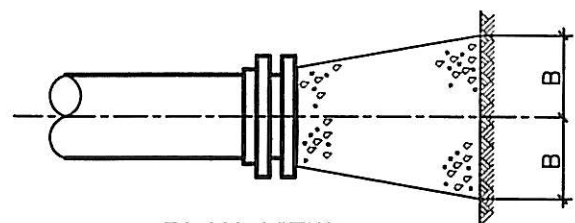
NOTE: METRIC DIMENSIONS (mm)

TRAP PRIMER:
PRECISION PLUMBING
PRODUCTS MODEL
NUMBER PO-500 OR
ACCEPTABLE EQUIVALENT.
PROVIDE DISTRIBUTION
UNITS WHERE MORE
THAN ONE FLOOR
DRAIN IS SERVED BY
ONE PRIMER

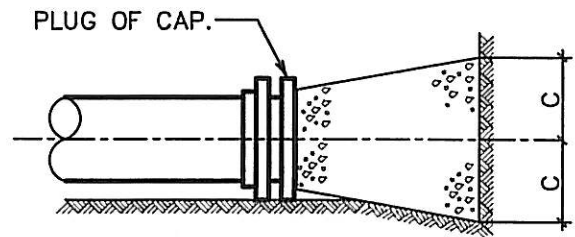




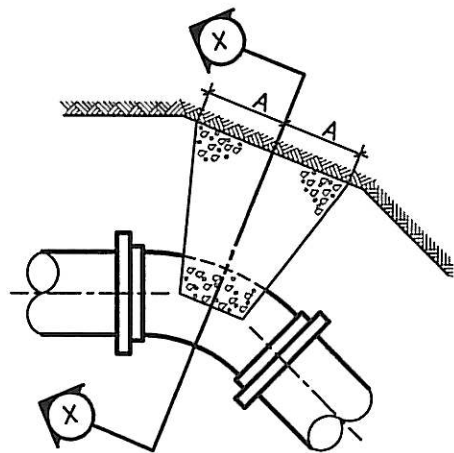
PLAN



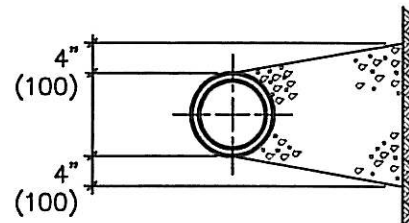
PLAN VIEW



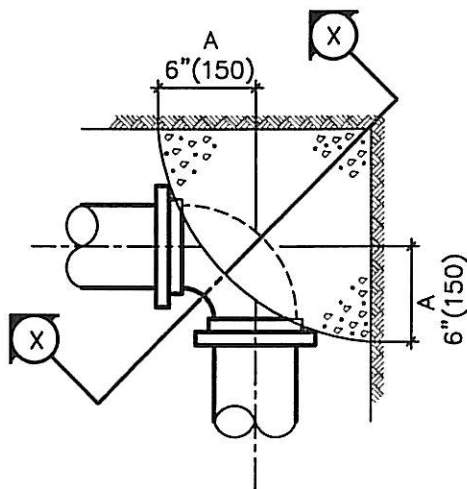
ELEVATION



PLAN



SECTION 'X'-'X'



PLAN

MINIMUM DIMENSIONS

SIZE OF PIPE	A	B	C
4" (100)	6" (150)	6" (150)	6" (150)
6" (150)	9.25" (230)	9.25" (230)	8" (200)
8" (200)	9.25" (230)	12" (300)	8" (200)
10" (250)	12" (300)	15.25" (380)	10" (250)
12" (300)	15.25" (380)	18" (450)	12" (300)
14" (350)	18" (450)	22" (550)	15.25" (380)
16" (400)	20" (500)	24" (600)	18" (450)

NOTES:

1. ALL CONCRETE TO BE 20 MPa.
2. ALL CONCRETE BLOCKING TO BE POURED AGAINST UNDISTURBED GROUND.
3. CLEARANCE OF 80mm TO BE MAINTAINED FROM FACE OF BELL TO CONCRETE.
4. POLYETHYLENE BOND BREAKER TO BE USED BETWEEN CONCRETE AND FITTING.
5. THIS BLOCKING DESIGN APPLIES ONLY WHERE 1030 KPa PRESSURE IS NOT EXCEEDED.
6. METRO DIMENSIONS (mm)

FOR HORIZONTAL BENDS, TEES & DEAD END MAIN.



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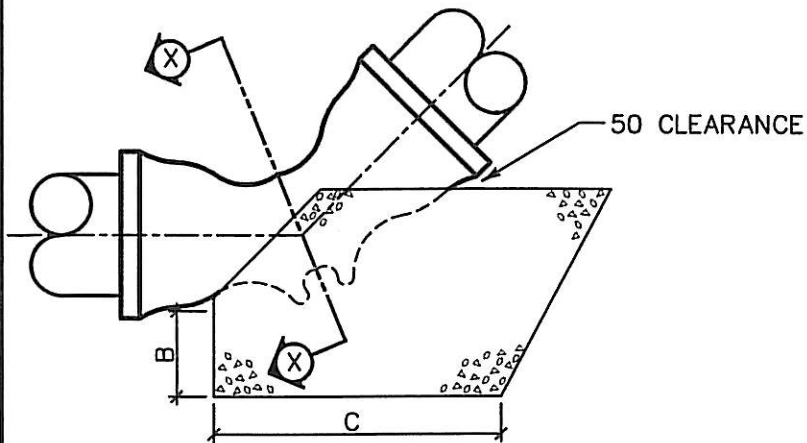
DETAIL DRAWING:

**CONCRETE THRUST BLOCKS
(HORIZONTAL)
N.T.S.**

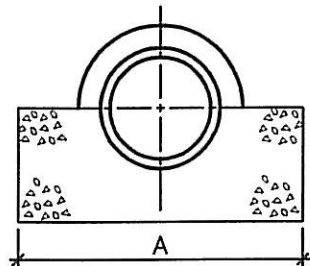
DETAIL No.

15400-008

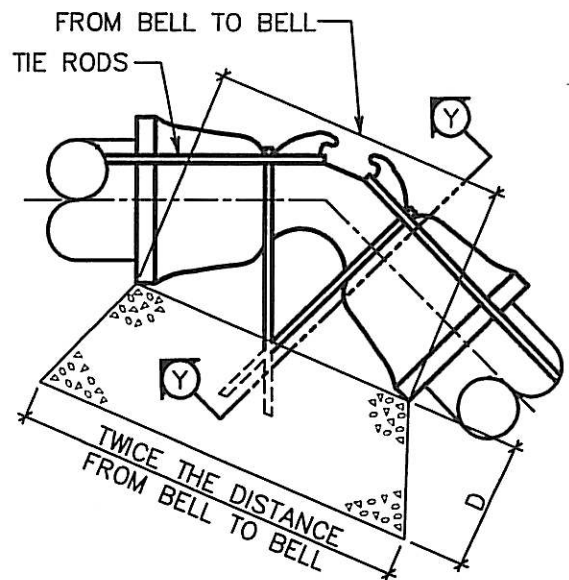
APRIL 22/04



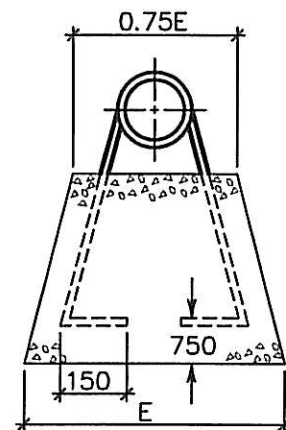
ELEVATION



SECTION 'X'-'X'



ELEVATION



SECTION 'Y'-'Y'

MINIMUM DIMENSION WATER PRESSURE UP TO 1030 KPa					
SIZE OF BENDS	A	B	C	D	E
150	675	225	675	900	675
200	750	350	900	900	750
250	900	450	1125	1125	825
300	1125	575	1350	1125	900
400	1350	750	1575	1350	1125

NOTES:

- 1) ALL STEEL RODS GRADE 350 DEFORMED
- 2) ALL CONCRETE 20 MPa
- 3) DIMENSIONS SHOWN ARE BASED ON WATER PRESS. OF 1035 KPa.

FOR VERTICAL BENDS



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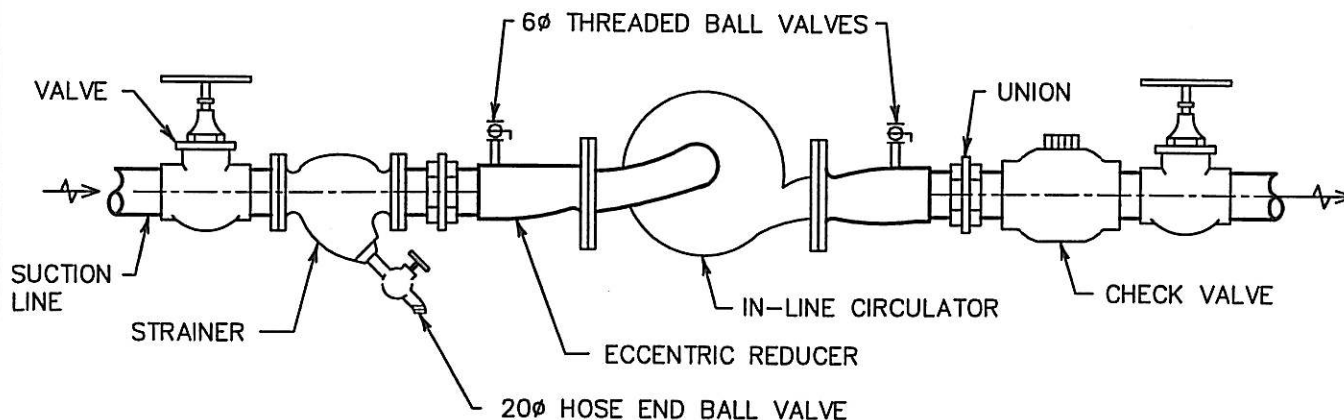
DETAIL DRAWING:

CONCRETE THRUST BLOCKS
(VERTICAL)
N.T.S.

DETAIL No.

15400-009

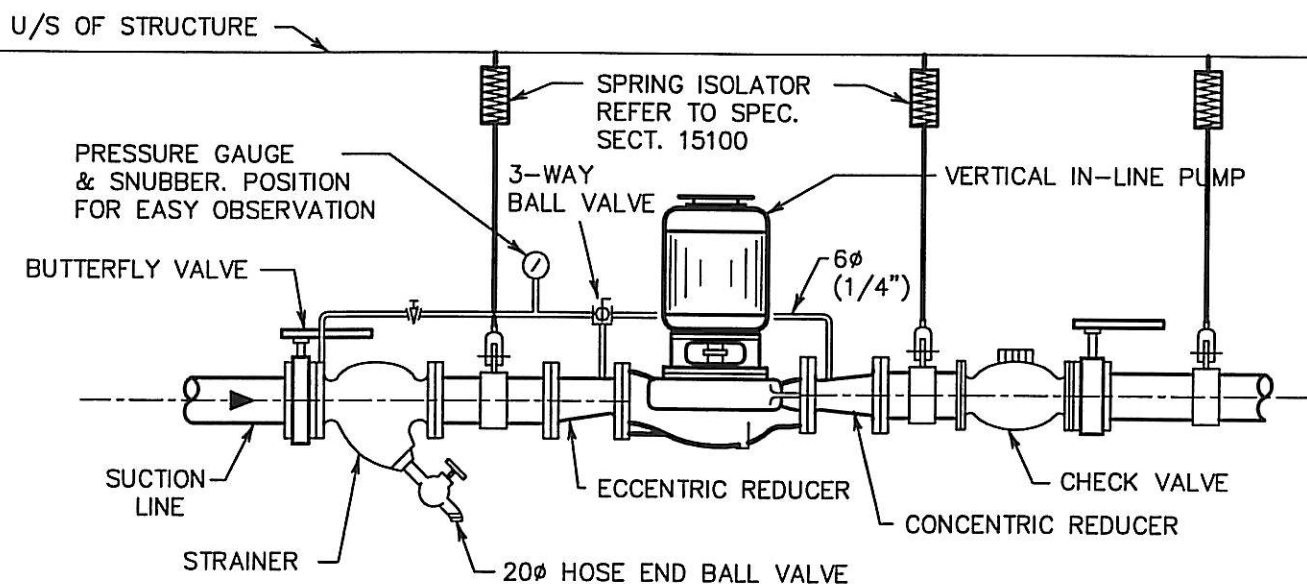
APRIL 22/04



NOTE:

- 1 VALVES AND STRAINER TO BE PIPE LINE SIZE AS INDICATED ON SCHEMATIC
- 2 THE PREFERRED POSITION OF THE PUMP, IS TO MOUNT IN A VERTICAL SECTION OF PIPE. FOLLOW MFR'S DATA FOR HORIZONTAL POSITIONING.

TYPICAL IN-LINE CIRCULATOR PUMP n.t.s.



NOTE:

- 1 VALVES AND STRAINER TO BE PIPE LINE SIZE AS INDICATED ON SCHEMATIC
- 2 SEE SPECIFICATIONS SECT. 15700 PART 3 FOR SUCTION PIPING REQUIREMENTS

TYPICAL VERTICAL IN-LINE PUMP n.t.s.
(3HP AND LESS UNLESS INDICATED OTHERWISE ON DWGS.)



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DETAIL DRAWING:

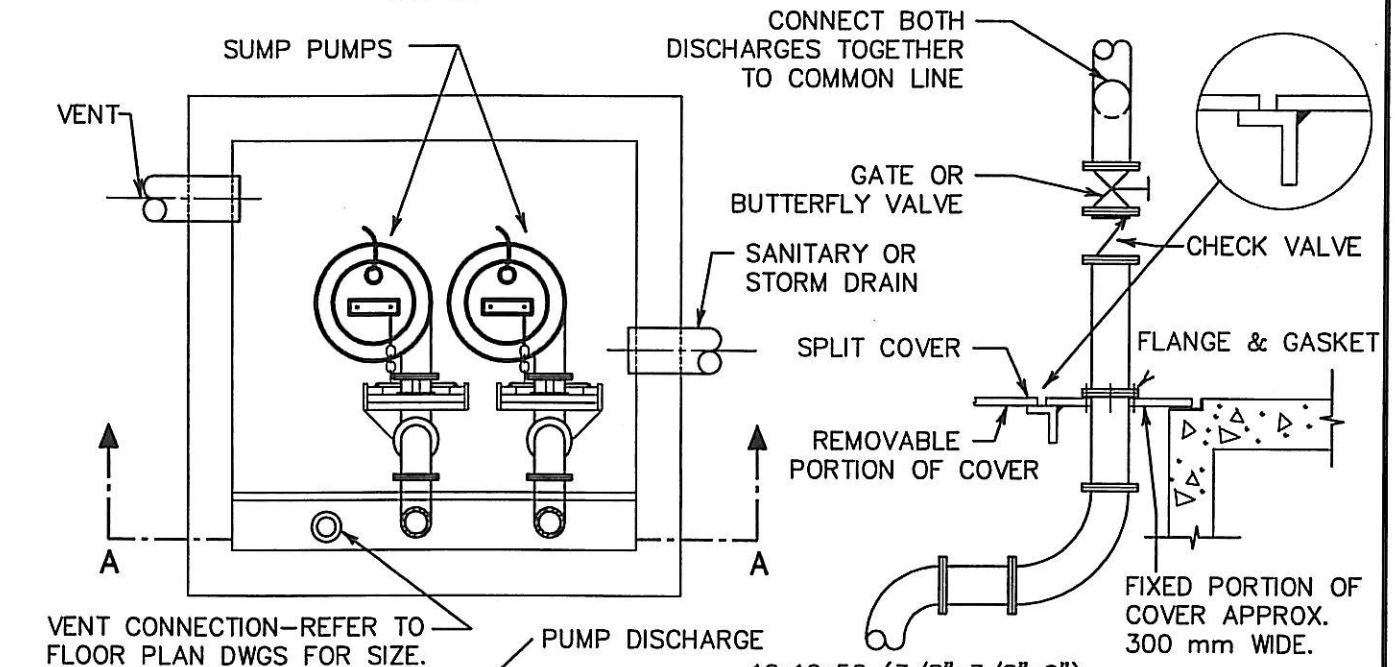
TYPICAL VERTICAL IN-LINE PUMP
N.T.S.

DETAIL No.

15400-010

APRIL 22/04

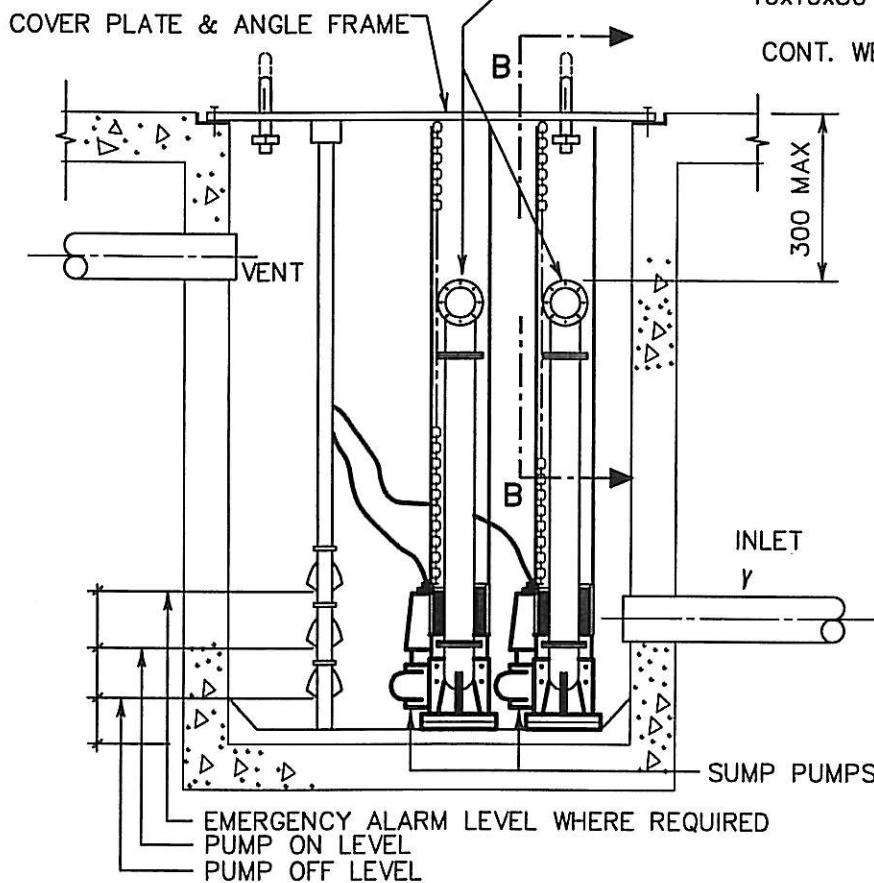
PLAN



SECTION B-B

NOTES:

1. USE ELECTRIC FLOAT & ALARM DEVICES WIRED TO REMOTE MTD. CONTROL PANEL.
2. PROVIDE REINFORCED SUMP-COVER WHERE CAR OR TRUCK TRAFFIC OCCURS
3. METRIC DIMENSIONS (mm)
4. PROVIDE GASKETTING ON BOLTS FIXED AND REMOVABLE PORTIONS OF COVER.
5. SECURE COVERS WITH STAINLESS STEEL 8mm (5/16") FLAT HEAD SCREWS TAPPED INTO.



SECTION A-A



MCW Consultants Ltd.

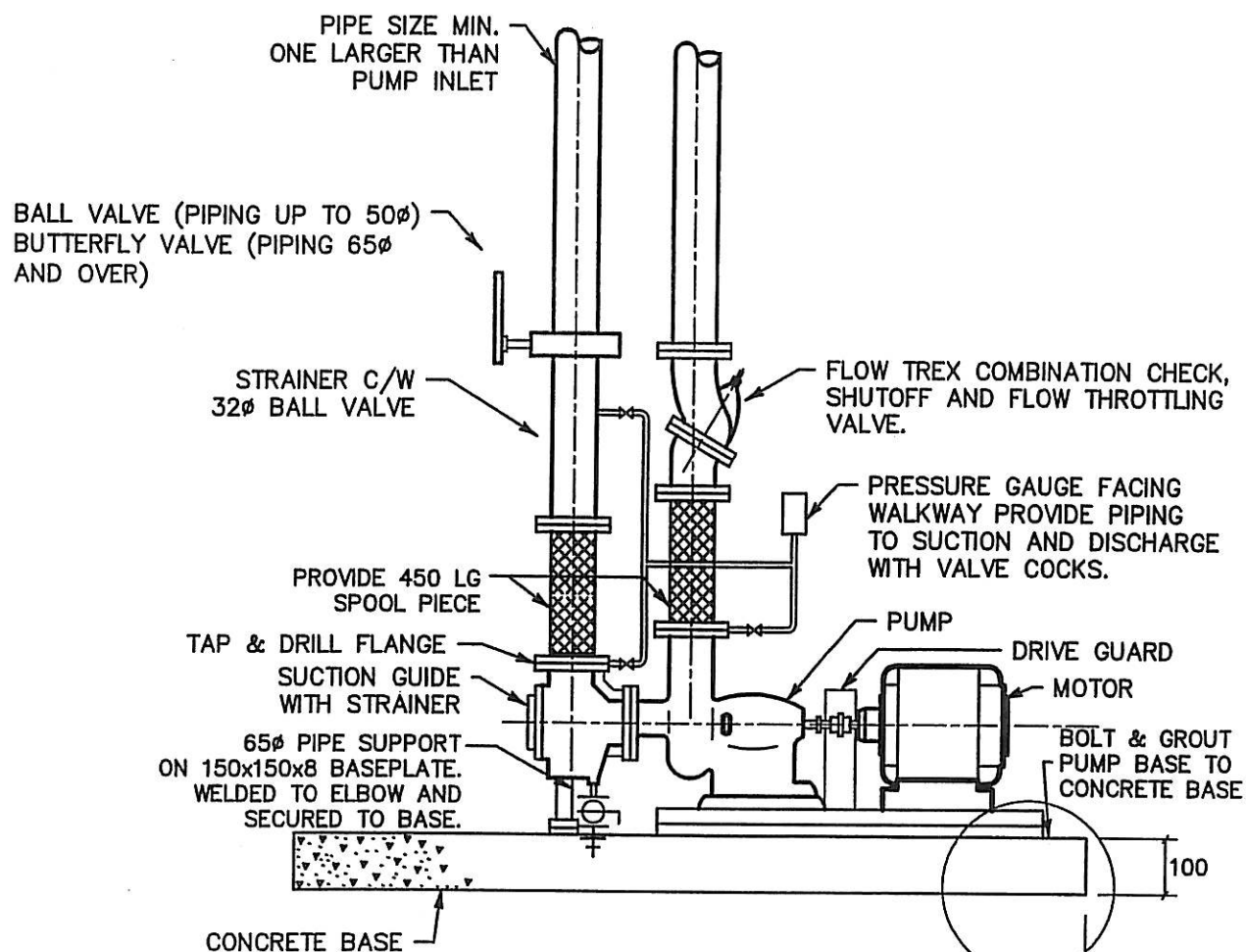
DETAIL DRAWING:

SUBMERSIBLE SLIDEWAY SUMP
PUMP SPLIT COVER TYPE
N.T.S.

DETAIL No.

15400-013A

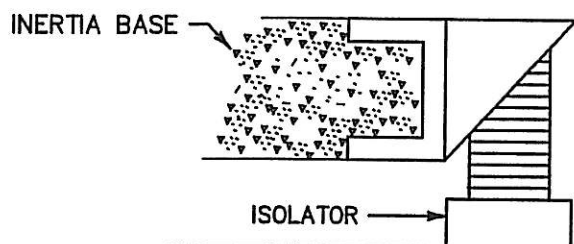
APRIL 22/04



NOTE:

- 1) VALVES TO BE PIPE LINE SIZE
AS INDICATED ON SCHEMATIC

SEE DETAIL BELOW



CONVENTIONAL METHOD
OF INSTALLATION

BASE DETAIL



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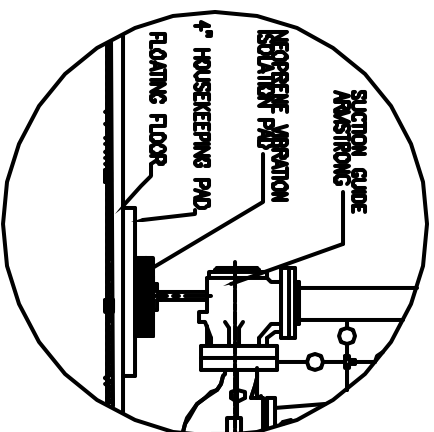
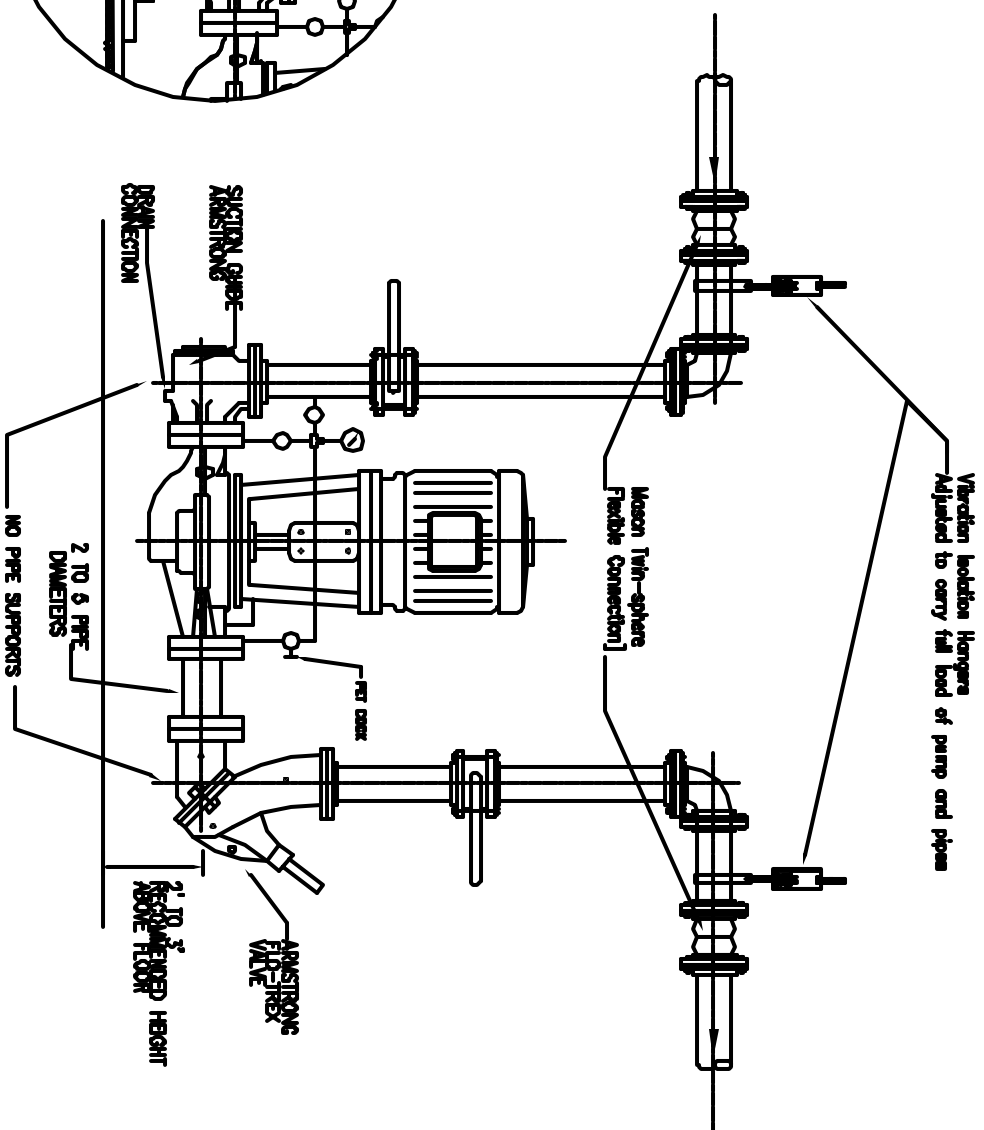
DETAIL DRAWING:

TYPICAL BASE MOUNTED PUMP
N.T.S.

DETAIL No.

15400-425A

APRIL 22/04



PIPE SUPPORTS DETAIL - WITH FLOATING FLOOR ONLY

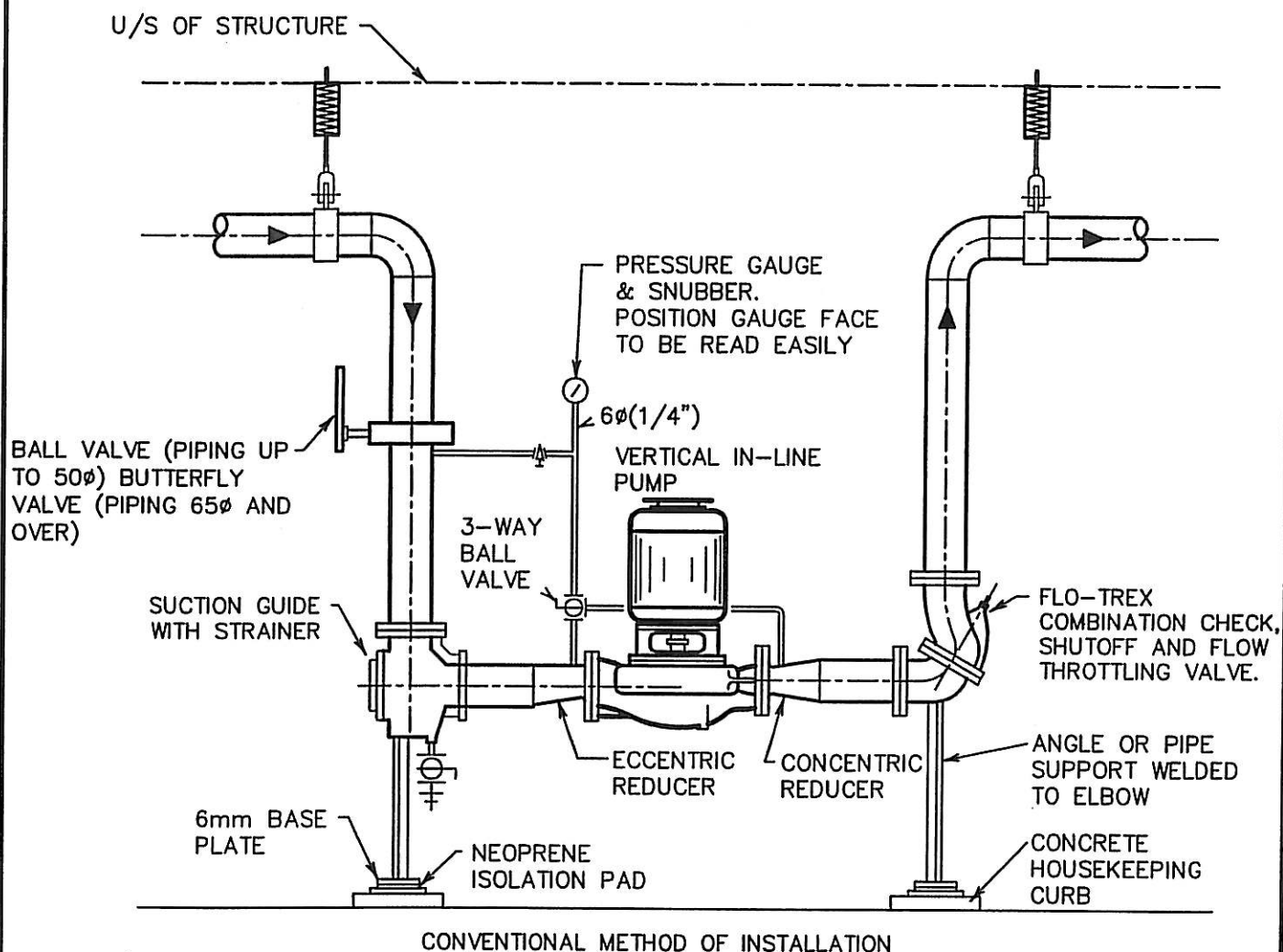
Detail - Vertical In-Line Pump Vibration Isolation and
Twin-Sphere Flexible Connection Placement

SCALE: Not To Scale

Concept and Drawing
Copyright 2007, HGC Engineering

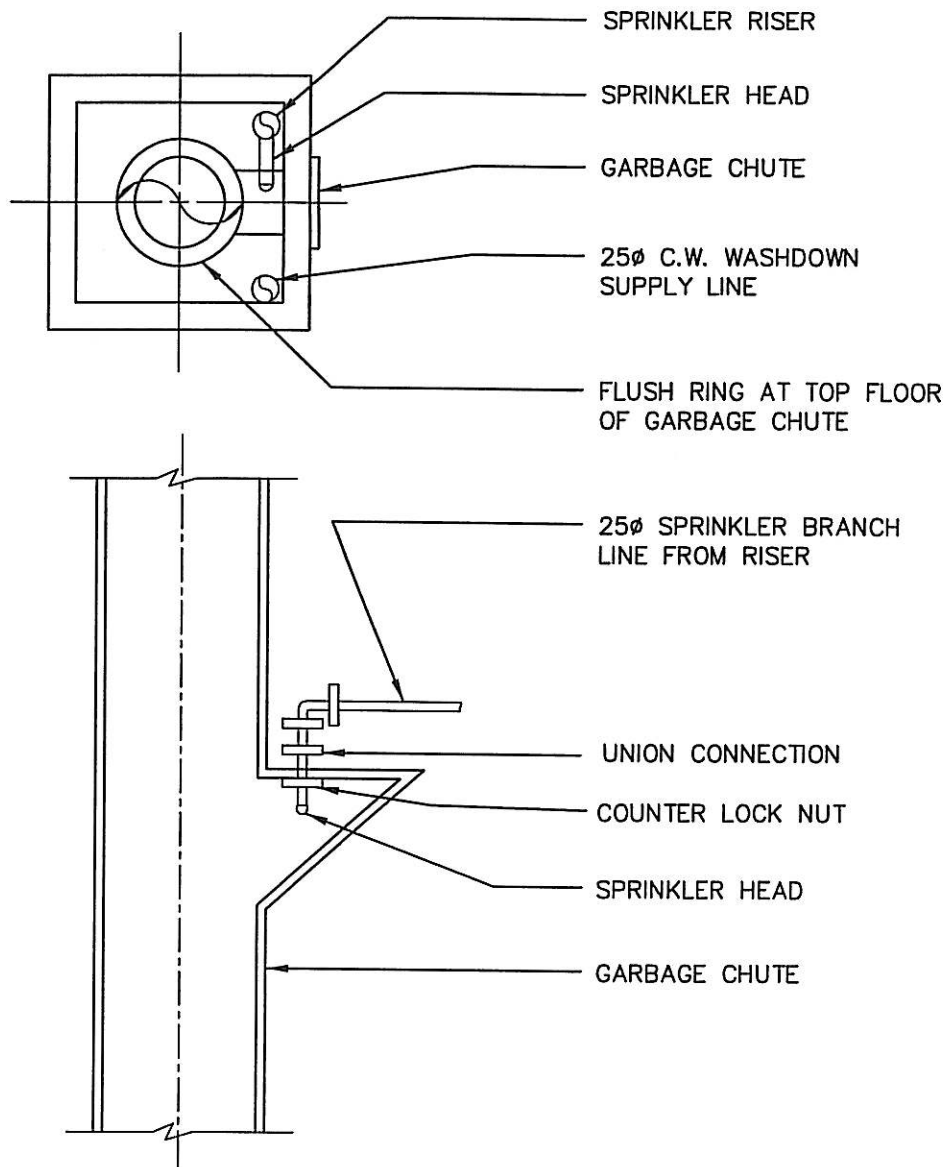
File: VIL with Twin Sphere
Drawn By: APL

HGC
ENGINEERING



NOTES:

- 1 VALVES AND STRAINER TO BE PIPE LINE SIZE AS INDICATED ON SCHEMATICS.
- 2 SEE SPEC. SECTION 15700 PART 3 FOR SUCTION PIPING REQUIREMENTS.



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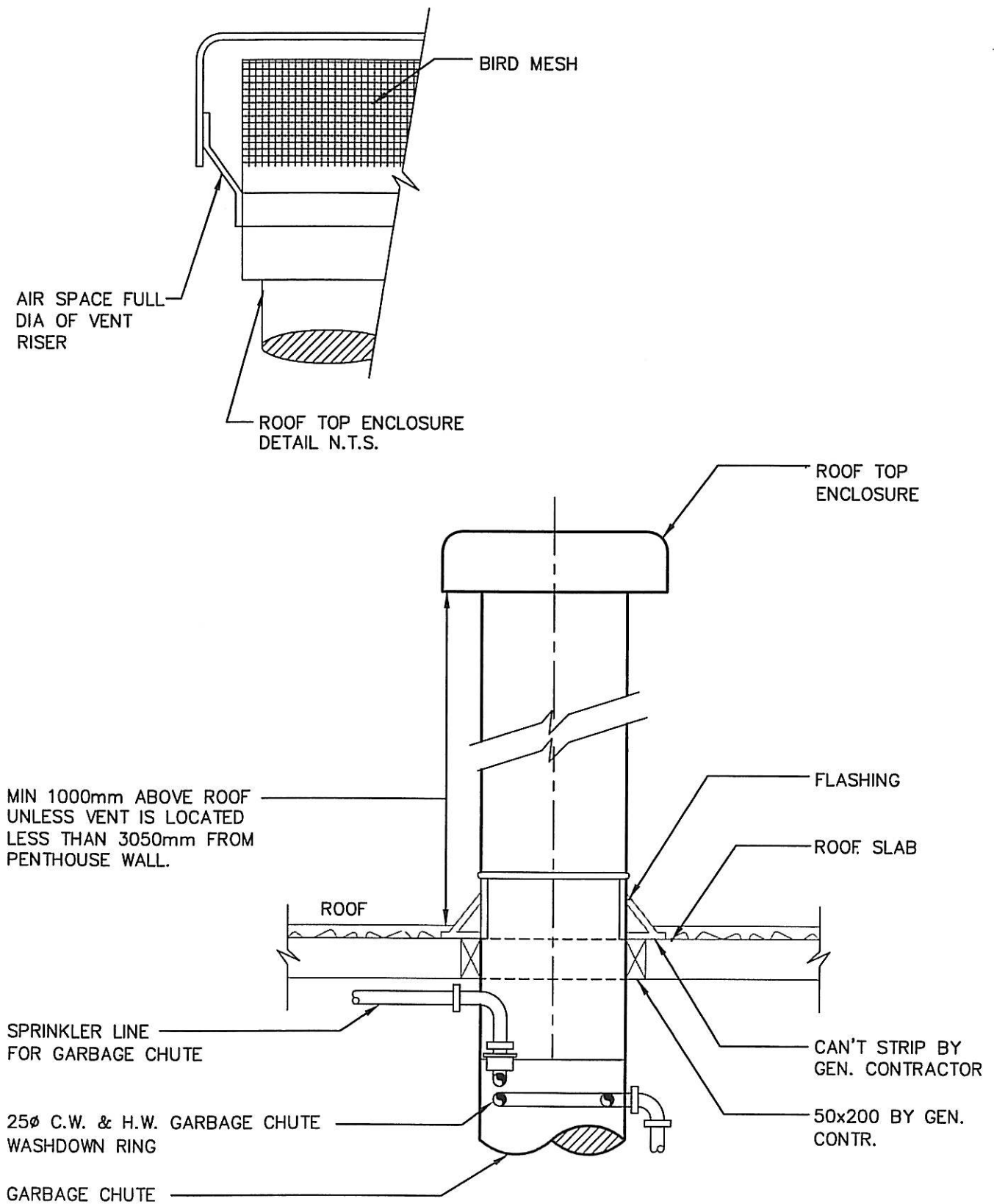
DETAIL DRAWING:

DETAIL OF GARBAGE
SPRINKLER HEAD CONN.
N.T.S.

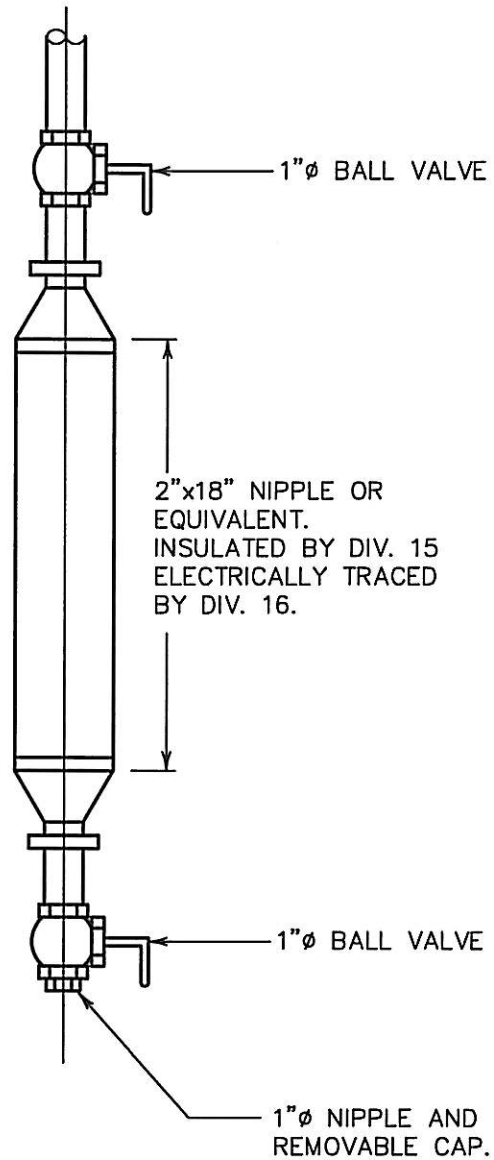
DETAIL No.

15500-002

APRIL 22/04



1" DRY SYSTEM
AUXILIARY DRAIN.



NOTE:

ALL DRUM DRIPS ARE TO
BE HEAT TRACED AND
INSULATED.

REFER TO SPECIFICATION
SECTION 15180 FOR PIPE
INSULATION AND SECTION
15410 FOR HEAT TRACING.



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DETAIL DRAWING:

DRUM DRIP DETAIL
N.T.S.

DETAIL No.

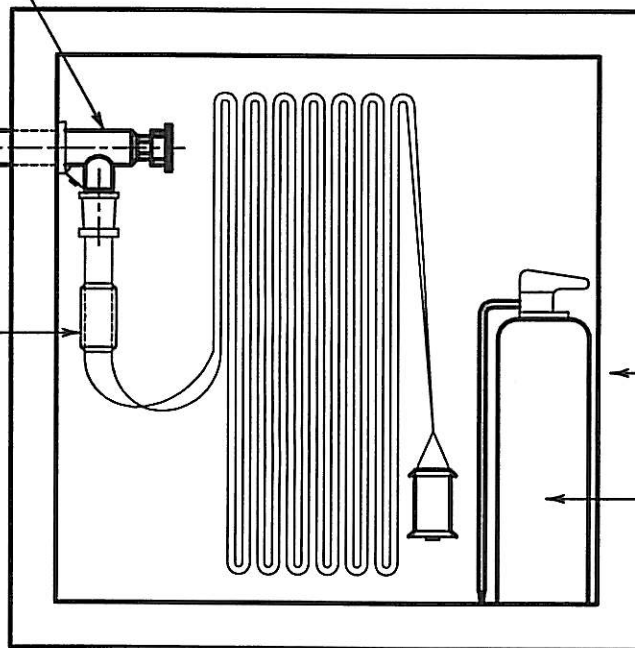
15500-005

APRIL 22/04

FORGED BRASS 40Ø
APPROVED ANGLE
WITH FORGED BRASS
PULL-OFF CAP

STANDPIPE RISER

WATER STOP



CABINET TUB

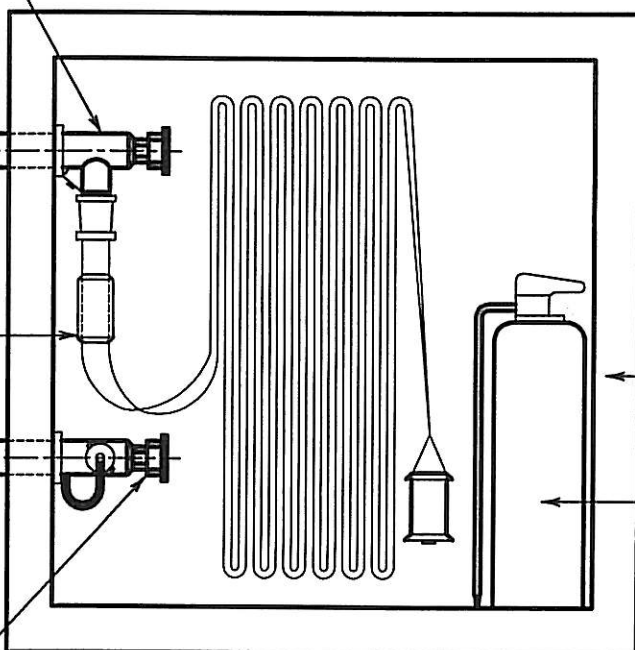
FIRE
EXTINGUISHER

SINGLE VALVE

FORGED BRASS 40Ø
APPROVED ANGLE
WITH FORGED BRASS
PULL-OFF CAP

STANDPIPE RISER

WATER STOP



CABINET TUB

FIRE
EXTINGUISHER

DOUBLE VALVE

FORGED BRASS 65Ø
APPROVED ANGLE
WITH FORGED BRASS
PULL-OFF CAP.



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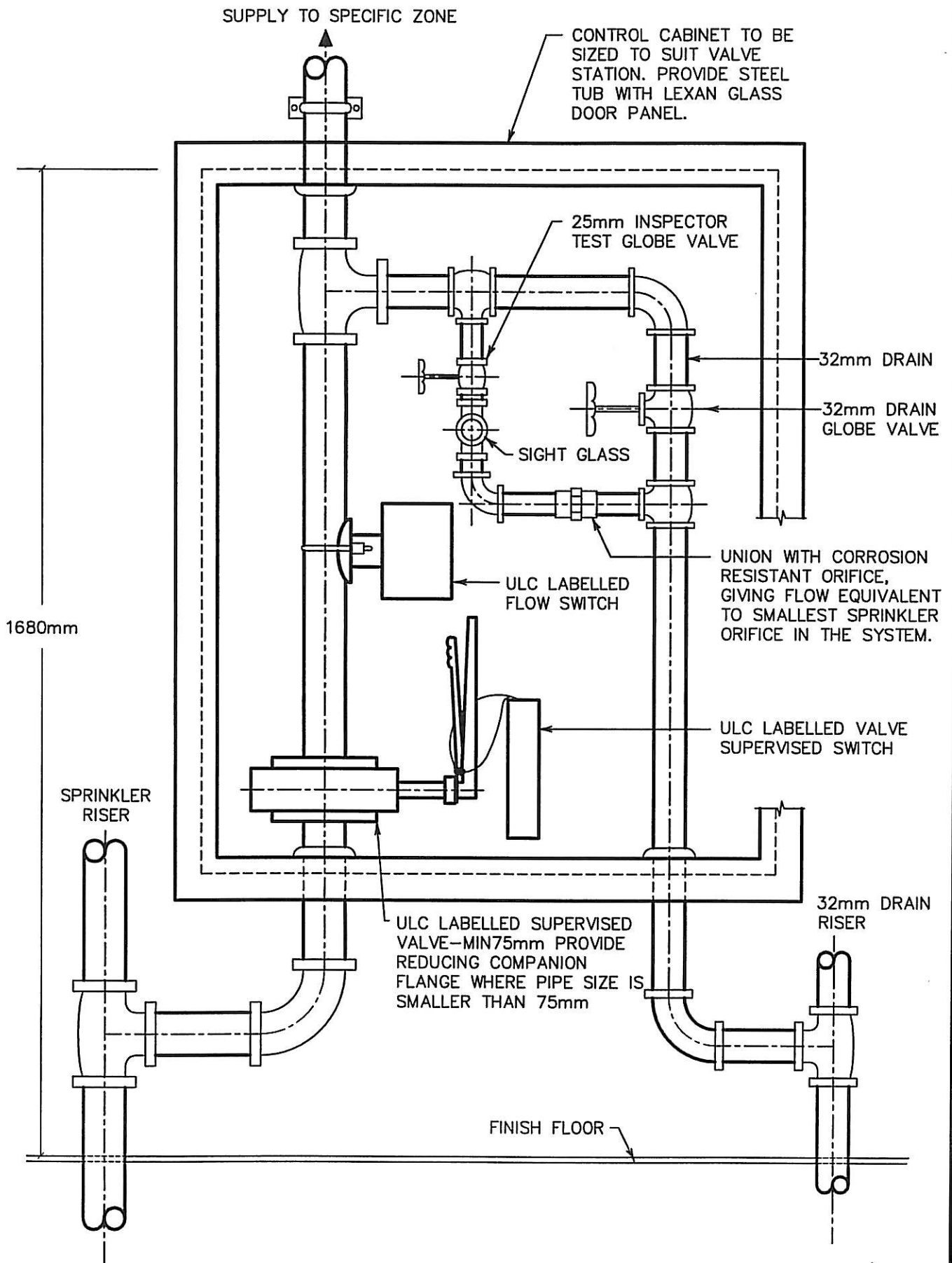
DETAIL DRAWING:

HOSE CABINET
N.T.S.

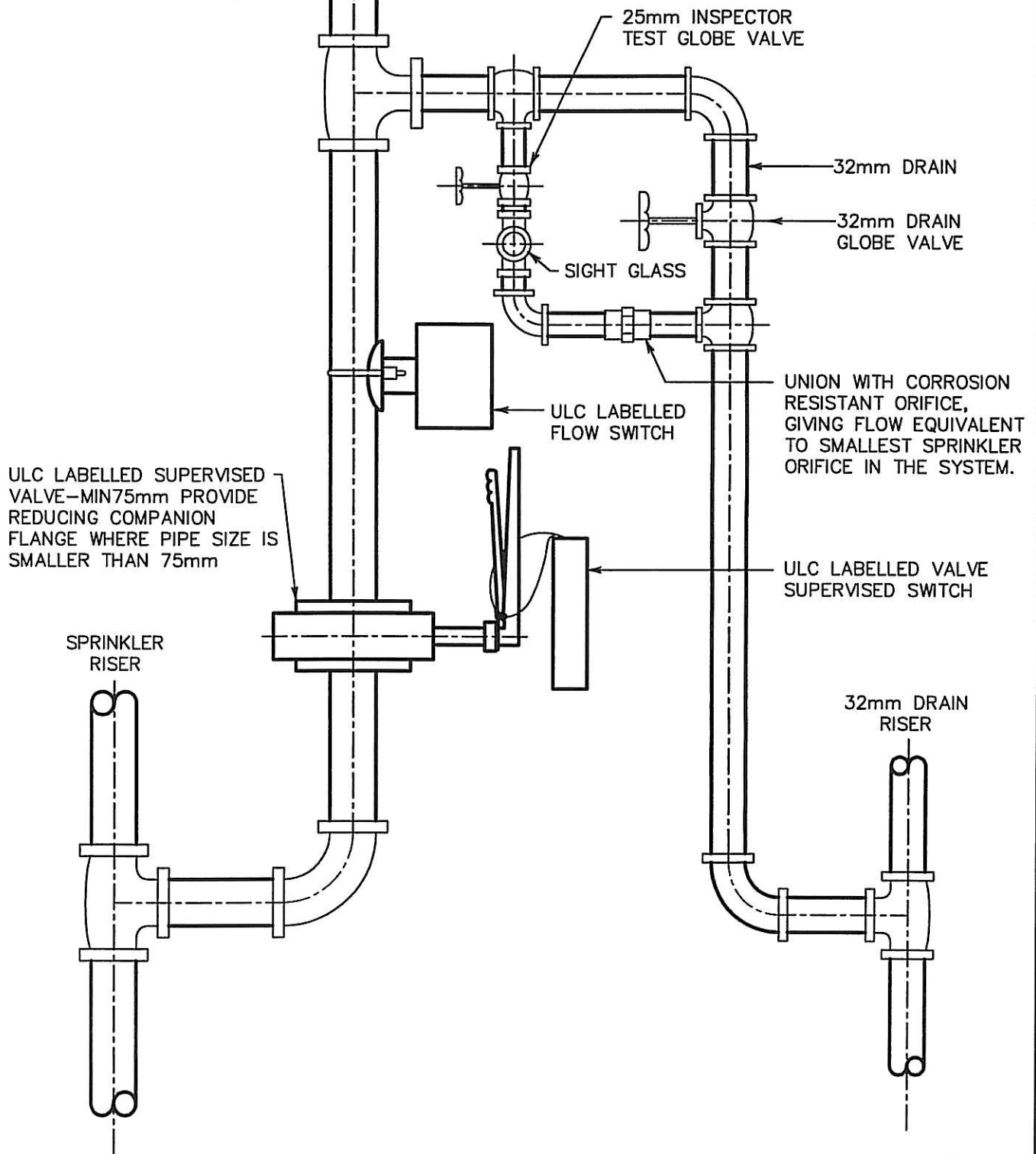
DETAIL No.

15500-006

APRIL 22/04



SUPPLY TO SPECIFIC ZONE



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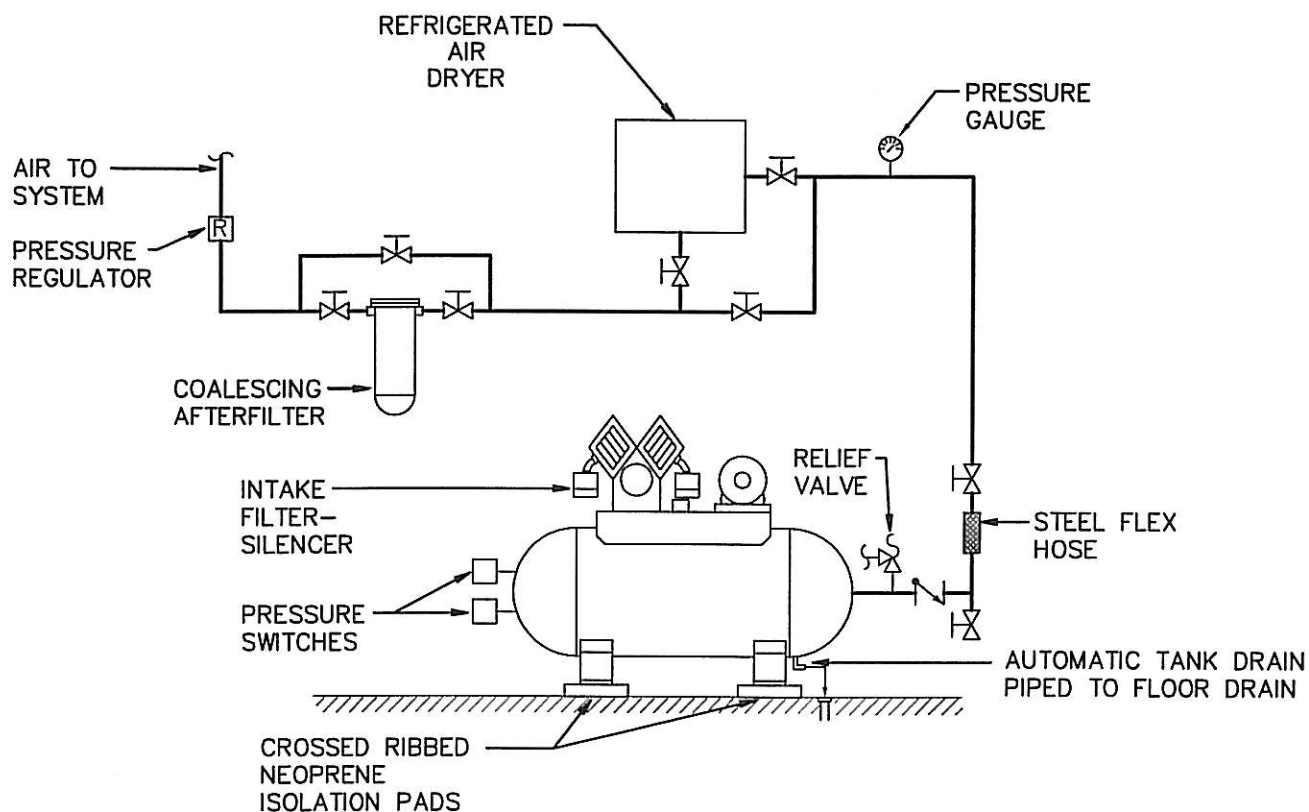
DETAIL DRAWING:

SPRINKLER CONTROL
N.T.S.

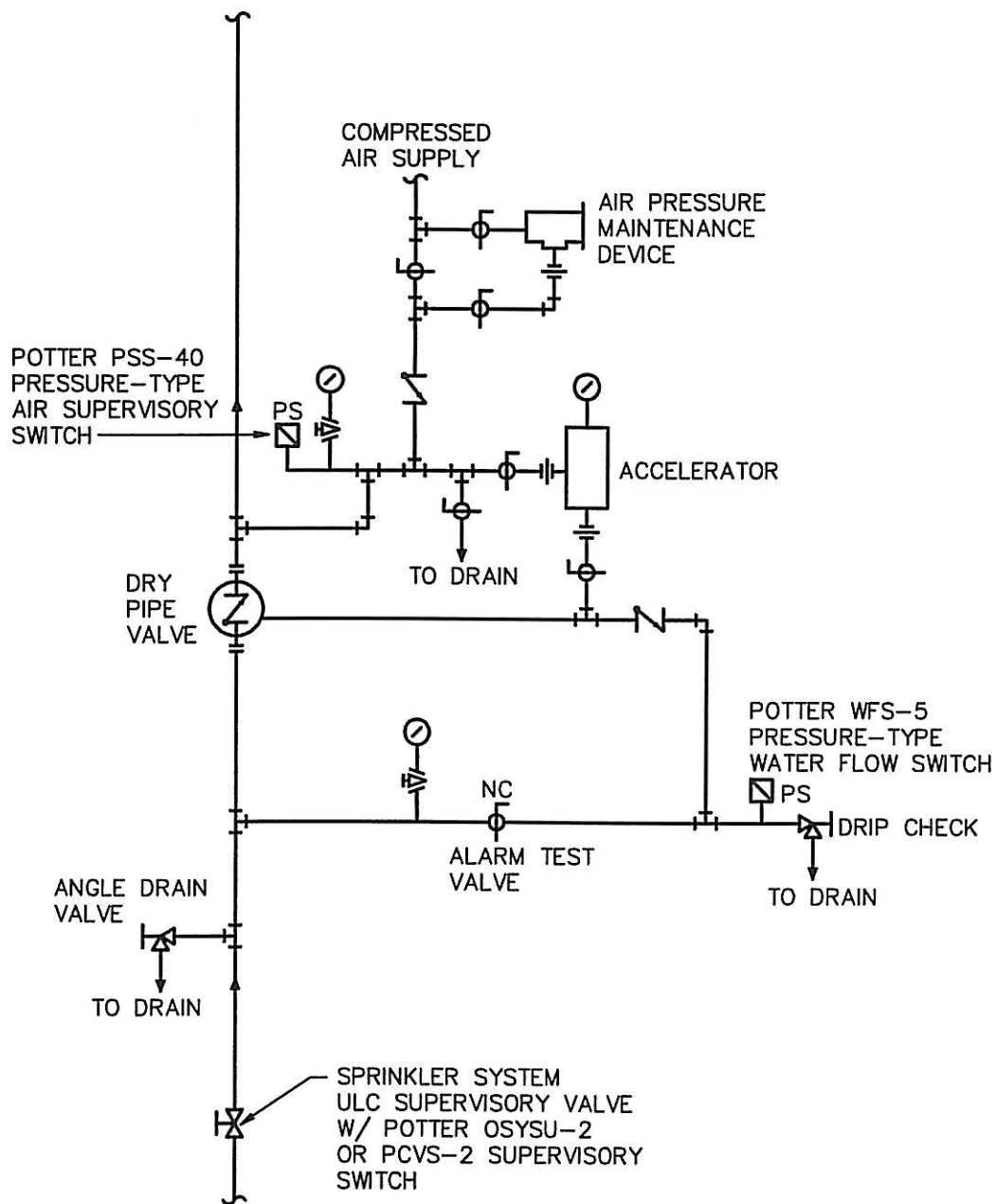
DETAIL No.

15500-081A

APRIL 22/04



DRY SPRINKLER SYSTEM
AIR COMPRESSOR SCHEMATIC PIPING DIAGRAM
 SCALE: N.T.S.



TYPICAL DRY SPRINKLER VALVE PIPING SCHEMATIC

SCALE: NTS



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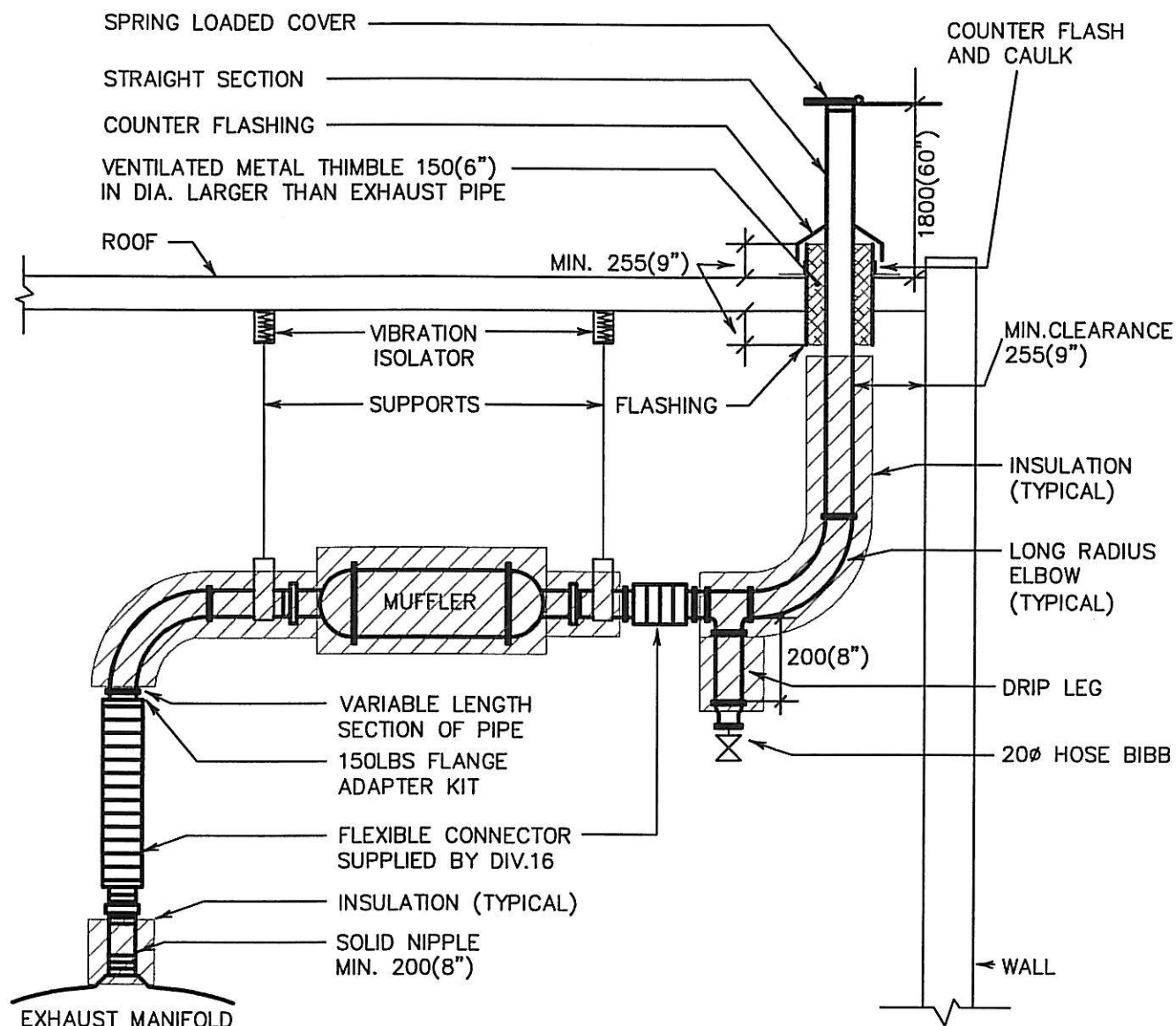
DETAIL DRAWING:

TYPICAL DRY SPRINKLER VALVE
PIPING SCHEMATIC

DETAIL No.

15500-094

APRIL 22/04



NOTES:

1. ENTIRE EXHAUST SYSTEM EXCEPT FOR FLEXIBLE CONNECTOR TO BE INSULATED
- REFER TO SPECIFICATIONS
2. FOR POSITIVE PRESSURE EXHAUST SYSTEMS
3. DIAGRAM ILLUSTRATES THE WIDE LINE OF PARTS THAT WOULD BE REQUIRED
FOR A POSITIVE PRESSURE EXHAUST (SUCH AS ON AN ENGINE)
4. REFER TO MANUFACTURE GENERAL INSTALLATION GUIDELINES FOR CLEARANCES,
HEIGHT LIMITATIONS AND OTHER GENERAL INSTRUCTIONS



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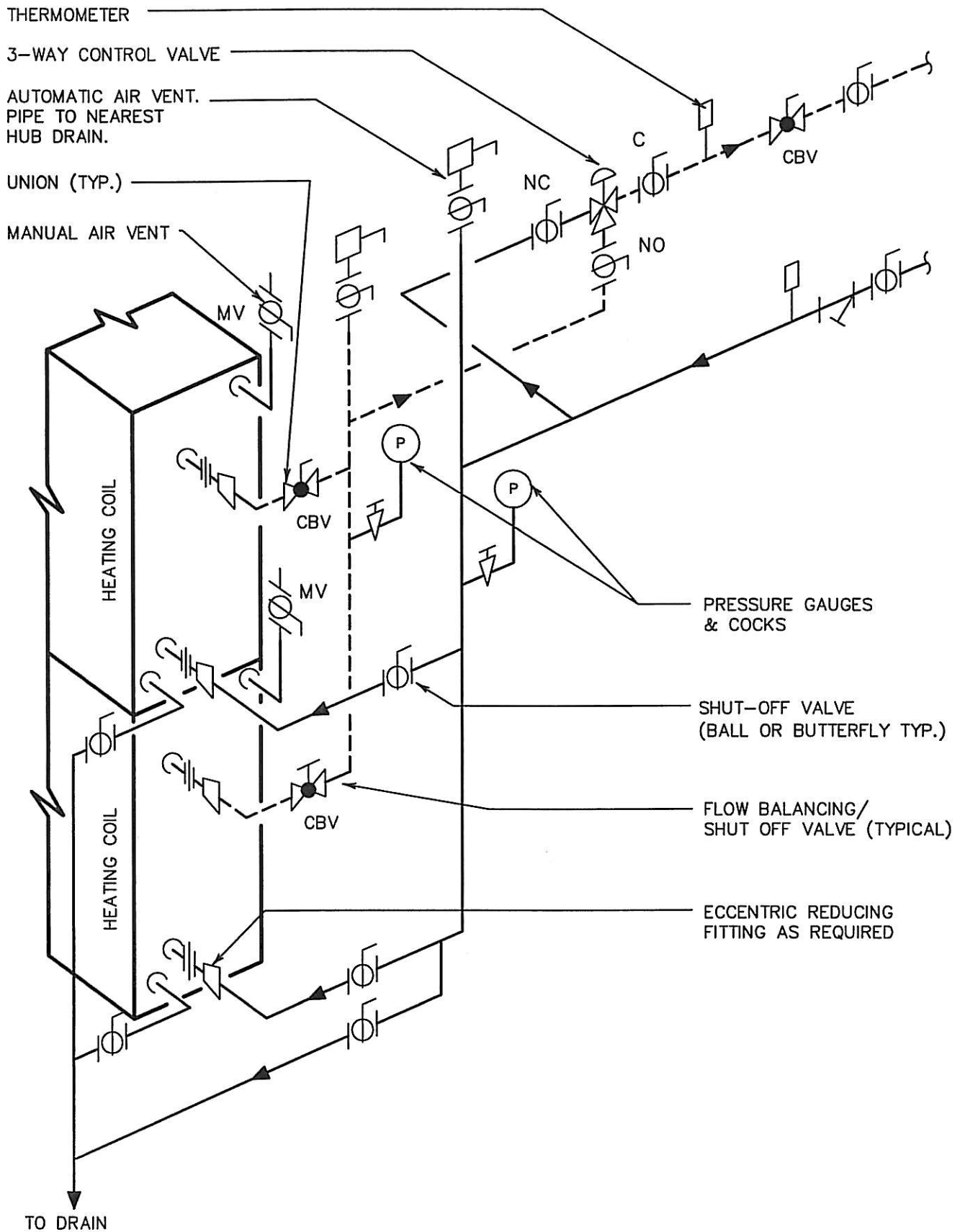
DETAIL DRAWING:

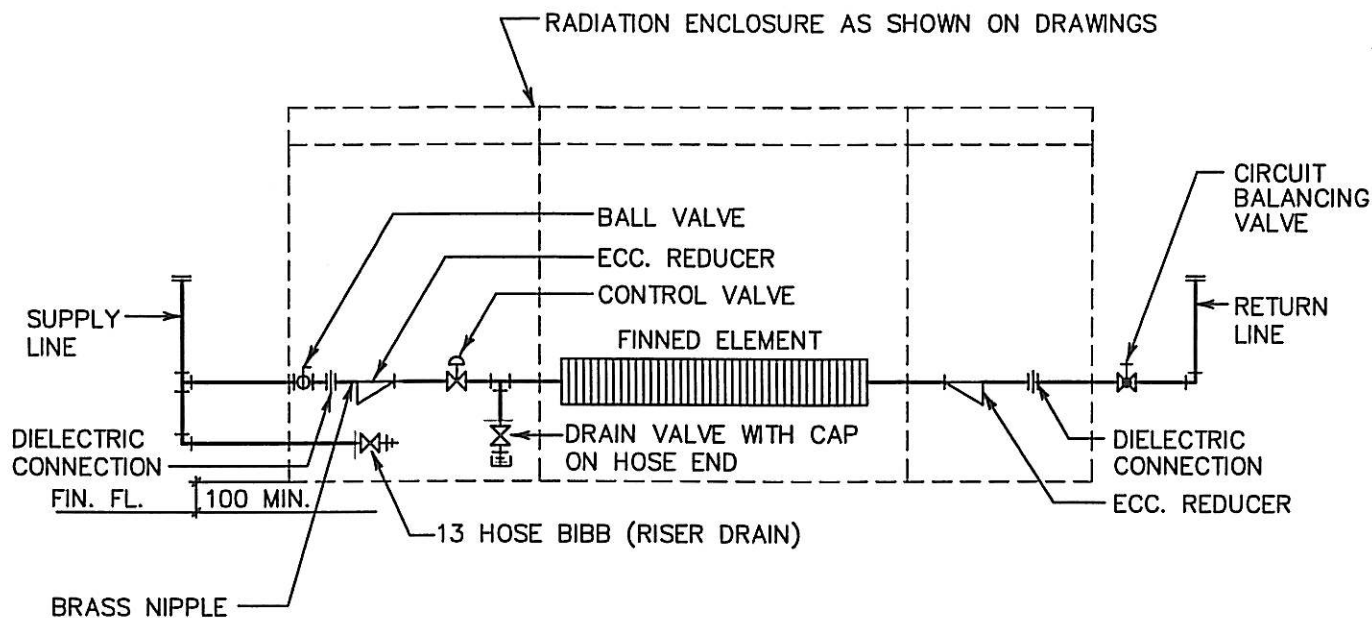
ENGINE EXHAUST OUTLET
N.T.S.

DETAIL No.

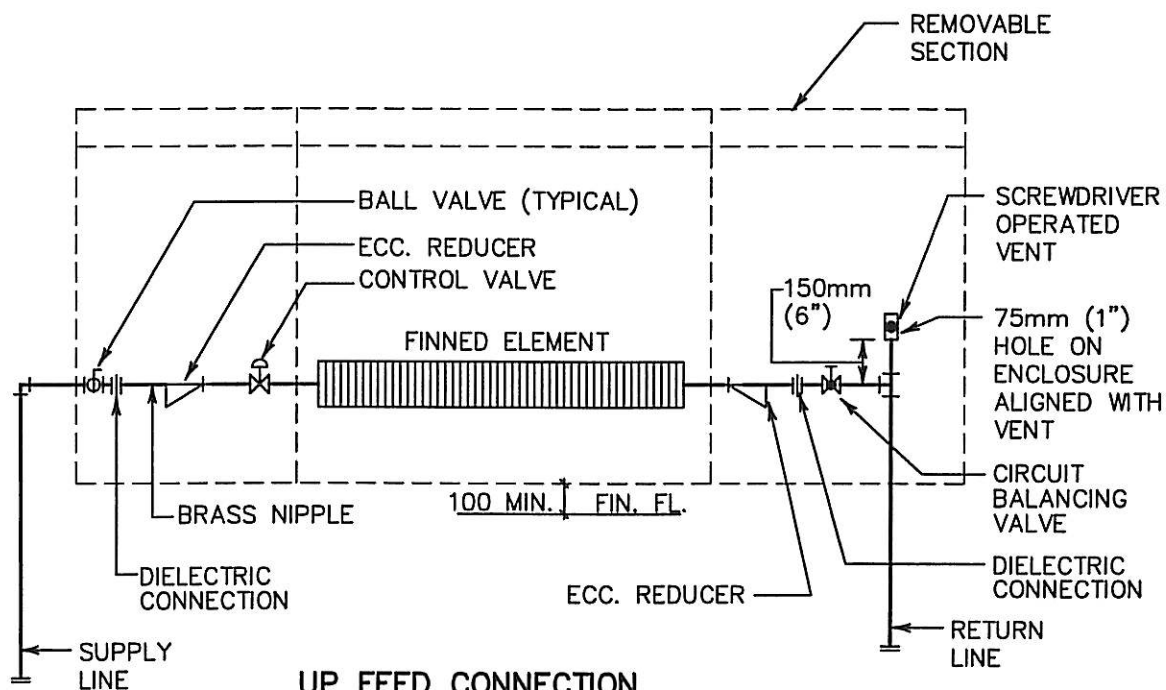
P-37A

JULY 04/01





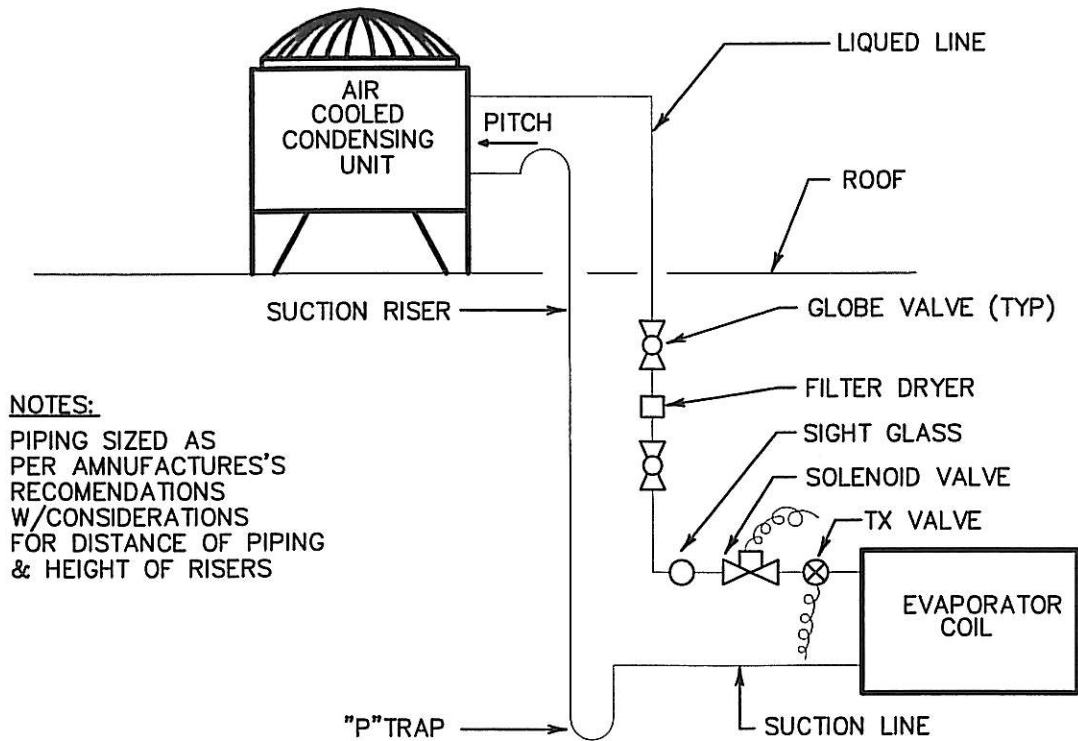
DOWN FEED CONNECTION



UP FEED CONNECTION

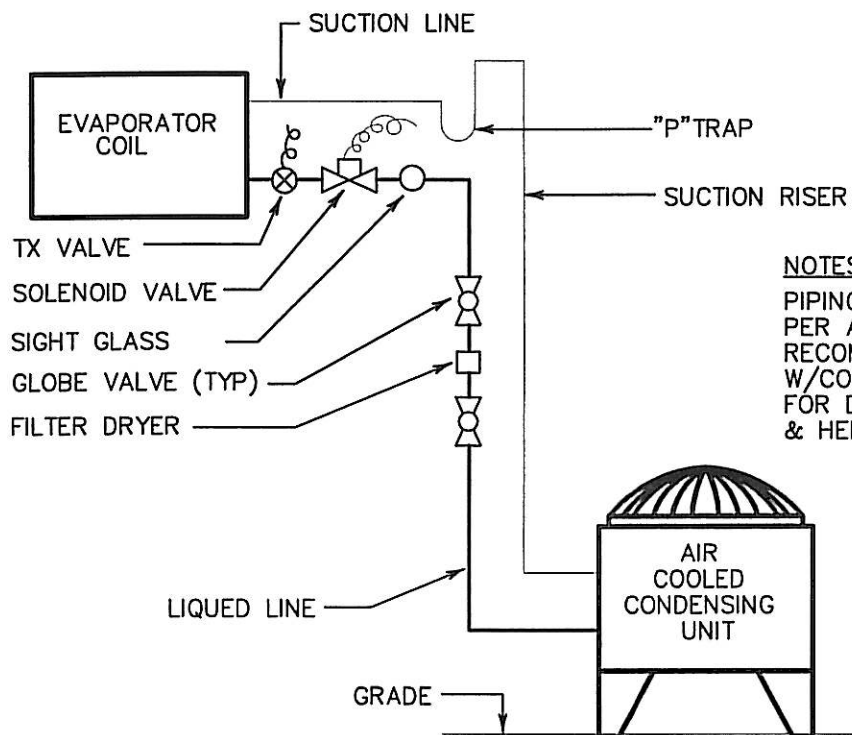
NOTES :

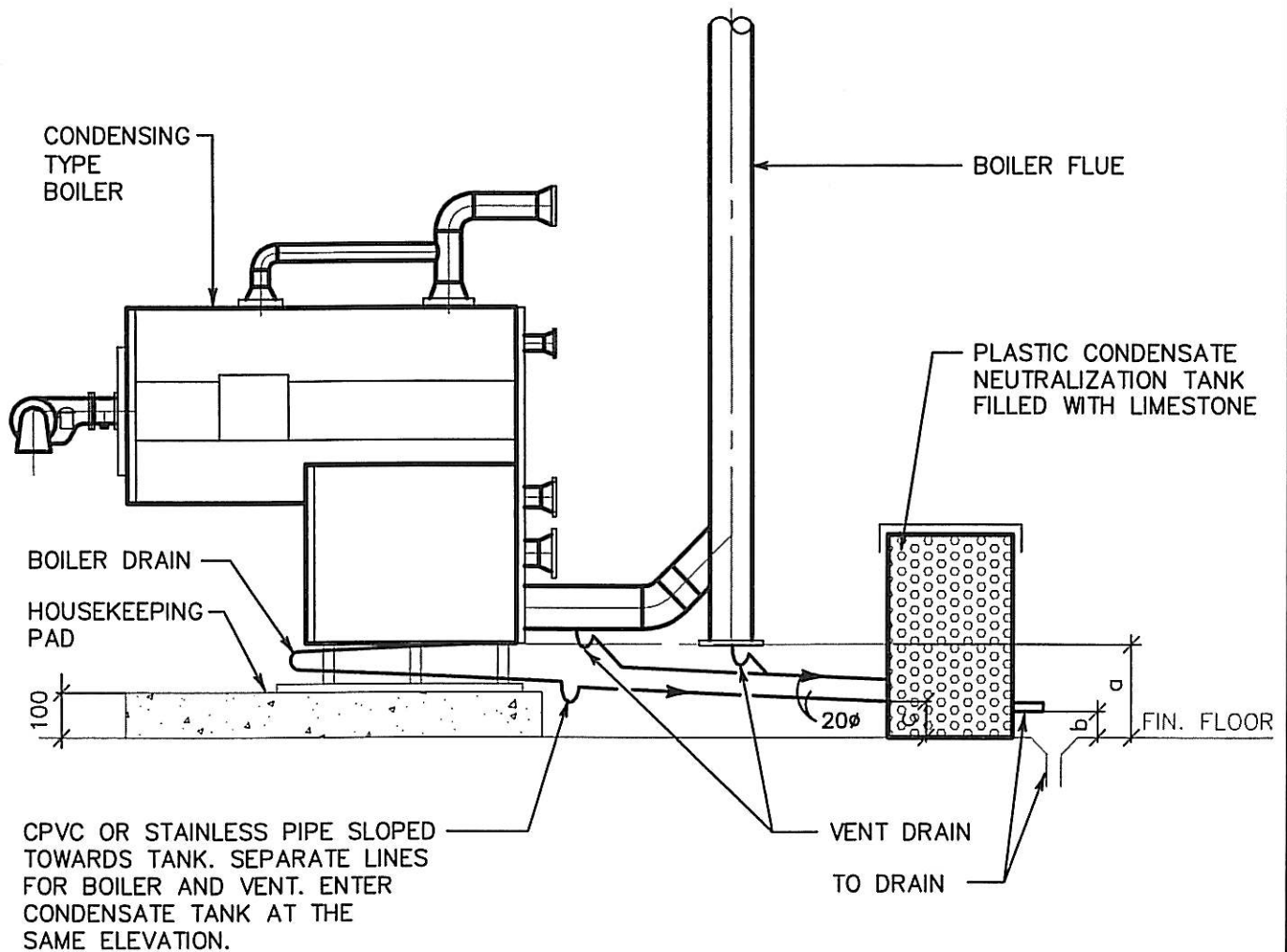
- 1) ALL MATERIALS BETWEEN DIELECTRIC CONNECTIONS TO BE BRASS OR COPPER.
- 2) ALL VALVES TO BE MTD. INSIDE RADIATION COVER BEHIND ACCESS DOOR.



TYPICAL SPLIT SYSTEM PIPING DETAIL

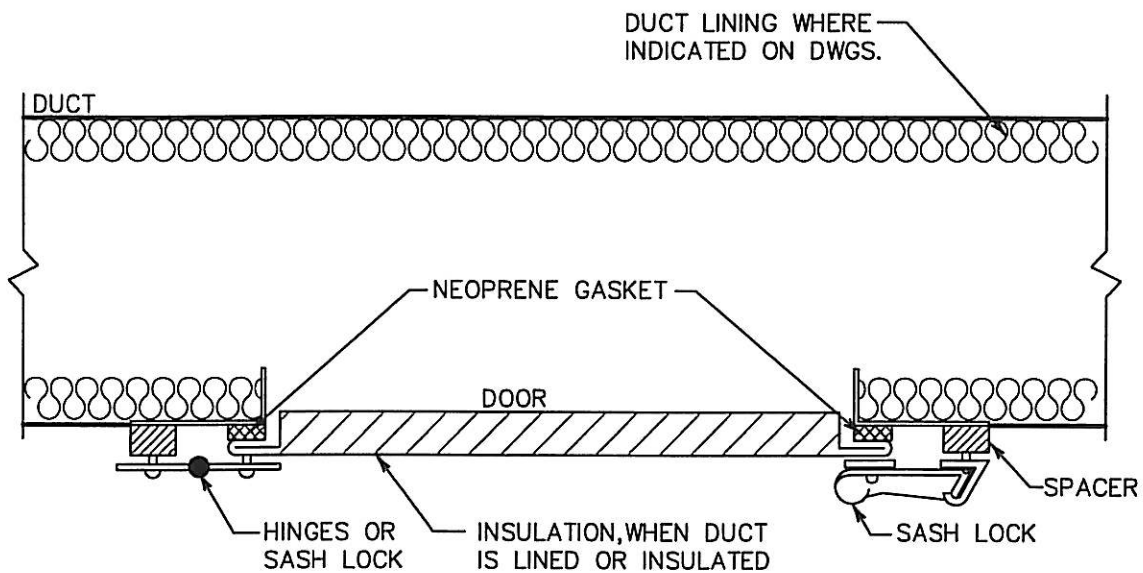
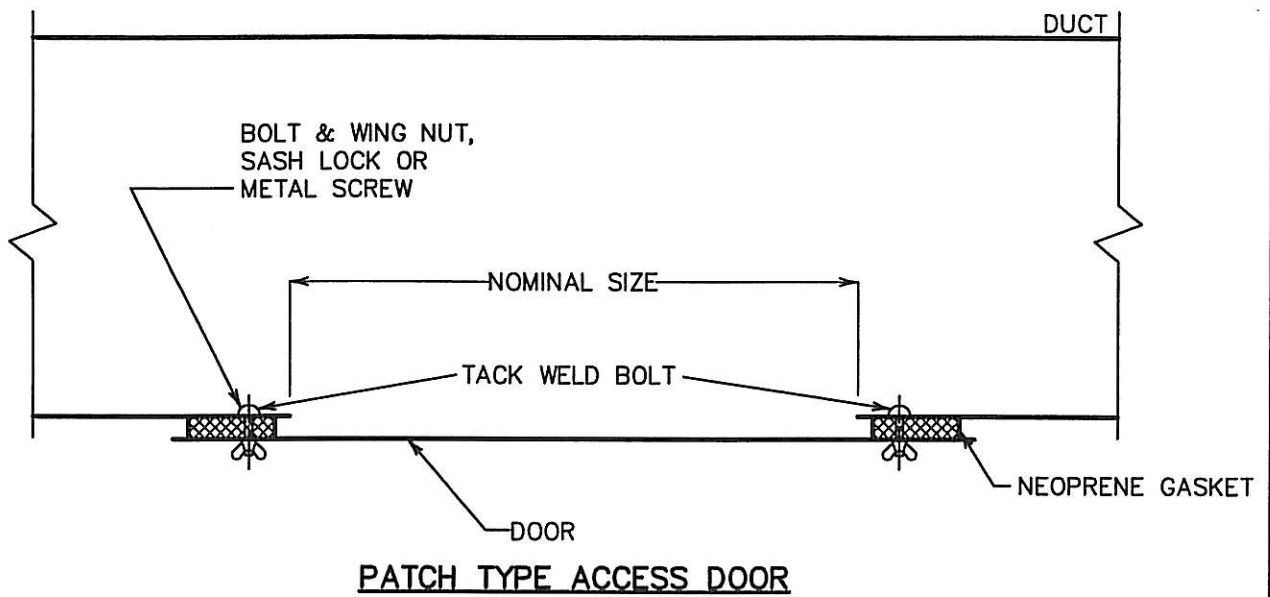
N.T.S.





NOTE:

1. 'a' MUST BE GREATER THAN 'b'.
2. WHEN 'b' IS GREATER THAN 'c' P TRAPS MAY NOT BE NEEDED.



NOTE:

ALL DOORS WITH ONE
DIMENSION > 600
USE HINGES.



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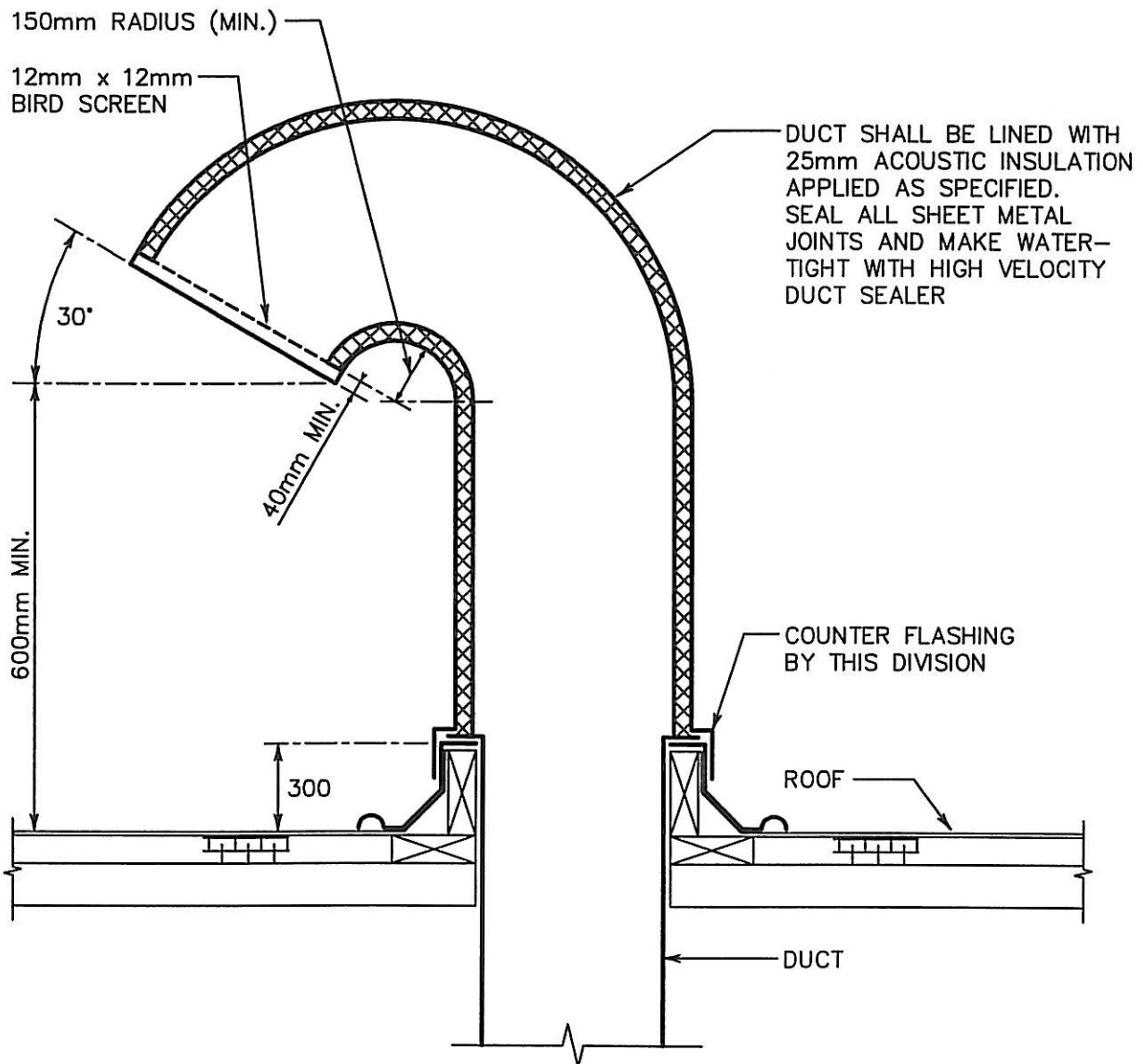
DETAIL DRAWING:

DUCT ACCESS DOOR DETAIL
N.T.S.

DETAIL No.

15800-006A

APRIL 22/04



NOTE:

1. DETAIL TYPICAL FOR GENERAL EXHAUST ONLY
2. KITCHEN EXHAUST GOOSENECK TO BE EXTERNALLY INSULATED AND WEATHERPROOFED
3. FRESH AIR INTAKE GOOSENECKS; NO INSULATION REQUIRED ON DUCTWORK EXTERIOR TO BUILDING



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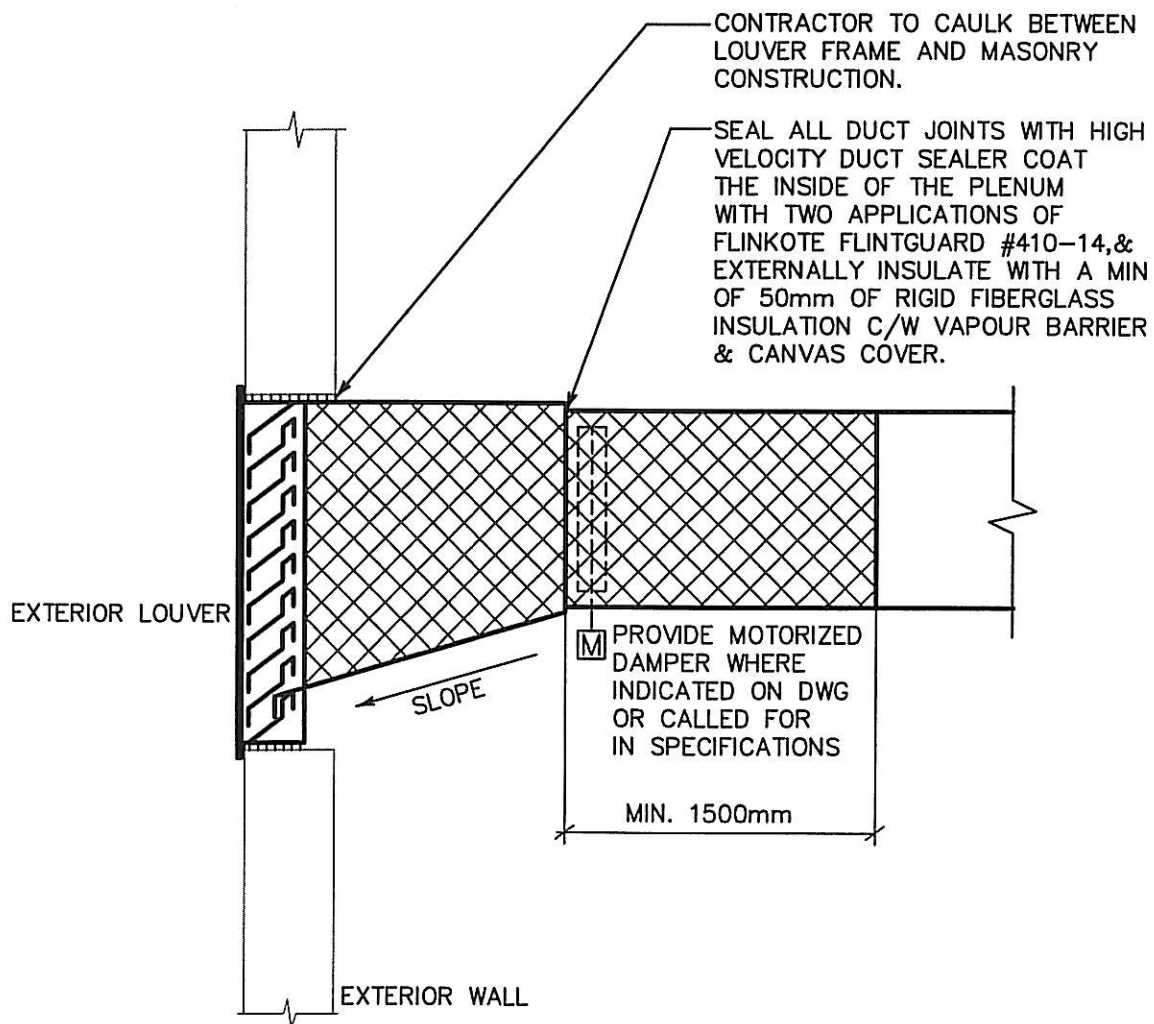
DETAIL DRAWING:

GOOSENECK
N.T.S.

DETAIL No.

15800-401

APRIL 22/04



MCW Consultants Ltd.

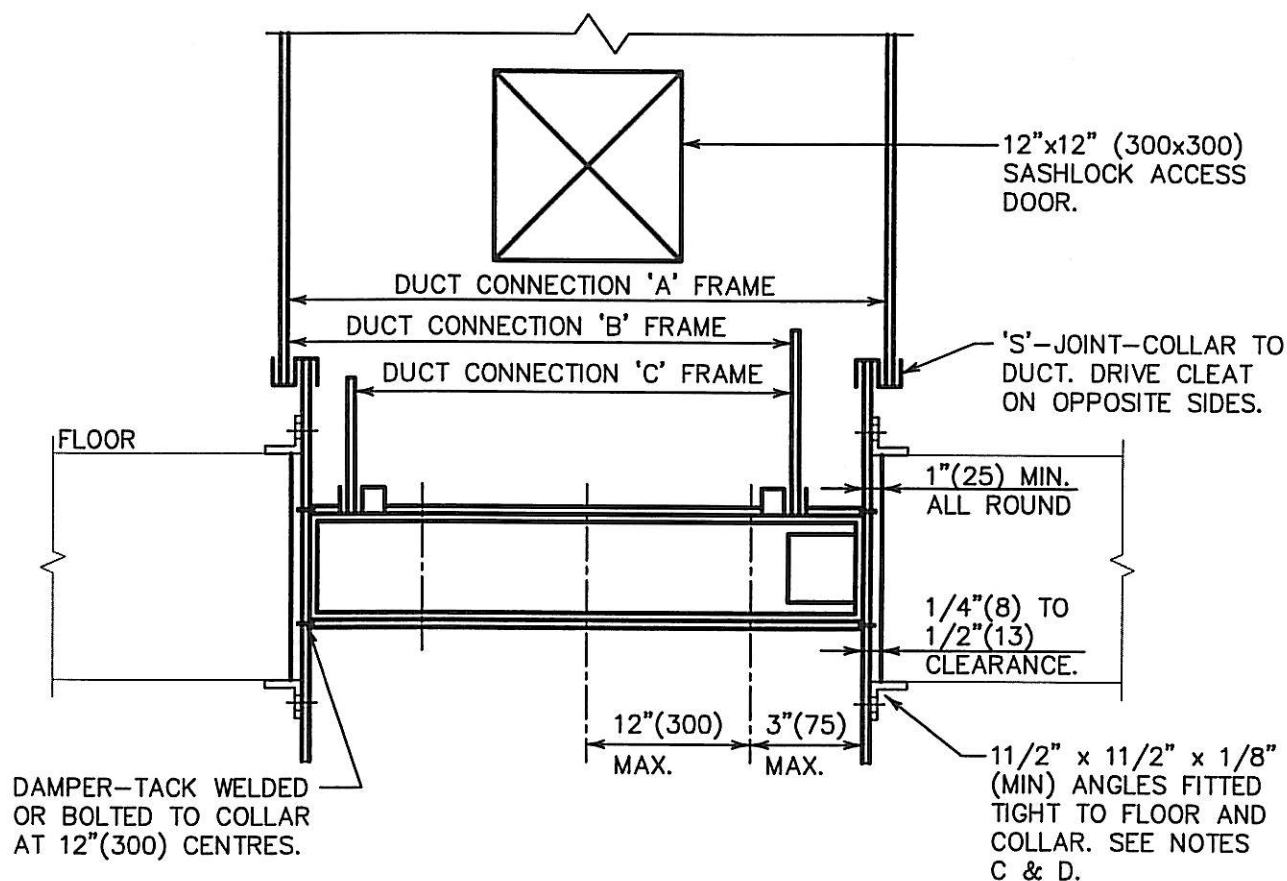
DETAIL DRAWING:

EXTERIOR LOUVER CONNECTION
N.T.S.

DETAIL No.

15800-402

APRIL 22/04



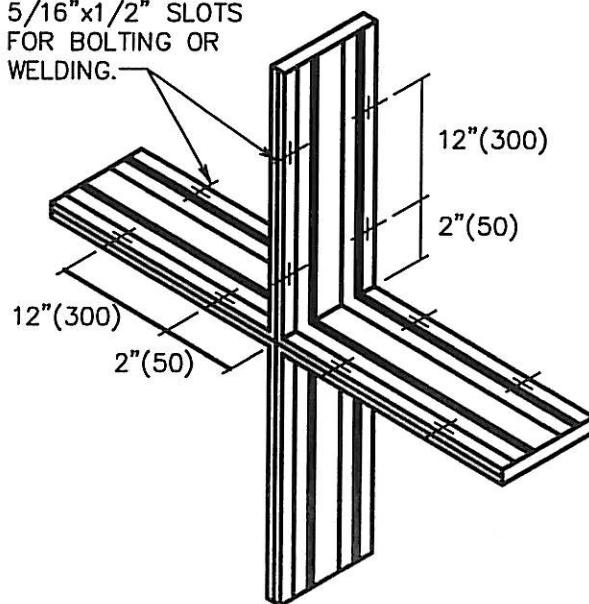
HORIZONTAL MOUNTING
(VERTICAL MOUNTING SIMILAR)

NOTES :

- A COLLAR MAY BE SAME GAUGE AS DUCT WHEN 'S' AND DRIVE CONN. ARE USED.
 - B INSTALLATION TO CONFORM TO N.F.P.A. - 90A AND/OR AUTHORITY WITH JURISDICTION.
 - C WHERE ANGLES ARE ATTACHED TO COLLARS A MIN. OF 2 FIXING ON EACH SIDE AT A MAX. OF 12"(300) CENTRES MUST BE USED.
 - D MAX. SIZE OF ULC LABELLED F.D'S ARE :
- | <u>MOUNTING</u> | <u>INDIVIDUAL</u> | <u>ASSEMBLY</u> |
|-----------------|-------------------|-----------------|
| VERTICAL | 60"x48" | 120"x72" |
| HORIZONTAL | 44"x44" | 114"x38" |

IF OPENING SIZE EXCEEDS ABOVE DIMENSIONS THEN DAMPER TO BE FITTED IN UNITS WITH MULLION BETWEEN EQUAL TO ONE COURSE OF CONCRETE BRICKS.

5/16"x1/2" SLOTS FOR BOLTING OR WELDING.



JOINING OF MULTIPLE SECTIONS



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DETAIL DRAWING:

FIRE DAMPER INSTALLATION
N.T.S.

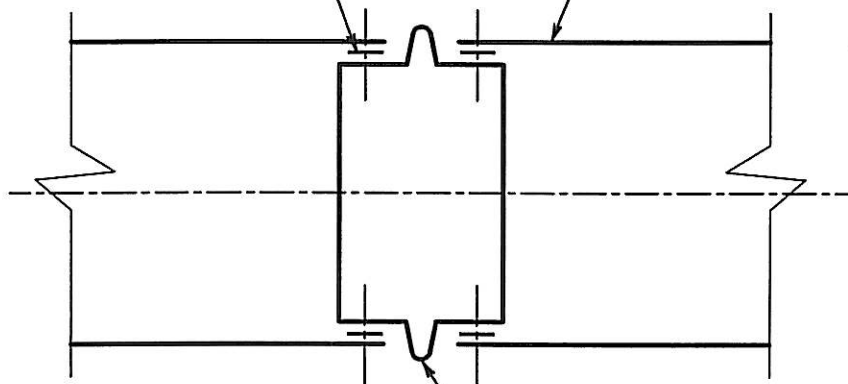
DETAIL No.

15800-403

APRIL 22/04

SEAL ALL JOINTS
-SEE SPECIFICATIONS

ROUND DUCTWORK



20 GAUGE DUCT SLEEVE
SECURED WITH S/M SCREWS
AT 380mm CENTRES
-3 MINIMUM



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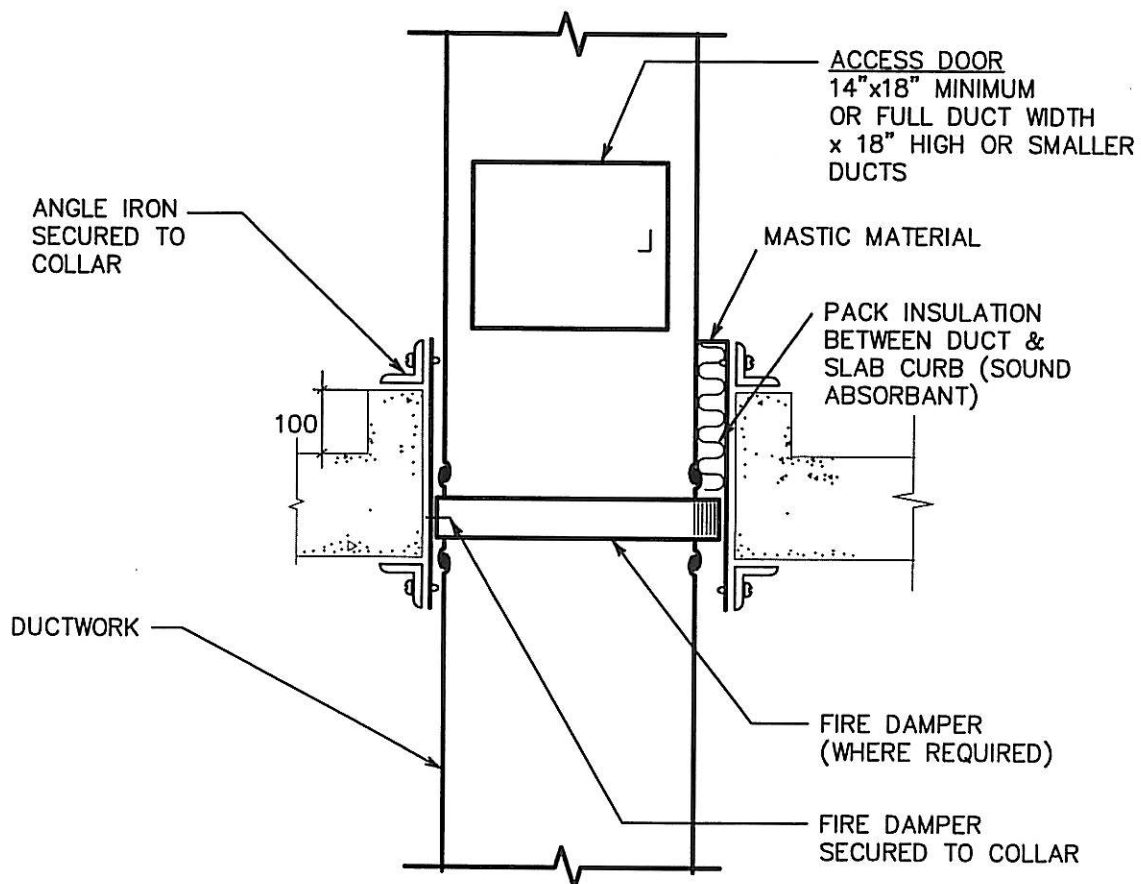
DETAIL DRAWING:

EXPOSED ROUND DUCT
SLIP JOINT
N.T.S.

DETAIL No.

15800-406

APRIL 22/04



NOTE:

REFER ALSO TO FIRE DAMPER
INSTALLATION DETAIL #V-10



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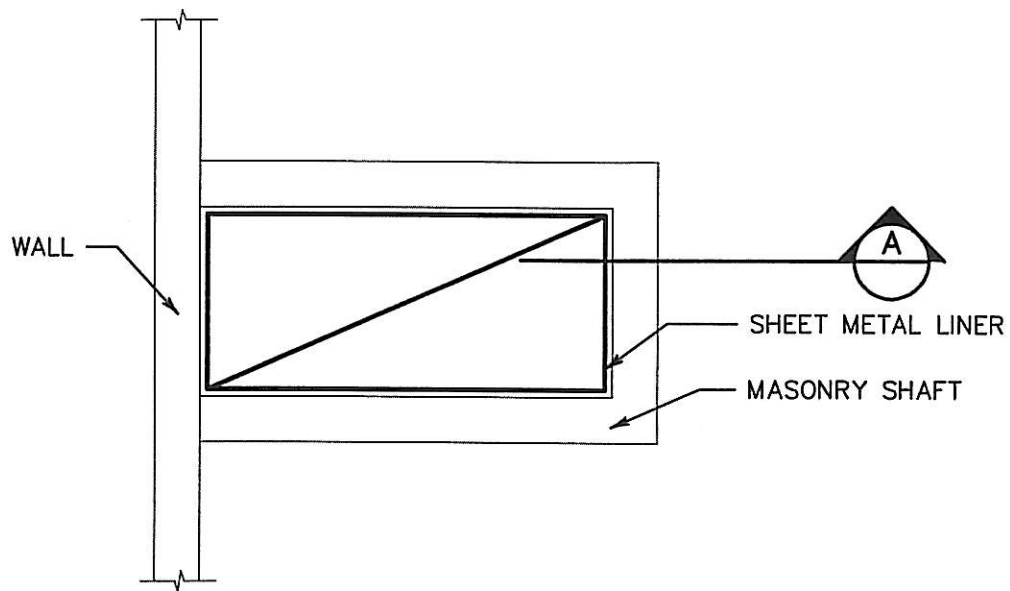
DETAIL DRAWING:

DUCT SLEEVE (THROUGH MECH.
ROOM & WET FLOORS)
N.T.S.

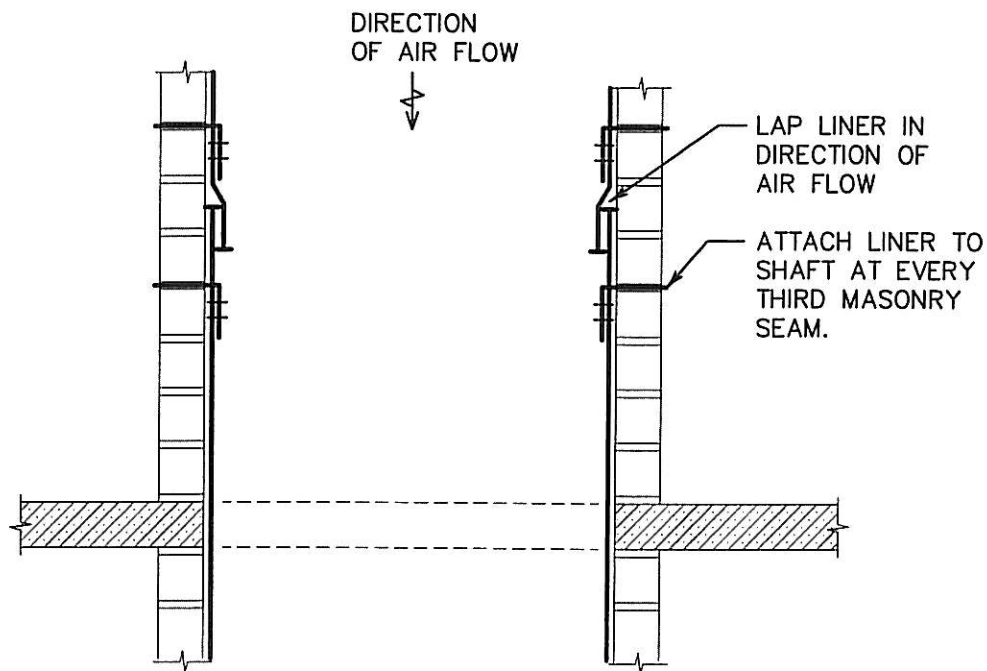
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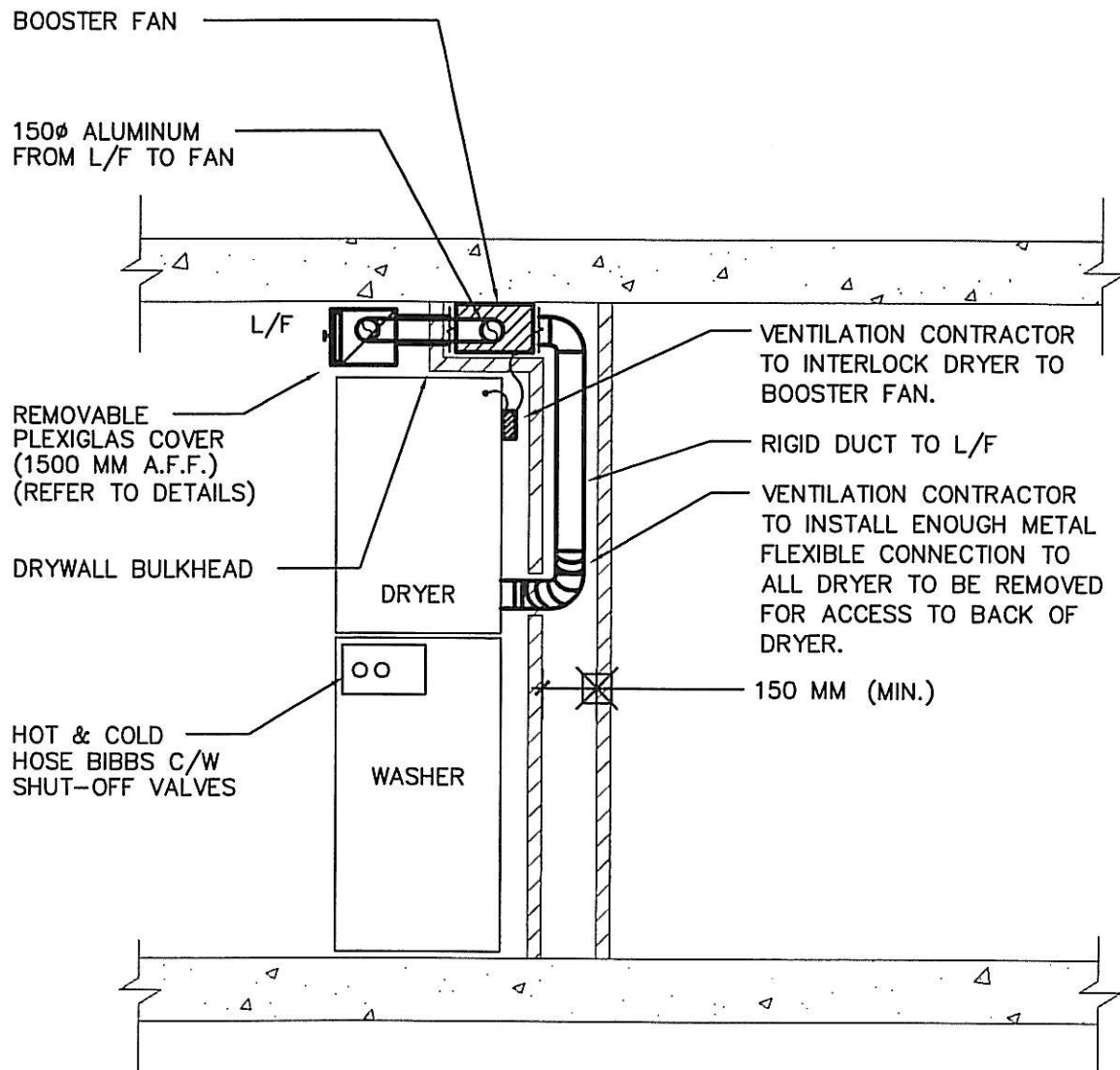
APRIL 22/04



SHAFT PLAN



SECTION A



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DETAIL DRAWING:

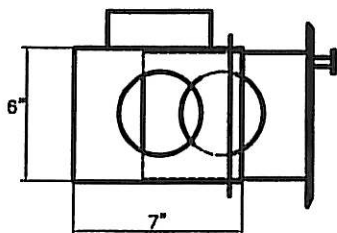
DRYER EXHAUST DETAIL
N.T.S.

DETAIL No.

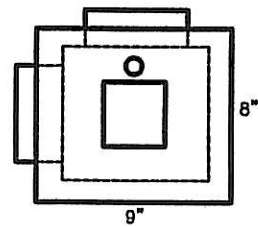
15800-414

APRIL 22/04

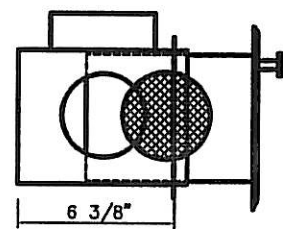
LINT TRAP - LT90



ALL DRYERS TO BE VENTED THROUGH THIS
LINT TRAP (TYPICAL)



ALUMINUM FLYSCREEN
FILTER



PLEXIGLASS SEE
THROUGH WINDOW



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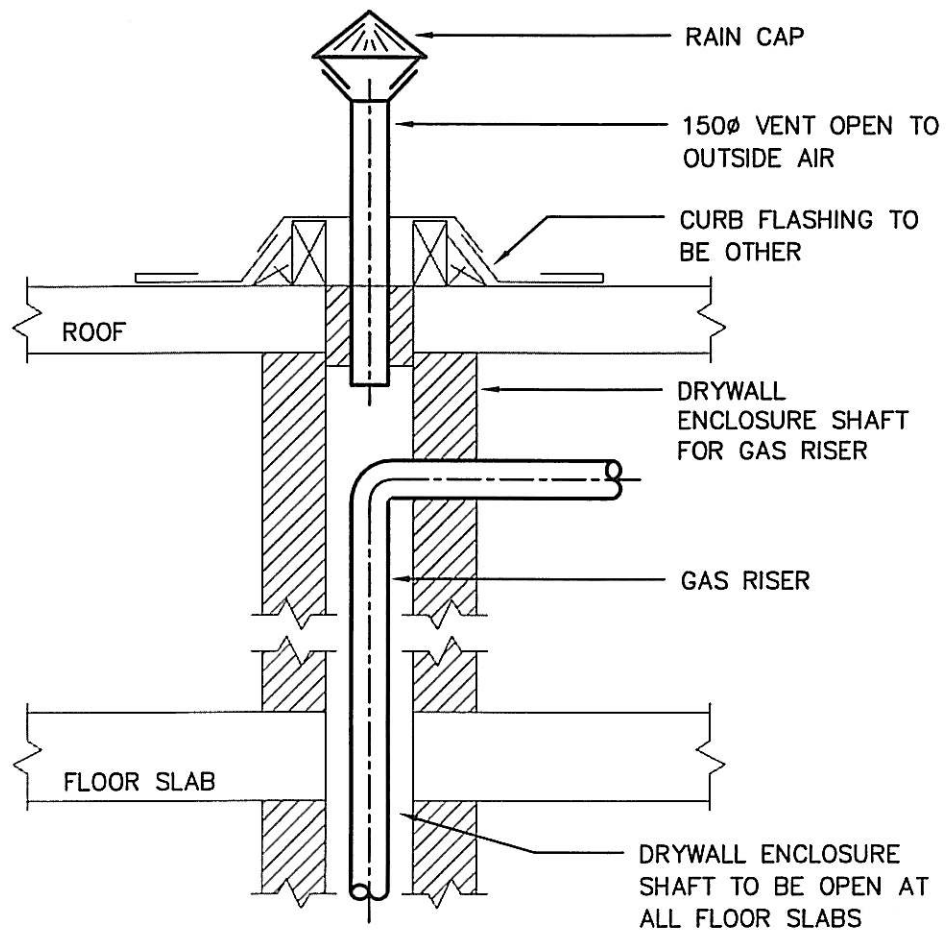
DETAIL DRAWING:

LINT TRAP DETAILS
N.T.S.

DETAIL No.

P-66

SEPT. 30/02



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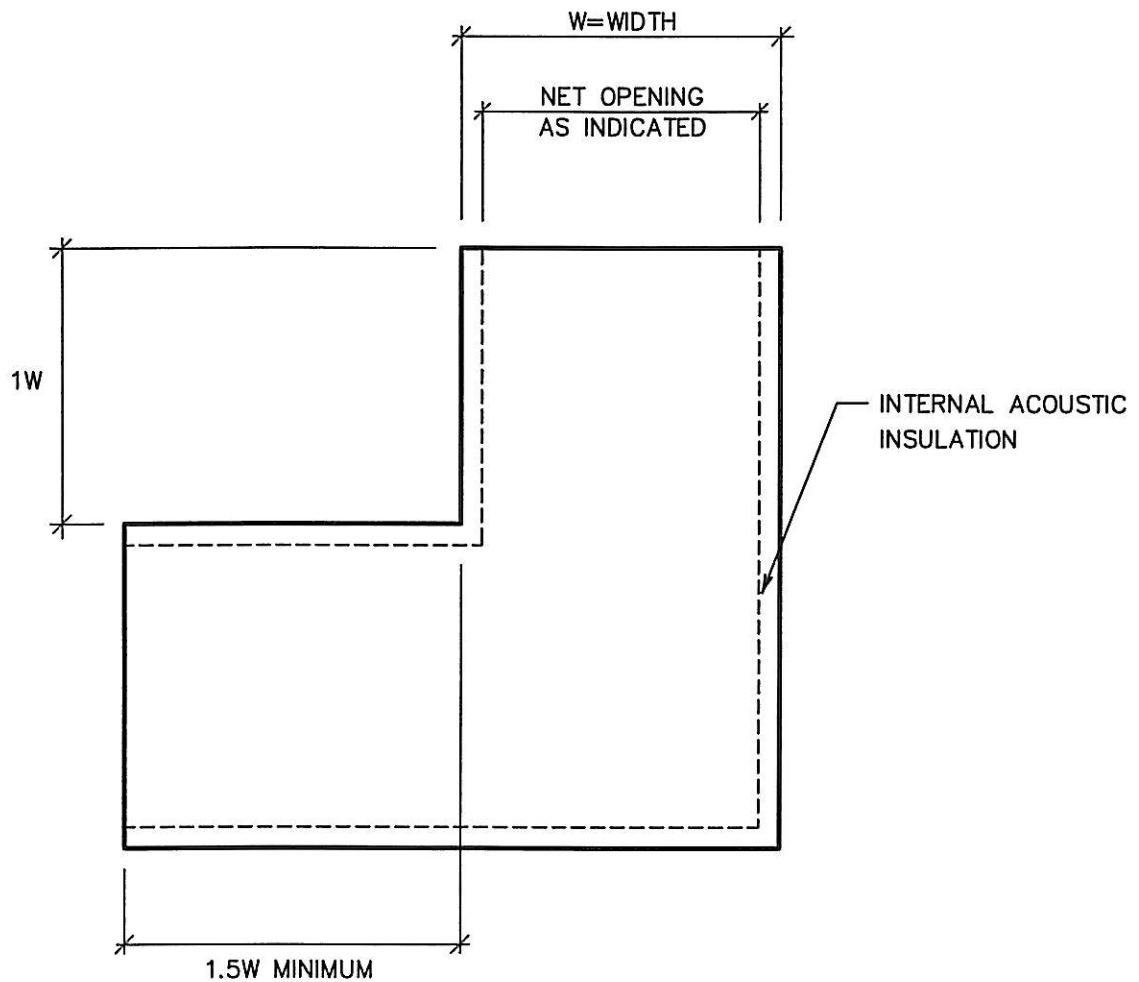
DETAIL DRAWING:

DEATIL OF GAS RISER
VENT SHAFT
N.T.S.

DETAIL No.

15800-601

APRIL 22/04



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DETAIL DRAWING:

TRANSFER AIR DUCT DETAIL
N.T.S.

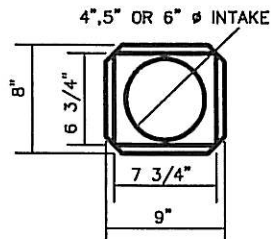
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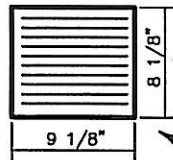
APRIL 22/04

SINGLE WALL BOX (WB-1)

SWB-8, SWB-12



BACK VIEW



FRONT VIEW WITH GRILLE

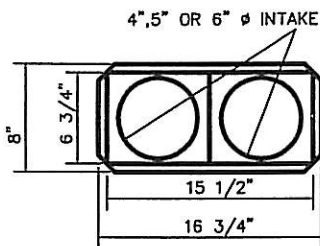
EXTERIOR GRILLES SUPPLIED AND INSTALLED BY WINDOW MANUFACTURER INSTALLER

VENTILATION CONTRACTOR TO SUBMIT WALL BOX SAMPLE PRIOR TO PRODUCTION (TYPICAL FOR ALL)

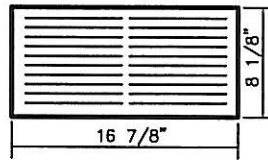
WALL BOXES SUPPLIED BY VENTILATION CONTRACTOR INSTALLED BY WINDOW MANUFACTURER INSTALLER

DOUBLE WALL BOX (WB-2)

DWB-8, DWB-12



BACK VIEW



FRONT VIEW WITH GRILLE

TOP BAFFEL

NYLON BUSHING FOR HINGE

ALUMINUM BACKDRAFT DAMPER WITH NEOPRENE GASKET

BOTTOM BAFFEL (ONLY FOR 12")

WATER DRIPS

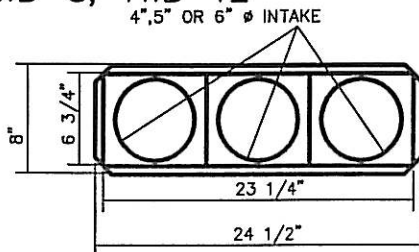
(SET SITE)

WALL BOX TO EXTEND 3" INTO ROOM PAST WALL THICKNESS.

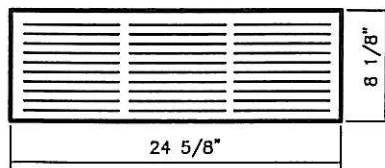
TYPICAL SIDE VIEW

TRIPLE WALL BOX (WB-3)

TWB-8, TWB-12



BACK VIEW



FRONT VIEW WITH GRILLE



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DETAIL DRAWING:

WALL BOX DETAIL
N.T.S.

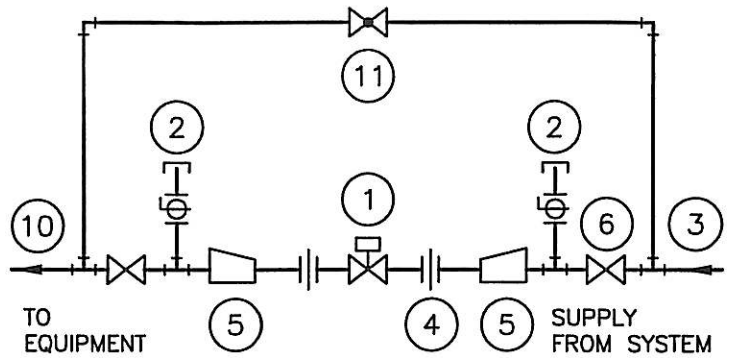
DETAIL No.

15800-703

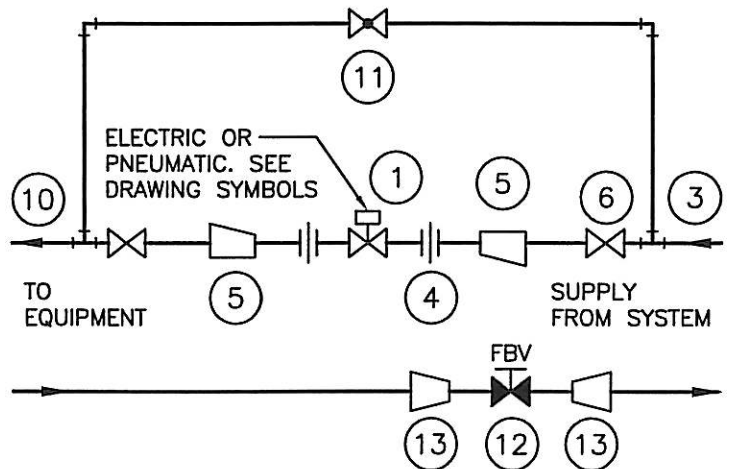
APRIL 22/04

NOTES:

1. CONTROL VALVE
2. PLUGGED 1/4"(6) PRESSURE GAUGE CONNECTION WITH VALVE.
3. SUPPLY PIPE SIZE AS SHOWN ON PLANS.
4. UNION OR FLANGE.
5. ECCENTRIC FITTINGS.
6. GATE VALVE.
7. BY-PASS FULL SIZE OF SUPPLY PIPE.
8. GLOBE VALVE.
9. RETURN PIPE SIZE AS SHOWN ON PLANS.
10. PIPING TO EQUIPMENT SAME SIZE AS SUPPLY AND/OR RETURN PIPE.
11. BY-PASS SAME SIZE AS CONTROL VALVE.
12. FLOW BALANCING VALVE
13. CONCENTRIC FITTINGS



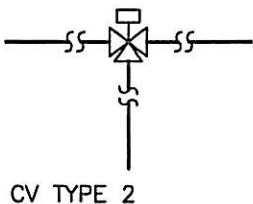
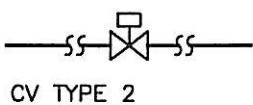
STEAM



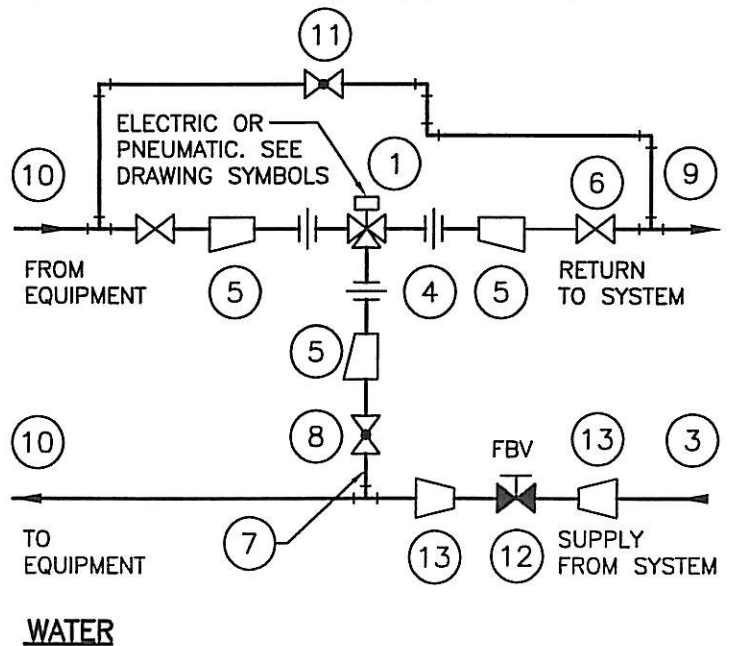
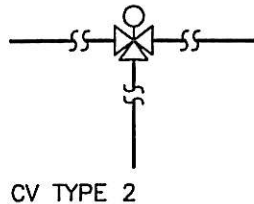
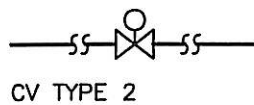
WATER

DRAWING SYMBOL

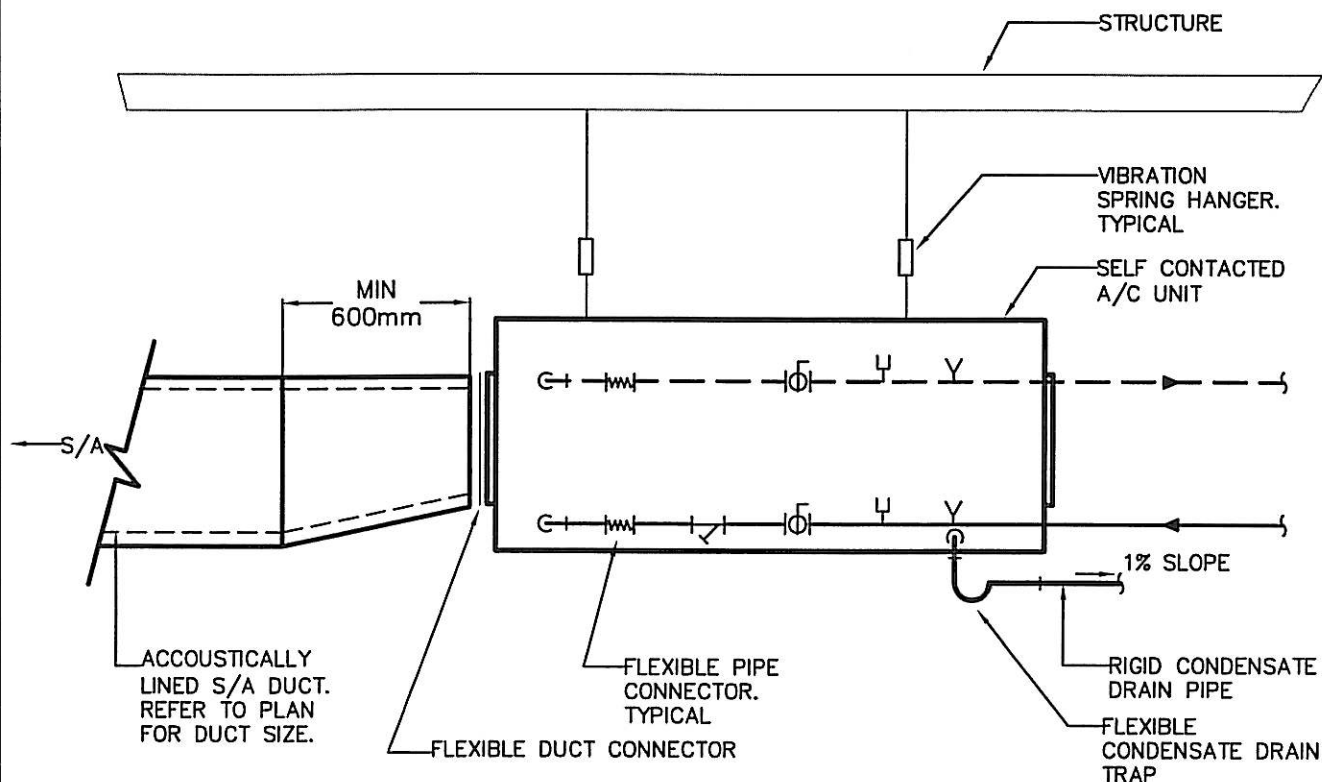
ELECTRIC



PNEUMATIC



WATER



NOTES:

1. PROVIDE ACOUSTICALLY LINE RETURN AIR PLENUM WHERE SHOWN ON PLAN.
2. PROVIDE 16 GAL. SHEET METAL DRAIN PAN BELOW ANY UNIT WHICH IS LOCATED ABOVE AN ELECTRICAL BUS DUCT AND APPARATUS (TRANSFORMER, SWITCH GEAR, MCC UNIT, ETC.) SIZE OF DRAIN PAN TO SPAN ENTIRE UNIT AND ALL ASSOCIATED PIPING CONNECTIONS.
3. MAINTAIN MINIMUM 900mm CLEAR SPACE BETWEEN PIPING CONNECTION AND ACCESS PANEL OF ADJACENT UNIT.
4. STRAIGHT DISCHARGE UNIT SHOWN. END DISCHARGE UNIT INSTALLATION SIMILAR.



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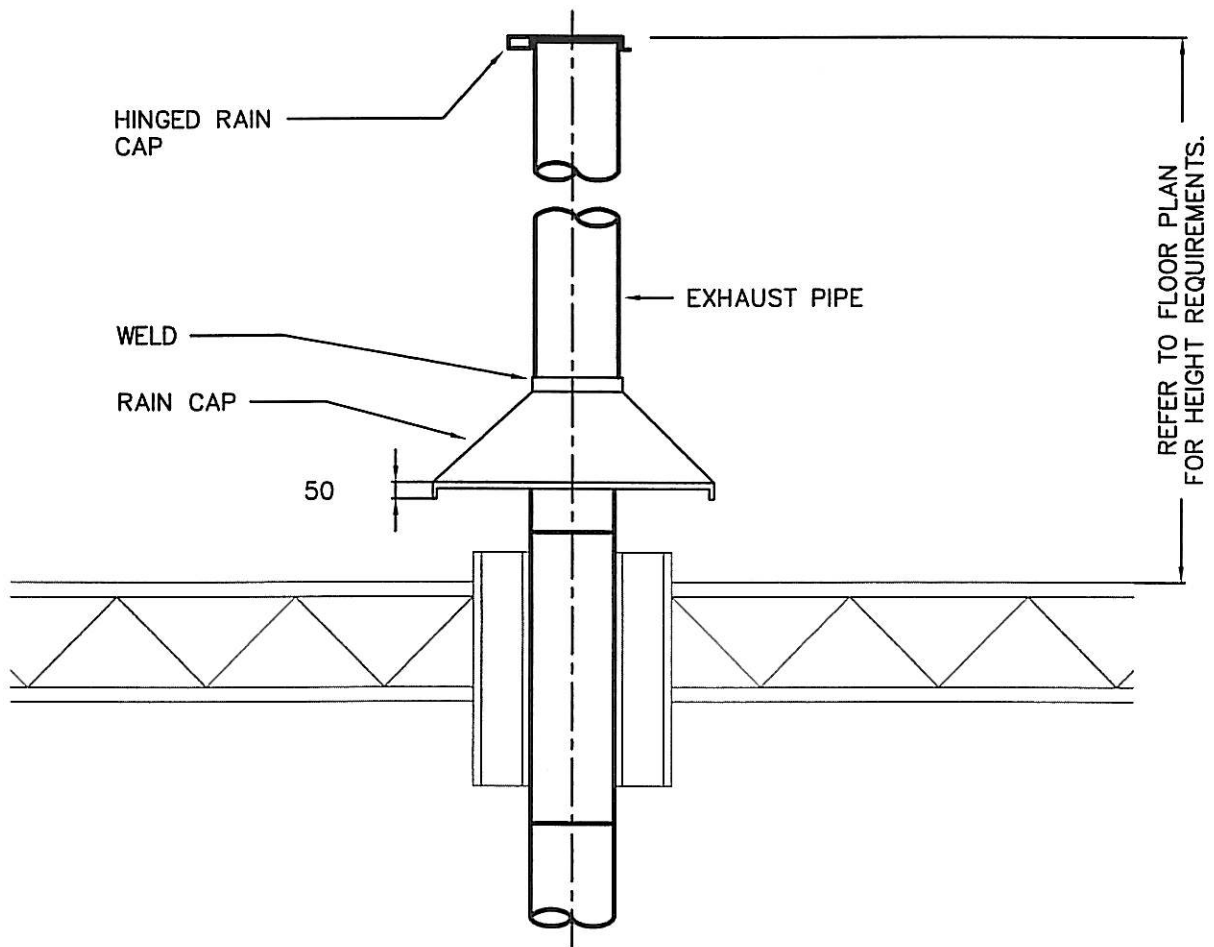
DETAIL DRAWING:

HORIZONTAL SELF CONTAINED A/C
UNIT INSTALLATION DETAIL

DETAIL No.

15000-

APRIL 28/04



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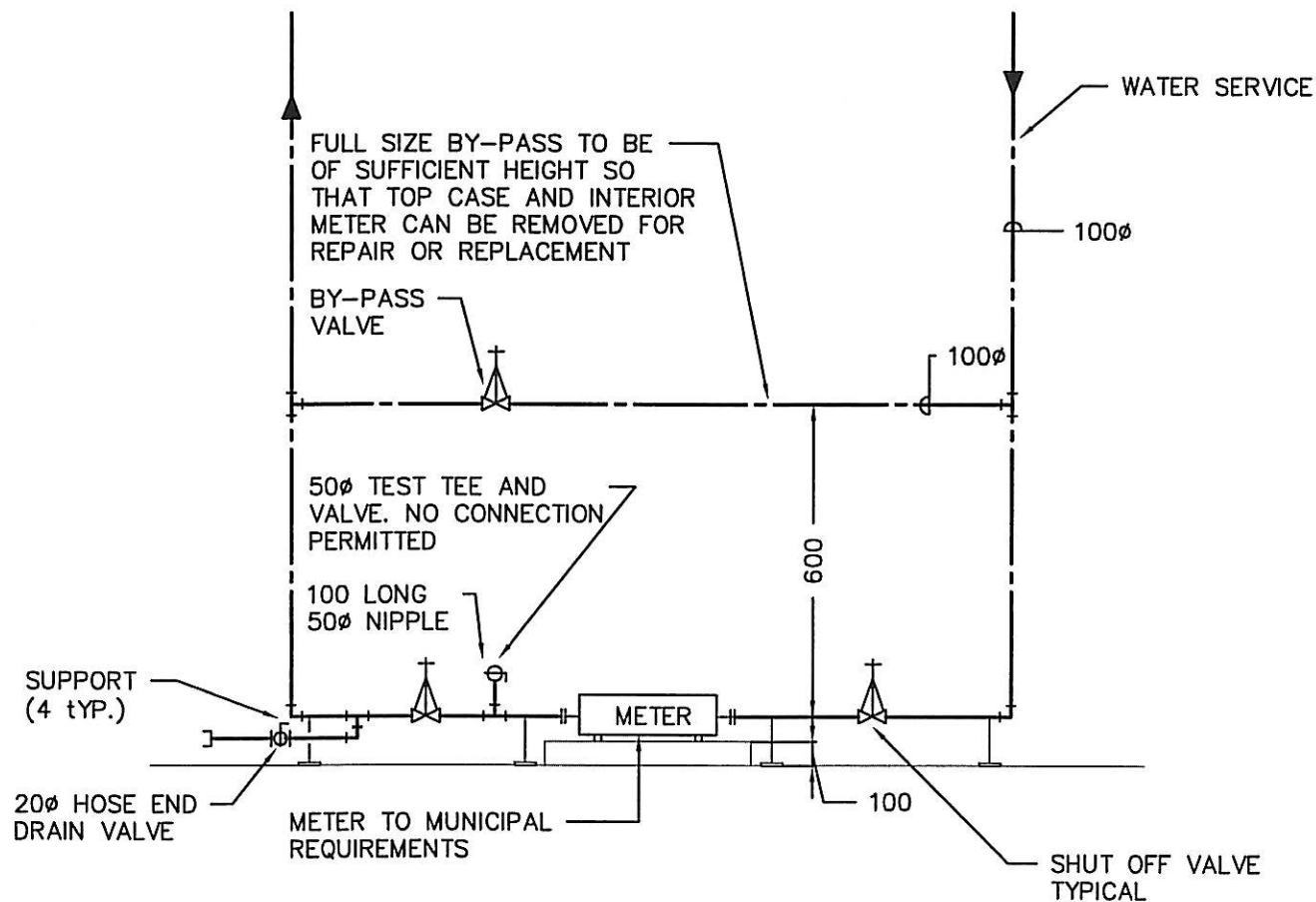
DETAIL DRAWING:

DIESEL EXHAUST THROUGH
ROOF DETAIL

DETAIL No.

15000-

APRIL 28/04



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DETAIL DRAWING:

DOMESTIC WATER METER
ASSEMBLY ARRANGEMENT

DETAIL No.

15000—

APRIL 28/04

CUT BACK AND VAPOUR
SEAL ALL DUCT INSULATION

USE 24 GAUGE "Z" SECTION ON
ALL SIDES TO PROTECT INSULATION
AND VAPOUR BARRIER.

SENSOR AND JUNCTION
BOX

1"
MIN.

DUCT

INSTALLATION OF SENSOR
AND BOX BY CONTROLS
CONTRACTOR

NOTE:

TO BE USED ONLY WHERE STAND-OFF
BOX CANNOT BE USED.



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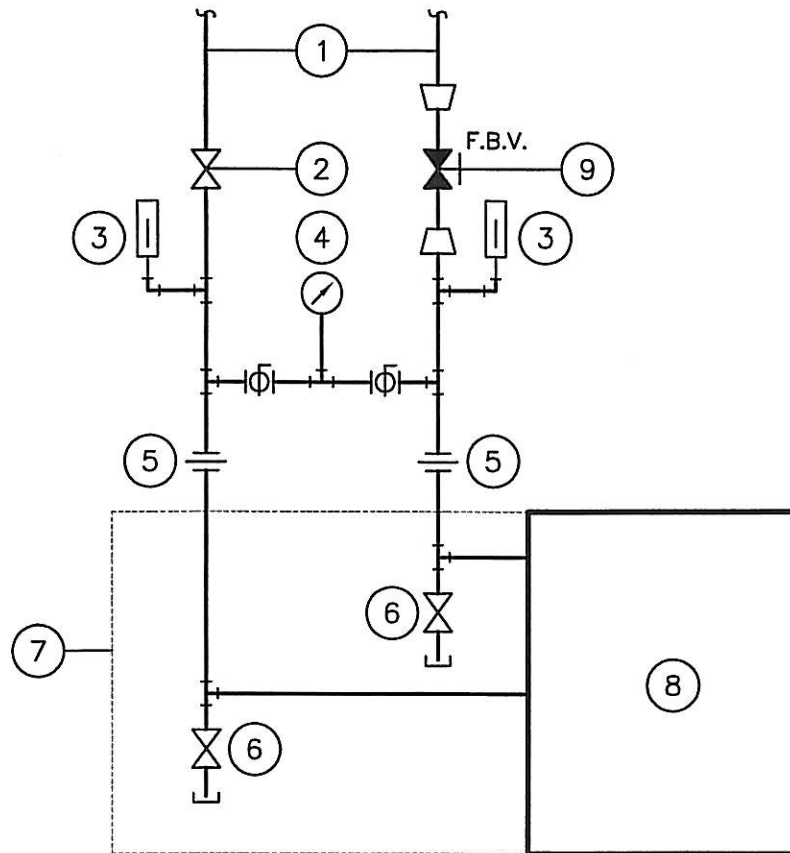
DETAIL DRAWING:

**DUCT SENSOR INSTALLATION
DETAIL
N.T.S.**

DETAIL No.

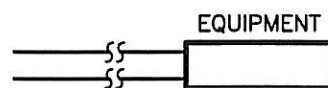
15000-

APRIL 28/04

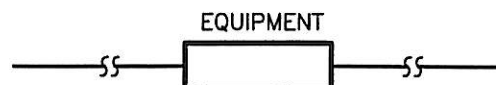


NOTES:

1. PIPE SIZES AS SHOWN ON PLANS.
2. GATE VALVES.
3. THERMOMETER.
4. PRESSURE GAUGE.
5. UNIONS OR FLANGES LOCATED CLEAR OF SERVICE SPACE AND TUBE REMOVAL.
6. DRAIN LEG AND VALVE
7. TUBE REMOVAL AND SERVICE SPACE.
8. HEAT EXCHANGER, CHILLER, CONVERTER OR ANY OTHER EQUIPMENT REQUIRING SERVICE.
9. FLOW BALANCING VALVE ONLY IF NO CONTROL VALVE, OTHERWISE GATE VALVE.



SAME END CONNECTIONS



OPPOSITE END CONNECTIONS

DRAWING SYMBOL



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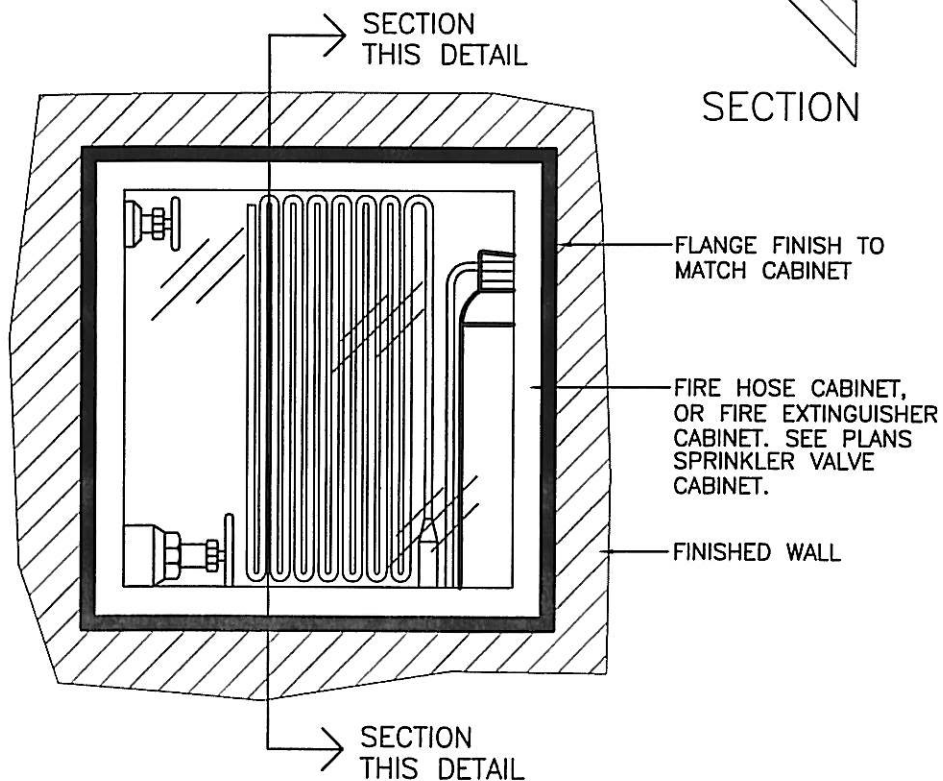
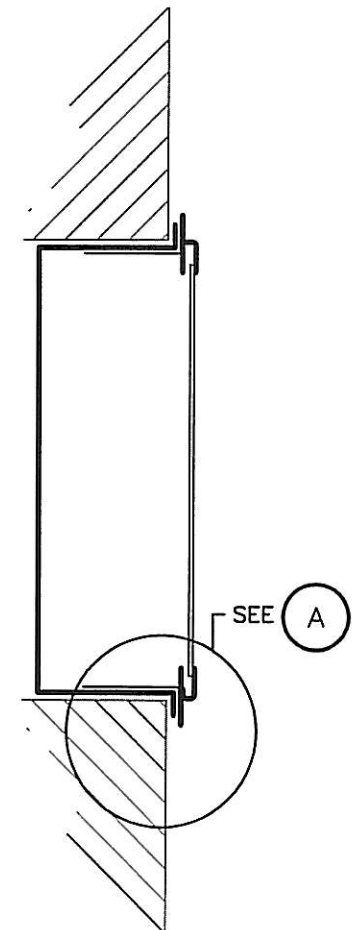
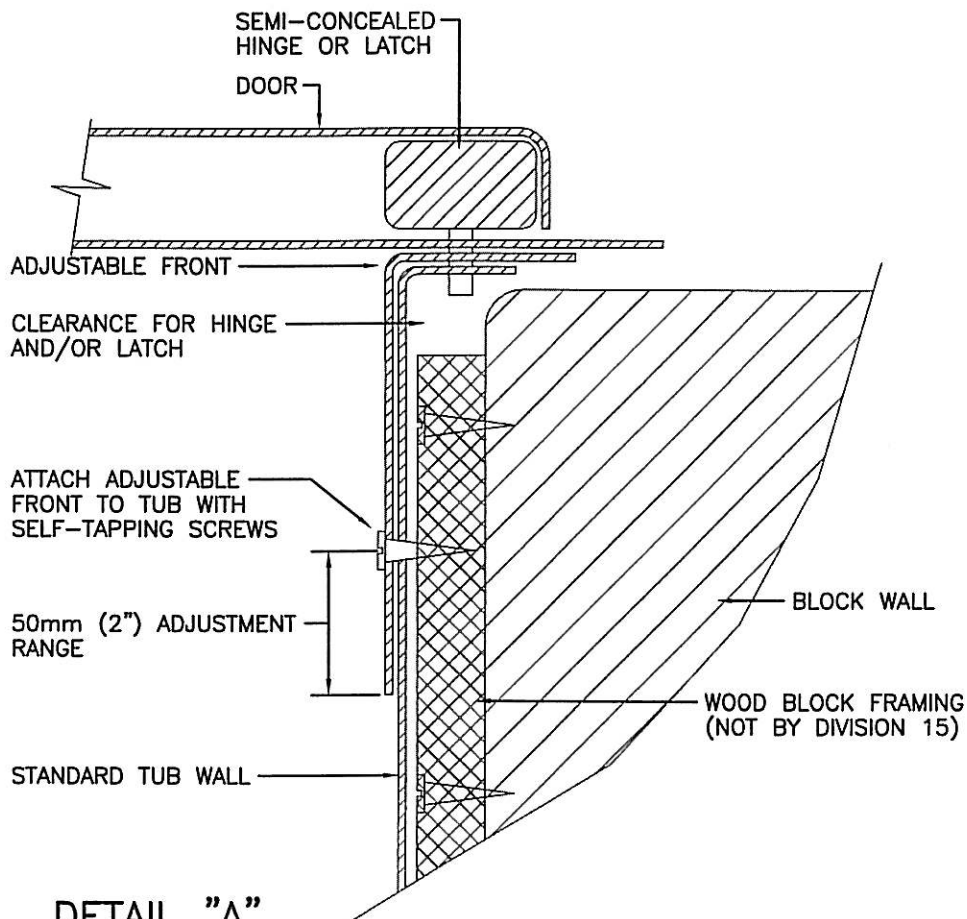
DETAIL DRAWING:

EQUIPMENT INSTALLATION

DETAIL No.

15000-

APRIL 28/04



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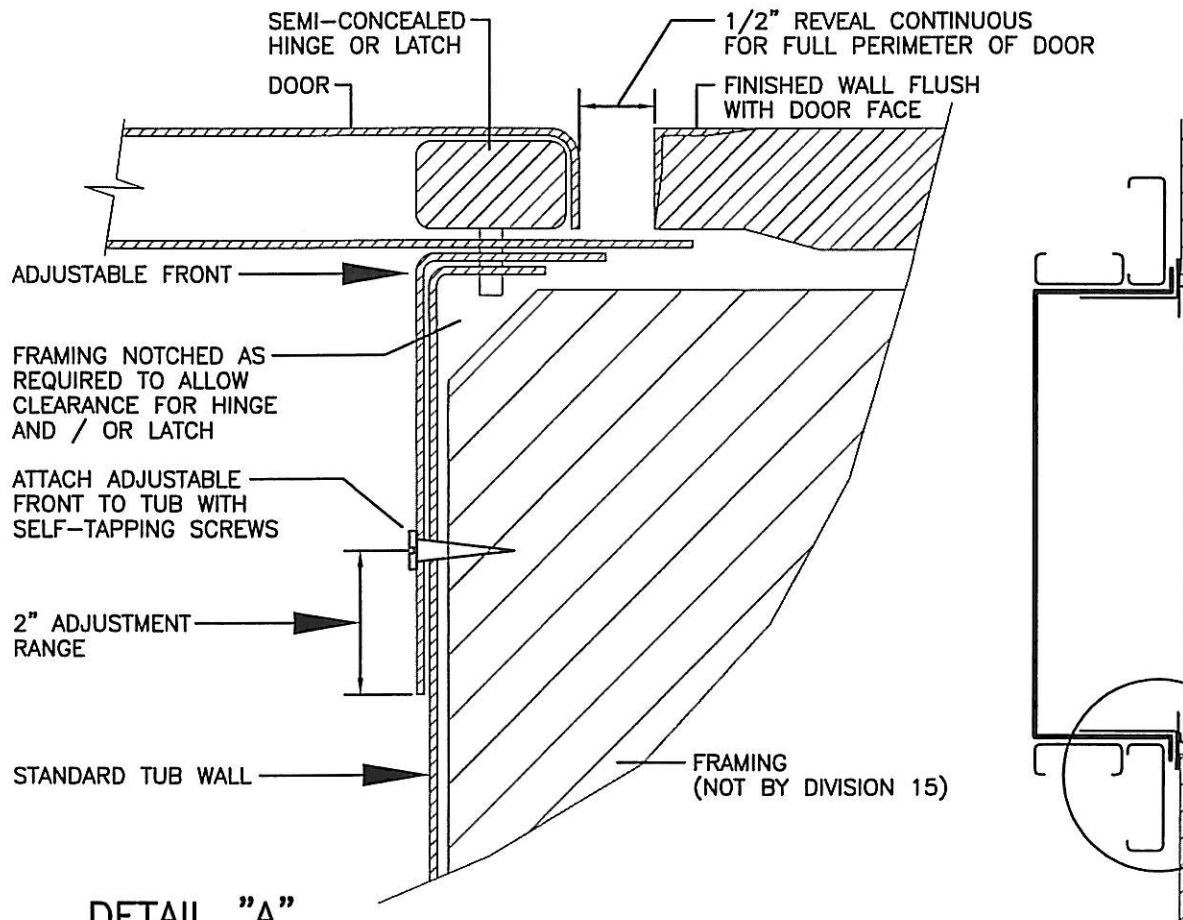
DETAIL DRAWING:

TYPICAL FIRE HOSE CABINET
C/W FIRE EXTINGUISHER
BLOCK WALL MOUNTED, N.T.S.

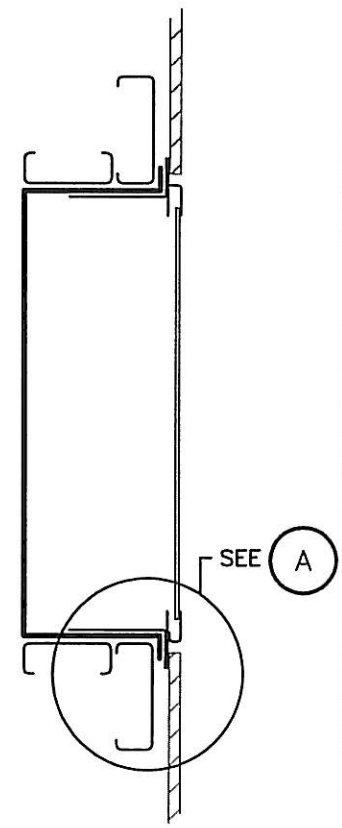
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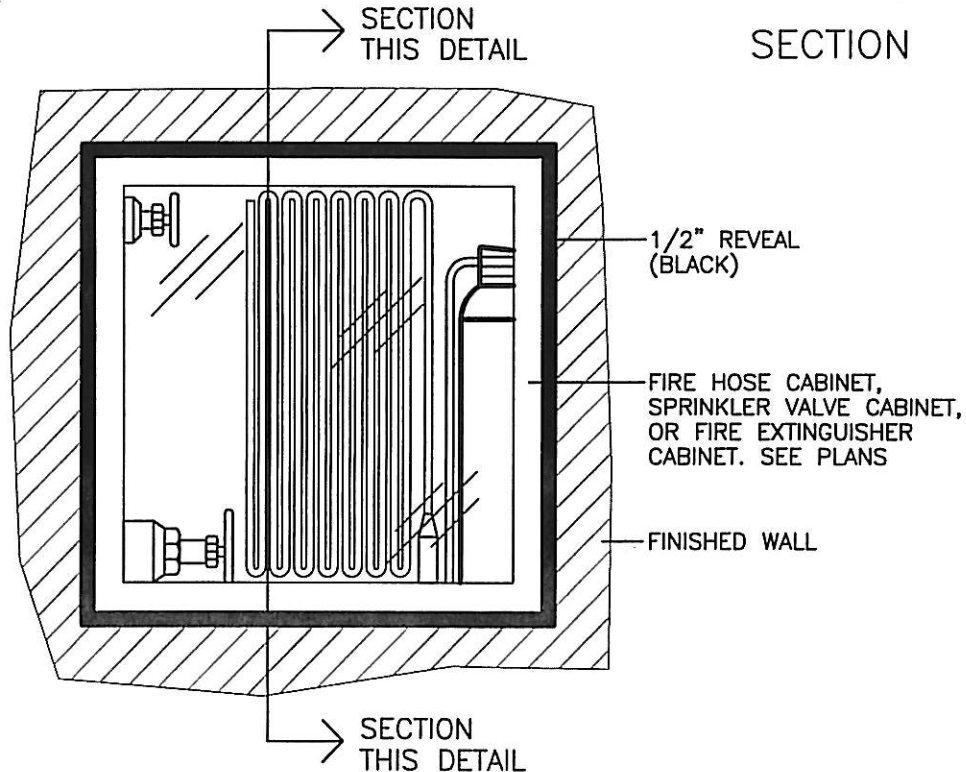
APRIL 28/04



DETAIL "A"



SECTION



ELEVATION



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DETAIL DRAWING:

TYPICAL FIRE HOSE CABINET
C/W FIRE EXTINGUISHER
DRYWALL MOUNTED N.T.S.

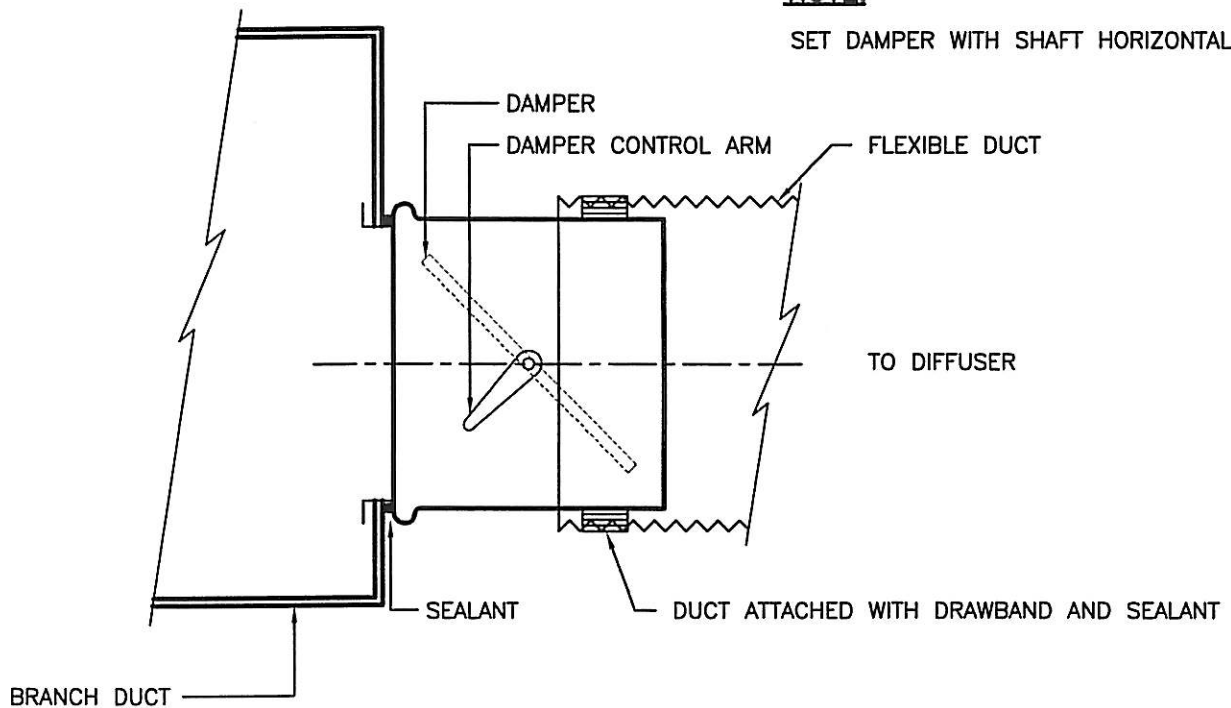
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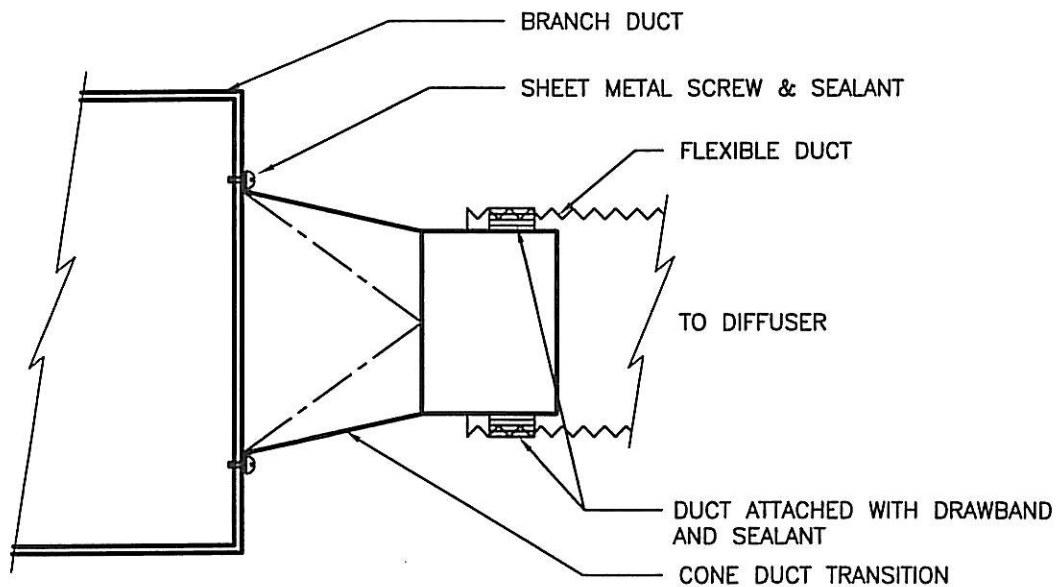
APRIL 28/04

NOTE:

SET DAMPER WITH SHAFT HORIZONTAL



SPIN-IN CONNECTION



SCREW FASTENED CONNECTION



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DETAIL DRAWING:

FLEXIBLE DUCT CONNECTIONS

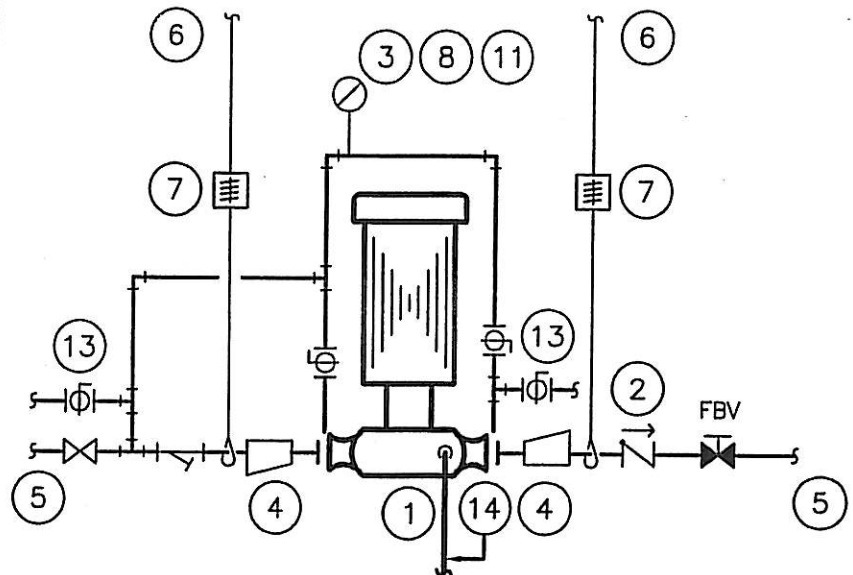
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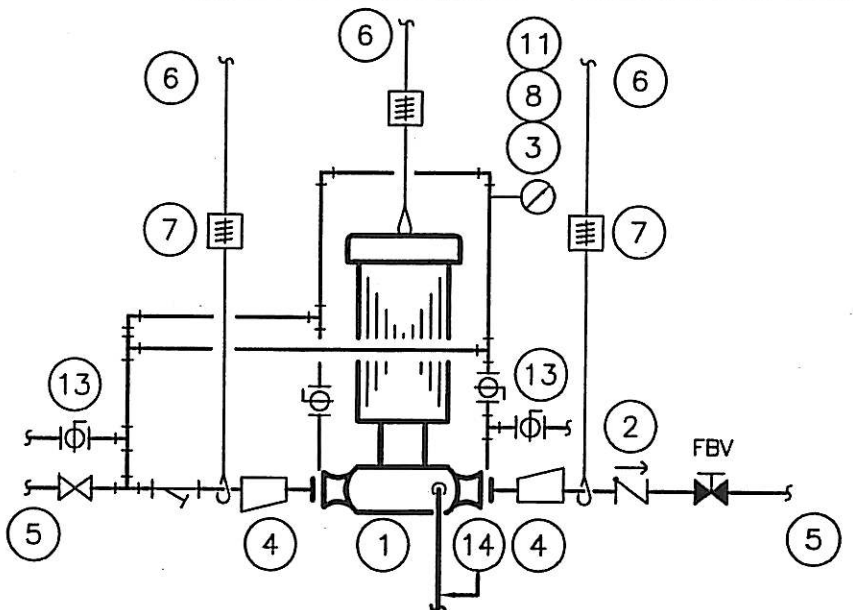
APRIL 28/04

NOTES:

1. PUMPS.
2. CHECK VALVE.
3. PRESSURE GAUGE WITH ANTI-PULSATION SNUBBER.
4. ECCENTRIC FITTINGS.
5. PIPE SIZES AS SHOWN ON DRAWINGS.
6. HANGER RODS.
7. VIBRATION ISOLATION REFER TO SPECIFICATION AND SCHEDULES.
8. FOR OPEN SYSTEMS USE INDIVIDUAL PRESSURE GAUGES ON PUMP SUCTION AND PUMP DISCHARGE.
9. CHECK VALVES ARE NOT REQUIRED ON SINGLE PUMPS IN A CLOSED SYSTEM.
10. STRAINERS ARE NOT REQUIRED ON DOMESTIC WATER SYSTEMS.
11. PRESSURE GAUGES ARE NOT REQUIRED ON DOMESTIC HOT WATER RECIRCULATION PUMPS.
12. TAPPINGS ON PUMP CASING TO BE USED FOR PRESSURE GAUGE CONNECTIONS. (WHERE PROVIDED)
13. CONNECTION TO DIFFERENTIAL PRESSURE SWITCH AS REQUIRED BY CONTROL SECTION.
14. DRAIN LINE TO NEAREST FLOOR DRAIN [CHILLED WATER PUMPS]

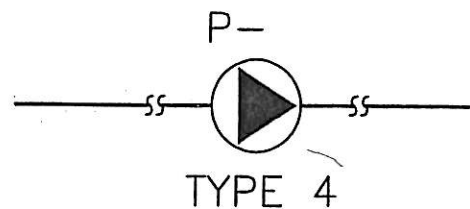


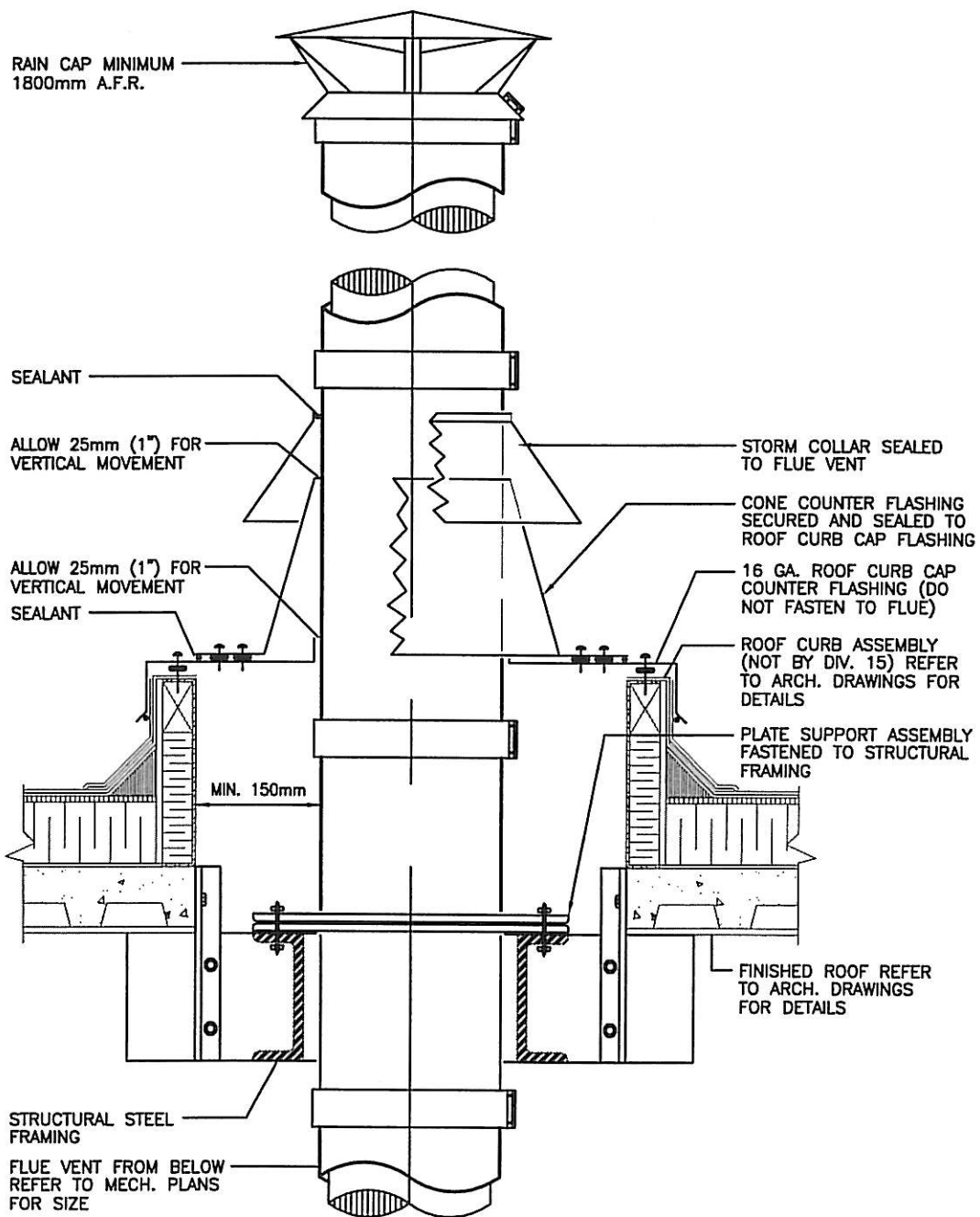
0.5 H.P. (0.37 kw) MOTOR AND LESS



0.75 H.P. (0.56 kw) MOTOR AND LARGER

DRAWING SYMBOL





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DETAIL DRAWING:

FLUE VENT ROOF
PENETRATION
N.T.S.

DETAIL No.

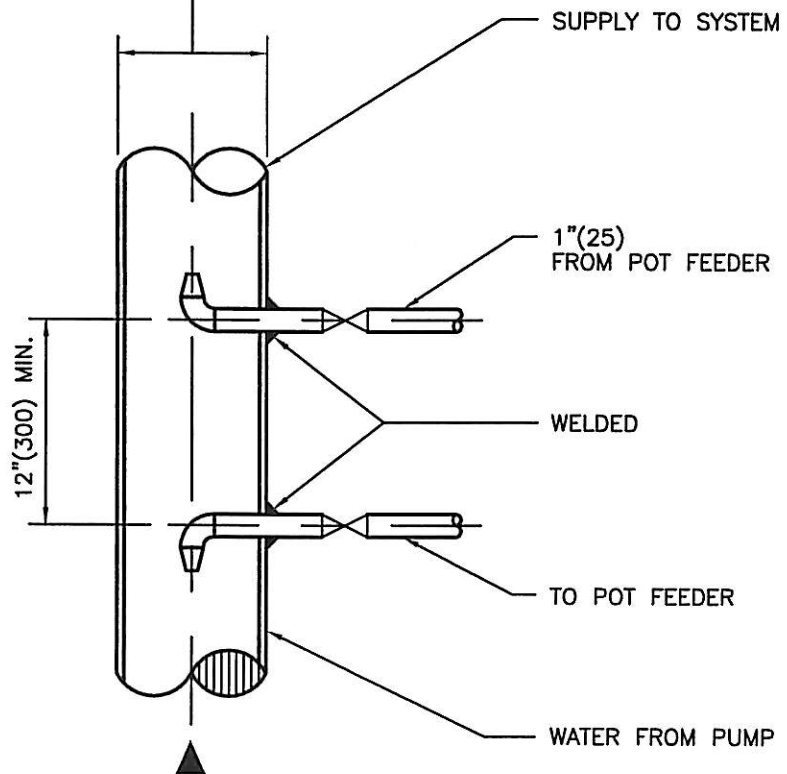
15000—

APRIL 28/04

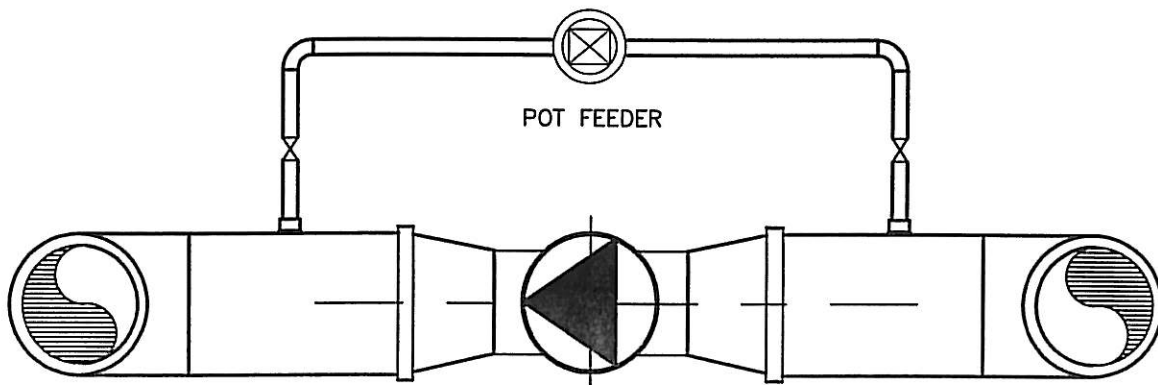
NOTE:

FOR CHILLED AND HOT WATER CLOSED SYSTEMS.

FOR PIPING 8"(200) DIA.
AND LARGER ONLY.



FLOW



FOR PIPING 6"(150) DIA.
AND SMALLER.



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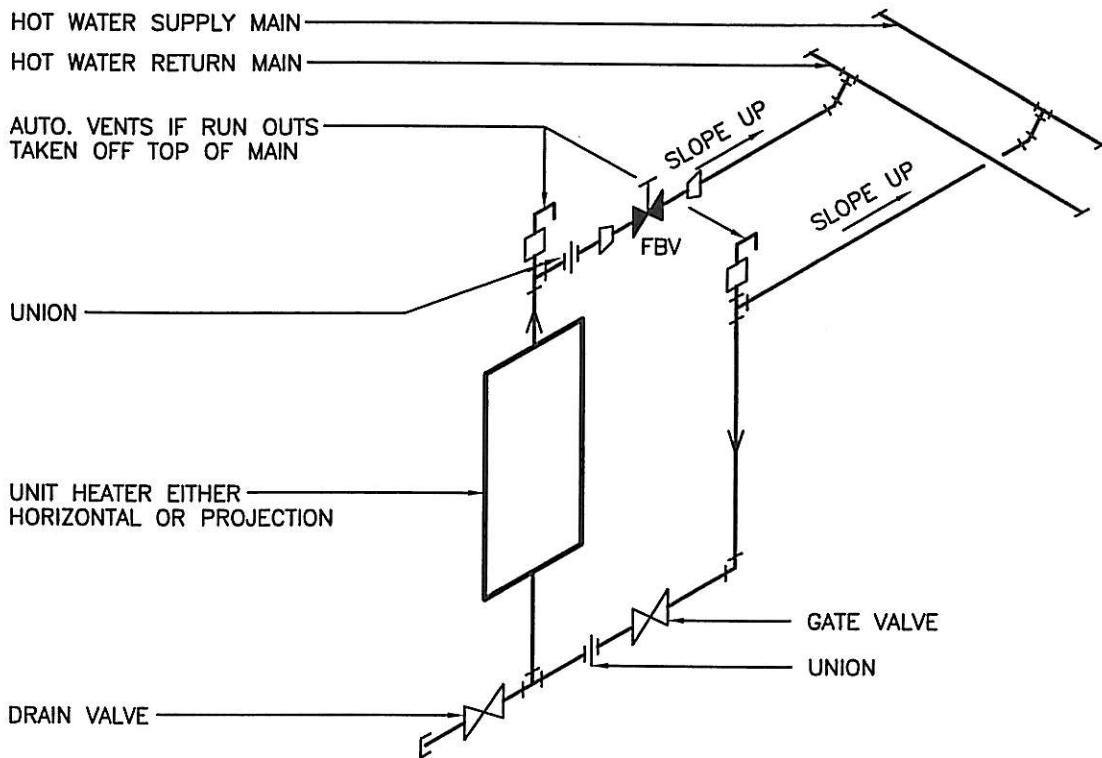
DETAIL DRAWING:

POT FEEDER PIPING

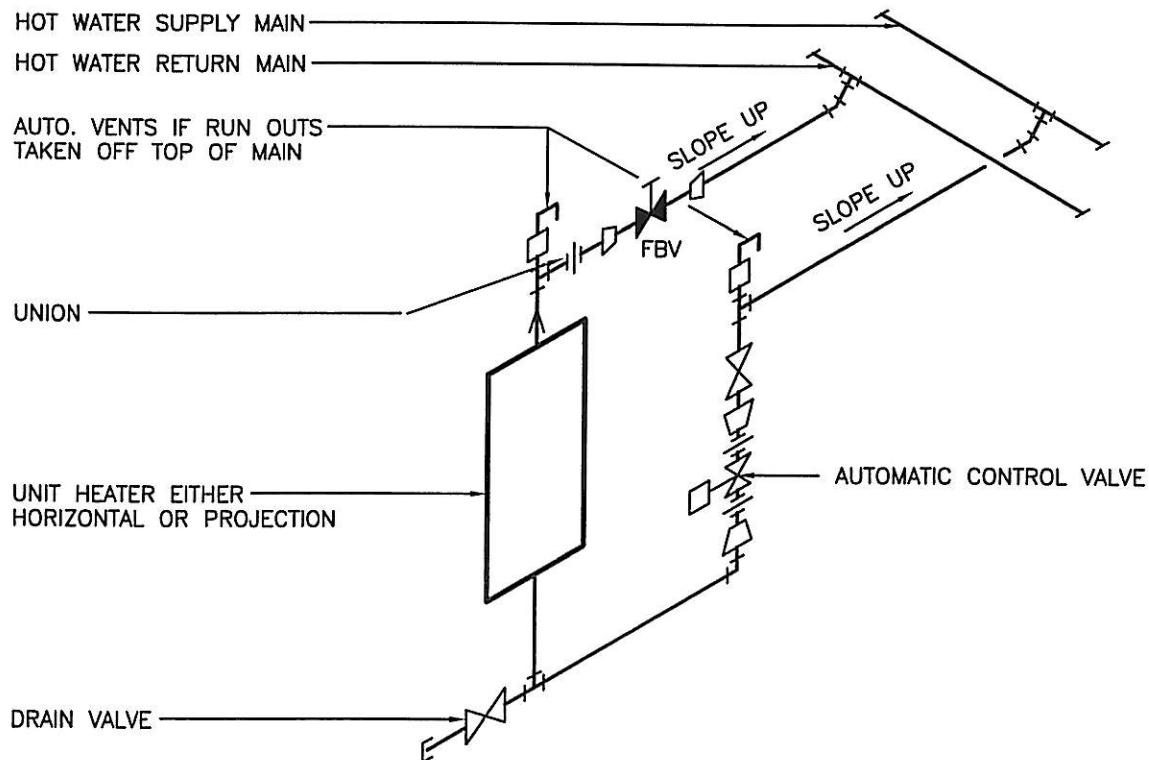
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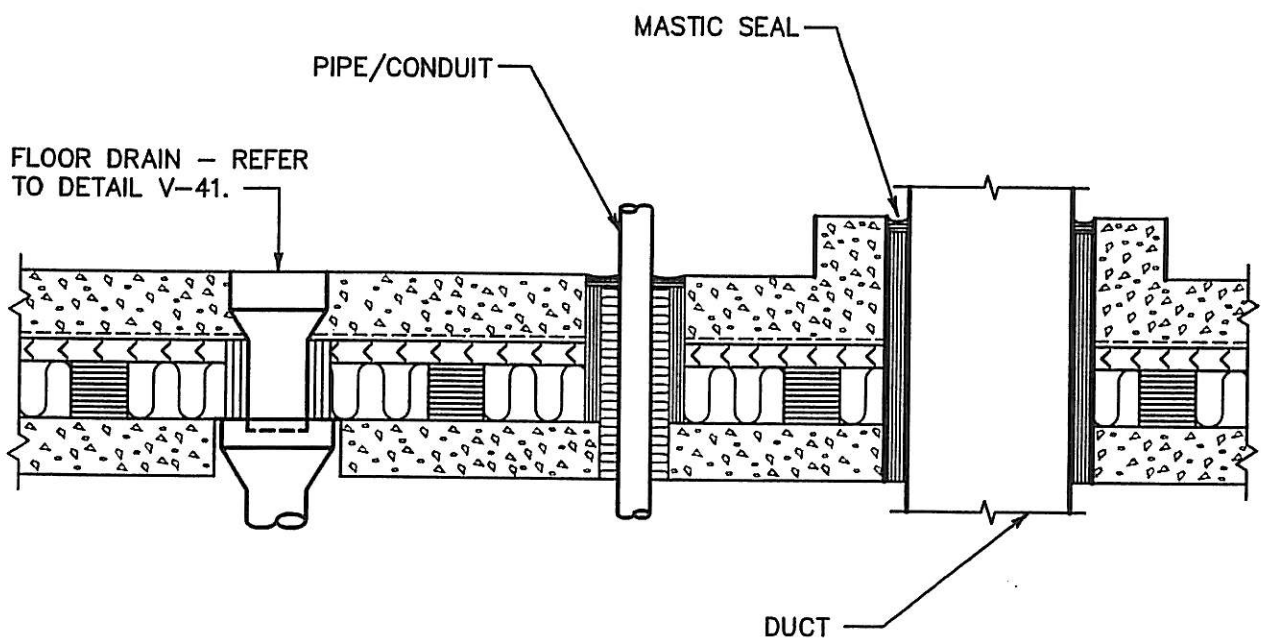
APRIL 28/04



UNIT HEATER WITH NO AUTOMATIC CONTROL VALVE



UNIT HEATER WITH AUTOMATIC CONTROL VALVE



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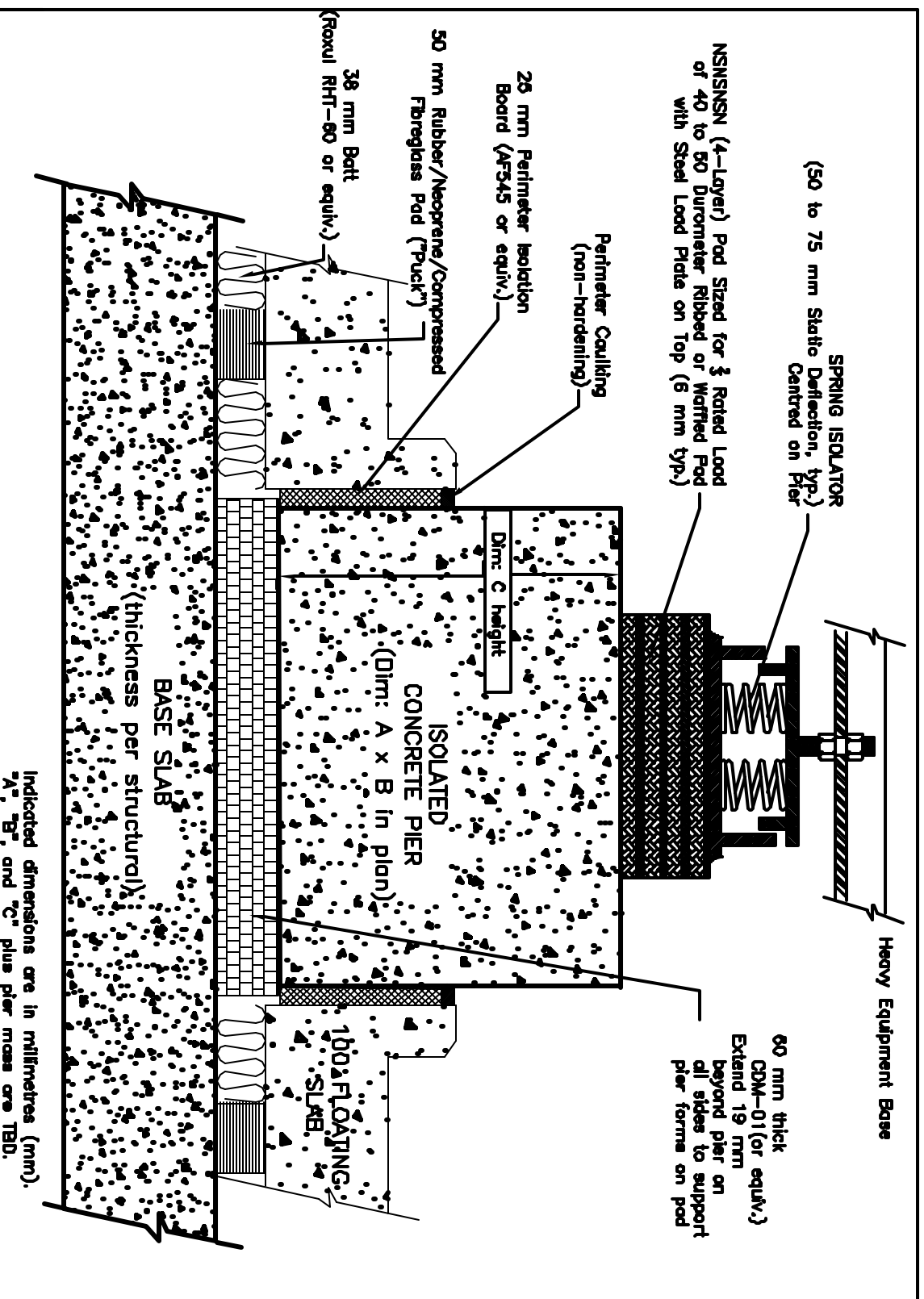
DETAIL DRAWING:

TYPICAL PENETRATIONS THRU
FLOATING FLOOR SLAB
N.T.S.

DETAIL No.

V-45

OCT. 01/02



Detail – Floating Floor with Isolated Pier
and Mounting of Heavy Equipment on Vibration Isolator

SCALE: Not To Scale

Concept and Drawing
Copyright 2007, HGC Engineering

File: Isd-pier-FLFL-Isol
Drawn By: APL

HGC
ENGINEERING

PART 1 - GENERAL

1.01 GENERAL DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Section 15010 Mechanical General Requirements and Section 15050 Mechanical Basic Materials and Methods.
- .3 Refer to acoustic notes shown on the drawings.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Provide all equipment, bases, isolators, floating floors, silencers, properly selected to provide sound, vibration and seismic control for all motor driven equipment.

1.03 QUALITY ASSURANCE

- .1 Execute work of this section in accordance with the manufacturer's instructions by workman only experienced in the installation of vibration isolation systems and equipment.
 - .1 Provide vibration and noise control products as manufactured by Vibro-Acoustics, E H Price Ltd or VAW Systems.
- .2 Alternative acceptable Manufacturer: Kinetic, Mason, others approved by acoustical engineer.
- .3 Ensure isolators and restraining devices which are factory supplied with equipment meet the requirements of this Section.
- .4 Provide all equipment to control noise and vibration such that the average noise criteria curves for the conditioned occupied space do not exceed NC35 in the suites and NC40 in public spaces and vibration is below the level of perception for these.
- .5 Provide the inspection and supervision services of the vibration and noise control equipment Manufacturer to ensure that during construction all equipment is installed as required to achieve specified performance.
- .6 Meet seismic requirements of the current National Building Code for the Place of the Work.

1.04 SUBMITTALS

- .1 Submit shop drawings on all required equipment inertia bases, vibration isolators, silencers and floating floors detailing geometry and construction, dynamic insertion losses, pressure drops and regenerated noise. For review by acoustical engineer.
- .2 Provide certified test data or calculations as prepared by a registered Professional Engineer attesting to conformance with the requirements of this section.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS

- .1 Provide all vibration isolation equipment as manufactured by one approved supplier.

- .2 Provide isolators as follows:
 - .1 Type 1 pad isolator: Neoprene-steel-neoprene pad isolators, manufactured from "Bridge Bearing Quality Neoprene" as defined by CSA Standard CAN 3-S6-M78 section 11.10. Select type 1 pads for a 2.5mm (0.1") static deflection or greater. Compression to be limited to 25% of unloaded thickness.
 - .2 Type 2 rubber floor isolators: Rubber-neoprene-in-shear isolators designed to meet specified seismic requirements. Select isolators for a 6mm (0.25") minimum static deflection, and bolt to structure. Provide protection of the rubber element to prevent oil coming in contact.
 - .3 Type 3 spring floor isolation: Open spring mounts complete with levelling devices, adjustable side dampers, ribbed neoprene sound pads capable of deflecting 1.25mm to 2.55mm (0.05" to 0.10") at operating load, and zinc chromate plated hardware. With snubbers correctly adjusted, the isolator shall meet seismic requirements in accordance with appropriate CISC handbook of steel construction design methods.
 - .4 Type 4 spring hangers: Open spring type within zinc chromate plated frame with neoprene grommet (1.25mm deflection) mounted over the retaining washer for placement under the support rod adjustment nut; to have a single stable position when loaded; to allow a ± 150 angular misalignment.
 - .5 Isolators and seismic restraints to meet the requirements of the 1980 National Building Code. Use horizontal force factor SP-10 for mechanical equipment, and SP-15 for equipment containing toxic or explosive materials including steam (these requirements generally mean 0.8 g and 1.4 g respectively for maximum impact loads transmitted to the structure).

2.02 VIBRATION ISOLATION - GENERAL

- .1 Provide vibration isolation on all motor driven equipment with electric motors of 0.37 KW (0.5 H.P.) and greater power output and on piping and ductwork as specified herein. For equipment less than 0.37 KW, provide neoprene grommets at the support points.
- .2 Provide seismic restraining devices for resiliently mounted equipment.
- .3 Ensure isolation systems have a natural frequency no higher than 10 – 15 % of the lowest forcing frequency unless otherwise specified.
- .4 Provide horizontal limit springs or snubbers on all spring isolated fans (except vertical discharge) in excess of 1 kPa (4" water gauge) static pressure, and on hanger supported horizontally mounted axial fans.
- .5 Provide, for equipment as designated in the Equipment Schedules or shown on the Drawings, concrete inertia bases or structural steel frames located between all vibrating equipment and vibration isolation elements. Structural steel frames will not be required if the equipment manufacturer certifies direct attachment capabilities. Provide inertia bases on centrifugal fans with static pressure in excess of 876 Pa (3.5") and/or motor in excess of 30 KW (40 HP) and on base mounted pumps over 8 KW (10 HP).
- .6 On fans, as designated in the Equipment Schedules or on the Drawings, provide stabilizing springs to eliminate movement at flexible connections to 25% of fabric width under steady

state conditions and 40% at start-up. Flexible duct connectors between all isolated fans and non-isolated ductwork are specified in Section 15800.

- .7 Provide weatherproof coating (Rustoleum or Neoprene paint) on springs and frames on all isolation equipment exposed to outdoors.

2.03 GENERAL VIBRATION ISOLATION SCHEDULE

Item	Isolator Type	Deflection (mm)	Comments
In-line Pumps	Type 4	43	Refer to Detail Drawing
Vertical In-line Pumps	Type 2	2.5	See Detail Drawing
Based Mounted Pumps	Type 3	50	Provide Inertia Base when motors are equal or larger than 7.5 kw (10 HP).
Chillers	Type 3 and Type 1	50 2.5	Mount on Pads through Floating Floor
Boilers	Type 1	2.5	
Tanks and Heat Exchangers supported from the floor	Type 1	2.5	
Piping Suspended in Mechanical Rooms	Type 3	25	
Cooling Towers	Type 3	65 min	
Base Mount Centrifugal Fans	Type 3	25	
Suspended Centrifugal Fans	Type 4	25	

2.04 FLOATING FLOOR

- .1 Provide a floating floor system, where indicated on the drawings, consisting of isolation panels, perimeter isolation material, penetration isolation, form work stiffeners, adhesive, caulking and temporary water proofing with components and characteristics as follows:
- .1 System Dynamic Natural Frequency: 15 Hz maximum.
 - .2 Isolation Panels: 20mm (3/4") exterior grade plywood with joints reinforced with steel plates to prevent deflection exceeding 6mm (1/4") under point load of 80 KG (175 lbs), factory bonded to and supported by isolation pads.
 - .3 Isolation Pads: Elastomeric membrane covered 50mm (2") thick pre-compressed moulded Fibreglas with rating of 18 to 90 KG (40 to 200 LBS) each spaced at 600mm (24") on centre.
 - .4 Fill: 40mm (1 1/2") thick low density fibreglass.
 - .5 Perimeter Isolation: 25mm (1") thick 144 KG/M³ (9 lbs/ft³) foam neoprene 100 to 300mm (4" to 12") wide adhered to walls, columns, around sleeves, based and any other vertical projections prior to placing isolation panels.
 - .6 Temporary Waterproofing: Two layers of 6 mil polyethylene film laid over panels taped at all joints and at vertical projections and walls.

- .2 Provide a double floor drain system as detailed in the manufacturer's literature for any drains occurring within the area of the floating floor system.
- .3 All concrete work is specified in Division 3.
- .4 Refer to floating floor notes in Section 3.03.

2.05 SILENCERS

- .1 Provide silencers as listed in the equipment schedules. Only silencers with certified insertion loss ratings will be accepted.
- .2 Construction:
 - .1 ROUND: 22 ga. galvanized steel outer shell with lock formed mastic filled seams pre-fabricated, with 40 kg/m³ (2 1/2 lb/ft³) density acoustic media packed under 10% compression and protection from air erosion by 22 ga. perforated galvanized steel liner, stream-lined inlets and tapered diffuser outlets for maximum insertion loss and minimum pressure drop.
 - .2 RECTANGULAR: as above with acoustic media on all four sides or HTL (high transmission loss) steel on uninsulated sides whereby HTL to be externally applied and sealed to the silencer to assure quality controlled transmission loss. Construction of the HTL walls to be as required to obtain the specified room noise criteria (NC) level and to ensure noise "Break-out" is prevented.
 - .3 Where internal air velocities exceed 23 m/s (75 ft/s), provide additional fiberglass cloth over perforated steel liner.

2.06 PIPE LINE VIBRATION ISOLATORS

- .1 Provide twin-sphere double arch units constructed of high strength fabric and elastomer, reinforced with metal rings or wire complete with elastomer, rubber or steel flanges capable of 12mm (2") transverse deflection and operating at 860 kPa (125 psi) pressure.
- .2 Acceptable Manufacturers: Manson Industries, Flexonics, Hydro-Flex, Spanflex Pathway.

PART 3 - EXECUTION

3.01 INSTALLATION

- .1 Obtain all relevant equipment information and provide shop and installation drawings for all vibration isolation elements and steel bases. Include details of attachment to both the equipment and the structure to meet the specified forces involved. Do not perform any work or order any materials or equipment prior to review of shop and installation drawings by the Consultant.
- .2 For all equipment mounted on vibration isolators, provide a minimum clearance of 50 mm (2") to other structures, piping, equipment, etc.
- .3 Space isolators under equipment so that the minimum distance between adjacent corner isolators is at least equal to the height of the centre of gravity of the equipment or specifically designed for increased forces on the supports. If improved supports are proposed, include design calculations with shop drawings, for approval.

- .4 Isolate all floor or pier mounted equipment on Type 3 isolators unless otherwise specified.
- .5 Use the lowest RPM scheduled for 2 speed equipment.
- .6 Under equipment mounted on Type 3 mounts, provide neoprene/steel/neoprene (Type 1) pads, adjacent to the springs selected for the manufacturer's optimum loading, and shimmed to be just clear of the base of the equipment under operating conditions. Bolt these pads to the floor slab, maintaining the top of the bolt below the top of the pads. These pads are to minimizing rocking of the equipment in the event of an earthquake and can be deleted if other provision is designed into the isolator to control rocking.
- .7 For equipment mounted on slab on grade including chillers and pumps, mount on Type 1 neoprene/steel/neoprene sandwich pads unless otherwise specified.
- .8 Use Type 4 spring hangers for a minimum static deflection of 25mm (1") for all ceiling hung fans, air handling units and emergency generator exhaust silencers.
- .9 Provide Type 4 resilient hangers on all piping connected to a vibrating source if the piping is supported from walls or ceiling slabs adjoining occupied spaces, and if the piping is in excess of 40mm (1.5") diameter. Provide the hangers for a distance of 4 m plus $0.03 \times (\text{pipe diameter mm})$ from the vibrating source – e.g., for 250mm pipe, required distance is 4 m plus $0.03 \times 250 = 11.5$ m. Use Type 1 pads under pipe pedestals on slab on grade. Bolt down equipment mounted on neoprene pad isolators using neoprene grommets.
- .10 Provide Type 4 isolators for all piping in the mechanical room over 38mm in diameter; the first three points of supports with the same static deflection as the equipment, the remaining support points with at least 25mm deflection.
- .11 Unless noted otherwise, provide flexible connectors for chillers, cooling towers and all pumps with motors higher than 3.7 kw (5 HP).
- .12 To limit noise transmission to the structure, the generator should be mounted on spring isolators with neoprene pads in series and all exhaust piping up to and including the mufflers resiliently suspended using spring isolators with fibreglass or felt in series.

3.02 HOUSEKEEPING PADS

- .1 Refer to Section 15050 for the provision of housekeeping pads.

3.03 FLOATING FLOORS

- .1 Engage the services of the vibration isolation equipment manufacturer to supervise, inspect and certify the floating floor installation.
- .2 Isolate floating floors at perimeter from adjoining walls and columns with isolating board.
- .3 Waterproof isolation panels with two layers at 4 mil. polyethylene film turned up at all vertical isolation material to top extremity, lapped, taped and caulked.
- .4 Provide vertical isolation padding at all points where ductwork, conduit, piping etc. penetrates the floor and thoroughly caulk.

END OF SECTION 15100

PART 1 - GENERAL

1.01 DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Mechanical General Requirements Section 15010 and Mechanical Basic Materials and Methods Section 15050.
- .3 Refer to fire protection drawings **prepared by Mirenda Inc.???** for sprinkler and stand pipe insulation requirements.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Supply and installation of piping, ductwork, and equipment insulation.

1.03 QUALITY ASSURANCE

- .1 Qualifications: Execute work of this section only by skilled tradesmen regularly employed in the application of insulation to piping, ductwork and equipment casings for building heating, cooling, ventilating and plumbing systems.
- .2 Insulation, self adhesive tape, adhesives and any insulation finishes to be ULC labelled and listed for flame spread rating of less than 25 and smoke development classification of less than 50.
- .3 Acceptable Manufacturers:
 - .1 Insulation: Fiberglas Canada Inc., Knauf Fiber Glass, Manson, Roxul.
 - .2 Tape: Avery Dennison, Mactac, Tuck, Compac.
 - .3 Canvas: Fattal Thermocanvas, Alpa-Maritex 3451-RW, Clairmont Diplag 60.
 - .4 Lagging adhesive: Childers CP.50A-HV2, Fosters 30-36 asbestos free.

1.04 DEFINITIONS

- .1 The word "exposed" where used in this Section means any work which is not concealed in wall, shaft, or ceiling cavities or spaces. Work behind doors in closets or cupboards or under counters is considered exposed.

PART 2 - PRODUCTS

2.01 INSULATION

- .1 Preformed: ULC Listed sectional glass fibre pipe insulation in compliance with ASTM C335-84 in sections 900mm (36") long, split and ready for application with a minimum Thermal Conductivity of 0.033 W/m deg C at 24 deg C mean temperature and be capable of use on service from -40 deg C to 260 deg C and with factory applied vapour seal jacket of vinyl coated foil Kraft laminate with reinforcing of open mesh glass fibre.
- .2 Rigid board: 72 kg/m³ (4.5 lbs/ft³) density ULC listed glass fibre board with glass fibre reinforced aluminium foil vapour seal facing and minimum thermal conductivity of 0.035 W/m deg C at 24 deg C mean temperature.

- .3 Blanket: 24 kg/m³ (1.5 lbs/ft³) ULC listed flexible glass fibre blanket with glass fibre reinforced aluminium foil vapour seal facing with thermal conductivity of 0.036 W/m deg C.
- .4 High temperature (over 200 deg C): Preformed calcium silicate or Roxul 1200 mineral fibre piping insulation.
- .5 Low temperature: 20mm (3/4") fire retardant closed cell Armaflex in sheet form or pre-formed for piping.

2.02 FINISHES AND PROTECTIVE COVERINGS

- .1 Canvas: 170 g/m² with lagging adhesive, ULC labelled.
- .2 Protective covering (aluminium): .020 Childers corrugated aluminium preformed covering complete with strapping and seals.
- .3 Trowelled-on weather protective coating: Bakor 110-14 asphalt mastic vapour barrier coating.

PART 3 - EXECUTION

3.01 EQUIPMENT AND MISCELLANEOUS APPLICATIONS

- .1 Water meter domestic water booster pump casing and chilled water pump casings: 25mm (1") thick blanket insulation. On steel or cast iron surfaces, apply one coat of Densopaste Primer prior to applying insulation. Apply flexible blanket insulation and seal all joints in vapour seal facing with self adhesive foil tape. Finish with insulating cement and canvas.
- .2 Heat exchangers and tanks: shell and tube type and hot water storage tanks: 50mm (2") thick rigid board or preformed. Insulation not required on plate type heat exchangers. Score and mitre to fit contours of equipment and secure with 12mm x 0.38mm (2" x 0.015") galvanized steel bands 600mm (24") OC. Point up all joints with insulating cement. Finish with specified canvas. Do not insulate over registration and nameplates.
- .3 Chiller vessels and refrigerant suction lines: 20mm (3/4") fire retardant closed cell Armaflex on evaporator, suction piping, and chilled water headers. Apply Armaflex with suitable adhesive and seal all joints with suitable plastic tape. For chiller heads, provide one or two piece slip-on field fabricated and fitted sections held in place with metal bands with screw driver operated tightening devices. Cover all Armaflex with specified canvas. Do not insulate over registration and nameplates.
- .4 Drains and water supplies for wall-hung handicapped lavatories: blanket type on exposed water supplies and drain under lavatory. Finish with canvas.

3.02 AIR UNIT CASINGS (INTERNAL)

- .1 25mm (1") thick rigid board neoprene faced. Install insulation on weld pins and speed washers 300mm (12") OC. Cut pins flush with surface of insulation and cover all pins and joints with glass fab tape embedded in two coats of approved mastic compound. Use the first coat to embed the glass fab tape and the second coat as a finish. Refer to detail drawings.

3.03 DUCTWORK

- .1 Installation

- .1 Exposed ductwork: rigid board Insulation
 - .1 Rectangular ductwork: Impale rigid board on weld pins and speed washers 300mm (12") OC with a minimum of two rows per side on any side greater than 300mm (12"). Cut pins flush with surface of insulation and cover with foil faced type. Cover all joints with foil faced self adhesive tape. Finish with canvas.
 - .2 Round ductwork: Score and mitre rigid board to fit contours of duct and secure with 12mm x 0.38mm (2" x 0.015") galvanized steel bands 300mm (12") OC. Point up all joints with insulating cement and seal with foil faced self adhesive tape. Finish with canvas.
- .2 Concealed ductwork:
 - .1 Blanket type insulation. Apply flexible blanket insulation with an approved adhesive brushed on in 100mm (4") wide strips 300mm (12") OC and at all joints. For rectangular ducts over 450mm (18"), blanket type insulation should be secured to the bottom side of the duct with mechanical fasteners spaced on 450mm (18") centres. Care should be taken to avoid over-compressing the insulation with the retaining washer. Seal all joints and perforations with foil faced self adhesive tape.
 - .2 Ductwork over 1500mm (5') in width or located in vertical shaft: Use rigid board insulation.
- .3 Ductwork exposed to outdoors: Impale rigid board on weld pins and speed washers 300mm (12") OC with a minimum of two rows per side on any side greater than 300mm (12"). Cut pins flush with surface of insulation and cover pins and joints with foil faced self adhesive tape. Finish with two applications of weather protective coating trowelled smooth.
- .4 Where ductwork is symbolized as external acoustic: apply over rigid board two coats of hard plaster at 9.53mm (8") thick each, trowel smooth and finish with canvas.
- .2 Application: Provide external ductwork insulation in thickness as listed below:
 - .1 All supply air ductwork from fan discharge or unit outlet of air handling systems delivering air at temperatures less than 18 deg C and greater than 30 deg C. This includes supply air ductwork connected to discharge side of fan coil units, heat pumps, reheat coils and air handling systems with cooling and/or heating coils and direct or indirect fired burner sections.
 - .1 Provide 25mm (1") thick for systems with 18 deg C or less air supply temperature.
 - .2 Provide 40mm (12") thick for systems with 30 deg C or greater air supply temperature.
 - .3 Outdoor intake ductwork, ductwork conveying mixed outdoor/return air and mixed air plenums: 25mm (1") thick.
 - .4 Supply and return air ductwork located outdoors: 75mm (3") thick.
 - .5 Exhaust ductwork located outdoors: 50mm (2") thick.

- .6 Exhaust ductwork located indoors for a minimum of 3m (10 ft.) back from the discharge point to outdoors: 25mm (1") thick.
- .7 Where specifically noted on drawings that could be an exception to the foregoing.
- .2 Exceptions: external duct insulation is not required where:
 - .1 Supply air ductwork installed exposed within conditioned space.
 - .2 Ductwork is internally insulated and located indoors.
 - .3 Collars to registers, grilles and diffusers are 900mm (3 ft.) or less in length.
 - .4 Acoustic type flexible ductwork is used.
 - .5 Duct silencers with acoustic media on all four sides are installed.
- .3 Where a supply or return duct is not protected by an insulated exterior wall or where the duct is exposed to an unheated space, provide a minimum of 75mm (3") of rigid board insulation with a minimum RSI 2.1 (R-12) insulation value.
- .4 Where exhaust ducts containing air from heated space pass through or are adjacent to unheated spaces, provide a minimum of 75mm (3") of rigid board insulation with a minimum RSI 2.1 (R-12) insulation value.

3.04 PIPING APPLICATION SCHEDULE

Item	Insulation Thickness & Type
Domestic hot water (Conditioned space)	25mm (1") pre-molded for pipe up to and including 50mm (2"). 40mm (1 1/2") for 65mm (2 1/2") pipe and greater.
Domestic hot water (non-conditioned space or outdoor)	40mm (1 1/2") for run-outs less than 50mm (2") pipe 65mm (2 1/2") pre-molded for pipe up to and including 50mm (2"). 76mm (3") pre-molded for pipe from 65mm (2 1/2") up to and including 100mm (4") 88mm (3 1/2") for 125mm (5") pipe and greater.
Domestic hot water recirculation (Conditioned space)	25mm (1") pre-molded. 40 mm (1 1/2") for 65mm (2 1/2") pipe and greater.
Domestic hot water recirculation (non-conditioned space or outdoor)	40mm (1 1/2") for run-outs less than 50mm (2") pipe 65mm (2 1/2") pre-molded for pipe up to and including 50mm (2").
Domestic cold water	12mm (1/2") pre-molded 40mm (1 1/2") pipe and below. 25mm (1") pre-molded for 50mm (2") pipe and greater.

Item	Insulation Thickness & Type
Heating system piping (Design operating temperature below 95 °C)	40mm (12") pre-molded 40mm (12") pipe and below. 50mm (2") pre-molded for 65mm (22") pipe and greater.
Chilled water piping (Design operating temperature 5-13 °C)	25mm (1") pre-molded
Chilled water piping (Design operating temperature below 5 °C)	25mm (1") pre-molded for 25mm (1") pipe and less. 40mm (12") pre-molded for pipe 32mm (13") and greater.
Traced piping (where indicated)	Indoors: 25mm (1") minimum for applications not listed in this table. Outdoors: 50mm (2").
Condensate Horizontal drains from fan coil units, heat pumps, and cooling coils, suspended horizontal drains receiving cooling coil condensate, suspended horizontal drains from urinals and water closets and roof drain receptors and horizontal rainwater leaders and fittings	25mm (1") pre-molded
Condenser water piping for systems that operate summer and winter.	50mm (2") pre-molded outdoors 25mm (1") pre-molded indoors
Glycol Circuits	40mm (12") pre-molded 40mm (12") pipe and below. 50mm (2") pre-molded for 65mm (22") pipe and greater.
Strom Line (Horizontal)	40mm (12") pre-molded

3.05 PIPING

- .1 Apply insulation at temperature of approximately 8°C over clean, dry surfaces. Butt adjoining sections of insulation firmly together with the longitudinal seam of the jacket located on the bottom half of the pipe.
- .2 Insulate and finish in the same manner and same thickness as piping, all valves, fittings and flanges on cold, hot, condenser and chilled water piping. Use PVC jacketed mitred sections of the specified pipe covering or preformed insulation to suit fitting. Do not insulate valves, strainers, unions and flanges on hot water service and where concealed, do not insulate any fittings; straight runs of pipe only.
- .3 Seal longitudinal lap joints with a suitable vapour barrier adhesive for cold and chilled water piping and a suitable cement capable of withstanding service temperature on hot water piping. Cover circumferential butt joints with a strip of the same material as the jacket and cement as indicated above. Cover all joints with foil faced self adhesive tape on chilled and cold water piping.

- .4 Concealed insulated items require no further finish than provided in factory applied jacket. Cover exposed insulation and all insulated equipment with canvas, field applied, adhered and lap sealed and finished off by a brush coat of approved sizing.
- .5 Insulated piping exposed to outdoors: Apply aluminium protective covering over all insulated pipe and fittings. Seal all joints with approved sealants.
- .6 Seal valves, fittings and flanges on cold and chilled water application in a manner as specified for circumferential joints. On strainers, insulate over blow-down valves and bushings or flanges required for strainer basket removal by providing a removable prefabricated Armaflex cover held in place with a stainless steel gear clamp. Do not insulate over blow-down valves and bushings or flanges for strainer basket removal on condenser water piping.
- .7 Seal end joints and perforation with 100mm (4") vapour barrier strips applied with the same adhesives and cements as previously specified for cold and chilled water.
- .8 On all domestic cold and chilled water piping:
 - .1 Where oversized hangers are used, protect insulation with a sheet metal saddle installed over the vapour barrier. For piping 40mm (1 1/2") and larger provide a section of rigid insulation or non-compressible material under the vapour barrier the same length as the saddle - see detail drawing.
 - .2 Where oversized hangers are not used, apply 12mm (1/2") insulation with vapour seal over hanger and support rod for a distance of two pipe diameters up the rod from the attachment point at the ring, clamp or clevis.
- .9 Apply blanket type insulation on piping using an approved adhesive and seal all longitudinal and transverse joints with foil faced tape. Insulate pipe hanger in similar manner for a distance of two pipe diameters up the rod beyond the attachment point at the ring, clamp or clevis.
- .10 Insulation on piping where Victaulic couplings are used:
 - .1 In concealed areas, provide insulation over couplings to same thickness as specified for piping.
 - .2 In exposed areas, (except mechanical and service rooms) increase insulation thickness and provide one-half specified thickness over couplings to achieve the appearance of uniform diameter of pipe and fittings.
 - .3 Where aluminium sheet cladding is required, increase insulation thickness as described in (2) above to achieve a standard and uniform diameter.

3.06 FINISHES

- .1 Canvas over insulated items where exposed indoors.
- .2 28 ga. aluminium over all insulated piping exposed to outdoors and over insulation on stand-by generator exhaust piping and muffler.
- .3 Weatherproof mastic, two coats trowelled smooth, over ductwork insulation where exposed outdoors.
- .4 Breeching Insulation: Apply 13mm (1/2") coat of hydraulic setting insulating cement trowelled smooth over metal mesh.

END OF SECTION 15180

PART 1 - GENERAL

1.01 DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Mechanical General Requirements Section 15010 and Mechanical Basic Materials and Methods Section 15050.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Provision of all required equipment, piping, wiring, and chemicals for scale, corrosion, algae, and bacteriological control of chilled, heating, glycol, condenser and sprayed coil, piping circuits. Provision of degreasing chemicals for degreasing of all heating, chilled, condenser and glycol water system piping and equipment.
- .2 Supervision of all degreasing procedures, initial fill/start-up, commissioning and monitoring of treated systems and training of Owner's staff in operating and maintenance procedures.
- .3 Submission of a report, on completion of the Work specified in this Section of the Specifications, for the following:
 - .1 Results of degreasing and initial fill of treated systems.
 - .2 Results of treatment procedures for each system treated.
 - .3 Details of instructions given to the Owner's staff and names of persons receiving instructions.

1.03 QUALITY ASSURANCE

- .1 Qualifications: Execute work of this section only by skilled tradesmen, technicians, and manufacturers regularly employed in the administration of water piping systems chemical treatment.

Acceptable Manufacturers or Suppliers: Drew Chemicals, Perolin-Bird Archer, GE-Betz, Dow Chemicals, Klenzoid and Interstate Chemical Co. Inc.

1.04 SUBMITTALS

- .1 Submit shop drawings on all equipment and piping arrangements and provide Material Safety Data Sheets on chemicals and degreasing compounds.

PART 2 - PRODUCTS

2.01 WATER TREATMENT

- .1 Provide a water conditioning system to control corrosion, scaling, algae and bacteria in chilled, condenser, heating and glycol piping systems.
- .2 Provide a water conditioning program complete with all required chemicals for a period of one year commencing with the start-up of the equipment and systems.

- .3 Provide welding sockets where required or shown on the drawings and piping therefrom to equipment required for water treatment such as pumps, chemical storage tanks, and include all necessary piping, valves and accessories and control wiring.
- .4 Use only chemicals and methods complying with local health codes that do not have a detrimental effect on non metallic materials such as rubber, neoprene and plastics used in the piping systems. Provide nitrite/borate type inhibitors.
- .5 Provide suitable corrosion test coupons installed in appropriate piping arrangements for each treated closed loop system representing the metals in the circuit. Control corrosion rates in steel piping at maximum depth of Pitting of 0.127mm (0.005") of penetration per year and a maximum corrosion rate for copper tubing of 0.025mm (0.001") per year.
- .6 Provide pot type feeders on all closed piping systems for injection of chemical treatment complete with corrosion coupon rack. Pot feeders are to be welded steel and have a maximum pressure rating of 2070 kPa (300 psi) and a maximum temperature rating of 94°C (200°F). In and connections are to be 19mm (3/4") FNPT.
- .7 Provide a low flow micron filter unit pipe line filter assembly with pressure gauge and an Arkon (ball type) flow indicator on the leaving side of each pot feeder.
- .8 Provide a system of automatic purging and injection of chemicals for treatment of the condenser water circuit through a system of measuring water consumption with a contact meter to initiate an interval timer with adjustable on-off cycle time periods to control purging and chemical injection in sequence with chemical feeding by means of a diaphragm pump connected to a 170 l (45 gal.) polyethylene mixing tank. For algae control, provide a pot feeder located within the equipment room on the condenser water circuit.
 - .1 For the sprayed coil system, provide a system of automatic purging and chemical feed through a diaphragm pump and 170 l (45 Imp. gal.) polyethylene tank complete with contact meter, controls etc. to function the same as that specified for the condenser water circuit.
- .9 Do not use chemical treatment containing tin or tin compounds in any cooling tower or any other evaporative process circuits.
- .10 Test equipment: Provide one metal test cabinet complete with light to hold all test apparatus. Provide all required chemicals, comparator, titration equipment and test tubes to provide a complete testing facility for the systems treated.

2.02 GLYCOL FEED SYSTEM

- .1 Provide a Drew Chemical Model 1100 packaged glycol feed system consisting of a 200 litre (45 gal.) polyethylene tank, 19 kw (3 HP) mixer, .25 kw (a HP) bronze gear pump with ODP motor and integral relief valve, capacity: .13 l/s (2 GPM) at 600 kPa (80 psi).
- .2 Operational Controls: low level switch and light, contact head water meter, system pressure switch, alarm bell with reset, hand-off-auto switch, motor rated switches for pump and mixer and SPST relay.
- .3 The entire system to be factory pre-piped and pre-wired with numbered terminal strip for wiring of remote items such as the pressure switch and the contact head meter.
- .4 System operation: pump to operate automatically or manually as selected by HOA switch and be interlocked with the tank low level switch. The contact head meter will initiate the alarm

bell when a predetermined amount of make-up has been added. A separate alarm contact is provided to connect into a remote alarm device.

PART 3 - EXECUTION

3.01 WATER TREATMENT

- .1 Install test equipment cabinet as directed by the Consultant or as shown on the drawings.
- .2 Chemical application rates are to be as required to maintain water quality guidelines in compliance with ASME and manufacturers' instructions (boiler, cooling tower etc.).
- .3 Thoroughly flush and clean all water circulating systems and clean strainer baskets as often as necessary to ensure that scale, metal particles, etc. have been completely removed.
- .4 As directed by the Owner's chemical treatment supplier, refill all systems and inject degreasants and circulate at temperatures and for periods as required to ensure that the systems are thoroughly cleaned. Flush systems and refill in preparation for administration of chemical Electrostatic treatment.

3.02 MONITORING AND INSTRUCTIONS

- .1 Advise Section 15700 Subtrade where drains and fill points are required in the piping systems to facilitate proper drainage and fill /injection of fluids.
- .2 Carefully monitor the condition of all systems from initial fill to the point at which the systems are considered under stable operating conditions.
- .3 Provide oral and written instructions to operating personnel for the maintenance and control of the water conditioning program.
- .4 Submit a written report of system start-up showing water analysis and corrosion check test as part of documentation at the completion of the work.
- .5 For the first year of operation, provide service calls once every thirty days and provide written reports to operating personnel showing details of each service call.

END OF SECTION 15200

PART 1 - GENERAL

1.01 DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Section 15010 Mechanical General Requirements and Section 15050 Mechanical Basic Materials and Methods.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Provide a complete plumbing system including domestic hot and cold water, natural gas piping, sanitary and storm drainage, and vent piping and all fixtures, trim and hot water heaters as shown on the drawings complete in every detail.
- .2 Provide services connections (domestic and fire protection water, sewers, natural gas) as indicated. Terminate fire protection supply within building with shut-off valve - continuation of fire protection work is specified in Section 15500.
- .3 Provide make-up water connections to heating and cooling systems and trapped condensate drains from cooling coil drip trays.

1.03 QUALITY ASSURANCE AND REGULATORY COMPLIANCE

- .1 Qualifications: Execute work of this section only by licensed tradesmen regularly employed in the installation of natural gas, fuel oil, plumbing and drainage piping systems and site water supply and drainage services.
- .2 Other acceptable manufacturers to specified items:
 - Plumbing Fixtures: Crane, Eljer, Kohler
 - Plumbing Brass: American Standard, Delta, Crane
 - Water Closet Seats: Moldex, Beneke, Olsonite
 - Drains and Specialities: Zurn, Mifab
 - Shower Valves: Leonard, Rada, Danfoss
 - Wash Fountains: Bradley, Willoughby
 - Precast Shower Bases and Mop Sinks: Fiat
 - Oil/Grease Interceptors: Mifab.
- .3 Provide all Barrier Free Fixtures and Fittings to CAN/CSA-B651-M90.
- .4 Provide water closets with maximum flush for 6.0 and 3.8 litres respectively and provide flush valves that match the fixture capacities that are installed.
- .5 Provide domestic hot water generation systems in compliance with ASHRAE 90.1, 1989.
- .6 Where stops or shut-off valves are specified for fixtures, provide ball type valves - rough brass where concealed and chrome plated where exposed.

1.04 SUBMITTALS

- .1 Submit shop drawings on fixtures, brass, tanks, water heaters, drains, pumps, hose bibbs, wall hydrants.

PART 2 - PRODUCTS

2.1. PLUMBING FIXTURES AND BRASS

- .1 Water closets **(WC)**: REFER TO: Aquavista Plumbing Scope.
- .2 Vanity Lavatory **(LAV)**: REFER TO: Aquavista Plumbing Scope.
- .3 Single/Double Compartment Stainless Steel Sink **(SK)**: REFER TO: Aquavista Plumbing Scope:
- .4 Shower **(SH)**: REFER TO: Aquavista Plumbing Scope.
- .5 Laundry Sink **(LS)**: REFER TO: Aquavista Plumbing Scope.
- .6 Bathtub **(BT)**: REFER TO: Aquavista Plumbing Scope.
- .7 Janitor Mop Sink **(JS-1)**:

Williams #MTB-2424, 24" x 24" x 12" (610 x 610 x 305mm) deep precast terrazzo mop service basin with drain and strainer and one piece stainless steel cast integral cap c/w drain and strainer. Trim fitting Chicago Faucets #305VB-R- XK-Hose Faucet, C.P. 8" (203mm) CC, wall mounted, solid cast brass lead free body, with ¼ turn ceramic disc cartridges, cast metal lever handles, body mounted vacuum breaker, integral stops, and 31" (787mm) vinyl hose and hanger. 3" (75mm) 'P' trap.
- .8 Washing machine hot/cold supply **(WM)**:

Symmons 'Eliminator' #W-600-X single lever operated valve, hose end outlets, copper liner, service stops, ½" (12.7mm) H & CW connection, 1 ½" (38mm) drain outlet, provide 'P' Trap cast brass, 1 ½" (38mm) (concealed in wall).
- .9 Drinking Fountain (wheelchair & general use) **(DF)** – Amenity Area

Haws #H1001-8 Cooler, wall mounted, stainless steel, 15 gauge (1.2mm) with #4 satin finish, 14" dia. (356mm) receptor, lead- free, 'Soft Touch Valve' forged brass control bubbler head, self-closing, automatic volume regulator, 100 micron in-line filter, vandal resistant open-grid strainer, tailpiece, capacity of 30 LPH (8GPH), compressor, with 0.5 gal. (1.9L) stainless steel reserve storage tank capacity, R 134A refrigerant, louvred access panel, air cooled with fan, hermetically sealed reciprocating type, 1/5 HP, 120 V. single phase A.C. 5.6 AMPS – chiller wired direct to incoming line. Provide ground fault interruptor. McGuire #HST11BV Fountain Supply. C.P. polished brass straight ¼ turn all brass ball valve stop with loose key handle. McGuire #8872C 'P' Trap, C.P., polished, cast brass adjustable body, 1-1/4" (32mm) with cleanout plug, seamless brass wall bend and escutcheon.

2.2. ROOF DRAINS

- .1 Standard roof drain **(RD-1)**:

Smith Series 1310ERCCID Roof Drain, all duco coated deep cast iron body, with under deck clamp, adjustable extension and sump receiver, 12" (300mm) secured cast iron dome. On small area roofs provide Series 1330CERCID Drain, with 82" (212mm) cast iron dome.

.2 Parapet or scupper drains **(RD-2)**:

Smith Series 1510/30SG Scupper Drain, all duco coated cast iron body, with secured angled grate, flashing clamp and 45 degree or 90 degree outlets.

.3 Patio and terrace areas **(RD-3)**:

Smith Series 1470ERCNB Drain, with adjustable slotted extensions and 8" x 8" (200mm x 200mm) nickel bronze square promenade top. For inverted roof installation use Series 1409RCNB Drains.

.4 Green roof drains **(RD-4)**:

Jay R. Smith #SQ-1-3927-CAN-CL-R-C-CID Roof Drain, all duco coated 15-1/4" (390mm) diameter cast iron body with perforated S.S. extension, flashing clamp with seepage openings and 11" (280mm) diameter secured cast iron dome with S.S. gravel guard. (Perforated S.S. extension - height to suit roof construction) , 'L' shaped underdeck clamp, sump receiver, underdeck clamp, cast iron dome.

.5 Planter roof drains **(RD-5)**:

Jay R. Smith #2675-EP-CID Planter Drain, all duco coated 12" (300mm) diameter cast iron body, flashing clamp with seepage openings, large S.S. mesh covered , extension Perforated to suit depth of bury, cast iron dome.

2.3. FLOOR DRAINS

.1 Floor drains - finished areas (and showers) **(FD-1)**: Smith Series 2005A Floor Drain, all duco coated cast iron body, reversible clamp device and adjustable 5" diameter (127mm) nickel bronze 3" (6.35mm) thick strainer, secured with SS screws, 4" (100mm) throat on strainer. In quarry or mosaic tiled areas, provide square 'B' - 5" x 5" (127mm x 127mm) polished bronze (PB) square strainer. Floor Drain with Hub provide 2005A-3580NB.

.2 Floor drains - mechanical rooms and unfinished areas **(FD-2)**: Smith Series 2320 Floor Drain, all duco coated cast iron body, seepage flange, adjustable collar, clamping device and 8" (200mm) diameter grate.

.3 Floor drains with combination funnel (unfinished areas) **(FD-3)**: Smith Series 2320-3591 Floor Drain, all duco coated cast iron body, seepage flange, adjustable collar, clamping service and 82" (216mm) with 4" x 9" (101.6mm x 228.6mm) oval funnel.

.4 Area Drain **(FD-4)**: Jay R. Smith #SQ-2-1717-B-M Floor Drain, all duco coated large cast iron body, flashing collar , sediment Bucket, ductile Iron Grate, cast iron hinged bar grate.

.5 Pit drain **(FD-5)**: Smith Series 1510/30SG Pit Drain, all duco coated cast iron body, angled drainage grate, flashing clamp and 45 degree or 90 degree outlets. For elevator pits use Series 7012MEXT Backwater Valve with extension, in line from floor drain immediately external to room. Provide access pit and cover for backwater valve if invert greater than 18" (457mm) from finished floor.

- .6 Trench drains **(FD-6)** – Poured in place – without catch basin – one grate with frame: Jay R. Smith #1330-MOD-2970-2971 Trench Drain, 12" x 24" (300mm x 600mm) grate with 12-1/2" x 24-1/2" (318mm x 622mm) anchoring frame. Trench width 10" (254mm). Drain in bottom of trench with 8-1/2" (216mm) dome one Heavy Duty 12" x 24" Grate Only and One Heavy Duty 12-1/2" x 24-1/2" Grate with Frame duco Cast Iron Grate with Steel Frame, polyethylene dome.
- .7 Sub-surface slab Area drains **(FD-7)**: Smith Series 2675CID all duco coated cast iron body, seepage flange, flashing clamping device, waterproofing, C.I. secured dome covered with S.S. mesh screen. Where access and surface water drainage required provide extensions perforated 'EP' to suit depth of bury and 8" (200mm) diameter grate

2.4. CLEAN-OUTS

- .1 Line clean-outs:

Smith Series 4420 Line Clean-out, in cast iron pipe with taper thread cover secured to body with full size pipe opening.
- .2 Stack Clean-out:

Smith Series 4510 Stack Clean-out, in base of cast iron stacks with neoprene gasketed secured cover. Where clean-outs are concealed behind finished walls access shall be made by 4530 round stainless steel plate and slotted flat head stainless steel screws.
- .3 Floor clean-outs:

In unfinished areas and outside areas, Smith 'Twist to Floor' Series 4220 Floor Clean-out, duco coated cast iron body with integral clamp device, and removable positive seal closure plug and heavy duty 6" (150mm) adjustable cover secured with stainless steel screws, C.O. cast in cover. (For water proofed areas provide 'FC' flange with flashing clamp).

 - .1 In tiled areas, Smith Series 4140 Floor Clean-out, same as above with square nickel bronze cover and frame recessed for tile. Cover can be adjusted to suit floor lines when installing finished floor. (Mosaic tile provide series 4160 with square cover).
 - .2 In terrazzo areas, Smith Series 4180 Floor Clean-out, same as above with square nickel bronze cover and frame recessed for terrazzo. Cover can be adjusted to suit floor lines when installing finished floor.
 - .3 In carpeted areas, Smith Series 4020Y Floor Clean-out, same as above with nickel bronze cover and frame.
 - .4 In other finished areas, Smith Series 4020 Floor Clean-out, same as above with nickel bronze frame and cover (for medium load traffic).
 - .5 For heavy traffic areas, Smith Series 4100 Floor Clean-out, same as above with extra heavy nickel bronze cover and frame.

2.5. TRAP SEAL PRIMERS

- .1 P.P.P. INC. Model PR-500 Automatic Cast Brass Trap Seal Primer Valve, serving individual or remote area drains with 2" (12mm) NPT (M to F) connections with strainer and integral back flow preventer and vacuum breaker. Complete with YS-8 Supply Tube.

- .2 Electronic trap priming manifold: P.P.P. INC model PT-4, PT-8, PT-12, PT-16, PT-20 or PT-24. Electronic Trap Priming Manifold, where four or more traps requiring priming are within 100 feet proximity to each other, the unit shall supply a minimum of 10 oz. (0.10L) of water per opening, once in each 24 hour period based on a system pressure of 60 PSI (420 kPa). Factory assembled with a bronze body ball valve, water hammer arrestor, solenoid valve, atmospheric vacuum breaker and A type L copper manifold. Electronic single point power connection 120V 1 AMP Draw, manual override switch, and a 24 hour timer. Provide access panel if required.
- .3 For areas with 4 or fewer drains within 30 meters proximity, provide MP-500-115V series electronic primers in conjunction with appropriate DU series distribution units.
- .4 Provide trap primer units for parking garage catch basins. Locate trap primer units in P-2 level mechanical pump rooms with 24 hour timer.

2.6. WATER HAMMER ARRESTORS

- .1 P.P.P. INC. 'Water Hammer Arrestors' Series 'SC' with brass piston in a type 'K' copper casing size according to manufacturer's recommendations chart below to eliminate water hammer and shock from piping system. Provide Water Hammer Arrestors on hot and cold water supplies to all quick valves, solenoids, and plumbing fixtures, and locate in an upright position between the last two fixtures on a line, or horizontally at the end of line closest to supply source.
- .2 On projects exceeding five stories in height, provide water hammer arrestors on domestic water risers as follows. Locate arrestors at the end of riser opposite supply source. Arrestor shall be two pipe sizes larger than the riser is at the connection point, not exceeding the largest pipe size diameter in the riser.

Size	Fixture Units	Model No.	Connection Size
A	1 - 11	SC - 500	2" (12mm)
B	12 - 32	SC - 700	3" (20mm)
C	33 - 60	SC - 1000	1" (25mm)
D	61 - 113	SC - 1250	1 1/2" (32mm)
E	114 - 154	SC - 1500	1 1/2" (38mm)
F	155 - 330	SC - 2000	2" (50mm)

2.7. HOSE BIBBS

- .1 Interior **HB-1**: Acorn 8121CR Chicago Faucets #5T-E27 12mm (2") wall type, C.P. rough bronze with hose end and vacuum breaker.
- .2 Exterior **HB-2**: Smith Series 5509QT box type hydrant, 20mm (3/4") non-freeze wall type with 1/4 turn ceramic disc cartridge, bronze face and box, adjustable wall flange, operating key and self-draining integral vacuum breaker. Length to suit wall thickness.

- .3 Exterior wall hydrant **HB-3**: Smith Series 5609QT 20mm (¾") non- freeze wall faucet with ¼ turn ceramic disc cartridge, with nickel bronze face and box, wall flange, operating key and vandal proof lock assembly and self draining vacuum breaker.

2.8. COMMERCIAL DOMESTIC HOT WATER TANK

- .1 Tank: Clemmer Model (Refer to drawing equipment schedules for Model, capacity and size) steel horizontal manufactured to the requirement of ASHRAE 90.1-2004 and complete with the following:
 - 1. Manufactured to current ASME and CSA Standards for operating pressure of 1034 kPa (150 psi).
 - 2. Cement lining suitable for storage of domestic hot water at 82°C.
 - 3. Red primed exterior surfaces.
 - 4. 300mm x 400mm (12" x 16") manhole.
 - 5. Tappings in quantities and sizes as shown on the drawings and as required for control points.
 - 6. Immersion heater- hot water tube bundle heat exchanger with oversized dimensions to suit tank lining; 20mm (0.75") OD copper tubing; welding collar; brass head, tube sheets and tube supports; constructed to ASME standards for design conditions of 1206 kPa (175 psi) and 180°C; refer to equipment schedules for capacities and sizes.
 - 7. Floor support saddles.
 - 8. Isolation pads, bushings, unions, flanges and gaskets for a completely corrosion protected installation.
 - 9. Acceptable alternative Manufacturer: A.O. Smith.

2.9. PUMPS

- .1 Domestic water recirculation, pressure booster and sump pumps: Refer to pump schedule and Section 15700.

2.10. MANHOLES AND CATCHBASINS

- .1 Manholes 1200mm (48") diameter pre-cast concrete as manufactured by Oaks Pre-Cast Industries Ltd., or approved equal. Provide frames and covers in accordance with current local standards. See detail drawings. Where diameter of incoming or leaving pipe exceeds 600 mm (24") use 1500mm (60") diameter manhole.
- .2 Catch basins as detailed on the drawings or pre-cast type as manufactured by Oaks Precast Industries Ltd., with grates, frames, and traps conforming to municipal requirements.

2.11. PRESSURE RELIEF AND REGULATING VALVES AND BACKFLOW PREVENTERS

- .1 Where indicated or performance specified on the drawings, provide pressure relief and regulating valves and backflow preventers as follows - also refer to Section 15050.
- .2 Provide a backflow preventer on any piping supplying potable water to a heating, chilled water, condenser water, sprinkler or any process piping system where chemical treatment or anti freeze solution is used or where chemicals are conveyed, provide a reduced pressure principle type backflow preventer to CSA B64.4-1976.
- .3 Acceptable Manufacturers: Watts, Singer, Honeywell, Braukmann, Wilkins, Conbraco.
- .4 For natural gas, provide CGA approved pressure regulating valves as manufactured by Fisher or Canadian Meter.

2.12. WATER TREATMENT FILTERS

- .1 Judo Water Treatment JPF-AT/P 6 'PROFIMAT', Size 6" (150mm) (Size as shown on drawings). Automatic Backwash Filter for C.W. service, with upper housing made of high-grade polymer-based materials and bottom housing made of high-grade cast-iron coated with rilsan. Equipped with a clear sight-glass, which allows you to view the filtration, soiling, and backwash functions. Filtration through a stainless steel filter sieve size of 100 microns. Backwash process using a patented point-rotation-system without any interruption of the water supply. Simultaneous cleaning of the sight-glass during the backwash process. Automatic backwash, generated by a time actuated relay, with the following adjustable range from 1 to 2,000 hours and a differential pressure control setting adjustable from 1-36 PSI differential. Electronic control enclosure with computer display for system diagnostics equipped with LED display indicators for operation, alarm fault buzzer and manual over-ride button for backwash start-up. 120/60 VAC (25W). Run three 3/4" (20mm) backwash flushing drain connections, for 5" (125mm) size filter and four 3/4" (20mm) drains for 6" (150mm) size filter, to nearest hub drain using an indirect connection. Horizontal pipe installation. Flanged connections to ASME B16.1. Provide 3 prong duplex box outlet with GFI.

2.13. MIXING VALVE (MV-1)

- .1 Provide tempered water mixing valve – Symmons Model 5-1000B, capacity 70gpm at 10psi pressure drop, suitable for 29 C to 71 C water temperature, thermostatic temperature control valve with liquid filled motor, check stops, safety shut-off, volume control valve, rough bronze, ball valves, dial thermometer, in a stainless steel cabinet, top supplies, top outlet.

PART 3 – EXECUTION

3.01 FIXTURE INSTALLATION

- .1 Install all fixtures, drains, clean-outs, brass and specialties to Manufacturer's requirements.
- .2 Connect fixtures, complete with supplies and drains, separately trapped, supported level and square. Provide chrome plated piping for all exposed water supply, waste and vent connections complete with CP escutcheons.
- .3 Provide supports to set fixtures square and level.

Obtain acceptance of mounting heights of all wall mounted fixtures.
- .4 Fixtures mounted on glazed tile surfaces: Provide ground faces to finished surfaces.
- .5 Install water hammer arrestors for each fixture or group of fixtures and top of all risers.

3.02 PIPE INSTALLATION

- .1 General: Install straight, parallel and close to walls and ceilings, with specified pitch. Use standard fittings for direction changes.
- .2 Install groups of piping parallel to each other on trapeze hangers; Space piping to permit application of insulation, identification and service access.
- .3 Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.

- .4 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.
- .5 Install brass and copper pipe and tubing free from surface damage. Replace damaged pipe or tubing.
- .6 Provide vents to atmosphere for all gas regulators as required by Code.
- .7 Ream ends of pipes and tubes before installation.
- .8 Lay copper tubing so that it is not in contact with dissimilar metal and will not be kinked or collapsed.
- .9 Provide non toxic lubricant or teflon tape applied to male thread on all threaded connections.
- .10 Clean ends of pipes or tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.
- .11 Sanitary and storm drainage: Run piping to main sewers with uniform grade.
- .12 Jointing of pipe: Compatible with type of pipe used.
- .13 Water piping: Run water piping from service connection and connect to fixtures and equipment. At lavatories install supplies as high as possible.
- .14 Provide washroom groups and branch take-offs from mains with isolating valves. Install stop valve in each fixture supply.
- .15 Where two or more branch recirculating hot water lines are connected to main recirculating line, provide circuit balancing (CBV) valve and check valve in each branch line for balancing water flow and for prevention of back flow in one branch. Adjust balancing valves to provide recirculation through each circuit. Turn over lock shield valve key to Owner.
- .16 Provide hose end ball valves at main low points, and base of hot and cold main risers for complete system drainage.
- .17 Provide branch take-offs from mains of domestic hot and cold water lines with water balancing valves and shut off valves.
- .18 Provide all parts of the plumbing system including all required venting in accordance with Part 7 of the Ontario Building Code to current amendments and Canadian National Plumbing Code.
- .19 Indirectly connect, to the sanitary sewer only, all drains and overflow lines from cooling towers, unitary cooling units, and suite fancoil units.

3.03 SPECIALTIES INSTALLATION

- .1 Cleanouts: Install accessible clean-outs at traps and where required by Code or Regulation.
- .2 Floor drains: Provide with trap primers connected to nearest cold water flush valve, or to automatic primer or flush tank. Prime all floor drain traps. Prime parking catch basins on parking level P-4.
- .3 Non-freeze wall hydrant: Install 360mm (14") above finished grade unless otherwise noted and with inside shut-off valve.

3.04 EQUIPMENT INSTALLATION

- .1 Hot Water Heaters: Install according to Manufacturer's instructions. Ensure all components are accessible.
- .2 Pumps: Install in-line pumps to manufacturer's requirements.
- .3 Install catch basins and manholes in accordance with municipal standards and the detail drawings.
- .4 Install the hydro-pneumatic tank in accordance with manufacturer's requirements.
- .5 Provide copper (plastic if outdoors) condensate drains with traps from all air handling equipment with cooling coils. Traps to provide water seal depth of 25mm (1 in.) in excess of air handling system operating static pressure at point of drain connection. Consult equipment Manufacturer for information on operating negative static pressure in the drain pan area or air handling unit.

3.05 PLANTER DRAINS

- .1 Provide gravel or crushed stone around dome of drain in accordance with manufacturer's instructions.

3.06 TESTING

- .1 Test piping in accordance with procedures outlined in Section 15050.
- .2 Ensure that insulated piping and equipment installed in concealed places is tested and inspected prior to permanent concealment.

3.07 COMMISSIONING

- .1 Potable water supply systems:
 - .1 Thoroughly flush and disinfect (chlorinate) water supply systems in accordance with municipal requirements.
 - .2 Flush domestic water piping with a sufficient flow to produce a velocity of 1 metre per second for ten minutes, or until all foreign materials have been removed and the flushed water is clear. Provide connections and pumps as required. Open and close valves, hydrants, and service connections to ensure thorough flushing.
 - .3 When flushing has been completed, introduce a strong chlorine solution into the piping and ensure that it is distributed throughout the entire domestic water system. Disinfect the piping in accordance with AWWA C601-68. The rate of chlorine application to be proportional to the rate of water entering the pipe.
 - .4 The point of chlorine application to be close as possible to the point of filling the piping and to occur simultaneously. Operate valves, hydrants and similar appurtenances while chlorine solution is in the piping. Flush piping of chlorine solution after 24 hours.
 - .5 Arrange and pay for water quality tests to be performed by an independent testing laboratory acceptable to the Consultant as follows:

- .1 Test for chlorine residuals at extreme ends of all piping systems. After a chlorine residual of not less than 50 ppm has been achieved in all parts of the system, let the system stand for 24 hours. After this period, take further samples to ensure that there is still not less than 10 ppm of chlorine residual throughout the system.
 - .2 When chlorine residuals of 10 ppm have been maintained for a minimum of 24 hours, flush the system and refill to put the system into service.
 - .3 Submit copy of report as prepared by the testing laboratory as well as a certificate attesting to level of safety of water supply being in conformance with standards of Authority having jurisdiction.
 - .2 Equipment: Make tests to demonstrate capabilities and general operating characteristics in the presence of the Consultant.
- 3.08 CLEAN-UP
- .1 Leave systems operating with work areas clean to acceptance of the Consultant.
- 3.09 NATURAL GAS SERVICE
- .1 Co-ordinate with Enbridge Consumers Gas and bear all costs in providing the natural gas service complete with meter to the building as shown on the drawings.
- 3.10 DOMESTIC WATER METER
- .1 Co-ordinate with the City of Toronto and bear all costs in providing a Building water meter/s as detailed on the drawings and make installation in accordance with municipal requirements.
 - .2 Provide water meters for other systems where shown and sized on the drawings, e.g., for cooling tower and heating/cooling systems make-up. Provide pulse initiator relays on these meters that are compatible with the EMCS - co-ordinate with Section 15900.

END OF SECTION 15400

PART 1 - GENERAL

1.01 DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Mechanical General Requirements Section 15010 and Mechanical Basic Materials and Methods, Section 15050.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Supply all materials, labour, equipment, design and working drawings to provide a complete fire protection system as described herein and shown on the drawings including, but not limited to the following:
 - .1 All piping including external fire department pumper connections, yard fire hydrants, post indicator valves and equipment.
 - .2 All fire hose cabinets and standpipe systems.
 - .3 Sprinkler systems.
 - .4 All fire extinguishers, cabinets and brackets.
 - .5 Temporary standpipe during construction as required by Authorities.
- .2 All necessary water flow tests for bidding and new water flow tests prior to system design.
- .3 Perform general review of the installation of the fire protection systems in conformance with the subsection 2.3.2 of the Building Code and provide certification letters as required by the authorities having jurisdiction.

1.03 QUALITY ASSURANCE

- .1 Qualifications: Execute work of this Section only by skilled tradesmen employed by a qualified Fire Protection Contractor licensed in the province of Ontario regularly engaged in the installation of automatic sprinkler systems and other fire protection equipment and who is a member in good standing of the Canadian Automatic Sprinkler Association.
- .2 Authorities and Agencies: Conform to requirements of Ontario Fire Code, NFPA 10, NFPA 13, NFPA 14, NFPA 20, the City of Toronto Building and Fire Department, the Ontario Building Code and the Owner's Insurance Underwriter and FM.
- .3 Arrange and pay for all inspections, examinations and tests required by all Authorities specified previously. Provide certificate, where given, to the Consultant.

1.05 APPROVALS

- .1 Prepare not less than seven (7) sets of sprinkler/ standpipe system installation drawings (sprinkler/ standpipe shop drawings) and associated detailed system hydraulic calculations and submit directly to the Insurance Authority for review and approval. After obtaining the Insurance Authority approval submit the approved drawings and hydraulic calculations to the local Building and Fire Departments for their review and approval. The fully approved drawings and hydraulic calculations shall then be submitted to the Consultant for review.

Note: No fabrication or installation shall proceed on the sprinkler systems until all approvals have been obtained.

- .2 Apply and pay for all permits, fees and inspections that are required for final acceptance of the Sprinkler Systems.
- .3 Include in the Tender Price all costs associated with the review and approval by the Insurance Authority.
- .4 All materials, equipment valves and devices installed and furnished under this Section shall be listed and approved for use in the Sprinkler Systems installation by the Authorities, Agencies, Codes and Standards named in this Section of the Specification.
- .5 Refer to: Underwriters Laboratories and Factory Mutual for approved Fire Protection Equipment list: ULC, ULI and FM.

1.06 SUBMITTALS

- .1 Submit shop drawings on pumps, hose cabinets, fire extinguishers, fire department pumper connections, compressors.
- .2 Before commencing Sprinkler System installation, prepare and submit for acceptance, a complete design, hydraulic calculations and working plans to the Authorities and Consultant. All work with other trades, especially work by other Sections of this Division and Division 16 must be co-ordinated. Extra compensation to remedy interference problems with the Work of Division 15 and 16 Subtrades will not be considered.
- .3 Submit samples of sprinkler heads and guards.

PART 2 - PRODUCTS

2.01 MATERIALS, EQUIPMENT, VALVES AND DEVICES

- .1 All materials, equipment, valves and devices provided under this section: ULC labelled, listed and approved as well as approved by the Authorities, Agencies Codes and Standards named in this Section. For reference use Underwriters' Laboratories approved fire protection equipment list (ULC).
- .2 Piping:
 - .1 Sprinkler Systems: Pipe and fittings to current requirements of NFPA 13. Approved Victaulic fittings may also be used - refer to Section 15050

IPEX BlazeMaster fire sprinkler CPVC pipe and fittings for 'light hazard' occupancy area application only, in compliance with NFPA 13, ASTM F442 and UL 1821 listed.

Provide schedule 40 galvanized pipe and fittings for dry and pre-action sprinkler systems.
 - .2 Buried yard piping: Universal cast iron with mechanical joints or PVC equal to John's Manville Class 150 water pipe with rubber gasketed fittings. Provide thrust blocks at all tees and changes in direction as well as at hydrants in accordance with manufacturer's instructions.
 - .3 Standpipe Systems: Pipe, fittings, hangers and accessories to NFPA 14 and the Ontario Building Code (Ontario Regulation 413/90) effective Oct. 1, 1990 and amended September 30, 1991 and to current amendments.

- .3 Fire Department Connections:
 - .1 Provide where shown, two Fire Department hose connections flush type Siamese National Fire Equipment Ltd. No. 229 , with double clapper. Cast bronze with chrome plated finish and properly labelled and identified for "standpipe" and "sprinkler" services.
 - .2 Other acceptable manufacturers: CFH, Stelpro, Wilson and Cousins.
- .4 Fire Hose Cabinets:
 - .1 National Fire Equipment Ltd. consisting of a 16 gauge steel factory prime coated tub with trim and door of 12 gauge steel and 5mm (3/16") clear float glass front, complete with 30 m Polyflex single jacket hose, water stop, pin rack, [chrome plated] forged brass couplings attached, 40mm (1.5") A156 pressure regulating chrome plated forged brass valve with hydrolater, 65mm (2.5") A156 pressure regulating chrome plated brass angle hose valve with cap and chain, 40mm (1.5") chrome-plated Lexan straight stream fog nozzles and [11.37 litre (3 US gal.) copper multi purpose, ammonium phosphate type tested and charged extinguisher with ULC listing 3A10BC, 2.3 kg (5 lbs) capacity and one trinal spanner. Provide 6mm (0.25") Lexan fronts on doors, brass valves and couplings and unplated nozzles in parking garage areas.
 - .2 Cabinets to be surface mounted or recessed as indicated on drawings.
 - .3 Provide a minimum of 4 additional spanners for hose couplings.
 - .4 Other acceptable manufacturers: CFH, Stelpro, Wilson and Cousins.
- .5 Fire Extinguishers, fire blankets and Cabinets:
 - .1 Provide portable filled and tested fire extinguishers as manufactured by National Fire Equipment Ltd., in sizes and classifications as shown on drawings. All extinguishers to be multi-purpose, ammonium phosphate type unless otherwise specified on the drawings.
 - .2 Provide wall brackets and cabinets as indicated on drawings. Cabinets: Model CE-950-2 surface mounted or recessed as indicated. All fronts: 5mm (3/16") Clear Float Glass. 6mm (0.25") Lexan in parking garage areas.
 - .3 Fire Blankets: Non-toxic fire retardant glass fibre, 1500 x 2000mm (60" x 78"), complete with quick release container.
 - .4 Other acceptable manufacturers: CFH, Stelpro, Wilson and Cousins.
- .6 Supervised Valves: All sprinkler and standpipe system branch supervised valves: Butterfly type Grinnell #WC8292ULC/FM Dual approved, or acceptable alternative, complete with micro switch for wiring into the fire alarm annunciation system. Micro switch to be in the closed position when the valve is full open and to open when the valve stem moves away from full open position. Wiring to annunciator panel by Division 16.
- .7 Excess Pressure and Jockey Pumps:
 - .1 Excess Pressure Pump: Albany Model CEP-67, or acceptable alternative, bronze close coupled rotary gear type complete with 1/3 HP motor, flex. hose connections,

discharge check valve, suction strainer, mounting bracket, PRV set at 1085 kPa (125 psig) and pressure switch rated for pump operation with range 70 to 860 kPa (10 to 125 psi).

- .2 Jockey Pump: AITT Series SSV, (refer to equipment schedules) vertical multi-stage design with a capacity of 5 usgpm and a pressure boost of 189 psi. Pump controller model JP3 and NFPA & ULC listed.

.7 Combined Sprinkler/Standpipe Booster Pump

- .1 Provide, in location and as detailed on the drawings, a complete packaged pump manufacturer factory assembled and tested booster pumping system consisting of horizontal split case vertical in line pumps, electric motor drives, coupling guards, controllers, accessories, as manufactured by ITT, A/C pump; listed and labelled by ULC; meeting requirements of NFPA 20. The fire pump package is to be ITT packaged fire pumping system, including pump, minimum fittings, motor, fire pump controller, check valve, butterfly valve and test tee on the pump discharge. OS&Y gate valve on the pump suction, jockey pump and jockey pump controller and non corrosive individual sensing lines as per NFPA 20, all assembled on a common base. The unit shall be completely assembled, wired, factory tested and shipped ready for customer's system inlet, outlet and power source. Fire pump, Jockey pump, controllers are to be mounted and wired on common base complete with NFPA 20 accessories.

Other acceptable manufacturers: Peerless, Aurora, Armstrong.

- .2 Selection: To satisfy hydraulic load calculation for sprinkler and standpipe systems to provide a residual pressure of 450 kPa (65 psi) at the most remote hose station while providing the required flow for both sprinkler and standpipe systems.
- .3 Performance: Capable of delivering not less than 150% of rated capacity at a pressure of not less than 65% of rated head; shut-off pressure not to exceed 120% of rated head at rated capacity; refer to equipment schedules for motor size. The complete package to be hydrostatically tested to twice the maximum pressure developed at shut-off but not less than 250 psig.
- .4 Accessories: Venturi type flow metering device, discharge tee, air release valve and fittings (UL/FM listed for fire pump service), discharge and suction pressure gauges, gauge cocks and nipples, casing relief valve, as per NFPA 20 section 3-3, by-pass relief valve or pressure relief as required by system design.
- .5 Controllers: ULC listed model GPR-GPG as manufactured by Tornatech. Combined manual and automatic reduced voltage starting (star delta closed transition) with externally openable quick-break disconnect switch, time delay type circuit breaker with trips in all phases set at 300% of full load current and interrupting capacity of 50,000 asymmetrical amperes; factory installed and wired pressure switch and automatic stop.

The fire pump controller shall meet the requirements per NFPA20.

- .6 Control Functions: Drop in system pressure starts pump which runs for 1 minute per 10 HP minimum.
- .7 Automatic Transfer Switch: The automatic transfer switch and the main pump controller is to be mounted in separate enclosures mechanically attached to form one

unit and to provide protection for the interlock wiring. The automatic transfer switch is to be mechanically held and electrically operable. It will provide automatic power transfer from normal to alternate power in case of a voltage drop below 90% of normal, phase failure, or phase reversal and automatic retransfer of power after restoration of normal power conditions.

The automatic transfer switch will furnish the following manual controls:

- a) An externally operable main isolating switch ahead of the alternate power terminals of the transfer switch.
- b) An operating handle to allow for the manual operation of the transfer switch.
- c) A test switch to momentarily simulate normal source failure.

The automatic transfer switch will furnish the following audio-visual alarms:

- a) Signal light (green) to indicate the transfer switch is connected to the normal source.
- b) Signal light (red) to indicate the transfer switch is connected to the alternate source.
- c) Signal light (red) and audible alarm to indicate alternate power isolating switch

The automatic transfer switch will furnish the following remote contacts:

- a) One normally closed contact for transfer switch connected to the normal source.
- b) One normally closed contact for transfer switch connected to the alternate source.
- c) One normally open and one normally closed contact for transfer switch isolating switch in the 'OFF' position.
- d) One normally closed contact to start alternate source generator in case of normal power failure. Signal to be interrupted if the isolation switch is in the 'OFF' position.

The automatic transfer switch will furnish the following time delays:

- a) One delay factory set to 3 seconds to delay power transfer and generator start signals.
- b) One unloaded generator delay factory set to 5 minutes to allow generator to cool down.
- c) One retransfer to normal power, delay factory set to 5 minutes with automatic bypass should the emergency power source fail.
- d) One electric motor start delay factory set to 2 seconds after power transfer to prevent current surges due to power source transfer.

The automatic transfer switch is to have a memory circuit to provide automatic starting of the electric motor if the motor was manually started or started by any means requiring manual shutdown.

- .8 Monitoring: Pilot lamp to indicate power available. Provide three (3) sets of normally open dry contacts for remote monitoring to indicate:
 - .1 Pump running;
 - .2 Loss of power;
 - .3 Phase reversal.
- .9 Provide a listed pressure recording device to sense and record the pressure in each fire pump sensing line at the input to the controller. The recorder is to be capable of operating for at least 7 days without being reset or rewound.

- .8 Pressure Switches and Flow Switches:
 - .1 Provide ULC approved Potter Electric pressure and flow switches with double sets of contacts in the mains where indicated on the drawings.
 - .2 Wiring for pressure and flow switches to be provided by Division 16.
 - .3 Other acceptable manufacturer: McDonnell & Miller.
- .9 Pressure Reducing Valves:
 - .1 Provide, where required, ULC and FM labelled pressure reducing valves (PRV) with adjustable spring range, sized to suit required flow and pressure differential, capable of maintaining differential pressure during both flow and static conditions.
 - .2 Provide all necessary trim: Downstream and upstream pressure gauges, isolation valves, by-pass valves, pressure relief valve on low pressure side to compensate for leakage across the PRV.
- .10 Booster Pump Test Connections:
 - .1 Provide in quantities and in locations as shown on the drawings National Fire Equipment Model 230 flush mounted chrome plated wall hydrants with escutcheons and stainless steel screws.
 - .2 Other acceptable manufacturers: CFH, Stelpro, Wilson and Cousins.
- .11 Backflow Prevention:
 - .1 Where standpipe and/or sprinkler systems are connected to a potable water supply, provide the following:
 - 1 A double check valve assembly to CSA B64.5 where no water treatment, antifreeze or other chemicals are used in the standpipe or sprinkler systems.
 - 2 A reduced pressure principle back flow preventer to CSA B64.4-M where chemicals, water treatment or antifreeze are used in the standpipe or sprinkler systems.

2.02 SPRINKLER SYSTEM AND STANDPIPE

- .1 Scope: Combination standpipe and wet sprinkler system for floors above grade; dry sprinkler system in underground parking areas; glycol solution wet dry sprinkler system in loading dock area and pre-action system for the elevator machine room.
- .2 Designs: Refer to the Drawings for Occupancy Classifications
 - .1 To earthquake zone requirements.
 - .2 Wet System: Ground floor and Mechanical Rooms; Ordinary Hazard Group II.
 - .3 Pre-action System, Elevator Machine Room: Ordinary Hazard Group II.
 - .4 Standpipe: 500 USGPM hose allowance.
 - .5 Dry system: unheated Parking Garage, Garbage Room, Moving Room, Ordinary Hazard Group II.

- .3 Sprinkler Heads: Rated to suit application, FM and ULC listed and labelled. Sprinkler heads to be as follows complete with Bellville seals. "O" ring seals are not acceptable.
- .1 Chrome plated pendant complete with CP escutcheon; Gem Type F980 (Bulb Type).
 - .2 Brass upright and pendant; Gem Type F950.
 - .3 Recessed chrome plated head and chrome plated cup; Gem Type F972 (Bulb Type).
 - .4 Concealed chrome-plated Gem Designer No. F976.
 - .5 Chrome plated horizontal sidewall with CP escutcheon; Gem Type F950/Q46.
 - .6 Brass pendant "Dry" Type: GEM issue 'C'.
 - .7 Sidewall; chrome-plated Gem F950/Q-48.
 - .8 Dry type sidewall; chrome-plated Gem F960/Q46.
 - .9 Dry type sidewall extended coverage, chrome-plated Gem F960/Q48.
 - .10 Dry type pendant; chrome-plated with escutcheon Gem F960.
 - .11 Window sprinkler heads Tyco WS-5.6.
 - .12 Provide wire guards for all sprinkler heads located in storage rooms, mechanical rooms, janitors' closets, stairwells, loading dock, and parking garage.
 - .13 FM and ULC listed and labelled sprinkler heads manufactured by Viking, Reliable, Star and Tyco will also be accepted.

Extended sprinkler heads are not allowed.

- .4 Flow Test: Perform all required flow tests and verify water supply as a basis for the sprinkler system design. Refer to Flow Test Certificate appended to the end of this Section. Co-ordinate with Authorities to determine permissible design allowance.
- .5 Alarm check and dry-pipe Valves: ULC labelled alarm check and dry-pipe valves with double sets of contacts, sized for the area they are to cover, and equipped with all necessary trim. Wiring of valves to the fire alarm system is specified in Division 16.
- .6 Spare Heads and Tools: Provide a kit mounted on the wall at the valve station consisting of labelled metal box, spare heads (approximately six (6)) and wrenches for emergency head replacement.
- .7 Water Motor Gong: Provide a labelled water motor gong piped on the interior of the building with the drain line piped to nearest open drain to work in conjunction with the appropriate fire alarm check valves.
- .8 Pre-action Systems: Provide pre-wired ULC labelled and listed pre-action valves. (Wiring by Division 16.)
- .9 Pressure Control Valves: Automatic balanced piston, adjustable spring loaded type, ULC labelled and listed National Fire Equipment Ltd. models A201 and A203 or acceptable alternative.

2.03 FIRE HYDRANTS AND VALVES

- .1 Provide all hydrants and valves to local Municipal requirements.
- .1 Compression type ULC and FM approved with 2 - 65mm (2 1/2") hose nozzles and a 100mm (4") steamer port with interior main valve 133mm (5 1/4") minimum diameter. End connections: 150mm (6") MJ, flanged, or ring-tite to suit supply pipe used. Hydrant to have safety flange and stem. Crane - McAvity model M-67.

- .2 Hydrant isolation valves: Crane "McAvity," to AWWA C509, 2006R flanged or with connections to suit supply piping 150mm (6") IBBM NRS type with 50mm (2") square operating nut with extension stem and McAvity adjustable sliding type valve box.
- .3 Water main gate valves: Iron body, inside screw, bronze trim, Underwriter's pattern Crane "McAvity" #6168-0 flanged or with connections to suit supply pipe being used and to be complete with McAvity adjustable sliding type valve box.
- .4 Post indicators, where shown on the Drawings: Crane McAvity model 6225, ULC and FM approved with type SS supervisory switch.

Wall Type; Crane 20060 with 6226 post and wheel operator.
- .5 Hydrants and valves as manufactured by Grinnell are also acceptable.

PART 3 - EXECUTION

3.01 SPRINKLER HEADS

- .1 Install and co-ordinate sprinkler head locations with the reflected ceiling plans and Architectural wall elevations and to ensure adequate coverage. Heads indicated on drawings are schematic, for purposes of indicating type of heads only.
- .2 Provide additional heads for mechanical rooms to accommodate ductworks.
- .3 Install chrome plated escutcheons for heads flush with wall and ceiling surface.
- .4 Install all piping to provide maximum headroom.
- .5 FM approved equipment are to be used and details of the installation to conform to FM Global recommended good practices and FM Global Data Sheet 2-8N.

3.02 DRAINS AND TEST RISERS

- .1 System drains and test connections: run to the nearest open drain in the building or to outdoors through wall away from paved areas. Seal and caulk around piping through wall and provide escutcheon and prime paint all metal surfaces exposed to outdoors. Run to the nearest janitors sink. Secure exposed piping with ring stays. Use copper piping only where exposed in the vicinity of the janitors sink.
- .2 Route PRV drain line on pressure reducing station into the inspectors test and drain line.
- .3 For standpipe system, provide a 75mm (3") permanently installed drain riser adjacent to each standpipe equipped with pressure regulating devices as per NFPA 14 Section 5-11. The riser to be equipped with 75mm (3") x 63mm (2.5") tee with an internal threaded swivel fitting having National Hose Standard threads, as specified in NFPA 1963, Standard for Fire Hose Connections, with a plug, located at least every other floor.
- .4 Run the base of the inspectors test and drain line and fire pump by-pass line into storm drain.
- .5 Provide drum drips on dry sprinkler system piping at low points and at any point where piping is trapped.

- .6 Provide 25mm (1") inspector's test connections at the end of the hydraulically most remote sprinkler lines for testing of the systems' alarm components. Test piping connections are to be piped to the nearest floor drain sized for full flow.
- .7 Provide a permanent placard attached to the automatic sprinkler risers indicating the hydraulic design of the installation. The information should include the design density, the demand area and the flow and pressure required at the base of the riser.

3.03 FIRE EXTINGUISHERS AND BLANKETS

- .1 Provide fire extinguishers for mechanical rooms, electrical rooms, storage rooms and garbage rooms.
- .2 Refer to drawings for location and types of extinguishers. Install brackets on firm backing to manufacturer's instruction. Install cabinets securely with flanges flush with finished wall surfaces.
- .3 Fire blankets to be wall mounted within easy access to hazard area.

3.04 HOSE CABINETS

- .1 Locate as shown on drawings with reference to Architectural wall elevations. Ensure valves are no greater than 1500mm (60") above finished floor or as required by Authorities. Also, confirm with Consultant.

3.05 VALVE STATION AND COMPRESSOR STATION

- .1 Arrange piping and equipment to provide adequate service accessibility and minimum space requirements.
- .2 Provide all electrically connected and supervised equipment and devices such as supervised valves, pressure switches, flow switches, alarm valves, pumps, and compressor, in locations as indicated on the drawings. Co-ordinate locations of these devices with Division 16.
- .3 Co-ordinate and co-operate with Division 16 regarding required interconnections for alarm points.

3.06 FIRE HYDRANTS AND EXTERIOR WORK

- .1 Bury all piping below the normal frost line. Refer to detail drawings.

3.07 BOOSTER AND EXCESS PRESSURE PUMPS

- .1 Install pumps in locations where they are readily accessible for maintenance and servicing. Refer to manufacturer's instructions and applicable codes for proper arrangement and connections. Mount the booster pump control panel as close as possible to the pump, but in a location providing at least 1m (3 ft.) clear space in front of the panel.
- .2 Provide the services of the pump manufacturer for field testing of the pumps, motors, and controllers.
- .3 Provide a full flow test and plot the actual pump performance curve. Comply with all other testing procedures as required by Authorities.

- .4 Perform all testing in the presence of the Authorities and the Consultant. Submit all test results to the Consultant.

3.08 ANCHORING

- .1 Provide joint anchors, thrust protection, etc. at all critical points in the piping systems throughout the building designed to withstand hydraulic shock and stresses produced by the pumping system. Submit anchor and thrust block design for review by the Consultant.

3.09 LABELLING

- .1 Refer to Section 15050 and comply therewith.
- .2 Label all sprinkler systems at the flow switch identifying the zone number. Co-ordinate zone numbers with Division 16 to match numbers on the fire alarm annunciator panel.
- .3 Label all sprinkler and standpipe zone and riser isolation valves. Mount design information near the labelling point or at base of riser in a glazed frame.
- .4 Label all piping throughout the building, i.e. "Sprinkler", "Inspector test".

3.10 PIPING

- .1 Wherever pipe routing is indicated, it is shown for the purposes of co-ordinating installation details. Co-ordinate work of this section with all affected trades.
- .2 Co-ordinate with Section 15180 and Division 16 Subtrades on all traced and insulated piping.
- .3 Where pressures exceed 865 kPa (125 psi), use ASTM A53 schedule 40 black steel pipe and 300 lb. threaded fittings or extra strong welded fittings.

3.11 WATER SUPPLY

- .1 Section 15500 Contractor is fully responsible for consulting with all Authorities, obtaining pertinent water flow and pressure test information together with any other additional information prior to submitted his bid. If current water flow information is not available the bidding subcontractor is required to arrange with the local authorities and do all necessary flow tests. All cost involved in obtaining this information is to be at the expenses of the bidding Section 15500 Contractor.
- .2 Refer to the architectural site plan drawings for the development of the exterior yard watermain distribution, etc.
- .3 No change to the Contract Price will be accepted due to a different water condition after a Contract has been awarded.

3.12 HYDRAULIC DESIGN

- .1 Sprinkler systems: Design to incorporate a booster pump system.
- .2 Limit pressure to fire hose cabinets to 448 kPa (65 psi) and 865 kPa (125 psi) to sprinkler system. Use approved pressure reducing valve stations as specified.
- .3 Perform a hydrant flow test to determine flow characteristics on the street watermain. Confirm with the Authorities the allowable flow test data to be used in the design calculations.

- .4 A minimum of 34.5 kPa (5 psi) pressure safety factor should be deducted from the water flow test results for the purposes of sprinkler and standpipe system design.

3.13 SPRINKLER ZONING

- .1 Generally provide sprinkler zoning as defined on the drawings and described herein:
- .2 Pre-action system: To include the entire elevator machine room, heads at the top of the shaft and in the shaft pit.

3.14 DRUM DRIPS

- .1 Provide drum drips on dry sprinkler system piping at low points and at any point where piping is trapped. Refer to detail Drawings.

3.15 TESTS

- .1 Cooperate and co-ordinate with Division 16 for all testing on zoning.
- .2 Pressure Tests:
 - .1 Sprinkler systems; to NFPA 13 requirements.
 - .2 Standpipe systems; for a period of two (2) hours without pressure loss at 345 kPa (gauge) higher than maximum service pressure, but not less than 1380 kPa (gauge).

3.16 TESTING AND VERIFICATION

- .1 Co-ordinate each test and provide at least two weeks advance notice to the Consultant and other inspection authorities. Inform the Consultant two weeks before testing, in writing, of special arrangements and co-ordination efforts necessary but not under his control.
- .2 Acceptance Testing of the Fire Protection System shall be in accordance with Authority requirements. The applicable Test Certificate(s) shall be completed at the time of testing and submitted as previously described.
- .3 Perform all tests in accordance with the Authorities' requirements, with N.F.P.A. standards, and Insurance Authority recommendations.
- .4 At the completion of the installation of all systems equipment and devices and when the system is fully operable, test and verify the entire system.
- .5 Notification of the Consultant and a demonstration of the proper functioning of the entire system is to be carried out after the testing and verification task is completed and all deficiencies are rectified.
- .6 The purpose of a verification procedure is to confirm that all equipment operates as intended. Upon completion of the verification procedures, a certificate of verification shall be given to the Consultant. A copy shall be kept with the system documentation. An equipment schedule listing each device and showing confirmation that it was verified, shall also be provided.
- .7 Certificate of verification is to be signed and sealed by a qualified engineer of the Contractor who witnessed the entire testing and verification procedure.

END OF SECTION 15500

PART 1 - GENERAL

1.01 DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Section 15010, Mechanical General Requirements and Section 15050, Mechanical Basic Materials and Methods.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Heating, cooling, refrigeration piping systems.
- .2 Supply and installation of boilers, pumps, convectors, chillers, cooling towers, condenser, tanks, coils, unit heaters, air handling units, heat exchangers and other heating/cooling systems piped components.

1.03 QUALITY ASSURANCE

- .1 .Qualifications: execute work of this section only by skilled tradesmen regularly employed on the installation of pressure piping systems and heating and cooling equipment.
- .2 All filters to be ULC labelled and listed for flame spread rating of less than 25 and smoke classification of less than 50.
- .3 Chillers to meet the energy efficiency requirement of CSA C743-02 Standard (latest edition). Other HVAC equipment to meet the performance standards of the Model National Energy Code of Canada for Buildings (latest edition) or ASHRAE 90.1-2001 whichever is more stringent.
- .4 Submittals: Submit shop drawings on boilers, cooling towers, heat exchangers, pumps, terminal heating equipment, coils, chiller, condenser, air handling units, refrigeration system. Provide fan curves for all air handling units.

PART 2 - PRODUCTS

2.01 CABINET HEATERS (HOT WATER)

- .1 Provide cabinet heaters in the configuration as shown on the Drawings and as detailed in the Equipment Schedules as follows:
 - .1 Casing - 16 gauge cold rolled steel with electrostatically applied and baked enamel with removable front panel and hinged access door with allen screw operated latch for electrical junction box , fan speed control switch and thermostat access.
 - .2 Coil - Aluminium fins mechanically bonded to 12mm (½") copper tube with galvanized steel casing and tested with air at 2065 kPa (300 psi).
 - .3 Fans - Double width, double inlet, direct driven, forward curved centrifugal, constructed of galvanized steel, balanced for vibration free operation with galvanized steel housings designed for efficient air flow.

- .4 Motor - Three speed, open type, resiliently mounted, with permanently lubricated bearings, internal overload protection, and permanent split capacitor.
 - .5 Switch - Factory installed and wired three speed type with "off" position.
 - .6 Thermostat - Unit mounted as described in the equipment schedules.
 - .7 Filters - 12mm (½") thick glass fibre disposable type in beverage board frames.
- .2 Units meeting the above requirement manufactured by Sterling, Trane, McQuay, Sigma, Rosemex and Dunham Bush will be accepted.

2.02 UNIT HEATERS (HOT WATER)

- .1 Hot Water Horizontal Type: Provide as shown on the Drawings and as described in the Equipment Schedules as follows:
- .1 Casing - 18 gauge cold rolled steel with electrostatically applied and baked enamel and with two 10mm (½") threaded hanger connections and individually adjustable four way louvred diffuser.
 - .2 Coil - Aluminium fins mechanically bonded to 12mm (½") copper tube with galvanized steel casing and tested with air at 2065 kPa (300 psi). Headers to be provided with steel MPT pipe connections.
 - .3 Fan - Propeller type, direct connected, dynamically balanced.
 - .4 Motor - Open type, resiliently mounted, with permanently lubricated bearings, internal overload protection, permanent split capacitor type with fan guard.
 - .5 Disconnect switch - Factory installed and wired.
 - .6 Thermostat - Remote type to cycle fan on/off- refer to equipment schedules.
- .2 Hot Water Vertical Type: Provide as shown on the Drawings and as described in the Equipment Schedules as follows:
- .1 Casing - 18 gauge cold rolled steel with electrostatically applied and baked enamel and with four 10mm (½") threaded hanger connections.
 - .2 Coil - Aluminium fins mechanically bonded to 15mm (5/8") copper tube with galvanized steel casing and tested with air at 2065 kPa (300 psi). Headers to be provided with steel MPT pipe connections.
 - .3 Fan - Propeller type, direct connected, dynamically balanced with fan guard.
 - .4 Motor - Open type, with permanently lubricated bearings, internal overload protection, permanent split capacitor type securely mounted in a vented steel well.
 - .5 Disconnect switch - Factory installed and wired.
 - .6 Thermostat - Remote type to cycle fan on/off- refer to equipment schedules.
 - .7 Diffuser - Adjustable cone type.
- .3 Units meeting the above requirement manufactured by Sterling, Trane, McQuay, Sigma, Rosemex and Dunham Bush will be accepted.

2.03 PUMPS AND CIRCULATORS

- .1 Provide pumps and circulators of type and size as indicated on the pump schedules.
- .1 All pumps - Equipped with mechanical seals, non-overloading (not including motor service factor) over entire performance curve and bronze fitted except where noted. Provide split coupling for pumps having a motor equal to or higher than 5.6 kw (7½ HP). All pumps to be complete with equally sized suction and

- discharge flanged connections, tapping for gauge, drain and flush line connections.
 - .2 Pumps for domestic hot water service - All bronze body or stainless steel.
 - .3 Base mounted pumps - complete with coupling guards. All vertical in-line and base mounted pumps with mechanical seals to be equipped with factory installed Micro- Wynd II Cuno filters and Arkon flow indicators.
 - .4 Provide an additional set of filters to replace original filters after system is cleaned and treated.
- .2 Variable Flow HVAC System Pumps:
- .1 HVAC Pumps are to be provided with Integrated Variable Frequency Drive and Controls.
 - .2 The variable frequency drive and controls are to be rated UL Type 12 and be an integral component of the pump.
 - .3 Integrated VFD shall have Sensorless control software to provide automatic speed control in variable volume systems without the need for pump mounted (internal/external) or remotely mounted differential pressure sensor.
 - .4 Integrated VFD Pumps shall be compatible with the Siemens FLN Protocol for direct peer-to-peer communications.
 - .5 Subject to the Engineers Approval, Non-Siemens FLN Protocol Integrated VFD Pumps will be considered, but must at a minimum include:
 - .1 Remote Start / Stop
 - .2 Remote Speed Reference Analog Input (-o-10VDC)
 - .3 Flow Rate Proportional Analog Output (0-10VDC)
 - .4 Alarm Contact Digital Output
 - .5 Remote Pump Rotation
 - .6 Automatic Lead Lag Fail-over
 - .7 Warning Contact Digital Output
 - .6 Acceptable manufacturers include: Grundfoss, Wilo, Armstrong or equivalent.
- .3 Sump pumps:
- .1 Submersible type - Units up to 372 watts (2 HP) to be c/w self-contained float controls. Larger pumps to be complete with separate float switches, mechanical alternators control panels c/w electric alternator, pilot lights, motor starters, relays and numbered terminal boards. Provide quick connect arrangement complete with rail guides and lifting cables.
 - .2 All sump pumps to be c/w sump frames and 10mm (d") thick steel covers unless specified otherwise. Refer to detail drawings for cover splitting arrangement for submersible pumps.
- .4 Packaged pressure booster: Factory assembled and tested centrifugal pump package complete requiring field connections only for piping and electrical power.
- .5 Control panel: Pre-wired with the following:
- .1 EEMAC-1 general purpose enclosure
 - .2 one main disconnect
 - .3 fused power supply for each pump
 - .4 magnetic starters with 3 leg OL protection
 - .5 selector switches (HOA) for each pump

- .6 pressure switches for low suction shut down and operating
 - .7 pressure gages for suction and discharge
 - .8 high pump casing temperature automatic relief (purge)
 - .9 minimum run time relays
 - .10 flow or load sensing for pump sequencing
 - .11 Pilot lights for power on, lead pump failure alarm, low suction pressure.
- .6 Valving and piping: Type K copper piping and headers with a pressure regulating valve on each pump discharge to provide constant pressure at variable flow sized to suit the application; check valves on each pump discharge; shut-off valves on each pump suction (upstream of strainer) and after each check valve; automatic thermal bleed on each pump for overheating protection on no flow. Provide an adjustable speed control in addition to the pilot PRV for reaction adjustment. Provide a suction and discharge manifold with flange connections.
- .7 Operation:
- .1 Flow or load sensing control to sequence pump operation in accordance with demand with lead pump on continuously; if a failure of one pump occurs, the next pump in sequence will operate.
 - .2 Provide a minimum of 5 step sequencing with a control sequence to measure the flow and determine optimum pump sequencing.
 - .3 Provide a thermal bleed circuit for pump over temperature protection.
 - .4 The booster pump package is to be completely run tested at the factory. Provide a complete operation flow test from zero to 100% design flow rate under the pressure as specified. All operations, safeties and starter functions to be checked. The manufacturer is to provide documentation indicating the pump package was factory tested.
 - .5 Refer to Equipment schedule for performance requirement.
- .8 Pumps as manufactured by S.A. Armstrong, Darling, PACO, Canada Pumps, Grundfos, Taco, Scarborough Pumps, Hydromatic and KSB, meeting all requirements are acceptable.

2.04 COOLING AND HEATING COILS

- .1 Water and DX Type: Provide cooling and heating coils as detailed on the coil schedule, A.R.I. rated and constructed of copper tubes and aluminium fins unless otherwise noted, and pressure tested for operation up to 1400 kPa (200 psi) for water coils. Pressure test refrigerant coils to 2067 kPa (300 psi). Refer to drawings for piping connections and dimensional data.
- .1 For direct expansion coils, provide full face alternate tube circuiting and expansion valves with external equalizers.
 - .2 Coils as manufactured by Trane, McQuay, Sheldons, York, Carrier and Aerofin are acceptable.
- .2 Electric duct coils: Chromalox with performance characteristics and features as listed in the Coil Schedule each completely pre-wired with:
- .1 Air pressure differential switch.
 - .2 Fused control circuit and transformer.

- .3 Single or multistage type contactors as indicated.
- .4 Over temperature protection.
- .5 Pre-wired terminals for connection of power and control circuits.
- .6 Incaloy sheathed elements.
- .7 Coils as manufactured by FPE are also acceptable.

2.05 AIR COOLED CONDENSERS

- .1 Provide air cooled condensers consisting of fans, controls and coils, with integral sub-cooling, supporting casing with stand, and vibration spring isolators.
 - .1 Coils - Aluminium plate fins on mechanically expanded copper tubes, cleaned, dehydrated, sealed, leak tested at 1000 kPa (150 psi), and pressure tested at 2900 kPa (420 psi).
 - .2 Fans - Direct drive, propeller type protected by guards.
 - .1 All motors - Permanent split capacitor type pre-lubricated, with built-in overload protection.
 - .2 Fan shaft - Corrosion protected.
 - .3 Fan blades - Iridite or aluminium finish.
 - .4 Magnetic contactors - Mounted and factory wired to power and control numbered terminals.
 - .5 Relays, contactors and controls - Mounted and factory wired to provide interlock with chiller control circuit. All fans to cycle to maintain constant head pressure down to 100C outdoor ambient.
 - .6 Casing - Weather Armor baked enamel finish. Provide access panels for electrical connections.
 - .7 Capacities and characteristics - As shown in the equipment schedules.
- .2 Other acceptable manufacturers: Trane, York, Dunham Bush, Carrier and McQuay.

2.06 AIR COOLED CONDENSING UNITS

- .1 Provide air cooled condensing units consisting of fans, controls and coils, with integral sub-cooling, supporting casing with stand, and vibration spring isolators.
 - .1 Coils - Aluminium plate fins on mechanically expanded copper tubes, cleaned, dehydrated, sealed, leak tested at 1000 kPa (150 psi), and pressure tested at 2900 kPa (420 psi).
 - .2 Fans - Direct drive, propeller type protected by guards.
 - .3 Fan motors - Permanent split capacitor type pre-lubricated, with built-in overload protection.
 - .4 Fan Shaft - Corrosion protected.
 - .5 Fan blades - Iridite or aluminium finish.
 - .6 Relays, Contactors and Controls - Mounted and factory wired to provide interlock with indoor air supply fan control circuit. All fans to cycle to maintain constant head pressure down to 100C outdoor ambient. Provide low ambient head pressure control as indicated in equipment schedules.
 - .7 Casing - Weather Armor baked enamel finish. Provide access panels for electrical connections.
 - .8 Construction - To ASME code, ARI standard 590-69, and CSA requirements (CSA labelled).
 - .9 Compressors - Complete with oil pump, suction and discharge valves, individual spring vibration isolators, thermally protected motors, crank case heater,

operating oil charge; extended parts and labour warranty for four (4) years. Reciprocating, scroll or screw type compressors are acceptable. Compressors up to and including 15 tons capacity may be hermetic sealed unserviceable type. Compressors 20 tons capacity and greater to be semi hermetic serviceable.

- .10 Overcurrent Protection - Factory installed circuit breakers calibrated manual reset, ambient insensitive, to open all 3 phases if overloaded on any one phase.
- .11 Refrigeration Circuits - Discharge line check valves (on combined circuits), combination moisture indicator and sight glass, filter/driers, charging valves, suction lines insulated with closed-cell Armaflex (20mm thick min.) on individual circuits. Provide discharge, suction and oil pressure gauges on compressors 20 tons capacity and greater.
- .12 Capacity Control - Multiple-step compressor cylinder unloading to provide compressor sequenced starting and loading. Provide hot gas by-pass where indicated on the equipment schedules - on restart unit to revert to lowest stage of capacity.
- .13 Safety and Operating Controls - Pre-wired and pre-piped motor contactors, high and low pressure cut-outs, oil failure, cut-out, start-stop switches, control power circuit breakers and manual lead-lag switch for compressors.
- .14 Electrical Connections - Power connections to unit manufacturer supplied lugs at one point only. Control connections to unit manufacturer supplied numbered terminal board.
- .15 Capacities and Characteristics - As shown in the equipment schedules.

- .2 Acceptable Manufacturers: Trane, York, Carrier, Dunham Bush and McQuay.

2.07 CENTRIFUGAL CHILLERS

- .1 Provide, as shown on the drawings, completely factory assembled water-cooled magnetic bearing frictionless chiller. Units shall be McQuay, Carrier or York and shall be in accordance with the latest AHRI standard 550, ANSI/ASHRAE15, CSA B52, ASME, Canadian UL listed and as follows:

- .1 Compressor And Motor – Frictionless Chiller

- .1 The unit shall utilize oil-free, magnetic bearing, semi-hermetic centrifugal compressors. Impellers shall be mounted on a single shaft, levitated during rotation by a digitally controlled, magnetic bearing system consisting of two radial and one axial magnetic bearing.
- .2 The motor shall be liquid refrigerant cooled with internal thermal sensing devices in the stator windings.
- .3 The chiller shall be equipped with an integrated Variable Frequency Drive (VFD) to automatically regulate compressor speed in response to cooling load and the compressor pressure lift requirement. Movable inlet guide vanes and variable compressor speed, shall provide unloading. The chiller controls shall coordinate compressor speed and guide vane position to optimize chiller efficiency.
- .4 Each compressor circuit shall be equipped with a line reactor to help protect against incoming power surges and help reduce harmonic distortion.
- .5 On dual compressor units, the evaporator and condenser refrigerant sides, and the expansion valve shall be common. The chiller shall be capable of running on one compressor with the other compressor or any of its auxiliaries inoperable or removed.

.2 Evaporator And Condenser

- .1 Evaporator and condenser shall be shell and tube, cleanable type with integrally finned copper tubes. Evaporator tubes shall be .025" thick. Condenser tubes shall be .025" thick. Water heads shall be removable and have Victalic connections. Provide vent and drain taps, liquid shut-off valve, purge valve and reseatable spring-loaded relief valves. Provide refrigerant and waterside constructed and stamped in accordance with ASME Requirements. Provide CRN numbers on each shell.
- .2 Provide an electronic or thermal expansion valve to meter refrigerant flow and to provide stable operation at low loads. Superheat shall be maintained at or below 1°F under all load conditions.
- .3 Complete evaporator water circuit shall be rated at 150 PSIG. Complete condenser water circuit shall be rated at 150 PSI.
- .4 Provide thermal dispersion flow switches for the chilled water and condenser water circuits.

.3 Sound

- .1 Do not exceed sound pressure levels as indicated below. All sound testing must be in accordance with ARI Standard 575 "Method of Measuring Machinery Sound Within Equipment Rooms".
 - .1 Octave Band
25 250 500 1000 2000 4000 8000 dba
46 55.5 65.5 70.5 74.5 76.0 80.0 74.5 83.5

.4 Control Panel

- .1 Provide a unit mounted, factory prewired DDC microprocessor based control system with super VGA colour monitor with touch screen data entry. Control system shall have all necessary temperature and pressure sensors factory mounted and wired. Temperature sensors shall be mounted in factory installed wells. Password security shall prevent access by unauthorized personnel.
- .2 The following operating data shall be displayed.
 - .1 Entering and leaving, chilled and condenser water temperatures.
 - .2 Evaporator, suction, discharge, condensing and liquid refrigerant temperatures.
 - .3 Evaporator, condenser and lift pressure.
 - .4 Actual motor amps and motor amps as a percent of RLA.
 - .5 Oil feed and sump temperature. Oil pressure (N/A with magnetic bearing machine)
 - .6 Total hours of operation and number of starts.
 - .7 Hours since last start.
 - .8 Unit Status including Start-up and shut-down sequence, and Operational status.
 - .9 Ent. water reset Off/On.
 - .10 Remote reset Off/On.
 - .11 Soft loading Off/On (N/A with magnetic bearing machine)
 - .12 Low pressure unloading Off/On.
 - .13 Max. AMP limit Off/On.
 - .14 Remote AMP limit Off/On.

- .15 .Manual AMP limit.
- .16 .Leaving evaporator setpoint.
- .17 .Reset leaving setpoint.
- .18 .Remote reset signal.
- .19 .Fault history (last 25 faults) with time and related operating conditions.
- .20 Critical sensor values at time of fault.
- .21 Trend log data in graphic format.
- .3 The following alarm conditions shall be monitored and displayed:
 - .1 No starter transition.
 - .2 Low/High oil sump temperature (N/A with magnetic bearing machine)
 - .3 Low evaporator pressure.
 - .4 High discharge pressure/temperature.
 - .5 Compressor surge.
 - .6 Low refrigerant charge.
 - .7 No evp/cds flow.
 - .8 Low oil pressure. (N/A with magnetic bearing machine)
 - .9 High motor current.
 - .10 Sensor failure.
- .4 The microprocessor shall employ P.I. control algorithms to ensure precise leaving water temperature control without hunting, drooping or overshooting the setpoint.
- .5 The microprocessor shall have the option of limiting the amp draw to a user- selected value from 30 to 100% of rated load amps. The controller shall use a softload function to prevent the chiller from operating at full load during initial pull down.
- .6 The microprocessor shall have the option of resetting the chilled water setpoint and demand limiting from 4-20mA remote signals. In addition, the chilled water setpoint shall be resettable by return water temperature if so programmed. The control panel shall be capable starting the chiller from a remote signal.
- .7 The microprocessor shall include Surge Guard protection. Upon recognition of a surge situation the controller shall shutdown the chiller and announce an alarm condition.
- .8 Chiller plant optimization software for up to 2 chillers shall also be included to provide automatic control of: evaporator and condenser pumps (primary and standby), up to 3 stages of cooling tower fans and a cooling tower modulating bypass valve and/or cooling tower fan variable frequency drives. There shall be five possible tower control strategies:
 - .1 Tower fan staging only – up to 3 stages controlled by either the entering condenser water temperature or lift differential temperature between the condenser and evaporator saturated temperatures.
 - .2 Tower fan staging plus low limit - controlled as in # 1 plus tower bypass valve set at a minimum entering condenser water temperature
 - .3 Tower staging with staged bypass control – similar to # 2 with additional control of the bypass valve between fan staging to smooth control and minimize fan staging.
 - .4 VFD staging only – in this mode, a variable speed drive controls the first fan with up to 3 more fans to be staged on and off and there is no bypass valve.

- .5 VFD and Valve Staging – same as # 4 plus bypass valve control.
- .9 The microprocessor shall include a time clock for chiller operation including programmable holiday schedule to override weekly schedule. Provide manual override time period.
- .10 Provide for auto-restart after a power failure. Microprocessor memory shall be non-volatile requiring no battery back-up while maintaining programmed data during an extended shut down or power failure.
- .11 Input/Output boards shall be optically isolated to prevent transients or incorrect voltage from entering the microprocessors. All field wiring shall terminate at a separate terminal strip.
- .12 The microprocessor shall have an auto-logging feature that will automatically log chiller functions at time of daily peak load or at present time and store up to six weeks of accumulated data. Data shall be downloadable via on board floppy drive.
- .13 The microprocessor shall have pre-alarm logic for high and low pressure controls. Logic shall take corrective action to avoid an alarm trip. The unit shall display pre-alarm warnings for low and high superheat, low oil temperature and high oil temperature.
- .14 The microprocessor shall inhibit loading and activate unloading to control low evaporator pressure conditions.
- .15 The centrifugal chiller shall be factory installed with a microprocessor based DDC controller capable of communications with Building Automation System or Temperature Control Company via LonMark, BACnet MS/TP, BACnet IP or Modbus protocols.

.5 Starters

- .1 Provide a motor protection system with solid-state overload protection, phase loss, phase reversal, phase unbalance, under and over voltage protection. System shall provide an alarm indicating impending trip. Provide factory installed surge capacitor wired to the motor circuit.
- .2 If the specified motor locked rotor and/or full load amps are exceeded, the chiller manufacturer must pay the additional costs associated with increases in wire sizes, conduit sizes, transformer sizes, disconnect sizes and the additional labour necessary to accommodate these changes.
- .3 Provide the starter with the following factory installed and wired accessories:
 - .1 Nonfused disconnect switch.
 - .2 Molded case circuit breaker sized for not less than 1.2 times the machine's FLA rating.
 - .3 Ammeter display.
 - .4 Full metering display of Amps and Volts.
 - .5 Ground Fault protection.
 - .6 Power Factor correction capacitors to correct full load power factor to not less than 0.95. (not applicable to magnetic bearing chillers)

.6 Auto Translineator

- .1 General:

- .1 All PWM AC Variable Frequency Centrifugal Chiller Drives shall be equipped with AutoTranslineator harmonic mitigation equipment to prevent power system problems resulting from high levels of harmonic distortion.
 - .2 The AutoTranslineator and all of its components shall be manufactured and tested in accordance with the latest applicable standards of UL, CSA and NEMA.
 - .3 Demonstration of compatibility between the AutoTranslineator and the Centrifugal Chiller VFD must be available upon request.
 - .4 The AutoTranslineator shall be warranted to be free of defects in materials and workmanship for a period of 3 years from the date of shipment.
 - .5 Factory Performance Testing: Manufacturer must be capable of factory testing for AutoTranslineator performance and energy efficiency under actual variable frequency drive loads. A detailed description of the program and a sample test report must be provided at time of quotation.
 - .6 Subject to compliance with all of the contract documents and specifications, the acceptable product and manufacturer is: ATL™ AUHF, by MIRUS International Inc. (905) 565-6900, Toll Free: (888) 866-4787
- .2 Product Requirements:
- .1 The Auto Translineator shall treat all of the characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.).
 - .2 The characteristic harmonics shall be suppressed without the need for individual tuning or the requirement to phase shift against other harmonic sources.
 - .3 Harmonic mitigation shall be by passive inductor/capacitor network. Active electronic components shall not be used.
 - .4 Power factor shall be .98 lagging to .95 leading in operating range from full to half load.
 - .5 To ensure compatibility with engine generators, the AutoTranslineator must never introduce a capacitive reactive power (KVAR), which is greater than 15% of its kVA rating.
 - .6 The AutoTranslineator shall not resonate with system impedances or attract harmonic currents from other harmonic sources.
 - .7 The AutoTranslineator in combination with the Centrifugal Chiller Variable Frequency Drive shall meet all requirements as outlined in the 1992 edition of IEEE std 519 for individual and total harmonic voltage and current distortion. The Point of Common Coupling (PCC) for all voltage and current harmonic calculations and measurements shall be the input terminals to the harmonic mitigation equipment.
 - .8 Total Harmonic Voltage Distortion (THVD) shall meet the requirements of Table 10.2 of IEEE std 519 by not exceeding 5% and by limiting the individual harmonic voltage distortion to less than 3%. These limits shall apply while operating on either utility supply or generator supply when applicable. The

- AutoTranslineator vendor shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.
- .9 Total Demand Distortion (TDD) of the current at the input terminals of the AutoTranslineator shall not exceed the limits as defined in Table 10.3 of IEEE std 519. For I_{sc}/I_L ratio < 20, TDD must be less than 5%. For all other I_{sc}/I_L ratios, the TDD must not exceed 8% even when Table 10.3 allows for more relaxed limits.
 - .10 The full load efficiency of the AutoTranslineator / Centrifugal Chiller VFD combination shall be greater than 95%. The AutoTranslineator itself shall have efficiency no less than 98%.
 - .11 All wiring shall be copper.
 - .12 Insulation class: 220°C system. Temperature rise: 130°C
 - .13 Anti-vibration pads shall be used between the reactor or transformer core and the enclosure.
 - .14 Ventilated, sprinkler proof NEMA-3R enclosure.
 - .15 The AutoTranslineator must be capable of stepping voltage up or down as required by the installation.
 - .16 Submit for approval before shipment certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.
- .3 Installation:
- .1 The Auto Translineator shall be handled, stored and installed in accordance with the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual. Installation shall comply with all applicable codes.
 - .2 Harmonic compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the input terminals of the harmonic mitigating equipment with and without the equipment operating. A recording type Fluke 41 or equivalent harmonics analyzer displaying individual and total harmonic currents and voltages must be utilized.
- .7 Pumpout System
- .1 The chiller shall come complete with an internal pumpout system allowing the entire refrigerant charge to be held in the condenser at 90F. The system shall include tight seating isolation valves at the entrance and exit. Where the manufacturer cannot pump the refrigerant into the condenser, a remote ASME rated storage vessel and pumpout system shall be provided.
- .8 Refrigerant Alarm Panels
- .1 The refrigerant monitoring system shall be comprised of three main components: one main control panel, a minimum of one remote alarm panel, and a minimum of one remote alarm sensor. The main panel shall be located inside the machinery room near the main entrance. The

- remote panel(s) shall be located outside of each entranceway to the machinery room.
- .2 Alarm panels shall be equipped with a visual flashing amber beacon, audible buzzer and a user interface touch screen display. The display on the main panel shall have a full color 6 inch screen. Remote panels shall be complete with a monochrome 4 inch display. Keypad menu entry touch keys shall also be provided for quick access to panel configuration settings and also to silence audible alarms.
- .1 The following menus shall be accessible via the touch screen displays:
1. System configuration
 2. Diagnostic information
 3. Alarm setup
 4. Sensor setup
 5. System test
- .3 The monitoring panel shall allow for two alarm settings. A low level alarm shall warn (flashing yellow screen) that refrigerant gas has been detected but the room is still at a safe level. The screen shall display the gas ppm concentration. A high level alarm shall automatically activate audio / visual alarms, and initiate mechanical ventilation. Three high level alarm relays shall be provided for customer interlocks; boiler alarm, fan relay and chiller relay.
- .4 All panels shall also include Ventilation ON and Chiller OFF switches. Switches shall be password protected on all remote panels.
- .5 The refrigerant sensor shall use non-dispersive infrared technology to selectively target the refrigerant gas. Sensor shall continuously monitor the air and must send a signal proportional to the refrigerant ppm concentration, back to the main control panel. Sensor shall have a life expectancy of 10 years.
- .6 Control panel relay outputs shall be configurable for Failsafe or Non-Failsafe modes of operation
- .7 The master panel shall be powered from a 120 volt circuit. The remote panel and refrigerant sensors shall be powered through this master panel.
- .8 Provide refrigerant sensors mounted in close proximity to the chillers and wired to the master panel. The refrigerant sensor shall be calibrated to detect refrigerant levels equal to or less than the TLV-TWA for the refrigerant used. The alarm system shall be activated when the refrigerant concentration in the MER equals the TLV-TWA for the refrigerant used.
- .9 The HTS Refrigerant monitoring system shall meet the requirements of CSA - B52 Mechanical Refrigeration Safety Code (latest version).
- .10 Provide a calibration kit. Include one cylinder of calibrated refrigerant gas for each refrigerant used in this installation.
- .9 Startup Service And Warranty
- .1 Manufacturer shall furnish a factory trained service technician to perform the leak testing, evacuation, dehydration, charging and startup of the unit. Units that are factory charged or shipped with a refrigerant holding charge shall not require field evacuation and dehydration. Manufacturer shall provide instruction of the owner's personnel on the operation and maintenance of the unit.

- .2 Warranty: The warranty period starts on the date of acceptance by the Consultant and shall continue for a period of one (1) year. Manufacturer's warranty shall include all parts and labour to install parts. Refer to Section 15010.

2.08 SCROLL CHILLERS

- .1 Provide, as shown on the drawings, completely factory assembled scroll compressor chiller.
- .2 Unit shall meet the performance detailed in the schedule. Construction and ratings shall be in accordance with latest ARI Standard 550/590, ANSI/ASHRAE 15, CSA-B52 and ASME Code.
- .3 Equipment shall meet efficiency standards of ASHRAE Standard 90.1
- .4 The unit shall be completely factory assembled on a rugged steel base and shall be shipped with a full operating charge of R410A refrigerant.
- .5 Spring vibration isolators shall be factory supplied for field installation.
- .6 Units shall be McQuay, Carrier or York and shall be Canadian UL listed and as follows:
 - .1 Compressors
 - .1 The compressors shall be sealed hermetic scroll type with crankcase oil heater and suction strainer. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on RIS vibration isolator pads.
 - .2 Evaporator
 - .1 Units from 135 to 200 tons shall be shell-and-tube type construction, insulated with 3/4 inch (19mm) closed cell polyurethane insulation, and rated for 150 psi (1033kPa) water-side working pressure.
 - .2 Provide a chilled water flow switch to be field mounted in the chilled water line and field wired to terminals in the control panel.
 - .3 Condenser
 - .1 Condenser shall be a steel shell with integral finned copper tubes rolled into steel tube sheets. The chiller shall be equipped with intermediate tube supports.
 - .2 It shall be designed for 232 psi (1599 kPa) water side working pressure and 450 psig (3104 kPa) refrigerant side pressure and be provided with ASME, ANSI B9.1 pressure relief valves.
 - .4 Refrigerant Circuit
 - .1 Each refrigerant circuit shall be completely independent and shall include a liquid line shutoff valve, replaceable core or sealed filter-drier, sight

glass with moisture indicator, liquid line solenoid valve, thermal expansion valve, and insulated suction line.

.5 Controls

- .1 The control panel shall contain a microprocessor controller providing operating and equipment protection controls, plus motor starting equipment. Controller shall be factory wired, operationally tested, and ready for operation. Standard components shall include a control transformer with primary and secondary fusing, microprocessor transformers with integral fusing, compressor contactors, circuit breakers, single-point wiring arrangement and switches for each circuit pump down and unit control power.
- .2 The control system shall stage the compressors based on the leaving water temperature.
- .3 Equipment protection devices include motor protection, high pressure, loss of refrigerant, loss of water flow, freeze protection, and low refrigerant pressure. Controls shall include auto/stop switch, chilled water set point adjustment, anti-recycle timer, and digital display with water temperature and set point, operating temperatures and pressures, and diagnostic messages.
- .4 The keypad/display shall provide access to all vital equipment data. Data shall include full description of current unit status, setpoint parameters, and alarms. Data shall be displayed in clear, precise English text with either English or metric units. Programmable security password protection shall be provided.
- .5 Control system shall monitor all system temperatures, pressures and safeties, and shall automatically shut down a refrigerant circuit or entire unit should a fault occur. All fault conditions shall be automatically time and date stamped, retained in memory and shall be available for display.
- .6 The DDC controller shall be equipped with a timeclock to allow the user to program a yearly schedule for weekday, weekend, and up to 14 separate holidays. The control system shall have auto-restart after power failure and NOT require battery back-up or auxiliary power supply for maintaining program memory. The microprocessor shall have a lithium battery timeclock to automatically ensure correct time of day input after power failure. Once power is restored, the controller shall check for any other faults and if none are present, shall permit normal unit operation.
- .7 Microprocessor shall accept a 4-20 mA DC for resetting chilled water temperature.
- .8 The microprocessor shall incorporate two short cycle time functions: start to start; and stop to start. These shall be specially programmed to provide the least amount of time off line while providing the maximum compressor motor protection.
- .9 During part load operation, the controller shall unload alternately between refrigeration circuits to maximize efficiency. On unit start-up, the microprocessor shall limit the rate at which chilled water loop temperature is pulled down. The pulldown rate shall be adjustable.
- .10 Controller shall provide output contact closure for control of chilled water and condenser water pump.
- .11 The chiller shall be factory installed with a microprocessor based DDC controller capable of communications with any Building Automation System supporting BACnet, Modbus and LONMark communications

protocol. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation.

.6 Electrical

- .1 Field power connection, control interlock terminals and unit control system shall be centrally located. Panel access door shall key lock to prevent unauthorized access. Dead front panel shall protect service personnel against accidental contact with line voltage components.
- .2 Chiller shall be supplied with factory installed non fused disconnect.

.7 STARTUP SERVICE AND WARRANTY

- .1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction of the owner's personnel on the operation and maintenance of the unit.
- .2 Warranty: The warranty period starts on the date of acceptance by the Consultant and shall continue for a period of one (1) year. Manufacturer's warranty shall include all parts and labour to install parts. Refer to Section 15010.

2.09 COOLING TOWERS (INDUCED DRAFT VERTICAL DISCHARGE)

- .1 Provide, as shown on the drawings and as described in the equipment schedules, induced draft counterflow, axial fan, open cooling towers with vertical air discharge, conforming in all aspects to the specifications.

.1 Thermal Capacity:

- .1 The thermal performance shall be certified by the Cooling Technology Institute in accordance with CTI Certification Standard STD-201. Manufacturers' performance guarantees or performance bonds without CTI Certification or independent field thermal performance test shall not be accepted. The cooling tower shall comply with the energy efficiency requirements of ASHRAE Standard 90.1.

.2 Quality Assurance:

- .1 The manufacturer shall have a Management System certified by an accredited registrar as complying with the requirements of ISO-9001 to ensure consistent quality of products and services. Manufacturers that are not ISO-9001 certified shall not be acceptable.

.3 Start-up service and warranty:

- .1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction of the owner's personnel on the operation and maintenance of the unit. The warranty period starts on the date of acceptance by the Consultant and shall continue for a period of one (1) year. Manufacturer's warranty shall include all parts and labour to install parts. Refer to Section 15010.

.4 Construction Details

- .1 Casing

- .1 Corrosion Resistant Standard Construction: All steel panels and structural members shall be constructed of heavy-gauge G-235 (Z700 metric) hot-dip galvanized steel with all edges given a protective coating of zinc-rich compound.
- .2 Cold Water Basin
 - .1 The cold water basin shall be constructed of heavy-gauge G-235 (Z700 metric) hot-dip galvanized steel panels and structural members. Standard basin accessories shall include: a corrosion resistant make-up valve with large diameter polystyrene filled plastic float for easy adjustment of the operating water level, removable anti-vortexing device to prevent air entrainment, and large area lift out strainers with perforated openings sized smaller than the water distribution system nozzles.
- .3 Air Inlet Louver Screens:
 - .1 All louvers shall be constructed from PVC. Louver sections shall be individually removable in 12" wide (maximum) sections, allowing for quick and easy access to any part of the cold water basin without the need for tools. Louvers shall prevent debris from entering the cold water basin as well as preventing splash out. Louvers which are greater than 12" wide or require tools for removal shall not be an acceptable alternate.
 - .2 Rigging: The cooling tower shall be designed and constructed to withstand rigging of the casing and cold water basin as a single piece.
 - .3 Casing Field Joint: The heat transfer section shall be joined to the lower section without the use of a gasket or sealer. The field joint shall be self aligning and require a minimum number of fasteners.
 - .4 Heat Transfer Section: The heat transfer section shall consist of fill, spray water distribution system and drift eliminators arranged for optimal thermal performance with minimal drift.
 - .5 Fill: The fill shall be formed from self-extinguishing polyvinyl chloride (PVC) having a flame spread rating of 25 per ASTM E84 and shall be impervious to rot, decay, and fungus or biological attack. The fill shall be suitable for use as a working platform, and shall be provided and performance tested by the cooling tower manufacturer to assure single source responsibility and control of the final product. The fill shall be able to withstand a water temperature of 140°F.
- .4 Water Distribution System:
 - .1 Water shall be distributed evenly over the fill by a water distribution system consisting of a header and spray branches of Schedule 40 PVC pipe with large orifice, non-clog plastic distribution nozzles. The headers shall have a removable cap facilitating quick header cleanout without removal. The spray nozzles shall be held in place by snap-in rubber grommets and the branches should be removable without tools or removal of branch supports, allowing quick removal of individual nozzles or complete branches for cleaning or flushing. Branches that require tools for removal or removal of branch supports shall not be an acceptable alternative.

- .5 Drift Eliminators:
 - .1 Eliminators shall be constructed of specially formulated PVC and be removable in easily handled sections. They shall have a minimum of three changes in air direction.
- .6 Mechanical Equipment
 - .1 Fan:
 - 1. Fan shall be Low Sound Type axial flow with corrosion resistant blades selected to provide optimum cooling tower thermal performance with minimal sound levels. Air shall discharge through a fan cylinder designed for streamlined air entry and minimum tip clearance for maximum fan efficiency. The top of the fan cylinder shall be equipped with a conical, non-sagging removable fan guard. The fan and fan drive system, including the fan motor, shall be factory test-mounted and aligned to ensure reliable operation and ease of maintenance.
 - .2 Fan Motor:
 - 1. Provide one 575/60/3 TEFC inverter duty, Cooling Tower Duty fan motor.
 - .3 Bearings:
 - 1. Fan and shaft shall be supported by heavy-duty, self-aligning, grease packed ball bearings with moisture proof seals and integral slinger collars, designed for L-10 80k Life. Extended bearing lube lines shall be terminated at the access door for ease of maintenance, and shall require opening the access door to insure proper lubrication.
 - .4 Fan Drive:
 - 1. The fan shall be driven by a one-piece, multi-groove, solid back V- type powerband with taper lock sheaves designed for 150% of the motor nameplate horsepower. The powerband shall be constructed of neoprene reinforced polyester cord and be specifically designed for cooling tower service.
 - .5 Sheaves:
 - 1. Fan and motor sheave shall be fabricated from corrosion-resistant materials to minimize maintenance and ensure maximum drive and powerband operating life.
- .7 Access
 - .1 Tower Access:
 - 1. Permanently mounted, inward sliding access doors are provided for safe and easy access to the spray branch and fan drive system for routine maintenance. Removable access doors are not acceptable.
- .8 Accessories
 - .1 Basin Heater:
 - 1. The cooling tower cold water basin shall be provided one (1) electric heater to prevent freezing in low ambient conditions. The heater shall be selected to maintain 40°F

- basin water temperatures at -20° F ambient. The heater shall be 575/60/3 electric and shall be provided with low water cutout and thermostat.
- .2 Basin Water Level Control:
 - 1. The cooling tower manufacturer shall provide an electric water level control (EWLC) system. The system shall consist of water level sensing and control units in quantities and locations as indicated on the drawings. Each water level sensing and control unit shall consist of the following: NEMA 4 enclosure with gasketed access cover; solid state controls including all necessary relays and contacts to achieve the specified sequence of operation; stainless steel water level sensing electrodes with brass holder; Schedule 40 PVC standpipe assembly with vent holes, and all necessary stainless steel mounting hardware. Provide PVC union directly below the control enclosure to facilitate the removal and access of electrodes and control enclosure.
 - 2. The number and position of water level sensing electrodes shall be provided to also sense the following: heater low level safety cutout.
 - .3 Vibration Cutout Switch:
 - 1. Provide mechanical local reset vibration switch. The mechanical vibration cut out switch will be guaranteed to trip at a point so as not to cause damage to the cooling tower. To ensure this, the trip point will be a frequency range of 0 to 3,600 RPM and a trip point of 0.2 to 2.0 g's.
 - .4 External Access – Access Door Platform:
 - 1. An external galvanized steel access platform at the access door of the unit provides access to the spray distribution system. An aluminum ladder with a steel safety cage and 1-1/4" galvanized steel pipe safety railing is included with the platform. Field installation is by others. This option meets pertinent OSHA standards. Provide a self- closing gate.
 - .5 Variable Frequency Drive:
 - 1. Provide a VFD for the fan motor in a NEMA1 enclosure.
 - .6 Starter Panel:
 - 1. Provide a starter panel in a NEMA 1 enclosure for the pan heater. Include a disconnect switch and fuses, off-auto selector switch, H-O- A selector switch for the EWLC, pilot lights, fused transformer and numbered wiring.
 - .7 Performance:
 - 1. Refer to equipment schedules.
 - .8 Equipment as manufactured by Baltimore Air Coil and Marley are acceptable.

2.10 BOILERS – CONDENSING TYPE

- .1 Provide natural gas fired condensing boilers as manufactured by Lochinvar Crest model with capacities and characteristics as indicated in the equipment schedules.

- .2 The boiler shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard. The boiler shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 standard and the minimum efficiency requirements of the latest edition of the ASHRAE 103 Standard. The boiler shall operate at a minimum of 92% thermal efficiency at full fire as registered with AHRI. All models shall operate up to 99% thermal efficiency with return water temperatures at 90°F or below. The boiler shall be certified for indoor installation.
- .3 The boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides.
- .4 The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided.
- .5 The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The boiler shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency.
- .6 The boiler shall operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by spark ignition with flame monitoring via a flame sensor.
- .7 Controls:
 - .1 The boiler shall utilize a 24 VAC control circuit and components. The control system shall have a Liquid Crystal touch screen display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front of the jacket. The boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 50 psi (standard); outlet water temperature sensor; return water temperature sensor; outdoor air sensor, flue temperature sensor; high and low gas pressure switches, low water cut off with manual reset and a condensate trap for the heat exchanger condensate drain.
 - .2 The boiler shall feature the "SMART TOUCH™" control with a Liquid Crystal touch screen display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, domestic hot water prioritization and PC port connection. The boiler shall have alarm contacts for any failures, runtime contacts and data logging of runtime, ignition attempts and ignition failures. The boiler shall allow 0-10 VDC input connection for BMS control and have built-in "Cascade" to sequence and rotate while maintaining modulation of up to eight boilers without utilization of an external controller. The control may be compatible with optional Modbus communication.
 - .3 The boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 30 data points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Louver Proving Switch, Tank Thermostat, Remote Enable/Disable (Wall Thermostat/Zone Control), System Supply Sensor, Outdoor Sensor, Tank Sensor, Modbus Building Management System signal and Cascade control circuit. A high voltage terminal strip shall be provided for Supply voltage.

- .8 Venting Options - The following venting options shall be utilized:
 - .1 Standard venting
 - .2 Horizontal and vertical outside air venting
 - .3 Through-wall venting
 - .4 Outdoor venting
 - .5 Direct venting
- .9 Refer to Section 15800 for exhaust vent and air intake requirements.
- .10 Acceptable alternate manufacturer: Camus, Laars Rheos.

2.11 HEAT EXCHANGER - PLATE TYPE

- .1 Provide plate type expandable/cleanable heat exchangers with capacities and characteristics as indicated in the equipment schedules.
- .2 Plate and frame construction capable of operating up to of 2415 kPa (350 psi) and a maximum temperature of 98.0 deg C meeting ASME and other local codes.
- .3 Frame: Painted carbon steel, with chrome plated carbon steel guide bars, zinc plated carbon steel tie bolts and epoxy coated with ANSI 300 flanges.
- .4 Plates: 304 stainless steel with Nitrile gaskets.
- .5 Integral Filter Baskets: Material AISI 316 stainless steel, 2.4mm (3/32") mesh size. Filter must be accessible without removing piping.
- .6 Acceptable manufacturers: Tranter, Alpha-Laval, Nixon Plate Coils, SA Armstrong, ITT.

2.12 HEAT RECOVERY AIR HANDLING UNITS (FACTORY FABRICATED MODULAR)

- .1 Provide in the arrangements and types as shown on the drawings and described in the Equipment Schedules, factory fabricated modular air handling units constructed with features as follows:
 - .1 Air handling units shall be ETL-Canada safety listed to conform to UL Standard 1995 and CAN/CSA Standard C22.2 No. 236. Air handling unit water heating & cooling coils shall be certified in accordance with the forced circulation air cooling and air heating coils certification program, which is based on ARI Standard 410.
- .2 Casing:
 - .1 Fabricate unit with 16 gauge nominal channel posts and panels secured with mechanical fasteners. All panels and access doors shall be sealed with bulb-type gasket.
 - .2 Panels and access doors shall be constructed as a 2-inch (50-mm) nominal thick, thermal broke double wall assembly, injected with foam insulation for an R-value of not less than R-13. The outer casing shall be constructed of heavy gauge G60 galvanized steel, phosphatized and painted with baked on enamel.
 - .3 The inner liner shall be constructed of G90 galvanized steel. Panel deflection shall not exceed L/240 at 125% of design static pressure, minimum +/- 5". Deflection shall be measured at the midpoint of the panel height.

- .4 Access doors shall be flush mounted to the cabinetry and secured with heavy-duty stainless steel hinges. The door latch handle assembly shall be provided with a full-size grip handle and roller pall for smooth operation. The assembly shall be gasketed and sealed to prevent thermal bridging. All access doors shall open against pressure. Provide inspection window for each access door.
 - .5 Construct drain pans from stainless steel with cross break and pitch to drain connection. Provide drain pans under cooling coil section and humidifier sections where applicable.
 - .6 Provide unit with a factory installed 6 inch high full perimeter channel base rail.
 - .7 Floor plate shall be constructed of aluminum tread plate .125 inch thick, 3.2mm.
- .3 Filters:
- .1 Provide filter box section with front loading filters shall be accessed via upstream access section.
 - .2 Air Filters: Camfil Farr 30/30 50mm (2") thick pleated type MERV 8 disposable with efficiency and arrestance to ASHRAE standard 52-2 in slide-out permanent metal frames. Maximum Face Velocity: 2.03 m/s (400 ft./min.). Provide MERV 13 final filters to meet LEED requirements.
 - .3 Provide a 14" section suitable for installation of 12" deep cartridge carbon filter.
 - .4 Carbon Filters: Provide Camfil Farr's Camsorb RigaCurb 95% odor removal efficiency carbon filters.
 - .5 Provide Magnihelic filter gauges for each filter bank flush mounted into unit casing with factory mounted probes.
- .4 Fans:
- .1 Provide forward curved or air foil fans as scheduled. Dynamically balance fans before and after installation in fan cabinet section. Ensure maximum fan RPM is below the first critical speed fan.
 - .1 Locate fan and motor internally on a steel base. Factory mount motor on a slide base that can be slid out of unit. Provide access to motor, drive and bearings through hinged access door. Provide fan and motor assembly mounted on 2" deflection spring vibration isolators inside cabinet.
 - .2 Provide self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Provide grease fittings attached to fan base assembly near access door.
 - .3 Bearings and Drives (not applicable to fan array)
 - .1 Provide bearings with basic load rating computed in accordance with AFBMA - ANSI Standards, L-50 life at 200,000 hours, heavy duty pillow block type, self-aligning, grease-lubricated ball bearings.
 - .2 Provide solid, hot rolled steel, ground and polished shaft, protectively coated with lubricating oil.
 - .3 Provide variable pitch sheaves on all motors 7 1/2 HP and lower. Provide constant pitch sheaves on all motors greater than 7 1/2 HP sizes V-belt drive for a service factor of 1.25. On constant pitch units, allow for one sheave change including belts (parts only, labour by balancing contractor).
 - .4 Provide open drip proof premium efficiency motors.
- .5 Coils:

- .1 Provide access to coils from connection side of unit for service and cleaning. Enclose coil headers and return bends fully within unit casing. Fabricate coil connections, vents and drains to extend beyond unit casing including grommets for an airtight unit casing. Coils shall be removable through side panels and/or top panels of unit without removal and disassembly of entire section.
- .2 Provide stainless steel drain pan located underneath and extending downstream of coil and intermediate drain pans.
- .3 Coil performance shall be as per schedule. Coil performance data shall be certified in accordance with ARI Standard 410 where applicable.
- .4 Construction:
 - Tubes: Copper.
 - Fins: Aluminum mechanically bonded to tubes.
 - Headers: Seamless copper with vent and drain connections.
 - Casing: 16 gauge, galvanized steel channels with 16 gauge center and end supports.
- .5 Water cooling and heating coils shall be circuited drainable with a vent connection at the highest point and a drain connection at the lowest point. Coil headers shall be copper with steel male pipe connections.
- .6 Face & Bypass Dampers:
 - .1 Provide factory mounted face and bypass low leak dampers, opposed blade, with vinyl bulb edging and stainless steel edge seals, galvanized steel frame and axles in self-lubricating nylon bearings, arranged to match coil face with top bypass. Blank-off and division sheets, internal linkage, access doors shall be installed by unit manufacturer. Internal face and bypass damper shall be contained in standard section height.
- .7 Access:
 - .1 Access sections shall be 24" deep or as shown on the drawings. Provide access doors of galvanized steel flush mounted, with gasket, latch and handle assembly.
- .8 Energy Recovery Wheel:
 - .1 Provide enthalpy wheels factory installed in units where scheduled.
 - .2 Energy recovery wheel shall be constructed of corrugated synthetic fibrous media. All surfaces shall be coated or uniformly bound with a non-migrating absorbent specifically developed for the selective transfer of water vapor.
 - .3 Media shall be engineered to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. The rotor media shall be capable of being cleaned with low temperature steam without degrading unit performance.
 - .4 The desiccant material shall be a molecular sieve, and specifically a 4A or smaller molecular sieve to minimize cross contamination.
 - .5 The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. Adjustable brush seals must be provided along the periphery of the rotor and between the inlet and outlet air passages to effectively prevent air leakage and cross-contamination between airflows.
 - .6 Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box tubing. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged or pillow block bearings.

- .7 The rotor drive system shall consist of a self-adjusting belt around the rotor perimeter driven by an AC motor with gear reduction. The variable speed drive shall be specifically designed for heat wheel applications and include: an AC inverter, soft start/stop, rotation detection w/alarm contacts, automatic self-cleaning jog cycle, and self-testing capability. The speed controller shall be capable of accepting a potentiometer, VDC, or mA control signal.
 - .8 The temperature control system shall consist of an integral control panel with remote temperature sensors mounted in each of the four air streams to monitor heat exchanger performance. The control shall modulate rotor speed to prevent frost build-up, reduce heat recovery for economizer mode, and switch to maximum heat recovery when outdoor temperature is higher than indoor temperature. A digital display keypad for monitoring temperatures and changing set points shall be included.
 - .9 Face and bypass dampers shall be factory installed to allow full bypass around the wheel during economizer modes or to relieve static pressure losses when the heat exchanger is not in use.
 - .10 The wheel shall be ARI certified by the energy recovery wheel supplier to ARI Standard 1060 and must bear the ARI certification stamp. Private independent testing performed "in accordance with" various standards is not a substitute for ARI certification and shall not be accepted. The wheel shall be listed or recognized by UL or equivalent.
- .9 Unit Electrical:
- .1 Provide factory mounted and wired starters for each fan motor. Each starter shall have a Hand-OFF-Auto control switch, thermal overload and disconnect switch.
 - .2 Unit manufacturer shall provide wiring from each fan motor to an external junction box.
 - .3 Provide lights in all access sections. Lights shall be wired to an ON-OFF switch mounted on the outside of the cabinet. Interconnecting wiring between split sections shall be field supplied and installed.
 - .4 Provide a GFI receptacle mounted on the outside of the unit cabinet. Installing contractor shall provide a separate power feed for the GFI.

2.13 AIR HANDLING UNITS (FACTORY FABRICATED MODULAR)

- .1 Provide in the arrangements and types as shown on the drawings and described in the Equipment Schedules, factory fabricated modular air handling units constructed with features as follows:
 - .1 Unit Casings: wiped coat 18 gauge (12 gauge for framing) galvanized steel rigidly reinforced with 25mm (1") interior neoprene coated insulation at coil headers and downstream from coil sections and 12mm (2") rigid type insulation on casing floor with condensate pans and drains. Provide hinged access doors on service side of unit for servicing of fans and coils.
 - .2 Fans: statically and dynamically balanced centrifugal DIDW with shafts operating less than 80% of first critical speed, bearings selected for average life of 150,000 hours and provided with lubrication fittings extended to the side of the unit where there is sufficient space for convenient servicing, refer to equipment layouts on drawings. Refer to fan schedules for performance.
 - .1 Volume control where specified in equipment schedules: Variable speed drive - refer to Section 15725.

- .3 Filters: Camfil Farr 30/30 50mm (2") thick pleated type MERV 8 disposable with efficiency and arrestance to ASHRAE standard 52-2 in slide-out permanent metal frames. Maximum Face Velocity: 2.03 m/s (400 ft./min.). Provide MERV 13 final filters to meet LEED requirements.
- .4 Provide magnehelic filter gauges.
- .5 Carbon Filters: Provide Camfil Farr's Camsorb RigaCurb 95% odor removal efficiency carbon filters.
- .6 Coils: ARI rated as described in article 2.04 of this section. Provide hinged, camlatched and insulated access doors on air leaving side of coil section. Locate access door on service side of unit.
- .7 Provide face and by-pass dampers.
- .8 Drives: Provide motor with variable frequency drive as specified in Sections 15050 and 15725.
- .9 Vibration Isolation: Spring isolators for either suspended or floor mounted application as indicated. Refer to Section 15100.
- .10 Provide inlet motorized damper.
- .11 Refer to section 15900 for controls. Units must be able to receive remote inputs such as start, stop, remote reset, heating and cooling enable etc.
- .12 Units as manufactured by Trane, Carrier, York and McQuay will be accepted.

2.14 FAN COIL UNITS

- .1 Provide 2-pipe and 4-pipe fan coil units in style, arrangement and with characteristics as shown on the drawings and as listed in the equipment schedules as follows:
 - .1 Fans: Galvanized steel centrifugal forward curved double width, statically and dynamically balanced with galvanized steel housings.
 - .2 Motors: ECM X13 type.
 - .3 Motor Control: Unit mounted three speed switch with "Off" position.
 - .4 Coils: Copper tube/aluminium fin mechanically bonded, 1725 kPa (250 psi) working pressure, with manual air vent.
 - .5 Pipe risers: Type L copper.
 - .6 Pipe Branches: NPS½" type "L" bending temper copper, and stainless steel braided flex hoses to provide expansion and contraction of risers including shut-off ball valves with flare nuts in the supply and return branches for easy removal; manual air vents are to be equipped in the top-floor units if the main supply or return is below the units.
 - .7 Filters: Best available 25mm (1") thick disposable media in permanent metal frame. Minimum MERV 11 for vertical FCU and minimum MERV 13 for horizontal FCU.
 - .8 Cabinet: 18 ga. cold rolled steel, primed and finished in baked enamel and where applicable, with stamped discharge grille, hinged top access doors (both sides) and one piece front access panel with slotted head quarter-turn positive locking fasteners; cabinet completely lined with 25mm (1") thick faced glass fibre acoustic insulation.
 - .9 Drain Pans: 18 ga. galvanized steel, lined with 12mm (1/2") thick closed cell foam insulation; pitched to 25mm (1") copper drain and projecting beyond coil under headers and return bends. Where applicable (vertical units), auxiliary drain pans to be provided of identical construction.
 - .10 Thermostats: To be 24V programmable with 3-speed fan function. If available at time of purchase, include on-board humidity sensor. Provide thermostats by Honeywell, TB7100 or equal. Either unit mounted or remote mounted. Refer to

the drawings and equipment schedules. Provide humidity read out to meet LEED requirements.

- .11 2-way and 3-way control valves: Properly sized and selected by the manufacturer in accordance with load requirements and characteristics of the systems to which they are applied.
 - .1 Water pressure drop through all two-way modulating control valves - 18 kPa (2.5 psi).
 - .2 All valves - Provide with integral seats ground into the body. Disc assemblies: replaceable and selected for fluid to be controlled.
 - .3 Modulating applications - Provide valves with throttling plugs for linear lift-flow ratio.
- .12 Provide unit c/w integral disconnect switch.
- .13 All vertical fan coil units are to have factory installed BTU meters. Co-ordinate with Provident Energy Management for BTU meter requirements.
- .14 Fan coil units located in living rooms or bedrooms which discharge directly into these spaces or via short duct runs are to have lined discharge plenums. The plenums are to be internally lined with minimum 1" thick acoustic insulation.
- .15 Provide acoustically lined return-air panels.
- .2 Acceptable Manufacturers:
 - .1 Vertical fan coils: Unilux, Enerzone, Temspec.
 - .2 Horizontal fan coils: International Environmental, York, McQuay, Trane

2.15 FINNED TUBE CONVECTOR AND ENCLOSURE

- .1 Provide where noted and detailed on drawings and in accordance with plan schedules, finned tube convectors with enclosures, continuous wall to wall where indicated.
- .2 Elements: 32mm (1¼") copper tubing complete with 100mm x 100mm (4" x 4") stamped pattern aluminium fins, with integral fin collars to provide even spacing of fins bonded to tubes by mechanical expansion of tube and supported at 1.22 meter (48") centres maximum with adjustable cradle type hangers. Performance based on 82.0C entering water temperature, with 11.0C temperature drop and entering air temperature corrected to 21.0C. Tube velocity to be based on forced circulation at 0.30 m/s (1 ft./s) minimum.
- .3 Finned tube convectors as above manufactured by Engineered Air, Sterling, Rosemex, Trane, Sigma and Dunham Bush will be accepted.

2.16 HVAC SPLIT SYSTEMS

- .1 Provide Carrier commercial air cooled split systems consisting of ceiling suspended fan coil terminals and remote air cooled condensing units with capacities and characteristics as described in the Equipment Schedules and in the following:
 - .1 Outdoor condensing unit:
 - .1 Factory assembled, single piece with all required wiring, piping, controls, R- 410 refrigerant charge.
 - .2 Galvanized steel cabinet with baked enamel finish.
 - .3 Removable access panels for access to all components.
 - .4 Direct driven statically and dynamically balanced propeller type condenser fans with class A insulation and permanently lubricated ball bearings and internal thermal overload protection.

- .5 Hermetic rotary type compressor with lubrication system, operating oil charge, suction line accumulator, muffler, NEMA class F motor, discharge valves, rubber vibration isolators.
 - .6 Aluminium fins/copper tube, cleaned, dehydrated, and sealed condenser coil.
 - .7 Refrigeration components: liquid and suction line service valves and service gauge ports, accumulator, pressure relief, liquid and suction line piping kit, and refrigerant operating charge.
 - .8 Controls: Short cycling protection, automatic restart on power failure, high temperature and freeze protection, system diagnostics, compressor motor overcurrent, overtemperature protection, low ambient control to -280C.
- .2 Indoor fan coil section:
- .1 Cabinet: zinc coated steel with baked enamel paint and matching mounting brackets.
 - .2 Centrifugal fan with automatic motor driven vertical air sweep.
 - .3 Coils: Copper tube, aluminium fins and galvanized steel tube sheets with drip pan and drain connection.
 - .4 Permanently lubricated multi-speed fan motor with inherent overload protection.
 - .5 Cleanable slide-out filters.
 - .6 Controls: microprocessor based for space temperature, optimum fan speed, run self diagnostics with test button, automatic restart after power failure, 15 hour timer cycle for system on/off, high discharge temperature shut-down. Also provide automatic change-over heat pump control with heat relay to enable operation of perimeter heating hot water convector valve for FC-2 system only.
 - .7 Wired remote system controller complete with interconnecting cable.
- .3 Other acceptable manufacturers: Toshiba, Daikin, Mitsubishi.

2.17 REFRIGERATION PIPING AND SYSTEMS

- .1 Provide for all systems indicated on the drawings a complete refrigeration piping system by a recognized contractor regularly employed in commercial and industrial refrigeration.
- .2 Prepare and submit layout drawings and control arrangements for review by the Consultant prior to starting work. Size piping equivalent to a maximum of 1.1°C temperature drop. Size all suction and hot gas piping, using double risers where necessary, to ensure oil entertainment under minimum load.
- .3 Refrigeration circuits: refer to schematics and provide strainer/driers, sight glasses, moisture indicators, shut-off valves, thermal expansion valves, solenoid valves, receiver, refrigerant, oil, safety accessories, etc. as required for a complete and working installation.
- .4 Provide all control wiring and motor control interlocks as described on the drawings and as required by the refrigeration equipment manufacturer's installation instructions and control schematics to achieve required operating sequences and maximum equipment protection.
- .5 Provide a 100% parts and labour, and loss of refrigerant and oil (by leakage or contamination) warranty during the normal guarantee period.

- .6 Piping: Type L hard temper copper tubing with bronze alloy (Silfos) joints. For sizes 12mm (2") and under, type K soft temper copper tubing with silfos or flared joints may be used.
- .7 Valves and Specialties: seal cap type, brass with teflon seats; acceptable manufacturers: Superior, Mueller, Henry, Frick. Check valves: type CK-1 as manufactured by Refrigeration Specialties or Frick. Thermal expansion valves, filter/driers, solenoid valves, moisture indicators: Sporlan. All thermal expansion valves to be provided with external equalisers.

2.18 GLYCOL SOLUTION PIPING SYSTEMS

- .1 Where indicated on the drawings, provide piping arrangements complete with all fill points, expansion tanks and equipment.
- .2 Provide inhibited 40% ethylene glycol solution using UNION CARBIDE UCAR thermo-fluid 17 or acceptable alternative. All glycol solutions to be acceptable to Authorities having jurisdiction regarding environmental acceptability.
- .3 Provide one 170 l (45 gal.) barrel and rotary drum pump complete with 4 m (12 ft.) of 25mm (1") rubber hose for future servicing.

2.19 AIR COMPRESSOR

- .1 Where indicated on the drawings, provide one 2 stage Pacific/Ranger Engineering #252H80-air cooled reciprocating air compressor complete with 7.5 HP motor, 80 gal. receiver ASME rated at 200 psi working pressure, capable of 25 displacement CFM at 100 psi. This unit to also be complete with matched set V-belt drive, pressure switch for automatic start/stop, check valve, air cooled after cooler, drain valve, belt guard, silenced inlet filter and pre-wired automatic drain.
- .2 Provide a refrigerated type air dryer Model #RRD25A to operate to a pressure dew point of 2AC. Dryer to be supplied with a power cable and plug for 115V/1/60, Freon suction gauge, air outlet pressure gauge, temperature gauge, running and high temperature lights, automatic drain trap for condensate and Model #RF-3 high efficiency pre-filter ahead of the dryer for 99.99% efficiency referred to 0.1 micron and air inlet temperature gauge.
- .3 Provide Pacific/Ranger Model No. F07313A pressure reducing valves c/w pressure gauges on high and low pressure side of valve.
- .4 Pressure reducing valves and secondary filters to be provided as indicated in the plans.
- .5 Power wiring of air compressor and refrigerated air dryer by Division 16 Sub-Contractor. Provide all required motor control wiring.

2.20 ENERGY RECOVERY VENTILATOR (REMOTE CEILING MOUNTED)

- .1 Provide units in every suite and as generally indicated on the drawings and as specified herein. Energy Recovery Ventilators with capacities, electrical and control characteristics as scheduled. Units shall be Mode RERV-D-100 Deluxe series as manufactured by Reversomatic. Units shall be equipped with built in true automatic electronic air balancing

and constant flow technology. ERV low and high speed flows are to be pre-set at the factory. Refer to drawings for required pre-set air flows. Capable of net supply airflows @ 30 l/s to 40 l/s at 100 PA on low speed and 40 l/s to 60 l/s at 100 PA on high speed.

- .2 Units shall be performance sized at both low and high speeds to work in conjunction with the controller Model WC-100. Units casing to be powder coat finish with swing-out pop off bottom access panel. Unit to have two washable filters.
- .3 Enthalpy core shall be washable polymeric membrane type and able to withstand freezing without loss of efficiency. Core shall be easily removable from bottom access panel.
- .4 Control of units shall be by low voltage timer (20, 40, 60 minutes) Model TC100 for single bathroom and additional timer for double bathroom.
- .5 Unit size, 28" x 21" x 9" high. Provide minimum 32" x 24" flush access door for easy removal of unit or manufacturer's recommendation. Submit sample of access door for Consultant and Owner's approval.
- .6 Unit shall be equipped with programmable multifunctional wall controller self-powered (low voltage)(5VDC) capable of controlling low, high recirculating, energy saving and off mode. Units to have OFF selection disabled.
- .7 Unit shall also be equipped with built in humidistat.
- .8 In off/ fan failure mode, the fresh air damper must shut off to prevent cold air from entering into the unit from outside.
- .9 Unit shall be capable of being mounted horizontally or vertically.
- .10 Provide best available air filters within unit enclosure, minimum MERV 8.
- .11 Provide Camfil Farr CIAQ 10"x10"x2" MERV 7 activated carbon filter, mounted inside a filter box with access door and installed separately into the fresh-air supply side before the ERV unit.

PART 3 - EXECUTION

3.01 EQUIPMENT AND TERMINALS

- .1 Deliver equipment to the Site of the Work and store in area as designated by the Contractor. Set equipment on temporary bases to avoid contact with the ground. Protect equipment from damage.
- .2 Comply with manufacturer's requirements for the installation of all specified equipment.
- .3 Locate equipment as shown on the drawings to provide best possible connection arrangement and accessibility for servicing. Provide clearances on all sides of equipment as required by Authorities having jurisdiction or manufacturer, whichever is greater.
- .4 Install items of equipment such as convectors with due regard to Architectural treatment, and ensure all items are level and finished in keeping with good workmanship. Grade all convector elements upward in direction of flow - refer to detail drawings.

- .5 Chillers:
- .1 Provide all necessary refrigerant relief lines, break-away flanges, valves, pneumatic and electric control connections and piping for chiller oil cooler and purge unit as required by chiller manufacturer.
 - .2 Install pipeline thermometers and/or sensor wells as required on system side of break-away flanges.
 - .3 Install in arrangements as shown on the drawings and when chiller installation consists of two units, or pairs of units, install each pair such that the control panel fronts face inward toward each other. If chiller installation is an odd number, i.e., 3 or 5, all control panel fronts to face each other as above. The odd unit panel to face the opposite side of the adjacent unit.
 - .4 Provide 1.25 m (4 ft.) spacing minimum between chiller control panel fronts. Provide rear service space as required by the manufacturer but in no case less than 600mm (2 ft.) from any component on the chiller.
 - .5 Refer to Section 15050 for wiring requirements.
 - .6 Install units on a flat surface level within 1/8 " and of sufficient strength to support concentrated loading with isolation spring assemblies under the units.
 - .7 Install components furnished by the manufacturer.
 - .8 Provide all water piping so unit and water circuits are serviceable without having to dismantle excessive lengths of pipe.
 - .9 Provide valves in water piping upstream and downstream of the evaporator and condenser water boxes connections for isolating the shells for maintenance.
 - .10 Provide drain valves and vent cocks to each water box.
 - .11 Install loose temperature sensors in accordance with the manufacturer's recommendations.
 - .12 Provide all necessary auxiliary water piping for oil cooler in accordance with the manufacturer's recommendations.
 - .13 Provide pressure relief piping from relief valve to outside in accordance with manufacturer's instructions and CSA-B52-1992.
 - .14 Provide certified wiring schematics to the electrical division for the chiller, associated equipment and controls.
 - .15 Provide all necessary control wiring as recommended by the manufacturer.
 - .16 Provide vapour proof flow switches in both chilled and condenser water piping interlocked to the control panel.
- .6 Provide drains to nearest floor drain on all back flow preventors.
- .7 Provide chemical treatment connections on chilled, heating and condenser circuits as directed by chemical treatment supplier.
- .8 Pitch coils for air handling systems 18mm/m (3"/ft) toward access end of unit.
- .9 Provide branch take-offs from mains of heating and cooling pipes with shut off valves.
- .10 Pumps: Install pumps as shown on detail drawings. Mount all vertical in-line pumps over 3.73 KW (5HP) at floor level as shown on the detail drawings. Provide a minimum of 1.83 m (6'-0") of pipe on pump suction one size larger than pump inlet complete with strainer and valve.
- .11 Provide 12mm (1/2") drain lines with ball valves from Cuno filters to nearest floor drain.

- .12 Install and connect remote components such as thermostats, humidistats, control panels, level controllers, etc., that are supplied with the equipment. Install in locations as shown on the drawings.
- .13 Cooling Towers
 - .1 Install in arrangement as shown on the drawings.
 - .2 Install cooling towers on supports of sufficient height to elevate bottom of sump 300mm (12") minimum higher than the top of the condenser shell on the chiller and in no case less than 1.83 m (6 ft.) higher than the centre line of the condenser pump suction connection.
 - .3 Provide additional bracing for ladder where extended to roof level or grade.
 - .4 Mount control panel such that it is accessible from roof level or grade.
- .14 Plate and frame heat exchanger: Install heat exchanger level with shims under supports. Arrange piping around heat exchangers to allow plate and gasket removal and re-assembly.

3.02 EQUIPMENT START-UP

- .1 Follow manufacturer's instructions and have manufacturer's representative present to certify the installation.
- .2 Check each item of equipment to ensure proper electrical connections, etc., and to verify proper operation.

3.03 REFRIGERATION SYSTEM

- .1 Submit application to TSSA and pay for all required fees. Obtain approval from TSSA prior to installation of the refrigeration system.
- .2 Install piping, components, equipment, etc., in accordance with schematics, code and standard industry practice.
- .3 During brazing procedures, charge piping with inert gas to prevent scale formation.
- .4 Pressure tests: Prior to application of insulation and dehydration, test all systems under pressure with nitrogen for 24 hours minimum until no pressure drop occurs. If leaks are detected, repeat test procedure after repairs. Test high side at 2100 kPa (300 psi) and low side at 1050 kPa (150 psi).
- .5 Dehydration: Evacuate system, and hold for 24 hours minimum a vacuum of 99.9 KPa (29" HG). Break vacuum with refrigerant operating charge, monitor moisture indicators and change or replace filter/driers, or filter drier cores until moisture is eliminated.
- .6 Start-up system, monitor operation and perform all tests to ensure system operates to manufacturer's requirements. Issue certificate attesting thereto.
- .7 Instruct Owner in proper operating and maintenance procedures.

3.04 STAND-BY GENERATOR EXHAUST

- .1 Refer to detail drawing and install exhaust piping, muffler, flexible connection as shown. Flexible connection and muffler supplied by Division 16.

3.05 WATER BALANCING

- .1 Refer to Section 15050.
- .2 Provide flow measurement ports as shown on detail drawings and piping schematics in locations as directed by the water balancing specialist. Provide balancing valves where required as directed by the water balancing specialist.
- .3 Provide any pump impeller modifications as recommended by the water balancing firm.

END OF SECTION 15700

PART 1 - GENERAL

1.01. GENERAL DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Section 15010, Mechanical General Requirements and Section 15050, mechanical Basic Materials and Methods.

1.02. QUALITY ASSURANCE

- .1 Qualifications: Execute work of this section only by skilled licensed tradesmen regularly employed in the installation of variable frequency drives.
- .2 Submittals: Submit shop drawings on variable frequency controllers and starters.

1.03. WARRANTY OF VARIABLE FREQUENCY DRIVES

- .1 Warranties for Variable Frequency Drives will start on the date of verification of acceptance by the Consultant.
- .2 This date of acceptance is independent of Substantial Performance of the Work and may occur after certification of Substantial Performance.
- .3 Variable Frequency Drives will be accepted after start-up, a minimum of 10 hours of logged trouble-free operation, 10 hours of connected EMCS trouble-free operation, four hours of instruction to Owner's operating staff and submission of written verification attesting thereto by manufacturer's representative. The Consultant must also witness a portion of this procedure.
- .4 Acceptance of the Variable Frequency Drives will occur after verification by the Consultant.
- .5 Include these certificates with the maintenance and operating manuals.

PART 2 - PRODUCTS

2.01 VARIABLE FREQUENCY CONTROLLERS

- .1 General: Provide as indicated in the Equipment Schedules factory fabricated and tested pulse width modulating frequency controllers compatible with the motor horse powers listed for the variable volume air handling units, pumps and cooling tower fans.
- .2 All variable frequency drives must be Siemens FLN compatible.
- .3 Application:
 - .1 The load characteristics of the application are:
 - .2 Variable torque (e.g. fans).
 - .3 Operating speed range from 180 to Normal Motor RPM (refer to FAN MOTOR DATA table in item .18).

- .4 Operating Conditions:
 - .1 Drive to accept power nominal AC voltage of 600V $\pm$ 15%, three-phase, frequency 60 Hertz.
 - .2 Operating ambient condition to have a temperature range of 0 to 40°C with a relative humidity of up to 95% (non-condensing).
 - .3 Altitude: 0 - 215m (0 - 700 ft.) above sea level.
- .5 AC Adjustable Speed Drive Systems:
 - .1 Adjustable frequency AC drives to convert 600V $\pm$ 15%, 3 phase, 60 Hertz utility input power to an adjustable AC frequency and voltage for controlling variable torque through speed of AC squirrel cage fan motors. Converters to be of the voltage source design with a pulse width modulated inverter section utilizing insulated gate bi-polar transistors (IGBT). The use of input/output transformers is not acceptable.

The drive controllers to be rated for 110% continuous of rated motor current and have capacity to provide speed control of motors throughout speed range specified.
 - .2 Controllers to include power conversion components, power control logic devices and regulator circuitry. Regulators to incorporate microprocessor technology for control of power semiconductors.
 - .3 Variable speed drive to be supplied in a NEMA 1 or NEMA 4 enclosure as required to meet code with drip hood if in sprinklered area and to be completely pre-wired and pre-piped for the specified control sequences, and require only field wiring from a power source to each motor and wiring of control points and safeties.
 - .1 The drive to contain the following, all interconnected and factory-wired to an identified terminal strip:
 - .1 Variable frequency controllers (VFC).
 - .2 Motor control components such as overload relays, fused control circuit transformers, pushbuttons, pilot lights and other items required to perform the specified sequences of operation.
 - .3 Terminals to which specified remote devices like start/stop; etc. may be wired to the Building Management System. Field wiring for these control devices to be the responsibility of Section 15900.
 - .4 Through-the-door disconnect switch.
- .6 Operating Characteristics:
 - .1 The adjustable frequency drives to have the following features:
 - .1 $\pm$ 1% frequency regulation.
 - .2 $\pm$ 1% voltage regulation.
 - .3 0 to 66 Hertz operating frequency range.
 - .4 Active current limit function, adjustable 0 to 100% of controller rating.
 - .5 Maximum efficiency at full load and speed of 98%.
 - .6 Minimum incoming line power factor throughout the load speed range of 0.95.

.7 Drive Diagnostics:

- .1 Provide fault diagnostics to simplify troubleshooting. Each of the following points to be indicated by on LCD screen:
 - .1 Lock-out - (fault shutdown after three (3) restart attempts)
 - .2 Line Fault - (Line over/under voltage, phase loss/unbalance)
 - .3 Controller Overtemperature
 - .4 Motor I²t Thermal Protection
 - .5 DC Bus Overvoltage
 - .6 DC Bus Undervoltage
 - .7 Auxiliary Power Supply Fault
 - .8 Output Fault - Phase A
 - .9 Output Fault - Phase B
 - .10 Output Fault - Phase C
- .2 Provide keypad accessibility to a non-volatile Fault History Memory which is not operator erasable. This memory to store the following data for each of the thirty (30) most recent drive shutdowns and include date, time and elapsed time meter:
 - .1 The fault which caused the shutdown
 - .2 Output frequency at time of trip
 - .3 Output voltage at time of trip
 - .4 Output load (power) at time of trip
 - .5 Whether the load was accelerating or decelerating

.8 Protective Functions:

- .1 Active limiting of fundamental current by frequency fold back on acceleration loads and frequency hold on decelerating loads.
- .2 Over current protection.
- .3 Short circuit protection.
- .4 Fast acting supply fuses.
- .5 Supply voltage phase loss.
- .6 DC intermediate bus under voltage.
- .7 DC intermediate bus over voltage.
- .8 Power section over temperature.
- .9 Power section faults.
- .10 Adjustments:
 - .1 Active current limit 0-100%.
 - .2 Maximum frequency 40-100%.
 - .3 Minimum frequency 0-50%.
 - .4 Acceleration/Deceleration separately adjustable from 1 to 999 seconds.

- .5 All adjustments shall be programmable from the front panel of VFD. Potentiometer or dip switch adjustment are not acceptable.
- .11 Auxiliary Contacts for Drive Logic Status:
 - .1 The following (NO, NC) contacts to be provided for the following logic conditions.
 - .2 Fault
 - .3 Start
 - .4 Motor contactor at the inverter output.
 - .5 Input card with auto/manual logic for isolation of analog input reference signals 4-20 mA.
- .12 Output card providing isolated 4-20 mA output for drive signals including output frequency, active or total output current.
- .13 Provide diagnostics for operator on-line status information. Each of the following status points shall be indicated on door mounted LCD screen:
 - .1 Power on
 - .2 Ready
 - .3 Run
 - .4 Jog
 - .5 Motor Accelerating
 - .6 Motor Decelerating
 - .7 Direction of rotation (forward or reverse) (if function enabled)
 - .8 Auto Mode (if function enabled)
 - .9 Manual Mode
 - .10 Stop
 - .11 Low Reference (missing or zero speed reference)
 - .12 External Trip (interlocks open)
 - .13 Current Limit
 - .14 Power Lost
 - .15 Fire Alarm Shut Down Contacts
- .14 Provide the following control functions on the door mounted keypad:
 - .1 Run
 - .2 Stop
 - .3 Jog (enabled in Stop Mode only)
 - .4 Auto/Manual (if Auto Mode is enabled)
 - .5 Forward/Reverse (if function enabled)
 - .6 Accelerate (Manual Mode)
 - .7 Decelerate (Manual Mode)
 - .8 Direct Speed Set (Manual Mode)
 - .9 Load meter to indicate active current
 - .10 Frequency meter
 - .11 Manual frequency reference potentiometer
 - .12 Provide diagnostic to allow signal tracing of the logic and base or gate driver circuit boards plus additional fault diagnostics.
 - .13 Provide terminals for interlocking of up to six (6) external interlocks e.g. Firestat, Freezestat, etc.
 - .14 Provide the following to interface with the Energy Management Control System (EMCS):

- .1 Dry contact closure or software connection from EMCS for run Command (Auto Mode).
 - .2 Isolated 4-20 mA (0-10 VDC, 0-5 VDC) signal from EMCS for speed control (Auto Mode).
 - .3 Dry contact or software connection (NO) output to EMCS to indicate:
 - Inverter Ready
 - Inverter Fault
 - Inverter Running
 - .4 Isolated 4-20 mA or isolated 0-10 VDC output to EMCS, proportional to 0-110% speed.
 - .5 Isolated 4-20 mA or isolated 0-10 VDC output to EMCS, proportional to 0-110% load power.
- .15 Provide for Remote Shut Down of Inverter Circuitry
- The variable frequency drive shall be fitted with a low voltage relay having normally closed contacts in the solid state electronic circuitry of the inverter to allow the power down of the inverter from a remote stop button mounted in a remote disconnected switch. This shall protect the inverter solid state electronic circuits prior to the line power being shut off at the remote disconnect switch.
- .16 AC Drive Quality Assurance:
- .1 Power semiconductors (thyristors, diodes, etc.) to be tested for proper electrical characteristics (dv/dt, di/dt, etc.) on LEM testers.
 - .2 All chips (CMOS, TTL, LINEAR, etc.) to be given a 100% burn-in with applied voltage, and then functionally tested.
 - .3 All power capacitors active components to be functionally tested.
- .17 Variable Frequency Drive Motor Capacities:
- Refer to equipment schedules on the drawings.
- Note: Co-ordinate with suppliers of equipment to ensure motor compatibility with variable frequency drive selections.
- .18 Provide guarantee that harmonics generated will not exceed 10% THD. If necessary provide line reactor or other filters to achieve this at no additional cost. External line reactors to be mounted in NEMA 1 or 4 enclosure as required to meet code.
- .19 Provide load reactor, if drive to be located more than 50 feet from motor.
- .20 Provide call back within 30 minutes of receiving emergency call for service and provide on-site service within two (2) hours.
- .21 All component parts must be maintained in Toronto based storage. Provide evidence of this in submission of shop drawings.
- .22 Start-Up Service: Provide on site commissioning (start-up) of the adjustable frequency drives by a qualified technician. Allow a minimum of half a day per system. Also include an allowance for a second visit to site of one day duration to train operating personnel in the operation and maintenance of the drives.

- .23 Acceptable manufacturers: ABB and Siemens. All drives must be Siemens FLN compatible.

PART 3 - EXECUTION

3.01 INSTALLATION OF VARIABLE FREQUENCY DRIVES

- .1 Install variable frequency drive units in locations shown on the contract drawings to provide the best possible connection arrangement and accessibility for service.
- .2 Provide clearances on all sides of the equipment as required by authorities having jurisdiction or manufacturers, whichever is greater.
- .3 Floor mounted units to be installed on a 100mm (4") thick concrete pad extending a minimum of 100mm (4") beyond foot print of drive unit. Pad to have all edges chamfered to avoid spalling.
- .4 Install drive units in accordance with the manufacturer's instructions and all applicable building and Canadian Electrical codes.
- .5 Co-ordinate the installation of variable frequency drives with the Division 16 Sub-Trade.
- .6 Co-ordinate the installation and commissioning of drive units with the Energy Management Control Contractor (Section 15900 Sub-Trade) and Air & Water Balancing Contractor.
- .7 The Division 15 contractor shall notify the Division 16 contractor of the requirement to provide remote disconnects of all motors controlled through variable frequency drives to be fitted with a low voltage push button for inverter circuit isolation.
- .8 The Division 15 contractor shall provide warning labels at remote disconnects stating that:

"Before shutting off main power, isolate the VFD inverter by depressing the low voltage push button".

"Push button to be reset and disconnect closed prior to restart of variable frequency drive."

3.02 VARIABLE FREQUENCY CONTROLLER TEST

- .1 Follow manufacturer's instructions and have manufacturer's representative present to certify the installation.
- .2 Check each item of equipment to ensure proper electrical connections, etc., and to verify proper operation.
- .3 Upon completion of installation of equipment start-up, operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.
- .4 Start each piece of equipment controlled via frequency controller and by varying the control set point check that speed variation is linear throughout the full control range.

- .5 Check that annunciator panel and alarms are functioning in accordance with the specifications, and that all signals between the variable frequency drive and EMCS are accurate.

END OF SECTION 15725

PART 1 - GENERAL

1.01 DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Mechanical General Requirements Section 15010 and Mechanical Basic Materials and Methods Section 15050.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Provide a complete installation of ventilation systems as shown of the Drawings and Detail Drawings including ductwork, grilles, and diffusers, fans, dampers, hoods and provision of personnel and materials to assist in air balancing.
- .2 Install all automatic dampers supplied by Section 15900.

1.03 QUALITY ASSURANCE

- .1 Execute work of this Section only by skilled tradesmen regularly employed in the manufacture and installation of sheetmetal ductwork and air handling equipment.

1.04 SUBMITTALS

- .1 Submit shop drawings on registers, grilles, diffusers, fans, fire dampers, filter gauges and factory fabricated ductwork. Provide fan curves for all fans 200l/s(400CFM) and greater capacity.

PART 2 - PRODUCTS

2.01 ACCESS DOORS

- .1 Ductwork: Provide latched access doors where required constructed of No. 22 gauge materials with flat iron or angle iron stiffening frame so constructed that the door can be operated without twisting or distortion. Doors in insulated ductwork: double panel construction with a 25mm (1") insulating filler. Refer to Detail Drawings.

Acceptable alternative: for non hinged type, provide cam-latched insulated access doors model 08 as manufactured by Nailor Industries Inc.

2.02 ACOUSTIC INSULATION

- .1 Provide acoustic duct liner as specified in Section 15185 Mechanical Duct Liner.
- .2 Duct size to increase relative to acoustic lining thickness to maintain equivalent free area.

2.03 FIRE DAMPERS AND CEILING DAMPERS

- .1 Provide ULC labelled and listed units as manufactured by Controlled Air Manufacturing Ltd. type "B" or "C" gravity or spring type.
- .2 Provide Fire Dampers in sizes and in arrangements to suit openings shown on the drawings to ULC requirements as they relate to maximum sizes permissible in the applicable fire

separation construction. Where installed in metal studs walls, comply with ULC requirements and advise other affected Trades i.e. stud and drywall installers.

- .3 Do not use asbestos in any form in the construction of fire dampers or ceiling dampers.
- .4 On ceiling dampers, in place of using ceiling tile material for diffuser protection as detailed, the CK2000 thermal blanket along with required transitions may be used.
- .5 Other acceptable manufacturers: Ruskin, Kerr-Hunt, Nailor Industries, Air Balance of Canada Ltd.

2.04 SPLITTER AND QUADRANT DAMPERS

- .1 Provide splitter dampers as described in the detail drawings.
- .2 Construct quadrant dampers of not less than 22 gauge material. Where installed in ducts up to 300mm (12") deep, provide single blade, and in ducts greater than 300mm (12") provide multi-blade with linkages, each blade being not wider than 228mm (9").

2.06 DUCTWORK

- .1 Provide rectangular and round ductwork constructed of ASTM A525 hot dip galvanized steel sheets in arrangements as shown on the Drawings complete with reinforcement, hanging methods, joints, seams and fittings as specified in Sections I through 5 as well as appendices A-1 through A-32 in the SMACNA HVAC Duct Construction Standards - Metal and Flexible 1995.
 - .1 For exhaust, return and air supply systems where system static pressure does not exceed 0.124 kPa (½" wg), positive or negative, provide reinforced ductwork in metal gages and reinforcement requirements as specified in SMACNA table 1-3.
 - .2 For exhaust, return and air supply systems where system static pressure does not exceed 0.248 kPa (1" wg), positive or negative, provide reinforced ductwork in metal gages and reinforcement requirements as specified in SMACNA table 1-4.
 - .3 For exhaust, return and air supply systems where system static pressure does not exceed 0.496 kPa (2" wg), positive or negative, provide reinforced ductwork in metal gages and reinforcement requirements as specified in SMACNA table 1-5.
 - .4 For exhaust, return and air supply systems where system static pressure does not exceed 0.744 kPa (3" wg), positive or negative, provide reinforced ductwork in metal gages and reinforcement requirements as specified in SMACNA table 1-6.
 - .5 Cross break all ductwork greater than 300mm (12") in width.
- .2 Factory fabricated ductwork and fittings: As an alternative to shop fabricated rectangular and round sheetmetal ductwork, factory fabricated "Spirosafe" ductwork and gasketed self sealing fittings as manufactured by Lindab Inc. to Lindab published specifications (manufacture and installation) and performing to specified system static pressure requirements is also acceptable.
- .3 Flexible ductwork: provide, where indicated on the Drawings, flexible ductwork bearing ULC Class 1 Label, insulated or acoustic, as manufactured by Flexmaster. Alpha Industries, or Thermaflex are acceptable alternative manufacturers. Refer to Section 15180 for insulation requirement of flexible ducts. Use Flexmaster model T/L-VT and T/L-A for insulated and acoustic flexible ducts. Flexible duct to be manufactured of aluminum with a continuous seam

capable of delivering air without leakage up to positive pressures of 3.0 kPa (12" w.g.) and negative pressure of 0.25 kPa (1" w.g).

- .4 Button lock longitudinal seam may be used on systems up to 0.125 kPa (½" w.g.) positive or negative static pressure provided seam is sealed or caulked with high velocity duct sealer.
- .5 Shower room exhaust ductwork: Where indicated on Drawings, one gauge lighter than specified above constructed of 316 stainless steel. Provide stainless steel hangers and stainless steel screws.
- .6 In place of duct joints previously specified, "Nexus" or "Ductmate" gasketed flanges, installed to Manufacturer's instructions, may be used provided gasketing meets approval of ULC and installation is to SMACNA Standards.

2.07 SEALANTS

.1 Duct Sealants

- .1 Provide water based duct sealant, Unimastic 181 as manufactured by United McGill Corporation, conforming to NFPA 90A, 90B and ASTM E 84 requirements and with UL classification of 0 flame spread and smoke development based on a .0028mm (0.011 inch) thick application and UL test methods.
- .2 Sealant to comply with SMACNA leakage requirements and be unyielding up to 10 times operating stress and permanently flexible when cured.
- .3 Sealant odour to be mild and non-irritating when wet and be odourless when dry.

.2 Internal Insulation Sealants

- .1 Provide Superseal joint and edge sealants on internal duct insulation as manufactured by Shuller.
- .2 Sealant to be acrylic polymer conforming to ASHRAE 62-89 as well as ASTM G-21 and G-22 for prevention of fungus and bacterial growth.

2.8 REGISTERS, GRILLES, DIFFUSERS

- .1 Provide registers, grilles and diffusers by manufacturer and sizes, styles and finishes as scheduled on the Drawings.
- .2 Ensure that the items supplied will be compatible with ceiling or wall construction.
- .3 Equipment as manufactured by E.H. Price, Carnes, Barber Coleman, Titus, Nailor Industries, Tuttle & Bailey, Metalaire and Krueger is acceptable.

2.9 LOUVRES

- .1 Louvres are specified in Section 10200.

2.10 ROOF MOUNTED LOUVRED ASSEMBLIES (EXHAUST AND INTAKE)

- .1 As described on the Drawings, provide rainproof roof mounted louvred aluminium alloy exhaust and intake assemblies complete with bird screens as manufactured by Penn, Airolite or Greenheck.

2.11 CENTRIFUGAL FANS

- .1 Provide fans as indicated on the Drawings and in the equipment schedules, statically and dynamically balanced, constructed in conformance with AMCA 2408-69 and carrying the AMCA seal for sound and air flow performance.
- .2 Bearings: Belted ventilating sets and Class I and Class II fans: Heavy duty ball bearings, grease lubricated self aligning pillow block. On arrangement III single inlet fans with ducted inlets, provide extended lubrication fittings.
- .3 Provide continuously welded scrolls on all fans.
- .4 Provide electric motors, disconnect switches (on roof mounted units), vibration isolators (refer to Section 15100), belts, belt guards, weatherhoods where mounted outdoors and back draft dampers on exhaust fans.
- .5 Provide integral bases on floor mounted Class I and Class II fans. Refer to Section 15100 for requirements for inertia bases.
- .6 Sheaves and Belts:
 - .1 Provide variable pitch sheaves on fans up to and including 3.7 KW (5 HP) and fixed pitch double belt sheaves on fans up to 7.47 KW (10 HP). For fans 11.2 KW (15 HP) and greater, provide a minimum of three groove fixed sheaves. Provide two sets of sheaves; one set to provide specified RPM and another set as specified by the air balance firm should field testing make this necessary.
 - .2 Provide premium quality oil resistant B or C section V belts. For fans 11.2 (15 HP) and greater, provide multi groove power band belts.
 - .3 Submit sheave and belt selection data with shop drawings.
- .7 Belt Guards: Provide expanded metal type with 25mm (1") dia. tachometer openings at both fan and motor shaft locations. Provide one opening with adjustable plate to compensate for motor position adjustment.
- .8 Acceptable Manufacturers:
 - .1 Greenheck, Chicago Blower, Sheldons, Barry Blower, Trane, Joy, Woods, SF, New York Blower, Twin City, Northern Blower and Acme for Belted Vent Sets, Class I, Class II, in line and propeller applications.
 - .2 Cook, Jenn Fan, Delhi, Lau, Greenheck, Aerovent, Acme, Penn and Carnes for Light Duty Roof and Sidewall Mounted Exhaust propeller, belted vent sets and Air Transfer.

2.12 ROOF AND SIDEWALL EXHAUST FANS

- .1 Centrifugal fan units, V belt or direct driven, with spun aluminium housings, complete with resilient mounted motor and fan, 12mm (2") mesh aluminium birdscreen, automatic gasketed backdraft dampers, disconnect switch within fan housing, continuous curb gaskets, stainless steel securing bolts and screws and sealed permanently lubricated ball bearings.
- .2 Acceptable manufacturers: Cook, Delhi, Lau, Jenn Fan, Greenheck, Carnes, Penn.

2.13 CENTRIFUGAL CABINET FANS

- .1 Twin or single blower, acoustic lined cabinet, complete with united mounted speed controller, with either inlet connections or inlet grille as required where shown and disconnect switch or receptacle, and back draft dampers. Refer to fan schedules.

2.14 GAS VENTS AND STACKS

- .1 Gas vents for atmospheric gas fired equipment: Type B ULC labelled complete with all supports, flashings, rain caps and bands, in sizes as shown complete to meet requirements of Authorities having jurisdiction. Provide ULC labelled vent in accordance code and suitable for outdoor installation where located above the roof line or beyond exterior walls.
- .2 Gas vents for stand-by generator exhaust and forced draft fired equipment: Metalbestos Model PS Insulated 316 stainless steel lined and clad all fuels type complete with all supports, flashings, rain caps and thimbles in size as shown complete to meet requirements of Authorities having jurisdiction.
- .3 Acceptable Alternative Manufacture: Vanpacker, ICC Industrial Chimney Inc. and Heat Fab Inc.

2.15 FLEXIBLE CONNECTIONS

- .1 General HVAC System: provide at connections to fans and at air handling units, neoprene coated glass fabric, factory fabricated, flexible connections, as approved by Authorities.

2.16 FILTER GAUGES

- .1 Across the filter bank of each air handling unit, provide Magnehelic differential pressure gauges, Dwyer series 2000 range (0 to 0.50 kPa) (0 to 2" wc).

2.17 MOTORIZED DAMPERS

- .1 Motorized dampers are specified in Section 15900.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

- .1 Install all ductwork and fittings using crossbreaking, joining, attachment and hanging methods as specified in the SMACNA HVAC Duct Construction Standards - Metal and Flexible 1995.
- .2 Provide hangers for rectangular and round ductwork as specified in tables 4-1 and 4-2 as specified in the SMACNA HVAC Duct Construction Standards - Metal and Flexible 1985.
- .3 Ductwork subject to static pressure in excess of 0.75 kPa (3 in.) w.c. shall be leaked test and be in conformance with sections of the HVAC Duct Leakage Test Manual. Provide all necessary assistance to the Air Balancing Contractor to perform such leakage test. Refer to Section 15050, Air and Water Balancing and Testing.
- .4 Ground across flexible connectors with No. 2/0 braided copper strap.
- .5 Install balancing dampers at branch ducts where indicated on the Drawings.
- .6 Flexible ductwork: Maximum installed length: One continuous length at 1600 mm (5'-0"). Use standard sheetmetal elbows at drop points to outlets and do not bend flexible ductwork any greater than 1.5 X diameter.

- .7 Sealing of ductwork and plenums: Apply sealant on all seams and joints on all air supply return and exhaust ducts. Refer to SMACNA HVAC Duct Construction Standards - 1985, Table 1-2, and provide sealants to seal classifications as follows:
 - .1 Seal Class C for all duct systems constructed for operation under, but not exceeding, 50 mm (2") static pressure (including variable volume systems).
 - .2 Seal Class B for all duct systems constructed for operation not exceeding 75mm (3") static pressure.
 - .3 Seal Class A for all duct systems constructed for operation in excess of 75mm (3").
 - .4 Seal Class A for all plenums and field constructed coil, filter and fan casings or combinations thereof.
- .8 Where interior of duct is visible through grilles, registers or diffusers, paint interior of duct with flat black Tremco paint formulated for galvanized surfaces.
- .9 Apply full coverage of adhesive (all internal surfaces) for internal insulation.
- .10 Apply internal insulation edge, joint and pin sealant to manufacturer's instructions. Thoroughly seal all exposed edges, perforations and joints on internal duct lining.
- .11 Ductwork installed outdoors (not externally insulated): Seal all joints with paintable Silicon caulking compound.
- .12 Provide spin-on connections c/w dampers at each boot or plenum supplying integrated ceiling air supply outlets.
- .13 During installation of ductwork, protect open ends of ducts to prevent entry of debris and dust.
- .14 Place ductwork as close as possible to partitions where shown on the Drawings in such locations.
- .15 Ventilation ducts for refrigeration exhaust systems of chiller rooms to be extended to 300mm (12") above finished floor.

3.02 GAS VENTS AND STACKS

- .1 Follow manufacturer's recommendations for prefabricated components. Comply with requirements of Authorities for installation of gas vents for both interior and outdoor locations. Provide a minimum of three 6mm (3") stainless steel guy cables with turnbuckles on any vent (or stack) higher than 1500mm (5'-0") above roof.
- .2 Vent connectors serving appliances vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure.

3.03 FIRE DAMPERS AND CEILING DAMPERS

- .1 Install to ULC requirements. Locate in fire walls, ceilings and partitions where indicated. Coordinate with and provide ULC installation details to drywall installer.
- .2 Seal around fire damper assembly.
- .3 After completion, have installation approved prior to concealment.

3.04 FRESH AIR AND EXHAUST LOUVRES

- .1 Louvres are specified in Section 10200 - this Section to make all required duct connections. Caulk all joints at louvre connection to ductwork.
- .2 Provide drain valves in fresh air and exhaust air plenums and connect valves to nearest floor drains.

3.05 FLASHING

- .1 Provide flashings to suit installation.
- .2 Follow detail Drawings for vents and pipes penetrating roofs.

3.06 GRILLES, REGISTERS AND DIFFUSERS

- .1 Fit frame with gasket to prevent leakage, and smudging.
- .2 Install with oval head plated screws in countersunk holes where fastenings are visible.
- .3 Ensure unit is compatible with ceiling or wall construction.
- .4 Make connections of rigid or flexible ductwork to diffusers and air distribution boots using a minimum of 3 self tapping screws and seal with glass fab tape and high velocity duct sealer.

3.07 FILTER GAUGES

- .1 Sensing Points: Locate as directed by the manufacturer and carefully clip tubing to avoid damage and interference with filter removal or servicing. Mount gauges on the unit for convenient observation as directed by the Consultant.

3.08 MOTORIZED DAMPERS

- .1 Install all automatic dampers, as supplied and instructed by Section 15900 subcontractor, free from distortion and binding of linkages. Thoroughly caulk around frames.

3.09 ACCESS DOORS

- .1 Refer to Section 15050.

3.10 FANS

- .1 Comply with manufacturers requirements. Ensure vibration free installation. Leave access for servicing. Install belt guards and weatherproof covers as required.

3.11 BAFFLES

- .1 Provide baffles, where required to reduce problems of air stratification, as directed by the Consultant.

3.12 VIBRATION AND OBJECTIONABLE NOISE

- .1 Install ductwork free from pulsation, chatter, vibration or objectionable noises. Should any of these defects appear after the system is in operation, correct same by either removing and replacing or reinforcing the work as directed by the Consultant.

3.13 AIR BALANCING

- .1 Air balancing is specified in Section 15050 - Basic Materials and Methods.
- .2 Provide personnel, tools and materials to assist and work under the direction of the air balancing firm to perform the following:
 - .1 Removal and replacement of ceiling tiles.
 - .2 Installation of pitot tube test opening enclosures.
 - .3 Installation of dampers and baffles as required for specified air balance and elimination of stratification.
 - .4 Provision of access openings and covers.
 - .5 Provision of ladders and scaffolds
 - .6 Removal and replacement of belt guards.
 - .7 Removal and replacement and provision of required sheaves and belts as directed, and other items as necessary for complete and acceptable air balancing procedures.

END OF SECTION 15800

PART 1 - GENERAL

1.01 DESCRIPTION

- .1 Comply with requirements of Tridel construction specifications and all documents referred to therein.
- .2 Comply with requirements of Mechanical General Provisions Section 15010 and Mechanical Basic Materials and Methods, Section 15050.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Provide a complete electric/electronic control system with all required temperature sensors, controllers, dampers, valves, operators, switches, wiring, thermostats and other accessory equipment, in accordance with the Drawings and as required by description of sequences including, but not limited to the following systems:
 - .1 Unit heaters and cabinet heaters.
 - .2 Supply and exhaust fans.
 - .3 Radiation control valves and thermostats.
 - .4 Fan coil unit low voltage wiring to remote thermostats (control valves and thermostats supplied by others).
 - .5 Low water cut offs.
 - .6 Freeze stats.
 - .7 Split system A/C unit wiring and controls
 - .8 ERV unit control wiring for suites and other areas
 - .9 Air supply, return, exhaust and relief systems
 - .10 Hot water heating and chilled water cooling systems
 - .11 Chillers, condensers, boilers, cooling towers and pumps
 - .12 Electronic/electric actuators for all combustion air dampers.
- .2 Assistance in balancing of all hydronic systems and air systems.
- .3 A complete direct digital control (DDC) Energy Management and Control System (EMCS) will be provided **under a separate contract by Provident Energy Management**. They will provide all required software, host computer, monitor, keyboard, printers, field processing units only. The systems that are controlled and monitored by the EMCS shall include, but not be limited to:
 - .1 Air supply, return, exhaust and relief systems.
 - .2 Hot water heating and chilled water cooling systems.
 - .3 Chillers, condensers, boilers, cooling towers, pumps.
 - .4 Electronic static pressure sensors and electric actuators for variable frequency drives on air handling unit fans.
 - .5 Electronic/electric actuators for all combustion air dampers.
 - .6 A complete dynamic colour graphics package including all necessary programming.
 - .7 Service contract.
- .4 The EMCS is intended to supplement and not replace the base building control system. This contractor is responsible to ensure sufficient base controls are installed to allow for basic full building HVAC system functionality irrespective of the EMCS.

1.03 QUALITY ASSURANCE

- .1 Qualifications: Execute work of this Section by a recognized firm engaged in the design, manufacturing and installation of controls equipment.
- .2 Wholesalers, subcontractors and franchised dealers will not be accepted.
- .3 Acceptable Firms: Invensys, Siemens, Johnson, Honeywell, Automated Logic (TAC), Delta Controls (Optimira).

1.04 SUBMITTALS

- .1 Submit control shop drawings and wiring diagrams with written sequences of operation and components description.
- .2 Submit catalogue cuts and specifications on all controls equipment.
- .3 Submit controls data by systems; i.e., FC-1 fan coil unit control, EF-1 exhaust fan, etc., whereby schematics, panel terminal wiring, sequences of operation, hardware and component lists are grouped together without requiring cross reference to other parts of the data.
- .4 Submit proposed form of contract for service work.
- .5 Show all dimensions and power requirements. Co-ordinate installation with other equipment i.e., fire alarm and security monitoring.

1.05 GUARANTEE

- .1 Guarantee the control system and all components thereof free from defects in operating sequences, materials and workmanship for a period of one year of normal use and service from the date of certified acceptance by the Consultant - refer to warranties Section 15010.

1.03 ACCEPTANCE

- .1 Acceptance by the Consultant will be granted when:
All components installed, operating and calibrated.
- .2 Operating personnel have received a minimum 8 hrs. of instructions.
- .3 As-built drawings and operating instructions submitted.

1.04 INSTRUCTION, ADJUSTMENT AND "AS-BUILT" DRAWINGS

- .1 On completion of the Work, calibrate and adjust all components to operate as required. Provide three complete instruction manuals with "as constructed" control drawings and instruct the Owner's operating personnel in the operation and function of the system.
- .2 Provide a minimum of 8 hrs. (2 - 4 Hr. sessions) instruction on controls operation to Owner's staff and 5 call-back sessions of 2 hrs. each during the first year of operation.

1.05 SERVICE CONTRACT

- .1 Include in the tender price the cost for a "full service" contract on all base building control components for 12 months commencing on the date of acceptance by the Consultant. This contract to include all required calibration, adjustments, and all other items required to keep

the system in first class operating condition as would be recommended by the installer on an on-going year to year basis.

This contract is to be between the Owner directly and the installing Subtrade performing the Work of this Section. Present two copies of the form of contract for review on submission of shop drawings.

1.06 SHOP DRAWINGS

- .1 Submit shop drawings for review in sufficient quantities to satisfy contractual requirements. Where shop drawings consist of printed catalogue sheets, submit at least ten (10) copies. Shop drawings pertain to each particular item as specified; show project and component name, item reference number, certified physical and performance data; and clearly indicate all applicable parts and accessories. Affix Contractor's "Approved" stamp on all copies of all shop drawings prior to their submittal to the Engineer for review. Approval stamp shows name of firm, date the approval was made and the checker's signature or initials. Should the above requirements not be adhered to, shop drawings submitted will be returned for proper re-submittal.
- .2 Shop drawing review by the Engineer is for the sole purpose of ascertaining conformance with general design concept. This review means that the Engineer does not approve the detail design inherent in the shop drawings, responsibility for which remains with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omission in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of the work of all subtrades.
- .3 Shop drawings (Adobe "PDF" format) shall show the following:
 - .1 Drawings of each HVAC system showing all connected devices, all wiring connections between all components with terminal numbers. Wiring diagrams shall clearly designate between Division 15, Division 16 and Section 15900 work.
 - .2 Documentation of all maintenance procedures for each system components including inspection, periodic preventive maintenance, fault diagnosis and repair or replacement of defective module. This shall include calibration, maintenance and repair of sensors, transmitters, transducers and panels plus diagnostics and repair or replacement of all system hardware.
 - .3 Damper schedules with construction details and dimensions. Identify dampers in accordance with specification and drawings.
 - .4 Specifications and data sheets for all control system components including relays, switches, thermostats, controllers, dampers, indicators, flow switches, sensors and similar components.
 - .5 Valve schedules with construction details, pressure drops and flows.
 - .6 Submit three (3) complete sequences of operation of the control systems in both program and written format.
 - ..7 Detail drawings showing typical mounting methods for all sensors, transmitters and status indicators.
- .4 Provide a copy of all "as-built" shop drawings in each of the Manuals specified. Provide an Operator's manual consisting of instructions, program listings and control sequences.
- .5 Shop Drawing must be approved before any materials are delivered or installed at site."

PART 2 - PRODUCTS

2.01 DAMPERS

- .1 Standard Dampers for Return Air: TAMCO series 1000 supplied by the automatic control manufacturer. Provide parallel blade type for mixing applications. All bearings to be "oilite" bronze. Size all dampers as NET dimensions (damper blade area = duct cross sectional area) as shown on drawings.
- .2 Low Leakage Dampers for Outdoor Intake and Exhaust Applications: Provide, in sizes and in locations as shown on the drawings, parallel blade (air flow directed upwards) extruded aluminium Tamco air foil dampers series 9000 as manufactured by T.A. Morrison with features as follows:
 - .1 1% leakage at 1 kPa (4") static pressure differential.
 - .2 12 ga. extruded aluminium air foil single unit internally reinforced blades with continuous extruded overlapping vinyl seals.
 - .3 12 ga. extruded frame with extruded vinyl seals on all sides.
 - .4 Out-of-airstream aluminium alloy linkages and crank arms with celcon bearings.
 - .5 Celcon and polycarbonate bearings with no metal to metal contact.
 - .6 Sized for "flanged" installation (damper blade area to be equal to duct cross sectional area).

2.02 ACTUATORS

- .1 Electric/Electronic Sized to provide adequate power for opening, closing and modulating dampers or valves in specified time.
- .2 Provide each actuator with a bracket for attaching to ductwork, building structure, or equipment. Do not install actuators in ducts or fresh air intakes.
- .3 Provide electric low temperature protected actuators in unheated areas such as parking garages, ventilation shafts and transformer rooms and on any equipment located outdoors.
- .4 Wherever possible, actuators to be provided to the original equipment manufacturer for factory installation (i.e. fan manufacturers). Provide actuators to equipment manufacturer's specifications.
- .5 All damper and valve actuators to be provided with spring return to normal position.
- .6 Unless shown otherwise on drawings, actuators to be provided and set up such that all heating valves and return air dampers are normally open and cooling valves, exhaust and outdoor air dampers are normally closed.
- .7 Floating control is not acceptable. 0-10VDC only will be accepted.
- .8 Acceptable manufacturers: Belimo.

2.03 AUTOMATIC CONTROL VALVES

- .1 Properly sized and selected by the manufacturer in accordance with load requirements and characteristics of the systems to which they are applied. Do not provide, under any conditions, valves smaller than 20mm (:").

- .2 Water pressure drop through all two-way modulating control valves: 18 kPa (2.5 PSI) Water pressure drop through all three-way modulating major system valves; 35 kPa (5 PSI).
- .3 Minimum close off pressure for valves in reheat coil application to be 400 kPa (58 PSI). Control valves for heating application to be spring return to open flow port in power off condition.
- .4 All valves: provide with integral seats ground into the body. Disc assemblies: replaceable and selected for fluid to be controlled.
- .5 Modulating applications: provide valves with throttling plugs for linear lift-flow ratio.
- .6 Where butterfly type valves are required, provide "high cycle" type. Provide industrial type actuators as manufactured by Rotork, Grinnell or Bettis.
- .7 Where butterfly type valves are used in a 3 port arrangement, mount valves on a common "tee" and use one actuator only.
- .8 Floating control is not acceptable. 0-10VDC only will be accepted.
- .9 Acceptable manufacturer: Siemens

2.04 WIRING

- .1 Provide all electrical wiring and components required (of any voltage) within the temperature control system such as low limit protection, thermostats, alarms, refrigeration system components, relays and interlocks as required to achieve the control function specified in the schematic drawings and sequences of operation. This work to include wiring into prefabricated control circuits (as co-ordinated with the appropriate sub trade or supplier) of boilers, fluid coolers, air cooled condensers, pump sets and fire alarm panels. Also provide suitably rated relays for single phase motors wired in series with manual starters where EMCS start/stop operation is required. Provide "Hand-Off-Auto" switch on relays.
- .2 Provide all power and interconnecting wiring to EMCS field panels. Co-ordinate with Division 16 Subtrade for appropriate locations of all power outlets for head-end equipment (monitor/keyboard, printers, clock). Do not wire any EMCS components into emergency power supply.
- .3 24 Volt, EMCS wiring may be run in ceiling spaces utilizing approved plenum cable.
- .4 Electric duct heater thermostat wiring is by this section. All other electric entrance heater thermostat wiring is by Division 16.

2.05 COMPONENTS

- .1 General standard of quality to be equal to the following:
 - .1 Dampers D1300 (Johnson Controls) for return air only)
 - .2 Flow Switches for Coil Freeze Protection Service and flow proving for boilers and fluid coolers: ULC labelled McDonnell Standard No. FS7.
 - .3 Timers: Rex (Davis Controls) Maxirex BDI single channel digital type with a minimum of 4 separate switch on - switch off programs for each day of the week with LCD continuous display of program status, 1 minute shortest switching period, rechargeable 100 HR reserve battery back-up, automatic or manual on-off operation and suitable for cut-out panel mounting.

2.06 FREEZE PROTECTION

- .1 Freeze protection devices (low limits) shall have manual reset features and shall NOT automatically recycle. Freeze controls shall have 6.0 m (20 ft.) capillary arranged in ducts for best possible protection. Provide freeze-stat for each 5.6 m² (60 ft²) of duct area where necessary, wired in series.

2.07 FIRE PROTECTION

- .1 Fire protection devices (high limits) shall have manual reset feature and shall not automatically recycle.

2.08 RELAYS

- .1 Relays shall be solid state, heavy duty type. Supply, install and wire all relays for line voltage applications.

2.09 HUMIDITY SENSORS

- .1 Humidity sensors shall utilize polymer film technology and shall have a 2% accuracy over a range of 10 to 90% R.H.
- .2 Provide sampling chamber for duct-mounted sensors.

2.10 SWITCHES

- .1 Pressure electric switches shall have diaphragm operated SPDT snap acting contacts with electrical rating suitable for applications as specified. Pressure electric switches shall withstand up to 25 psig and be provided with adjustable cut-in and cut-out settings between 3 and 20 psig.
- .2 Water flow switches shall be general purpose with a paddle actuated, snap acting SPDT switch rated at 16 amp 120/1/60 AC full load.
- .3 Air proving (differential pressure) switches shall utilize a differential pressure activated, diaphragm actuated, snap acting SPDT switch rated at 9.8 amp 120/1/60 AC full load. Differential pressure range shall be selected to suit the application, set point shall be adjustable. Mount switches with diaphragm in a vertical plane. Switches shall be CSA approved.
- .4 Minimum positioning switches shall be installed inside local cabinets. After system balancing, switches shall be locked.
- .5 Damper status switches shall be lever operated, activated by damper blade movement and mounted securely on damper frame. Switches shall have a contact rating of 5A to 120 VAC and shall be CSA approved.

2.11 ELECTRIC LINE VOLTAGE THERMOSTAT

- .1 Provide heavy duty type. Include back plate and bracket for mounting on standard size outlet box where required.
- .2 Provide heating/cooling type thermostat where sequencing of heating and cooling/ventilation is required.

- .3 Provide guards for thermostats located in all public areas.

2.12 ELECTRIC LOW VOLTAGE THERMOSTAT

- .1 Provide complete with heat anticipator, and back plate and bracket for mounting on standard size outlet box where required. Include sub-base with fan On-Off-Auto switch with each thermostat where summer ventilation is required. Include modulating heating or cooling stage where used in conjunction with control valves; step controllers; SCR's; or similar equipment requiring modulation, and mercury switches where On-Off control is required.
- .2 Provide guards for thermostats located in all public areas.

2.13 NAMEPLATES

- .1 Provide lamacoid nameplates, 25mm x 550mm (1" x 22") at all control system devices to clearly indicate the service of a particular device. All manual switches, unless they come with standard nameplates, are labelled. All thermostats, thermometers and switches installed on all local panels shall be similarly labelled. Permanent painted stencil labels may be used on all controllers and relays mounted inside local panels, if so desired. Tape labels are not acceptable.
- .2 All duct and pipe mounted sensors, ASC's, etc. are to be similarly labelled.

2.14 ACCESS DOORS

- .1 Refer to Section 15050 for access door requirements.

2.15 ERV CONTROLS

- .1 Suite ERV's: Main controller to be model 4027. Auxiliary controller to be model 1806110.
- .2 Amenity ERV's: Interlocked with ventilation unit controls.

PART 3 - EXECUTION

3.01 COMPONENTS

- .1 Mount all controllers and relays within control panel cubicles. Mount exposed components for easy access and protect from damage.
- .2 Cut-out mount switches and timers on control panel fronts.
 - .1 Identify all exposed components and equipment mounted on the control panel front with lamacoid nameplates screwed or pop-riveted in place. Identify instruments inside the cabinet with Dymo tape labels.
 - .2 Locate all local control panels as shown on the drawings or as directed by the Consultant.
 - .3 Provide electric freeze protection thermostats with averaging elements capable of sensitivity on any 300mm (12") portion. Mount element across coil face approximately 150mm (6") downstream of coil in rows 400mm (16") OC. Locate

lowest row no higher than 1500 mm (6") above bottom of coil. Mount thermostats side-by-side 1500mm (60") above floor on service side of unit.

Provide relay such that on low temperature shut-down, one button will reset control circuit. Label and locate button on service side of equipment.

- .4 Mount CO detectors between 900 to 1200mm (3'- 0" to 4'- 0") above floor. Provide a lockable wire guard enclosure over unit. Provide field calibration by manufacturer's designated representative.

3.02 CO-ORDINATION

- .1 Attend and assist in testing and commissioning the chiller, cooling tower, boiler and pumping systems.
- .2 Attend and assist in testing and commissioning air handling and distribution systems.
- .3 Set outdoor air dampers to minimum positions as verified by the air balancing specialist.
- .4 Attend and assist in commissioning, start-up and testing of fans and smoke/fire dampers.

3.03 WIRING

- .1 Install all wiring in conduit and conform to CSA, ULC and local Code requirements as well as requirements as specified in Division 16 except as stipulated in following paragraph .2.
- .2 EMCS 24 Volt Wiring: In ceiling spaces, approved plenum cable to be installed neatly clipped to structure in 8 foot intervals and run parallel and at right angles to building structural members. Plenum cable to be installed clear of any electrical or mechanical components requiring access or servicing.

3.04 CHILLERS AND BOILERS

- .1 Co-ordinate with chiller and boiler manufacturers and provide all required wiring and components as required to achieve specified sequences of operation.

3.05 DDC SYSTEM

- .1 Provided by Provident Energy Management.

3.06 LABELLING

- .1 All control equipment is to be labelled with lamacoid plates with a designation corresponding to the specific system point description/label. All lamacoids shall be mechanically fastened to surfaces. Submit samples to the Owner for approval.

3.07 ERV CONTROLS

- .1 Locate main controller 4027 in the main bathroom. If two bathroom suite, locate auxiliary controller 1806110 in the 2nd bathroom. Controls are to be mounted adjacent to bathroom light switches.

3.08 SEQUENCES OF OPERATION

- .1 Elevator Machine Room Temperature Control: During summer a sensor/controller on sensing a rise in space temperature will open the control valve on the fan coil unit dedicated to this elevator machine room. During winter a sensor/controller on sensing a drop in space temperature will open the control valve on the fan coil unit dedicated to this elevator machine room. During winter a sensor/controller on sensing a rise in space temperature will open the intake damper and cycle on the exhaust fan dedicated to this elevator machine room.
- .2 Emergency Generator Room Temperature Control: A temperature sensor will control the room temperature with two operating modes.
 - .1 When the generator is on:
 - On sensing a temperature drop, modulate the generator outdoor air and exhaust dampers open and the recirculation damper open. Unit heaters to be cycled "on" if temperature continues to drop.
 - On a space temperature rise, modulate the generator outdoor air and exhaust dampers open and the recirculation damper closed.
 - .2 When the generator is off:
 - On sensing a temperature drop, cycle "on" the unit heaters.
 - On a space temperature rise, modulate the room exhaust and intake dampers open and cycle on the room exhaust fan.
- .3 Mechanical and Electrical Room Temperature Control: (Separate Loop) A heating/cooling thermostat will, on a temperature drop, cycle on the unit heater. On a space temperature rise the thermostat will open the intake damper and start exhaust fan.
- .4 Garbage Room Temperature Control: (Separate Loop) A heating/cooling thermostat will, on a temperature drop, cycle on the unit heater. On a space temperature rise the thermostat will open the intake damper and start exhaust fan. This system also applies to water meter and oil tank rooms.
- .5 Domestic Water Booster: Booster pump package operates continuously on factory supplied controls during normal operating hours.
- .6 Domestic Hot Water Recirculating Pumps: To run continuously.
- .7 Boiler Room Temperature Control: (Separate Loop) A sensor/controller will, on a temperature drop, cycle on the unit heater. On a space temperature rise it will open the supply and relief dampers and start the supply air fan.
- .8 Combination Sprinkler and Standpipe Pump: (Separate Loop) The fire pump will cycle in response to the factory supplied pressure controller. This section to provide a pressure controller and wiring to cycle the excess pressure and jockey pumps.
- .9 Trap Seal Primers: (Separate Loop) Wherever flush tanks are used for trap seal priming, provide a control valve on the water supply controlled by a timing device to allow water flow for a maximum period of 1 hour once for each 24 hour period.
- .10 Miscellaneous parking level mechanical and storage rooms: A heating thermostat will on sensing a space temperature drop activate the unit or entrance heater and upon a space temperature rise cycle on the exhaust fan.
- .11 Suite ERV units are to generally operate continuously at low speed and then switch to high speed when the override button is activated at one or more of the controllers. Units shall not be turned off except for service.

- .12 Amenity ERV unit is to be controlled by the BAS according to TOD scheduling. Unit generally operates at constant speed during occupied hours and is off during unoccupied hours.
- .13 Fresh Air Systems:
 - .1 The unit to start according to TOD scheduling and factory installed controls. The inlet air damper should prove open before the supply fan starts – end switch tied to VFD enable. The controller shall maintain a fixed discharge air set point of 67 deg F, adjustable by the building operator.
 - .2 MUA is to be set back to 50% (20 cfm per door) for 20 hours a day and is only operate at 100% (40 cfm per door) during peak hours (4 hours per day).
 - .3 Safeties: Fan to stop if:
 - .1 Smoke detector (Div. 16) senses products of combustion.
 - .2 Low limit temperature sensor LT senses below set point.

END OF SECTION 15900