April, 2015

Introduction

The following are the University of Toronto Mechanical Design Standards. The information contained within these standards must be followed unless:

1. They cannot be applied to the specific design work planned. The design consultant must present the information to the Project Manager to point out the problem and receive permission to implement the alternative solution.

2. If an alternate product or system is available, which is the recommended standard of the consultant for the project, approval may be requested for such an alternate through the Project Manager.

3. If there is a conflict between the standards and codes, such issues should be brought to the attention of the Project Manager for a decision on what to use.

4. If there is a substantial cost savings to be realized by changing from a particular standard and the consultant is recommending such a saving, the Project Manager will consider such a request. The consultant might be requested to substantiate the cost savings.

5. The consultant must point out any problems with the standards, and provide alternates that may be more appropriate. The consultant is also encouraged to comment on the appropriateness of the standards as compared to general industry standards.

6. Should there be a discrepancy between products or models stated in the text of this standard or in Appendix A – "List of Mandatory and Preferred Manufacturers", Appendix A shall have priority.

7. The Project Manager must consult with the appropriate operating division of Facilities and Services before giving approval for any deviations from this Standard.

MECHANICAL DIVISION 15 PART 2 SECTION B

CONTENTS

Note:

- **For Fire Alarm requirements refer to Division #28 31 00.**
- **For Fire protection sprinklers, piping and pumping requirements, refer to Section Division #21 xx xx**
- **For Controls/BAS requirements, refer to Division 25 xx xx**

Appendices

Basic Mechanical Design Guidelines

1. All work on pressure vessels, boilers and power piping shall only be done by companies that are registered and certified by the Technical Standards and Safety Authority (TSSA) of Ontario.

2. Due to the capacity and hydraulics limitations of the Mechanical utilities from the Central Heating Plant (17 Russell Street) and the Central Cooling Plants (North-West Chiller, Bahen Centre and Medical Sciences), verify the addition of new loads onto these systems with the Director, Utilities and Building Operations.

3. Metering: (also refer to metering requirements within section 25 xx xx)
   - Provide monitored (connected to building DDC system) flow, temperature and energy meters on all central cooling water, steam and high temperature water.
   - Provide volume metering on all irrigation system supplies, cooling tower city water makeups and bleeds and swimming pool makeup. Provide shutoff valves and a bypass connection as necessary to allow continuous service when maintenance is performed on the meters.
   - **As it is often the case that construction activities will require the use of University-generated heating or cooling energy prior to the University's takeover of the new facilities, the above metering must be fully installed, operational and commissioned prior to the University allowing the opening of any shutoff valves for the heating or cooling systems.**

4. Lifts or removable ladders shall not be relied upon for access unless approved by University representative.

5. Provide pedestrian waterproof traffic topping system over entire mechanical room floor including over housekeeping pads under air handling units etc (see architectural finishes section).

6. Consultant shall include a statement in the specifications to the effect that all components of the mechanical systems (e.g. fans, ducting, insulation, sound attenuators, air terminal boxes, pumps, VFD drives etc) must be kept clean and dry as manufactured, delivered, stored and installed before operating the mechanical systems.

7. The abandonment of existing equipment and material in place is not acceptable. Abandoned systems can become a serious liability since it cannot be easily determined what is active and what is not. The correction of existing mechanical problems and removal of abandoned mechanical equipment while maintaining the proper operation of the building, all need to be addressed in the contract documents.

8. These standards are intended to be cost effective standards. The consultant, however, should understand that the University strives to achieve sustainability, operability, more permanence and lower long term maintenance costs incurred in the products that are purchased and installed. The standard therefore, might be slightly higher than the normal commercial standard.

Mechanical Design Standards - Checklist

The Design Team is required to read and comply with the full Design standard as it applies to this project. A completed copy of this checklist must be submitted by the Design Team to the University's Project Manager at the end of the Design Development Phase. In all cases, if a "does not comply" has been noted, please indicate why. Attach additional sheets as necessary.

15 xxx MECHANICAL

	C	N	N/A
15000 Placement of Equipment			
1. **General** :			
1.1. Do not locate equipment in areas which are difficult to access and maintain.	☐	☐	☐
1.2. Do not locate equipment in window wells, etc. that are at risk of flooding.	☐	☐	☐
1.3. Provision must be made for lifting and moving spare supplies, parts, equipment and chemicals into and out of mechanical rooms. Consider providing electric hoist or elevator.	☐	☐	☐
1.4. The location of fresh air intake for buildings is extremely important. They must be located so that no car, truck or diesel generator fumes get drawn into the air system. The designer must consider the location in relationship to parking, shipping and receiving areas, loading docks etc.	☐	☐	☐
1.5. Avoid locating air vents on grade. If this is absolutely necessary, then the grates must be fastened down securely, and protection from outside influence must be provided.	☐	☐	☐
1.6. Provide adequately sized access pathways for the repair, maintenance and eventual replacement of the equipment such as heating/cooling coils and other large pieces of equipment.	☐	☐	☐
2. **Mechanical room floors:**			
2.1. Provide sealed curbing of all floor penetrations. Curbing shall be at least 6″ high. (Coordination with Architect required)	☐	☐	☐
2.2. Provide adequate floor drains, and slope floors down to the drains. Provide individual floor drains for equipment discharge.	☐	☐	☐
2.3. Provide pedestrian waterproof traffic topping system over entire mechanical room floor including over housekeeping pads under air handling units etc (see architectural finishes section).	☐	☐	☐
3. **Placement of equipment on roof:**			
3.1. Air handling units with chilled water and hydronic coils shall utilize an appropriate glycol solution or be drainable and fitted with coil moisture evacuation fittings (see sketch # 15.1 in appendix B at end of these standards). The use of and location of steam coils in air handling units shall be approved by U. of T. representative.	☐	☐	☐
3.2. Cooling towers shall be equipped with platforms constructed in such a way as to allow easy and safe access to serviceable components (e.g., motors, fans, valves etc). (Coordination required between Mechanical consultant & Architectural consultant for walkways and roof accessories).	☐	☐	☐
3.3. Access to the roof for mechanical room access shall be by normal stairs and doors rather than ladders and hatches. Lifts or removable ladders shall not be relied upon for access unless approved by University representative. (Coordination required with Architect).	☐	☐	☐

	C	N	N/A
3.4. Adequate rooftop walkways must be provided for servicing mechanical equipment. These walkways shall be raised at least 4" above roof grade**,** shall be minimum 30 Inch width, be equipped with handrails and shall run from roof access to the maintenance areas of the equipment on roof. These walkways shall be constructed of galvanized steel grating or wood boards. (Refer to Architect for roof platforms, walkways & roof accessories).	☐	☐	☐
3.5. The roof is to be protected from damage during equipment installation.	☐	☐	☐
3.6. All guy wires shall be adequately identified with yellow protective sleeves.	☐	☐	☐
3.7. If possible equipment should not be placed closer than 6' 0" from the edge of the roof. Any mechanical equipment, (such as fans, AC units, etc.) that must be located within 6 ft. or less of roof perimeter, shall be provided with guard-rails unless there is a parapet wall of 36" high minimum at the roof perimeter. (Refer to Architect for roofing design & accessories)	☐	☐	☐

3.8. **Fundamental Instructions for Installation of New Equipment on Flat Roofs**

3.8.1. Any new equipment that is to be installed on a **steel framing** (for example but not limited to; cooling towers, faculty equipment etc) above the roof level shall maintain a 30” clearance between the top of the roof system and the bottom of the equipment). This space is required to ensure access to the roof membrane under the equipment. The supporting I-beams must clear the top of the roof by minimum 12”, and there must also be access to the space under the equipment. (Refer to Architect, roofing consultant and structural engineer).	☐	☐	☐
3.8.2. Any new equipment that is to be installed on top of a **curb/base/sleeper** (for example but not limited to; Exhaust fans, packaged roof top AC units, air cooled condensers, rooftop installed air-handling units) shall be mounted to ensure a clearance of 12” to 18” from the top of the roof level. (Refer to Architect & roofing consultant)	☐	☐	☐
3.8.3. Ducting, piping and conduits (for example but not limited to; Cooling tower condensate water piping, side/end discharge of air-handling unit’s duct work running above the roof, refrigeration piping, electrical/control wiring, gas lines etc) shall be installed a minimum 12” above top of roof level. If the piping or duct work bundled together or the duct is wider than 24”, then the clearance from the top of the roof level must be increased from minimum of 12” to ensure access to roof membrane. (Refer to Architectural & roofing consultant).	☐	☐	☐
3.8.4. To ensure the integrity of the new roofing, all roof penetrations must comply with IRC’s detailed construction. Pitch pocket type of roof penetration are not to be used. (Refer to Architect & roofing consultant).	☐	☐	☐
3.8.5. Existing equipment on old roofs, which will be replaced with the new roofing system, shall be lifted (relocated) during the re-roofing process to the heights outlined above to ensure proper access to roof membrane for maintenance purposes. (Refer to Architect & roofing consultant).	☐	☐	☐
3.8.6. Paint gas lines in their entirety where exposed to the outdoors.	☐	☐	☐

15060 Pipe Supports and Hangers

1. Provide sufficient supports and hangers for pipe services per code. Heated plastic pipes shall have continuous pipe trays on horizontal runs.	☐	☐	☐

	C	N	N/A

15075 Identification of Piping Systems:

1. All piping except where actually concealed in a pipe space or chase shall be identified according to latest ASME A13.1 “Scheme for the Identification of Piping Systems”. Directional arrows indicating the direction of flow shall be applied adjacent to each identifying legend location. The code consists of two colours for primary (background) and secondary (wording and abbreviations identifying the fluids or gases being carried within the piping) classification. ☐ ☐ ☐

15080 Mechanical Insulation

1. Piping insulation thicknesses shall comply with latest ASHRAE standard 90.1 (Energy Standard for Buildings Except Low-Rise Residential Buildings). ☐ ☐ ☐
2. 30 gauge aluminum cladding protection shall be used for protection in high traffic areas and where exposed to ultraviolet light and weather (e.g. roofs, etc). Use of PVC Zeston 2000 by Johns Manville would be acceptable elsewhere. ☐ ☐ ☐
3. Use of PVC cladding is acceptable on cold water, chilled water, heating water and steam piping and fittings. Where a vapour barrier is required, the barrier shall be an integral part of the insulation. ☐ ☐ ☐
4. Provide removable/replaceable insulation sections at control valves, metering stations, orifice plates. ☐ ☐ ☐
5. Provide insulation on cold water drains where required. ☐ ☐ ☐

15100, 15200, 15300 Pipes & Fittings

(Note: For Fire Protection Piping requirements, see separate Div. 13)

1. Provide galvanized schedule 40 pipe sleeves for all piping penetrations through concrete and masonry. (Coordinate with architectural and structural for location and installation). ☐ ☐ ☐
2. Safety relief devices shall be vented individually, and connected vent piping shall be designed to convey the fluid, without pockets, to the outside atmosphere, and then directed away from equipment ventilation systems and vents from other systems. ☐ ☐ ☐

Pipe and pipe fittings shall be in accordance with the following schedules:

1. Domestic Water

SERVICE	PIPE MATERIAL	FITTINGS	JOINTS			
Domestic Hot & Cold: (above ground)	Copper Type L	Wrought Copper	Soldered, Propress, Victaulic Grooved end	☐	☐	☐
Domestic Cold Water: (buried)	Copper Type K Ductile Iron (Under 2”)	Wrought Copper, Ductile Iron	Soldered Joint, Mechanical Joint	☐	☐	☐

2. Storm and Sanitary Sewage

SERVICE	PIPE MATERIAL	FITTINGS	JOINTS	C	N	N/A
Storm: RWL (vertical runs only inside building)	Cast Iron	Cast Iron	Mechanical Joint,	☐	☐	☐
Storm: (buried outside building)	Cast Iron PVC Sch80 Concrete	Cast Iron PVC	Mechanical Joint PVC Solvent	☐	☐	☐
Sanitary: (up to and including 3")	Copper Type L PVC in Fire Separations	Wrought Copper	Soldered Joint	☐	☐	☐
Sanitary: (over 3" inside building)	Cast Iron	Cast Iron	Mechanical Joint	☐	☐	☐
Sanitary: (buried)	Cast Iron PVC Sch 80	Cast Iron PVC	Mechanical Joint PVC Solvent	☐	☐	☐

3. Steam /High Temp Hot Water (HTHW) and Condensate

SERVICE	PIPE MATERIAL	FITTINGS	JOINTS	C	N	N/A
Steam/HTHW (1-1/4" and under)	Seamless Sch80	Sch80 3000 lb. WOG	Socket welded up to 1st isolating valve threaded after	☐	☐	☐
Steam/HTHW (1-1/2" and over)	Seamless Sch40	Welded Fitting Sch40; 2000 lb. WOG	Welded (10% X-rayed)	☐	☐	☐
Condensate (1-1/2" and under)	Seamless Sch80	Sch80	Threaded	☐	☐	☐
Condensate (over 1-1/2")	Seamless Sch80	Welded Fitting Sch80	Welded	☐	☐	☐
1. All valves connected to the U of T district heating system (steam or HTHW) must be welded and have CRN numbers.				☐	☐	☐
2. a) Steam drip trap valves to be ¾" WO4-2054T-02TS Velan Bellows sealed valves or equivalent. All piping, valves, fittings and flex hose materials must comply with CSA B51 and ASME B31.1 power piping code and must have CRN numbers. Pressure relief valves must be reinspected and have revalidated CRN #				☐	☐	☐
b) High pressure steam drip traps shall be of Bestobel manufacture, bimetallic type, Model DM-25.				☐	☐	☐
3. All piping joints must be hydrostatic / pneumatic tested as per applicable ASME 331.1 Section code or 100% x-rayed if above test is unsafe.				☐	☐	☐

4. Air Conditioning Heating and Cooling Medium

SERVICE	PIPE MATERIAL	FITTINGS	JOINTS	C	N	N/A
Heating Water, Chilled Water & Glycol - Within building or tunnel	1-1/2" and under: Sch40	1-1/2" and under: Sch40	1-1/2" and under: Sch40	☐	☐	☐
	2" and over: Sch40	2"and over: Welded or Victaulic type.	2" and over: Welded or grooved end, e.g. Victaulic	☐	☐	☐
Heating Water - buried	Ricwil pre-insulated or approved equivalent	Ricwil or approved equivalent	Ricwil or approved equivalent	☐	☐	☐
Chilled water - inside building or tunnel	Sch40	1-1/2" and under: Threaded 2" and over: Victaulic or welded	Welded or Victaulic Grooved end	☐	☐	☐
Chilled water - buried	Ricwil pre-insulated pipe or approved equivalent	Ricwil approved	Ricwil approved	☐	☐	☐
1. Filament-wound fibreglass epoxy type is NOT an acceptable option 2. Ricwil buried piping shall incorporate a leak detection system. Piping shall incorporate Galva-Gard hot dipped galvanized outer casing.						

5. Air

SERVICE	PIPE MATERIAL	FITTINGS	JOINTS	C	N	N/A
Compressed air – shop	Stainless Sch 5 or 10	Stainless Steel	Screwed or grooved end, (e.g.Victaulic)	☐	☐	☐
Compressed air - lab control air	Copper Type L stainless steel SS-304	Copper SS-304	Joint Welded; under 2" Pressfit (eg Propress) ; Joints 2" or over; welded or grooved end (e.g. Victaulic)	☐	☐	☐
Vacuum Line	Copper Type L Sch40	Copper/ Mall Iron	Soldered Joint/ Screwed	☐	☐	☐

C N N/A

6. Gases, Chemicals and Laboratory Services

SERVICE	PIPE MATERIAL	FITTINGS	JOINTS			
Distilled water	PVC	PVC	PVC Solvent	☐	☐	☐
Deionized water	PVC	PVC	PVC Solvent	☐	☐	☐
Reverse osmosis water	PVC Sch80	PVC	PVC Solvent	☐	☐	☐
Natural gas, 2" and under	Sch40	Mall Iron	Screwed Viega Propress	☐	☐	☐
Natural gas over 2"	Sch40	Welded Fitting	Welded	☐	☐	☐
Laboratory waste - above ground	Glass or as necessary for the service	Glass or as necessary for the service	Coupling Joint	☐	☐	☐
Laboratory waste - buried	CPVC Sch80	CPVC	CPVC Solvent	☐	☐	☐

7. Other Services

SERVICE	PIPE MATERIAL	FITTINGS	JOINTS			
Lawn Sprinkler	PVC	PVC	PVC Solvent	☐	☐	☐

15100, 15780, 15935 Heat Transfer

1. Provide reverse return hydronic piping systems. ☐ ☐ ☐
2. Individual (ie, separate loop from those serving A/H Units) hydronic circulating loop shall be provided for radiant panel heat transfer systems in order to maintain performance of radiant panels. Do not use radiant panel heating for reheat purposes. ☐ ☐ ☐
3. Constant 180 degree Fahrenheit supply water shall be used to serve radiant panels. ☐ ☐ ☐
4. Individual hydronic circulating loops shall be designed for different systems to maintain control integrity, i.e., greenhouse heating system should not be coupled to general building heating. ☐ ☐ ☐
5. Glycol heating or cooling:
   Use 50% (by volume) solution of propylene glycol and water for heating systems and 20% (by volume) solution for cooling/air conditioning systems. Use of a preheat coil for fresh air intake using hot glycol shall be discussed with U of T representative. ☐ ☐ ☐
6. Heat recovery systems which incorporate the transfer of energy between exhaust air and fresh air are preferred wherever possible. ☐ ☐ ☐

15110 Valves

1. Isolating valves.

   1.1 Acceptable manufacturers in this section include: Challenger, Zurick, and Apollo. ☐ ☐ ☐

	C	N	N/A
1.2 Provide isolating valves for all plumbing fixtures and appliances.	☐	☐	☐
1.3 Provide isolating valves on both inlet and outlet sides of all mechanical equipment to allow easy service. Equipment in this category shall include but not be limited to coils, pumps, pressure reducing valves, control valves, and balancing valves.	☐	☐	☐
1.4 Provide isolating valves on hot, cold and recirculating water services to all washrooms and labs.	☐	☐	☐
1.5 Balancing valves shall not be used as isolating valves.	☐	☐	☐
1.6 Isolating valves for various services shall conform to the following table:	☐	☐	☐

Service	**Ball**	**Gate**	**Butterfly**
Dom. hot water	≤ 2”	> 2”	> 3”
Dom. cold Water	≤ 2”	> 2”	> 3”
Steam < 15 psig	≤ 1.5”	> 1.5”	No
Steam > 15 psig	≤ 1	> 1”	No
High temperature hot water	≤ 1”	> 1”	No
Secondary heating water	≤ 2”	> 2”	> 3”
Cooling tower water			See 1.8
Chilled water	≤ 2”	> 2”	> 3”
Distilled, de-io ized, reverse osmosis water	See 1.6	No	No

1.7 Isolating valves for distilled, de-ionized and reverse osmosis water shall be PVC ball valves. Ensure that the material is compatible with the fluid.	☐	☐	☐
1.8 Butterfly valves used in cooling tower systems shall have seats and seals capable of resisting attack from the water treatment chemicals.	☐	☐	☐
1.9 Connections and valve ratings shall be compatible with pressure and temperature conditions.	☐	☐	☐
1.10 Sectional valves shall be used where possible in piping systems for ease of repairs.	☐	☐	☐
1.11 Self-actuated (Braukman) valves may be used on hot water and steam radiator systems.	☐	☐	☐

2. Buried valves

2.1 All buried valves shall close in a clockwise direction.	☐	☐	☐
2.2 Provide curb box for all buried valves for lateral services and valve chamber for valves on water mains; size and construction of curb box and valve chamber shall comply with latest City of Toronto standard.	☐	☐	☐

3. Emergency Diesel Generator Set

3.1 A fusible fire shutoff valve shall be installed in the fuel supply line.	☐	☐	☐

4. Balancing valves

4.1 Balancing valves 2” or less shall be globe type.	☐	☐	☐

	C	N	N/A

15140 Back Flow Preventers

		C	N	N/A
1.	Main incoming domestic water from the street requires a duplex arrangement c/w isolating valves. Provide backflow preventers in locations and configuration per applicable codes. Acceptable manufacturer shall be Watts.	☐	☐	☐
2.	Laboratory facilities shall have backflow prevention provided to conform to CSA Standard B64.10 or latest version.	☐	☐	☐

15150 Plumbing Traps

1.	Plastic Poly pipe is acceptable for under-slab trap seal primer lines. Exposed shall be copper Type K soft tubing.	☐	☐	☐
2.	Running traps shall have cleanouts on both legs.	☐	☐	☐

15150 Cleanouts and Cleanout Covers

1.	Drain cleanout locations shall comply with plumbing code. These should also be installed through the floor of the room for which they serve, wherever code allows. Covers shall be of square shape.	☐	☐	☐

15160 Drainage

1.	For outside drainage (storm water management), brass drain catch basins sometimes prove to be too narrow to handle any sudden flow rates. Ensure drain size is adequate.	☐	☐	☐

15180 Piping Expansion Joints

1.	Bellows joints shall not be used unless the consultant can demonstrate that there is no other reasonable choice. Provide appropriate offsets in piping or expansion loops instead to accommodate thermal expansion.	☐	☐	☐

15180 Centrifugal Pumps

1.	Provide 100% back up for circulating pumps of heating, cooling and condenser water systems as well as city water boosters. In-line centrifugal pumps are preferred.	☐	☐	☐
2.	All exposed moving parts of pumps shall be properly guarded.	☐	☐	☐
3.	Mechanical seals are preferred rather than stuffing box style.	☐	☐	☐
4.	Provide gauge ports across pumps. A single gauge shall be piped and valved to allow isolation of pump suction and discharge pressures gauges	☐	☐	☐
5.	Provide a duplex system of fine mesh filters/strainers upstream of the pumps, complete with isolating valves, both before and after the filters/strainers.	☐	☐	☐
6.	Provide individual supports for centrifugal pumps and vibration isolators between pumps and pipework as appropriate.	☐	☐	☐
7.	Use variable frequency drive or variable speed pump for City booster pumps over 2HP. Include pressure sensor located at top floor for control of pressure.	☐	☐	☐
8.	Bleed line complete with solenoid shall be provided to protect the pump from overheating.	☐	☐	☐

	C	N	N/A

15180 Steam Components

1. **Steam Traps:**

1.1.	High pressure steam (above 50 PSIg) system shall have thermostatic traps selected for continuous system operation at a specific design temperature. Bimetallic traps (Bestobell DM-25) shall be used for high pressure drip traps.	☐	☐	☐
1.2.	Low pressure steam systems up to 15 psig shall have float and thermostatic traps of Spirax-Sarco manufacture. Rad traps shall be either of Spirax-Sarco or Dunham-Bush manufacture.	☐	☐	☐

2. Pressure Reducing Valves:

2.1	Building main pressure reducing valves shall be Masoneilan series 500 or Fisher model 655 or 92B or C pilot operated and self-actuating.	☐	☐	☐
2.2	Shall be dual-station type if pressure difference exceeds 100 psig.	☐	☐	☐

3.	Provide strainers on the inlet side of steam traps and control valves to prevent dirt and pipe scale from entering the devices	☐	☐	☐
4.	New buildings supplied with steam shall have Spirax Sarco Gilflo variable orifice steam metering shall be connected to the building BAS. (See Section 15900 Energy & Flow Metering for particulars).	☐	☐	☐
5.	All steam coils shall include a steam vacuum breaker	☐	☐	☐
6.	High pressure steam valves shall be industrial grade, suitable for working pressure and temperature requirements. Bellows non-leak or zero-leak type operators are preferred.	☐	☐	☐

15210 Laboratory Natural Gas Shutoff Valves

1.	Provide emergency shut-off valve in a cabinet with glazed door and proper signage at the entry to each laboratory. Provide downstream of this shut-off valve a check valve with soft disk.	☐	☐	☐

15220 Reverse Osmosis (R.O.) Water Service

1.	Provide booster pump(s) on feed supply to R.O. unit(s) to maintain residual pressure at 35 psig.	☐	☐	☐
2.	Provide duplex treatment system if continuous flow is essential.	☐	☐	☐
3.	All systems shall be supplied with city water makeup meter as well as RO output meter.	☐	☐	☐

15410 Plumbing Fixtures and Trim

1.	Plumbing fixtures shall be white colour except where otherwise specified.	☐	☐	☐
2.	Lavatory faucets shall be fitted with replaceable cartridges, not washers.	☐	☐	☐
3.	Lavatory basin wastes shall have grids and extra heavy quality traps.	☐	☐	☐
4.	Water closets shall be siphon jet type.	☐	☐	☐
5.	Do not use chain and plug for basins. Provide grids at drain outlet instead of pop-up drain.	☐	☐	☐
6.	'Cheater vents' are not to be used on any system.	☐	☐	☐
7.	All urinals shall have cleanouts located above flood level of fixture as per plumbing code.	☐	☐	☐
8.	All banks of toilets (three or more, shall have four inch cleanout located in the same room as the fixtures as per plumbing code.	☐	☐	☐
9.	All outside hose bibs shall be frost free.	☐	☐	☐

	C	N	N/A
10. Floor drains shall be located in all washrooms and in any lab with a deluge shower.	☐	☐	☐
11. Use of hands-free faucets, urinals and toilets is preferred and shall be discussed with UofT representative. All fixtures shall be low flow water saving type. See appendix "A" at end of these standards for schedule of acceptable manufacture/models of fixtures etc.	☐	☐	☐

15410 Vanity Basins

1. The provision of lavatory basins mounted in vanity units is preferred for ALL washrooms.	☐	☐	☐
2. For plumbing fixtures for physically challenged people, refer to Accessibility Standards.	☐	☐	☐

15410 Mop Sinks (Also refer to "Cleaning & Caretaking Standards)

1. Minimum one (1) mop sink per floor is required.	☐	☐	☐
2. Mop sinks shall be floor mounted (with a 6″ lip above floor level).	☐	☐	☐

15412 Emergency Eyewash & Safety Shower Units

1. Units shall comply with U of T Environmental Health & Safety specifications which can be found at the following link under item "Emergency Eyewash and Shower Standard": Policies and Procedures Listing	☐	☐	☐

15426 Drinking Fountains

1. Drinking fountains shall be 'EZH2O' combination fountain/bottle filling station manufactured by ELKAY commercial products. They shall be OADA compliant for wheel chair access, have tamperproof fasteners and all-stainless steel surfaces. The water supply shall incorporate a separate one-quarter turn shutoff to enable filter replacement.	☐	☐	☐
2. Preferred location requirements as follows: lecture halls, classrooms, large student labs/computer rooms, lobby areas, gymnasiums and cafeterias. The units should be installed in a central area and easily accessible to everyone.	☐	☐	☐

15440 Sump Pumps

1. Sump pumps shall be Gorman Rupp or Gould Pumps manufacture or equivalent and shall be self-priming surface mounted direct drive type with the exception that fractional horsepower units may be of the submersible type.	☐	☐	☐
2. 'Column' style pumps are not acceptable.	☐	☐	☐
3. Shall be fully serviceable.	☐	☐	☐
4. Shall be connected to emergency power.	☐	☐	☐

15470 Pipeline Filters Installation

1. If pipeline filters are present for equipment serving laboratories, provide shut off valves upstream and downstream of the filters.	☐	☐	☐

15480 City Water for Air Conditioning

1. Air conditioning equipment that uses once-through city water for cooling shall not be used.	☐	☐	☐

15545 Water Treatment Standard

PART I – GENERAL

1.1 GENERAL REQUIREMENTS

1.1.1. The water treatment vendor to be used on building additions and new construction shall be the incumbent supplier used by the campus for the rest of its buildings. ☐ ☐ ☐

1.1.2. Conform to the conditions stated in the University's water treatment contract from the detailing of the automation systems and associated software, to the outline of specific products required for pre-cleaning and inhibition programs ☐ ☐ ☐

1.2 WORK INCLUDED

1.2.1. Furnish all consulting, shop drawings, materials, instruments and program instruction necessary for all required aspects of the water treatment program, including testing of said program. ☐ ☐ ☐

1.2.2. Clean and re-inhibit ALL new and existing recirculating closed systems such as Chilled Water, Glycol and Heating Water Systems, as well as any open systems such as the Condenser Water Loop. Supply ALL necessary chemicals to perform the above. NO cleaning activity shall adversely affect the existing systems by contaminating them with foreign deposits from new piping cleaning process. Cleanings must be performed independent of each other. ☐ ☐ ☐

1.3 QUALITY ASSURANCE

1.3.1. Provide proof of ISO-9001 accreditation. ☐ ☐ ☐

1.3.2. Provide the services of the incumbent water treatment supplier currently employed by the University to service the campus buildings to supervise system pre-cleanings and inhibition programs and to certify that the work has been successfully completed, via reports from their laboratory analysis. All chemicals used for cleaning treatment must be compliant with outlined products in each application of this specification. ☐ ☐ ☐

1.3.3. The flushing, cleaning and chemical treatment programs shall be administered by the Water Treatment Consultant who shall supply installation drawings, on-site supervision, detailed description procedures, and written instruction of the chemical treatment dosages control charts and test procedures. The Water Treatment Consultant must also provide automation and software program outline and training to on-site staff. ☐ ☐ ☐

1.3.4. Test procedures shall be in accordance with applicable portions of ASME, ASHRAE, SMACNA, NFPA, CFA, ANSI and other recognized test codes as far as field conditions permit. Spectrophotometry technology must be used in on-site testing methods for all aspects of treatment program to ensure accuracy of results. ☐ ☐ ☐

1.3.5. Maintain treatment program in such a manner as to ensure that fouling factor does not exceed 1 degree C rise above the normal operating temperature difference between condenser water leaving temperature and liquid refrigerant leaving temperatures. Program must ensure heating and cooling systems are kept deposit-free by achieving the following corrosion rate criteria: ☐ ☐ ☐

	Mild Steel	**Copper**
Open Systems	< 0.5 mm/year	< 0.1 mm/year
Closed Systems	< 0.05 mm/year	< 0.01 mm/year

	C	N	N/A

PART II - PRODUCTS

2.1 PRE-OPERATIONAL CLEANER

2.1.1 Cleaner must ensure the REMOVAL OF ALL organic deposits such as pipe dope, oil and grease deposits. Surface corrosion must be removed by DISSOLVING rust at a NEUTRAL pH, while preventing flash rusting, utilizing same said cleaner. No TSP (Tri-Sodium Phosphate) is to be used due to its environmental impact. The Water Treatment Consultant must provide proof of cleanser's properties via product fact sheet and MSDS. Quantity of cleaner required in association with system volumes must also be submitted. ☐ ☐ ☐

2.1.2 Cleaner must have long-term metallurgical passivating properties to ensure piping integrity through zone tie-in during the cleaning stage. Passivator must have potential in cleaner to last 2-6 months if required. Again, evidence is required via product fact sheet and MSDS. ☐ ☐ ☐

2.2 CLOSED SYSTEM TREATMENTS & EQUIPMENT

2.2.1 Closed System inhibitor must be of the sodium molybdate type with non-sodium hydroxide pH buffers within. Proof is required via product fact sheet and MSDS. Dosage control parameters to maintain 80-100 ppm as molybdenum, in system at all times through completion of cleanings to turn over to owner and plant staff. ☐ ☐ ☐

2.2.2 Chemical bypass feeder: Feeder shall be complete with isolating valves, drain valve, and funnel feeder with isolating valve. One unit for each system. Bypass feeder to act as back up to automation system in place, monitoring closed loops. ☐ ☐ ☐

2.2.3 In-line filters: Filter housing sized to handle 5 percent of recirculating rate of system. The filter shall be of steel construction and shall be capable of operating at the system working pressure. ☐ ☐ ☐

2.2.4 Each closed system shall have a minimum ¾ inch Cold Water Contact Head makeup Meter which will tie into the PLC Controller (if applicable), providing control of closed system treatment levels for water treatment automation. ☐ ☐ ☐

2.3 COOLING TOWER TREATMENTS & EQUIPMENT

2.3.1. Chemicals: No Organo Phosphate (primary ingredient) or Chromate based scale and corrosion inhibitors shall be used in the open loop. The mode of corrosion and scale protection shall be an ALL ORGANIC natured program that is halogen resistant and environmentally friendly. ☐ ☐ ☐

2.3.2. An oxidizing biocide shall be used in conjunction with a non-oxidizing biocide to ensure the most effective biological kill efficiency with the least environmental impact. Said biocides are also known components of killing the legionella bacterium. ☐ ☐ ☐

2.3.3. Chemical bypass feeder: Feeder shall be complete with isolating valves, drain valve, and funnel feeder with isolating valve. This shall act as a back up to the feed automation system. ☐ ☐ ☐

2.3.4. CHEMICAL FEED EQUIPMENT: Contact head cold water meters for makeup and bleed off shall be provided and tied in to the PLC based automation control panel.
The Water Treatment Data Software Program shall be modem, remote viewing friendly. ☐ ☐ ☐

2.3.5. Signals of control must come from Micrologics Control System (PLC based) with data being transferred to Water Treatment Data Software Program must be in Windows application, and able to store data transferred from PLC and/or manual data entry. Software program installment is required and training of software to on-site staff must be performed. ☐ ☐ ☐

2.3.6. The control system shall feed organic inhibitor based on a software program that allows for a contact to come from the makeup water meter, base bleed off or conductivity regulation, and incorporate a dual biocide feed program, all coming from the PLC based controller. ☐ ☐ ☐

2.3.7. Chemical pumps shall be provided for the organic inhibitor and the two biocides. Utilize compatible **Pulsatron chemical feed pumps**. Feed signal from the control device and suitable ☐ ☐ ☐

	C	N	N/A

for the application. Three Pulsatron pumps required.

2.3.8. Sequence of Operations: A Jesco water meter on the makeup line to the cooling tower will send signals to the programmable controller. The controller registers the volume (litres/gallons) of water passing through the flow meter and causes the organic inhibitor feed pump to activate proportionately. Chemicals are all fed directly from on-site stations with level control sensors in the containers (use flexible hoses for pumps). The control system will regulate bleed off by measuring the conductivity of the cooling water and provide a visual display of real time conductivity, pH and ORP for oxidizing biocide feeding at all times. When the conductivity of the water exceeds a programmed set point, a bleed solenoid is activated. The biocide will be controlled by an ORP controller (or optional "Actives-based" online colourimetric analyzer) so that a free available halogen residual of 0.3 to 0.5 ppm FAC is maintained on the condenser side. The discharge of the chemical feed pumps shall be piped downstream of the bleed off solenoid, to the supply line to the Cooling Tower. ☐ ☐ ☐

2.3.9. Bleed off solenoid must be suitable for 1-inch bleed off line with isolation BALL valves to enable isolation of solenoid in case of repair. ☐ ☐ ☐

2.3.10. Corrosion coupon racks to be provided for each closed and open loops. Each rack must consist of 4 coupon locations installed across a recirculation pump or headers that allow for constant flow past the coupons installed. Each rack must have isolation ball valves with a drain line and flow regulators. Shall provide corrosion monitoring coupons along with laboratory results for 1 year after turnover of plant to the owner. ☐ ☐ ☐

PART III - EXECUTION

3.1 CLEANING AND FLUSHING

3.1.1. Thoroughly inspect all piping systems and remove heavy debris and excessive oil, grease, pipe dope and surface corrosion. ☐ ☐ ☐

3.1.2. Install temporary strainers, grids and filters just prior to cleaning and flushing piping systems. ☐ ☐ ☐

3.1.3. Flush and clean systems before opening new piping system to existing system. Certify that systems are clean and inform consultant when system cleaning is complete. Demonstrate to consultant that systems are cleaned. Once approved, open new system to existing systems. ☐ ☐ ☐

3.1.4. During flushing and cleaning, maintain all isolating and control valves in the open position. Also allow for Zone tie-ins. ☐ ☐ ☐

3.1.5. Provide a letter of certificate when all cleaning and flushing has been carried out in accordance with the specifications, and authorities having jurisdiction (City of Toronto, Ministry of Environment etc.). Include copies of certificate in the Program Operating Manuals. ☐ ☐ ☐

3.1.6. **CLOSED SYSTEMS**

3.1.6.1. Provide temporary caps, connection points, etc. as required to subdivide large systems to ensure a thorough cleaning. Install temporary connection between supply and return lines to permit circulation. ☐ ☐ ☐

3.1.6.2. Circulate pre-operation cleaner for a minimum of 72 hours. Periodically clean all strainers and repeat flushing operating to the approval of the consultant until no foreign material collects in the strainer. ☐ ☐ ☐

3.1.6.3. Drain and purge system and clean all strainers. Refill with fresh water and circulate to flush out remaining chemical solution, via fill and flush process. ☐ ☐ ☐

3.1.6.4. Drain system and remove temporary caps, circulation connections, etc. for permanent operation. Refill using clean water and immediately treat with the corrosion inhibitor ☐ ☐ ☐

	C	N	N/A

required for permanent operation.

3.2 CHEMICAL TREATMENT

3.2.1. **CLOSED SYSTEMS**

3.2.1.1 Provide chemical treatment equipment, chemicals, and test equipment for heating, chilled, and glycol closed water systems. ☐ ☐ ☐

3.2.1.2 Supply and install on each pumping system a bypass feeder and in-line filter. ☐ ☐ ☐

3.2.1.3 Provide sufficient corrosion inhibitor chemical in each system to raise initial molybdenum level to 80 ppm. Provide additional 114 litres (25 IG) of corrosion inhibitor chemical for each system. ☐ ☐ ☐

3.2.2. **COOLING TOWER WATER SYSTEMS**

3.2.2.1 Provide a complete system of water treatment for the cooling tower to control scale, corrosion and algae/bacteria growth complete with chemicals and test equipment for a 1-year term after Substantial Completion. ☐ ☐ ☐

3.2.2.2 Provide a minimum of 1 service call per month after Substantial Completion and all necessary supervision of cleaning procedures and monitoring of treatment program prior to construction completion. Submit written reports on all activities and testing results achieved in servicing this location. ☐ ☐ ☐

3.3 WATER TREATMENT SERVICE PROVIDER

3.3.1 Provide a minimum of 1 service call per month after Substantial Completion and all necessary supervision of cleaning procedures and monitoring of treatment program prior to construction completion. Submit written reports on all activities and testing results achieved in servicing this location. ☐ ☐ ☐

3.3.2 Inspect any system or equipment when open for waterside inspections as requested by customer, at no additional charge. ☐ ☐ ☐

3.3.3 Provide immediate emergency service response at no additional charge. ☐ ☐ ☐

3.3.4 Manage and maintain on-site chemical inventories. Responsible for removing from premises all empty water treatment chemical containers, in a timely manner. ☐ ☐ ☐

3.3.5 Maintain MSDS binder in compliance at all times. ☐ ☐ ☐

3.3.6 Provide/maintain logbook for data collection ☐ ☐ ☐

3.4 GENERAL

3.4.1. The chemical supply company shall instruct the Owner's operating staff (minimum 2 hours of training) before acceptance of the installation by the Consultant. Supply copies of training material, written instructions of the treatment dosages, control charts and test procedures. ☐ ☐ ☐

3.4.2. Chemical supply company must supply written reports, submitted to the site consultant indicating progression of job status as well as PROOF of implementation of requirements within this specification. ☐ ☐ ☐

3.4.3. Specification MUST be followed as designed and must NOT deviate from this outline. ☐ ☐ ☐

3.4.4. Central Cooling Water is treated by the University at Central Chiller Plants. For CCW treatment, notification must be given to the Utilities Division of the startup date/time and total system ☐ ☐ ☐

	C	N	N/A
volume.			

15600 Refrigerants

		C	N	N/A
1.	In accordance with the Montreal Protocol on substances that deplete the Ozone layer, all new refrigerating, cooling and air conditioning equipment shall not contain any CFC nor HCFC based refrigerants nor mixtures of such refrigerants.	☐	☐	☐
2.	Major chillers MUST operate with 134/A refrigerant	☐	☐	☐
3.	Refrigerant Monitoring Systems must be by Arjay.	☐	☐	☐

15700 Access Doors

☐ ☐ ☐

1.	Provide access doors/panels in solid ceilings so that the equipment and the various components that must be serviced, may easily be reached. The doors/panels should be centered on the items to be serviced and be of adequate size to allow removal of the service parts. In no case shall the size of access door be less than 24″ x 24″. Provide access panels associated with each fire/smoke damper.	☐	☐	☐
2.	Where devices such as reheat coils are mounted in the ducts, access openings must be installed in the duct in front of and behind the device to facilitate cleaning and maintenance.	☐	☐	☐

15720 Air Handling Equipment

1.	Provide internal waterproof lighting in all accessible air handling unit compartments.	☐	☐	☐
2.	Provide hinged access doors to the equipment compartments, with latching hold-open devices and door handles on both sides of door. Ensure no interference of pipings and access doors with respect to coil removal space.	☐	☐	☐
3.	For all outside air systems, face and by-pass type dampers with anti-stratification mixing section shall be used when freeze protection freeze-stat is required.	☐	☐	☐
4.	Ensure that construction and equipment installation allows space sufficient for the removal of coils from the air handling units. Such allotted coil removal space should be indicated on the drawings. Provide lifting facilities such as eye bolts, I-beams and A-frames for coils heavier than 200 lbs.	☐	☐	☐
5.	Variable frequency drives shall be used for fans to vary air flow, rather than inlet vane control. Provide electronic filter circuits to suppress electronic noise and harmonics generated by the device.	☐	☐	☐
6.	Fan bearings shall be lubricated externally. Do not use remote grease pipings or tubings.	☐	☐	☐
7.	Fan drives: V-belt shall be industrial grade. Multi-sheave belts shall be "power bands".	☐	☐	☐
8.	Cooling coils shall have stainless steel frame rather than galvanized steel frame; if not available, advise U. of T. representative.	☐	☐	☐
9.	Moisture eliminators are mandatory and shall be made of stainless steel	☐	☐	☐
10.	Provide moisture evacuation facilities for all cooling coils drained for the heating season. (See Appendix 'C' Diagram #15.1). Connections to the pipe shall be by 'Threadolet'.	☐	☐	☐
11.	Provide local isolation valves for coils where possible.	☐	☐	☐
12.	Drain pans in built-up air handling units should be constructed of stainless steel of appropriate gauge. Pans shall slope down to drain. Drain trap height shall exceed maximum fan suction static pressure at dirty filter condition.	☐	☐	☐
13.	14 Gage checker plate floor shall be installed on the base. Floor shall be flat, reinforced from below, with all seams continuously welded. The base shall be insulated with 2" (50 mm) 1-1/2 Lb/ft3 fibreglass under the floor.	☐	☐	☐

	C	N	N/A
14. All external louvers shall be constructed of galvanized steel and include a galvanized steel bird screen. Prefinished anodized aluminium louvers will be considered as an alternative.	☐	☐	☐
15. A Dwyer Magnehelic pressure gauge shall be provided in main supply air ducts near fan discharge, to indicate dropped fire dampers or other obstructions in the supply duct system.	☐	☐	☐
16. Do not use aluminium ductwork for corrosion resistance within supply air systems downstream of humidifiers. Stainless welded is acceptable.	☐	☐	☐
17. Noise control shall comply with noise criteria (N-C) standards of noise measurement. The space noise levels shall comply with ASHRAE guidelines. Noise levels shall be measured by an independent acoustic consultant as directed by U. of T.	☐	☐	☐
18. Duct configurations located upstream and downstream of air velocity measuring stations shall be sized adequately in accordance with manufacturer's installation guide and recommendations. Operating air velocity shall not be less than 700 feet per minute.	☐	☐	☐
19. **Air Filters for General Office Buildings**			
19.1. Provide air filters of the appropriate type for the application.	☐	☐	☐
19.2. Filters shall be purchased from UofT incumbent supplier.	☐	☐	☐
19.3. Test method for all particulate filters shall conform to ASHRAE Standards #52.2-2007B or later revision, including 'Appendix J' and test results shall be provided.	☐	☐	☐
19.4. Filters shall have Class 2 fire rating by Underwriters Laboratories of Canada or be classified as UL900.	☐	☐	☐
19.5. Manufacturer shall provide evidence of facility certification to ISO 9001:2000	☐	☐	☐
19.6. **Prefilters**:			
19.6.1. 24"x24"x2" thick, polyester media pads with average synthetic dust weight arrestance of not less than 75% and dust holding capacity of not less than 125 grams, both at a final pressure drop of 1" w.g. and a face velocity of 500 F.P.M. Equivalent to AAF VA Blue	☐	☐	☐
19.7. **Medium Efficiency Filters**:			
19.7.1. Air filters shall be medium efficiency ASHRAE pleated panels consisting of lofted media blend, welded wire media support grid, and beverage board enclosing frame. Sizes shall be noted on drawings or other supporting material.	☐	☐	☐
19.7.2. Construction:			
19.7.2.1. A welded wire grid, treated for corrosion resistance shall be bonded to the	☐	☐	☐
19.7.2.2. downstream side of the media to maintain radial pleats and prevent media oscillation.	☐	☐	☐
19.7.2.3. An enclosing frame of no less than 28-point high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.	☐	☐	☐
19.7.3. Performance:			
19.7.3.1. The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2-2007B (or later revision). It shall also have a MERV 8A rating when tested per Appendix J of the same standard. The media shall maintain or increase in efficiency over the life of the filter.	☐	☐	☐
19.7.3.2. Initial resistance to airflow shall not exceed 0.23", 0.31" or 0.27" w.g. at an airflow of 350, 500 or 500 fpm on 1", 2" or 4" deep models respectively.	☐	☐	☐
19.7.3.3. Filter shall be warranted by manufacturer to last at least 4380 hours @ 1970 cfm, and 1.0" w.g. under normal operating conditions in the case of 2" depth filter.	☐	☐	☐
19.7.3.4. Manufacturer shall guarantee the integrity of the filter pack to 2.0" w.g.	☐	☐	☐
19.8. **High Efficiency Final Filters**:			
19.8.1. 24"x 24"x12" deep rigid fixed pleated media type with 80% minimum dust spot efficiency	☐	☐	☐

	C	N	N/A
and 95% arrestance per ASHRAE 52.1-92 test method. Minimum efficiency reporting value (MERV) of 13 per ASHRAE Standard 52.2- 2007. Equivalent to AAF Varicel or equal.			
19.8.2. Air filters shall be high efficiency ASHRAE extended surface pocket style filters consisting of high loft air laid microfine glass media, a reinforced ABS plastic header, ABS plastic pocket retainers, and bonding agents to prevent air bypass and ensure leak free performance.	☐	☐	☐
19.8.3. Sizes shall be as noted on drawings or other supporting materials. Performance values for reference purposes shall be based upon 24-inch by 24-inch by 21 or 22-inch 10-pocket model.	☐	☐	☐
19.8.4. Construction:			
19.8.4.1. Filter media shall consist of high-density air laid lofted microfine glass media that is chemically bonded to a micro mesh media support backing forming a lofted filter blanket.	☐	☐	☐
19.8.4.2. All stitching centers shall be sealed through the use of a foam based sealant that shall remain pliable throughout the life of the filter.	☐	☐	☐
19.8.4.3. Pockets shall be formed into tapered pleats, supported by controlled media space stitching, to promote uniform airflow across the surface of the media. The pockets shall also have a conical configuration to minimize contact with HVAC system components.	☐	☐	☐
19.8.4.4. Support members shall include an ABS plastic header and ABS plastic pocket retainers that may be either recyclable or incinerable to promote sustainability. The header shall be joined to the media to prevent air bypass. The frame shall form a rigid and durable support assembly.	☐	☐	☐
19.8.4.5. The air exiting side of the air tunnels include a pocket flange to ensure pocket integrity throughout the life of the filter. A downstream pocket-to-pocket partition shall provide additional pocket separation to ensure full flow through the entire media area.	☐	☐	☐
19.8.4.6. A filter-to-filter sealing gasket shall be installed on one of the vertical members of the filter header.	☐	☐	☐
19.8.5. Performance:			
19.8.5.1. The filter shall have a Minimum Efficiency Reporting Value of MERV 13 per ASHRAE Standard 52.2 2007B (or later revision), Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size. It shall further have a MERV 13A rating when tested under Appendix J of said standard.	☐	☐	☐
19.8.5.2. Initial resistance to airflow as listed by the manufacturer on a 21" or 22" depth 10-pocket bag shall be a maximum of 0.40" w.g at an airflow of 500 fpm.	☐	☐	☐
19.8.5.3. The manufacturer shall warranty that the filter shall be capable of withstanding 10.0" w.g. without failure of the filter.	☐	☐	☐
19.8.5.4. Filter shall be warranted by manufacturer to last at least 8760 hours @ 1970 cfm and 1.0" w.g., without the requirement of a pre-filter, under normal operating conditions in the case of up to 12" pocket depth; 13140 hours for a 13"- 22" depth pocket; twenty-four 17520 hours for a 23"- 32" depth. In all cases this warranty shall apply without the requirement of a pre-filter, and filter shall not exceed 1" w.g. at an airflow of 500 fpm at the end of these in-service periods. Filter shall further be warranted to maintain rated efficiency throughout its service life.	☐	☐	☐
19.9. Supporting Data:			
19.9.1. Provide complete ASHRAE test report per ASHRAE Standard 52.2-2007B (or later revision) including full testing per Appendix J of this Standard by an INDEPENDENT TESTING LABORATORY that participated in the ASHRAE Research Project RP-1088 (Coordinate and Analyze Interlaboratory Testing of Filters under ASHRAE Standard 52.2 to Determine the Adequacy of the Apparatus Qualification Tests).	☐	☐	☐
19.10. Product shall be Camfil Hi-Flo ES or approved equal.	☐	☐	☐
19.11. Filter Warranty Requirement:			
19.11.1. If a bank of filters within the AHU causes the w.g. to exceed 1.0" at an airflow of 500 fpm, under normal operating conditions (as deemed by the University's Operations staff)	☐	☐	☐

	C	N	N/A
19.11.2. during the warranty period, a new set of filters of the same specification will be supplied to the University at the Vendor's expense. These filters will be warranted for the balance of the original warranty period.	☐	☐	☐
19.12. Filter Frames:			
19.12.1. Frames shall be constructed of 16 gauge galvanized steel at least 3 inches deep and permanently assembled with solid rivets.	☐	☐	☐
19.12.2. Where possible, the prefilters and afterfilters shall be installed in separate frames allowing the final filters to be replaced without having to remove the prefilters.	☐	☐	☐
19.12.3. Closed cell gasketing shall be included allowing a tight seal to filter header/frame.	☐	☐	☐
19.13. Magnehelic type differential pressure gauge with BacNet connectivity shall be provided across each air filter bank	☐	☐	☐

15760 Hydronic Radiator Installation

1. Provide a hose bib drain at all radiators that have supply and return mains above the radiators, and on any other radiator that will not drain through its piping.	☐	☐	☐
2. Provide automatic air vents and air separators at high spots in the piping systems.	☐	☐	☐
3. Provide a shut-off valve at supply and return connections of radiator. Provide separate balancing valve or shut-off valve with memory position.	☐	☐	☐

15830 Fume Hood Exhaust Fans / Environmental Compliance Approval (ECA)

1. **Fume Hood Ventilation Guidelines:**
The following guidelines shall be used as a checklist of items to be considered. The consultant shall refer to the standards and codes for specific requirements.

1.1 Systems shall comply with U of T Environmental Health & Safety specifications, which can be found at the following link under item "Laboratory Fumehood Standard": Policies and Procedures Listing	☐	☐	☐
1.2 Give consideration to use of energy conservation systems incorporating common exhaust ducting, VAV hoods and reduced face velocity standby operation.	☐	☐	☐
1.3 Radioisotope and perchloric acid fume hoods shall be separately ducted to outside; the design and construction shall incorporate precautions for safety.	☐	☐	☐
1.4 Exhaust stacks shall discharge vertically upwards at approved exit velocity and of sufficient height and so positioned as to ensure that emissions are unable to re-enter the building, and adjacent buildings.	☐	☐	☐
1.5 A drain connection system shall be provided at fan low point.	☐	☐	☐
1.6 Air filters, if installed, shall be as close as possible to the fume hood.	☐	☐	☐
1.7 Do not connect a fume hood to an existing fume hood duct, unless cleared with Environmental Health and Safety, and Utilities. Ensure air balancing is checked.	☐	☐	☐
1.8 Stack supports, stainless steel guy wires and attachment points are to be designed by a registered structural engineer. Provide identified yellow protective sleeves on guy wires.	☐	☐	☐
1.9 Label each stack with corresponding room number and exhaust hood number.	☐	☐	☐
1.10 Label each isolating disconnect as to voltage and source of supply, (e.g., PANEL ABC - CIRC 7) and ensure that source breaker is identified as to load (e.g., AC#7 Roof).	☐	☐	☐

	C	N	N/A

2. **Environmental Compliance Approval**

2.1. Each fume hood, fume hood fan or fume hood stack that is to be added or modified shall be compliant with existing Environmental Compliance Approval. ☐ ☐ ☐

2.2. Before the project can proceed, the University of Toronto Office of Environmental, Health and Safety shall be notified of any proposed additions or modifications and given all planning details and drawings in order for them to determine compliance or the need for amendment to an existing ECA. ☐ ☐ ☐

2.3. The University of Toronto Office of Environmental, Health and Safety shall be made aware of all chemicals that: ☐ ☐ ☐

2.3.1. Are currently being used in the laboratory containing or will contain the fume hood. ☐ ☐ ☐

2.3.2. Will be used in the laboratory containing or will contain the fume hood. ☐ ☐ ☐

3. **Labeling**

3.1. All fume hoods must be labeled numerically (ascending from 1) based on the number of fume hoods located in a lab. The label must indicate which mechanical room contains the corresponding fume hood fan. ☐ ☐ ☐

3.2. All fume hood fans must be labeled with the associated fume hood room number and fume hood number (or numbers if the fan is connected to multiple fume hoods). ☐ ☐ ☐

3.3. All fume hood exhaust stacks must be labeled with the associated fume hood room number and fume hood number (or numbers if the fan is connected to multiple fume hoods). ☐ ☐ ☐

15840 Air Terminal Units

1. Ensure that access is provided to each air terminal unit, including VAV and CV boxes, as appropriate to enable the carrying out of periodic cleaning of the reheat coil and inlet screen. ☐ ☐ ☐

2. VAV boxes minimum airflow settings shall comply with ASHRAE recommended values and required matching reheat coils shall comply with latest OBC/ASHRAE requirements. ☐ ☐ ☐

15850 Air Distribution

1. When duct thermal insulation is required, it shall be of external type only. ☐ ☐ ☐

2. Due to the cleaning requirements for the ducting, no internal acoustical lining is allowed. Use appropriate noise silencers instead. ☐ ☐ ☐

3. Internal acoustical insulation may be used for transfer ducting only. ☐ ☐ ☐

4. Under floor air distribution systems shall be supplied with floor mounted plenum separations. Press-fitted plenum dividers are not acceptable. Air tight air plenums are essential. Caulk sealing is required around the plenum. ☐ ☐ ☐

5. Air flow straightener turning vanes shall be installed in all cases where 90 degree square main ducts are used. ☐ ☐ ☐

15915 Electrical Work

Electrical power and control wiring for mechanical equipment and systems shall comply with the following requirements:

	C	N	N/A
1. **Motor Starters and Motor Control Centres**			
Combination Across the Line Magnetic Motor Starters			
1.1. Combination starters shall be CSA certified	☐	☐	☐
1.2. Combination magnetic starters shall be complete with the following;	☐	☐	☐
1.2.1. Main circuit breaker (fuses not acceptable) sized to provide motor short circuit protection and meet system interrupting capacity. Circuit breaker operating handle shall be lockable in the open position	☐	☐	☐
1.2.2. Magnetic contactor	☐	☐	☐
1.2.3. Overload relays, one per phase	☐	☐	☐
1.2.4. Sprinklerproof enclosure for stand alone starters	☐	☐	☐
1.2.5. Primary and secondary fused control transformer having 120vac secondary rating and 100 watt spare capacity. Fuses shall be type CC time delay	☐	☐	☐
1.2.6. Hand-Off-Auto selector switch	☐	☐	☐
1.2.7. Running LED type pilot light (red)	☐	☐	☐
1.2.8. Reset Button	☐	☐	☐
1.2.9. Minimum two sets of Form C auxiliary dry contacts in mylar enclosure and wired to a terminal strip within the starter for remote status wiring connections	☐	☐	☐
1.2.10. Prewired control relays compatible with thermistors where motors are provided with thermistors wired to initiate immediate motor shutdown in the event of thermistor operation. Provide a separately identifiable LED type pilot light to indicate when a control relay has been operated by a motor thermistor together with a separately identifiable reset button for resetting the control relays. Wire the relay activation circuit to a terminal strip within the starter for connection to the motor thermistor wiring	☐	☐	☐
1.2.11. Terminal strip within the starter for termination of all external protection and control wiring (e.g.: remote firestat, freezestat)	☐	☐	☐
1.2.12. Provide accurate schematic permanently affixed to the inside of door showing all internal and external wiring connections	☐	☐	☐
1.2.13. Provide defeat mechanism to access starter without having to de-energize starter	☐	☐	☐
1.2.14. Starter components shall be readily accessible for replacement and shall not require major component replacement to repair or access a minor component	☐	☐	☐
1.2.15. A lamacoid plate shall be affixed to the starter cover with stainless steel screws, identifying load supplied, voltage rating, and source of supply. For starters on normal supply, letter shall be black on white background. For starters on emergency supply letters shall be white on green background.	☐	☐	☐
1.2.16. Starters shall be of North America manufacture and of the same manufacturer	☐	☐	☐
2. **Variable Frequency Drive Starters**	☐	☐	☐
General			
2.1. Variable frequency drives shall be CSA certified	☐	☐	☐
2.2. Drives shall be of the adjustable frequency totally digital pulse width modulated type			
2.3. Drives shall be suitable for use with high efficiency motors			
2.4. Drive enclosures shall be rated NEMA 12 UL Type 12 and shall be UL listed as a plenum rated VFD,	☐	☐	☐

	C	N	N/A
designed to prevent unfiltered air from entering enclosure utilizing filters and associated integral fan cooling			
2.5. Drives shall be provided with an isolation 'service switch' and an Auto-Off-Bypass selection feature (keypad, selector switch) mounted on front face/door together with a red LED running light	☐	☐	☐
2.6. The bypass system shall NOT depend on the VFD for bypass operation. The bypass shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the enclosure for repair/ replacement	☐	☐	☐
2.7. Drives shall interface via terminal block (s) for connection of all external wiring. Hardwire connections between drive and external wiring are not acceptable	☐	☐	☐
2.8. Drives shall have an accurate schematic wiring diagram permanently affixed to the inside of door showing all internal and external wiring connections	☐	☐	☐
2.9. A door defeat mechanism shall be provided to open door to access drive components when the main disconnect switch is in the closed position	☐	☐	☐
2.10. Drive components shall be readily accessible for replacement and shall not require major component removal nor replacement to repair or access a minor component	☐	☐	☐
2.11. Drives shall have a lamacoid plate affixed to the cover with stainless steel screws, identifying the load supplied, and in the case of standalone drives (not installed in an MCC), shall also indicate voltage rating and source of supply. For drives on normal supply, letters shall be black on white background. For drives supplied from an emergency power source during normal power supply outage, letters shall be white on green background	☐	☐	☐
2.12. Drives shall be manufactured by ABB or acceptable equivalent.	☐	☐	☐
Performance:	☐	☐	☐
2.13. Drives shall be designed to operate at rated voltage +/- 15%, 3 phase, 60 Hz input power supply and rated motor voltage output at 0.5 to 60 Hz output. Transformers shall not be used to achieve rated voltage inputs and outputs.			
2.14. The total harmonic distortion for any particular installation must be less than 5%.	☐	☐	☐
2.15. Drives shall have a continuous duty service factor of 110% of rated motor current.	☐	☐	☐
2.16. Drives shall have a minimum efficiency of 98% at maximum load and speed	☐	☐	☐
2.17. Drives shall have a minimum line side displacement power factor of 0.98 at all speeds	☐	☐	☐
2.18. Drives shall meet all performance requirements to a maximum of 40 degrees C, 95% maximum non condensing humidity, and maximum 1000 metres ASL	☐	☐	☐
2.19. Drives shall have adjustable minimum speed of 0-80% and adjustable maximum speed of 50-110%	☐	☐	☐
2.20. Drives shall have separately adjustable acceleration and deceleration ramps from 1 to 999 seconds (0 to 110% speed)	☐	☐	☐
2.21. Drives shall automatically initiate motor restart when a momentarily or prolonged power interruption has occurred and been restored and provided a run enable signal is present. The motor shall restart at the speed at which it is rotating and accelerate to the speed called for by the last speed reference signal	☐	☐	☐
2.22. Drives shall be provided with a 30 Hz ride through	☐	☐	☐
2.23. Drives shall be capable of operating for setup and testing without a motor connected	☐	☐	☐

	C	N	N/A
Protection:	☐	☐	☐
2.24. Drives shall be provided with main horsepower rated disconnect switch to isolate the drive. Switch handle shall be accessible on the front of the drive and padlockable in the closed and open positions.			
2.25. A combination circuit breaker and contactor shall be provided on the load side of the main disconnect switch for supply of the motor in Auto mode. A combination circuit breaker and contactor shall be provided also on the load side of the main disconnect switch for supply of the motor in bypass mode. Circuit breakers shall provide motor and drive short circuit protection and meet system supply available short circuit rating	☐	☐	☐
2.26. Drive contactors shall be horsepower rated and match the motor maximum horsepower rating			
2.26.1. Drives shall be provided with line over and under voltage protection, phase loss protection and phase unbalance protection to trip the drive off whether in Auto or Bypass mode	☐	☐	☐
2.26.2. Drives shall have thermal overload protection to trip the drive off should a motor overload or stall condition occur in either the Auto or Bypass mode	☐	☐	☐
2.26.3. Drives shall have internal over temperature protection to protect the internal drive components and trip the drive off in the event of over temperature	☐	☐	☐
2.26.4. Drives shall have 3 phase thermistor relay protection for connection to external motor thermistors in motors 100HP and larger. Should a relay operate, the drive controller shall shut down whether in Auto or Bypass mode, and a separate LED on the front of the door shall indicate “Motor Overtemp”	☐	☐	☐
2.26.5. Drives shall be provided with input transient protection in the form of line reactors to prevent drive damage from line transients on the power distribution system	☐	☐	☐
2.26.6. Drives shall be able to accept a remote isolation of the motor (e.g.: remote motor disconnect switch operation) while motor running without causing damage to the drive whether running in the Auto or Bypass mode	☐	☐	☐
2.26.7. Drive control and logic supply transformers shall have primary and secondary fusing. Fuses shall be Type CC time delay	☐	☐	☐
2.26.8. Control and Monitoring	☐	☐	☐
2.26.9. Drives shall be provided with an Auto-Off-Bypass selector switch on the front of the door together with a red LED running light	☐	☐	☐
2.26.10. Drives shall have a regulated 24 VDC power supply for output connection to remote sensors requiring power to supply drive input control	☐	☐	☐
2.26.11. Drives shall have a signal follower for interface connection to both 4-20ma and 0-10VDC remote inputs from remote sensors controlling drive in the Auto mode			
2.26.12. Drives shall have interface connection to the University Enterprise Management and reporting System (EMRS) using BACnet – 135 communication and interoperability protocols through the BAS:	☐	☐	☐
2.26.12.1. Bacnet IP			
2.26.12.2. BACnetMS/TP			
2.26.12.3. MODBUS RTU			
2.26.12.4. Proprietary			
2.26.13. Provide current Protocol Implementation Conformance Statement (PICS)			

	C	N	N/A
2.26.14. 4-20MA output when in Auto and Bypass for remote monitoring	☐	☐	☐
2.26.15. Remote dry contact from BAS for run command in the Auto mode	☐	☐	☐
2.26.16. Dry contact for connection to BAS to indicate VSD shutdown (fault condition)	☐	☐	☐
2.26.17. Drives shall be have interface connection to remote safety interlocks (e.g. : firestat, freezestat, etc) in Auto and Bypass modes	☐	☐	☐
2.26.17.1. Drives shall be provided with external interlock contact connection for run control in either the Auto or Bypass mode	☐	☐	☐
2.26.17.2. All readout information shall be displayed on a high resolution dot matrix alpha-numeric high resolution LCD display. Information shall be presented in descriptive user friendly format. Coded and abbreviated displays are not acceptable	☐	☐	☐
2.26.17.3. All readout information shall be readable at the EMRS and includes at a minimum;			
2.26.17.3.1. Amps per phase			
2.26.17.3.2. Volts per phase			
2.26.17.3.3. Kilowatt-Hours			
2.26.17.3.4. Reactive power			
2.26.17.3.5. Real Power			
2.26.17.3.6. Time stamps			
2.26.18. Direct keyboard entry shall enable display of and <u>password</u> enable changing of the following parameters:			
2.26.19. Maximum speed setting	☐	☐	☐
2.26.20. Minimum speed setting	☐	☐	☐
2.26.20.1. Acceleration rate			
2.26.20.2. Deceleration rate			
2.26.20.3. Current limit-monitoring			
2.26.20.4. Current limit-regenerating			
2.26.20.5. Up to 3 preset speeds			
2.26.20.6. Up to 3 frequency points to avoid resonant speeds			
2.26.20.7. Direct keyboard entry shall enable display of the following to permit diagnostic troubleshooting:			
2.26.20.8. Lockout and cause			
2.26.20.9. Line under/over voltage, phase loss/unbalance			
2.26.20.10. Drive overtemperature			
2.26.21. Motor thermal overload trip	☐	☐	☐
2.26.21.1. Motor thermistor trip operation			
2.26.21.2. Invertor DC bus over/under voltage			
2.26.21.3. Loss of 24VDC for remote sensing devices			

	C	N	N/A
2.26.21.4. Output fault on any one phase including phase identification			
2.26.21.5. Missing or zero speed reference			
2.26.21.6. Trip caused by external interlock			
2.26.21.7. Direct keyboard entry shall enable display of the following:			
2.26.21.8. Power on			
2.26.21.9. Ready			
2.26.21.10. Running			
2.26.22. Jogging	☐	☐	☐
2.26.22.1. Motor accelerating			
2.26.22.2. Motor decelerating			
2.26.22.3. Direction of rotation			
2.26.22.4. Selection status (auto, off, bypass)			
2.26.22.5. Current limit			
2.26.22.6. Direct keyboard entry shall enable a manual (non-permanent override control of preset memory settings) control of the following control functions:			
2.26.22.7. Run			
2.26.22.8. Stop			
2.26.22.9. Jog			
2.26.23. Acceleration and deceleration speed	☐	☐	☐
2.26.23.1. Speed set			
2.26.23.2. Direct keyboard entry shall enable non erasable nonvolatile memory display of the last 30 drive shutdowns and include the following data:			
2.26.23.3. Date, time, and elapsed time of shutdown			
2.26.23.4. Cause of shutdown			
2.26.23.5. Output frequency, voltage and load at time of shutdown			
2.26.24. Accelerating or decelerating at time of shutdown	☐	☐	☐
2.26.24.1. **Motor Control Centers**			
2.26.24.2. Motor control centres shall comply to the latest CSA requirements.			
2.26.24.3. MCC's shall be sprinklerproof construction, free-standing, front access, Class II type B, with rms current interrupting rating to suit and comply with and include the following:			
2.26.24.4. Closed, dead front construction			
3. Main breaker	☐	☐	☐
3.1. 3.2.3 Tinned copper main bus	☐	☐	☐
3.2. 3.2.4 Tinned copper vertical bus in each section	☐	☐	☐
3.2.5 Continuous ground bus			
3.2.6 Full height barrier to isolate the vertical bus from the starters			
3.2.7 Full height wiring trough with cable supports for wiring for power and control wiring			

3.2.8 Line and control terminal blocks, each with 20% spare capacity

3.2.9 Starters and disconnects shall have free floating, self-aligning construction with silver-to-silver contact. Each starter and disconnect shall be capable of being removed with the remainder of the MCC still energized.

3.2.10 Where spaces are noted for future, provide each space with blank cover, rails and necessary hardware to allow a starter or breaker to be installed and connected at a later date without changes to the internal distribution.

15950 Testing, Adjusting and Balancing

Testing and Balancing of Piping and Air Systems:

This work may be tendered and contracted separately to appropriately divorce it from the Mechanical construction contract. This separate contract should include the stratification testing and adjustments.

Design flow rates on VFD systems shall be accomplished with the VFD operating at 55-58 Hz

Systems shall be balanced to AABC or NEBB standards

Check Airflow capacity to ensure that at filter simulated maximum (dirty filter) differential pressure, maximum design flow values are able to be maintained.

1. Reported measurements shall be subject to verification by the Commissioning Authority (CA). Provide instrumentation and manpower required to verify results of up to 30% of all reported measurements. The number and location of the verified measurements to be at the discretion of the CA. A measured deviation of more than 10% between the verification reading and the design value shall be considered unacceptable. ☐ ☐ ☐

Appendix 'A'

LIST OF MANDATORY and PREFERRED MANUFACTURERS

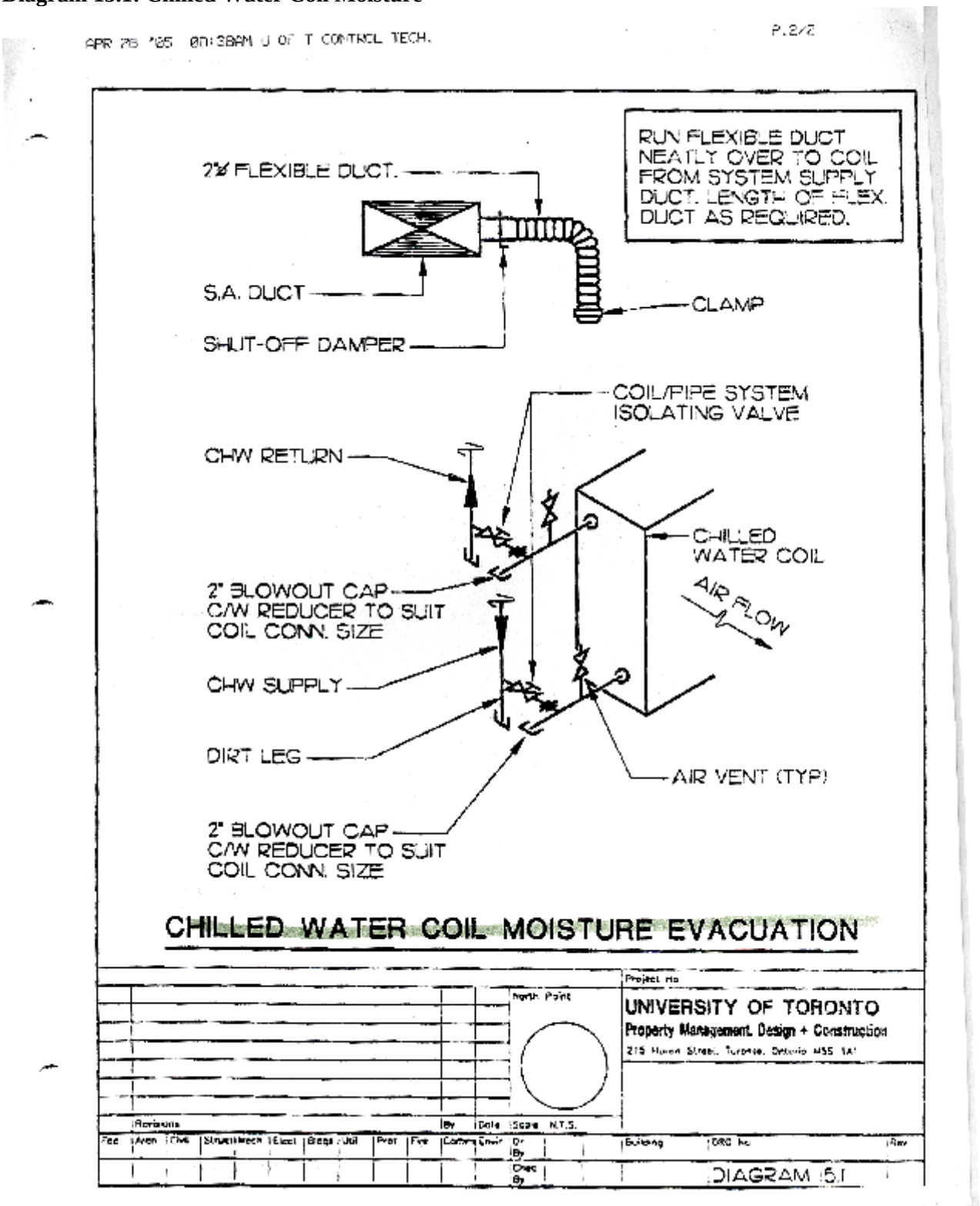
Canadian Master Format 1995	Canadian Master Format 2014	Page #	Item # and Name	Manufacturers and Models
			#3.2	*Mandatory*
15100; 15200; 15300	221000; 226000; 231500; 23113; 232100;232200	8	Steam Drip Trap Valves	Manufacturer: **Velan** Model: ¾" WO4-2054T-02TS Bellows sealed valves
15100; 15200; 15300	221000; 226000; 231500; 23113; 232100;232200	8	#4 High Pressure Steam Drip Traps	*Mandatory* Manufacturer: **Bestobel** Model: DM-25, bimetallic type
15100; 15200; 15300	221000; 226000; 231500; 23113; 232100;232200	8	#4 H&A/C- Chilled Water (buried)	**Ricwil** approved
15110	224201	10	General: Rad. Valves	Manufacturer:**Braukman**, or equivalent
15110	224201	10	#2.1 Non-Buried Valves: Domestic Hot and Cold water	*Mandatory* Manufacturer: **Challenger** Model: Gate, or Globe butterfly valves
15140	224201	10	#1 Back Flow Preventers	*Mandatory* Manufacturer: **Watts**
15180	230516	11	#1.2 Steam Traps: Low Pressure Steam	*Mandatory* <u>Low Pressure</u> Manufacturer: **Spirax-Sarco** Type: Float and Thermostatic Traps <u>Rad Traps</u> Manufacturer: **Spirax-Sarco** or **Dunham-Bush**
15180	230516	11	#2.1 Pressure Reducing Valves	*Mandatory* Manufacturer: **Masoneilan** Model: Series 500 or Manufacturer: **Fisher** Model: 655 or 93B or C
15180	230516	11	#4 Variable Orifice Steam Metering	*Mandatory* Manufacturer: **Spirax-Sarco** Model: Gilflo
15410	221000	12	Battery Exposed Flush Valves	*Mandatory* Manufacturer: **Delta** 'Teck' Flush Valve Toilet; Model: DEL81T201BTA Urinal: 3.8 Litre, model DEL81T231BTA-38 1.9 Litre, model DEL81T231BTA-19 (recommended) 0.5 Litre, model DEL81T231BTA-05 (not recommended where building drains don't allow a clear flow discharge) Manufacturer: Moen M-Power #8311 – Sensor operated closet FV – (1.28 gpf/4.28lpf) M-Power #8315 – sensor operated urinal FV – (0.5 gpf/1.9 lpf) M-Power #8305 – Sensor operated lavatory faucets.
15410	221000	12	Battery Deck Faucets	*Mandatory* Manufacturer: **Delta** 8" CENTER SET: Model DEL590T1850 4" CENTER SET: Model DEL590T1250 SINGLE HOLE: Model DEL590T1150 (also available in hard wired)

CONTINUED ON NEXT PAGE

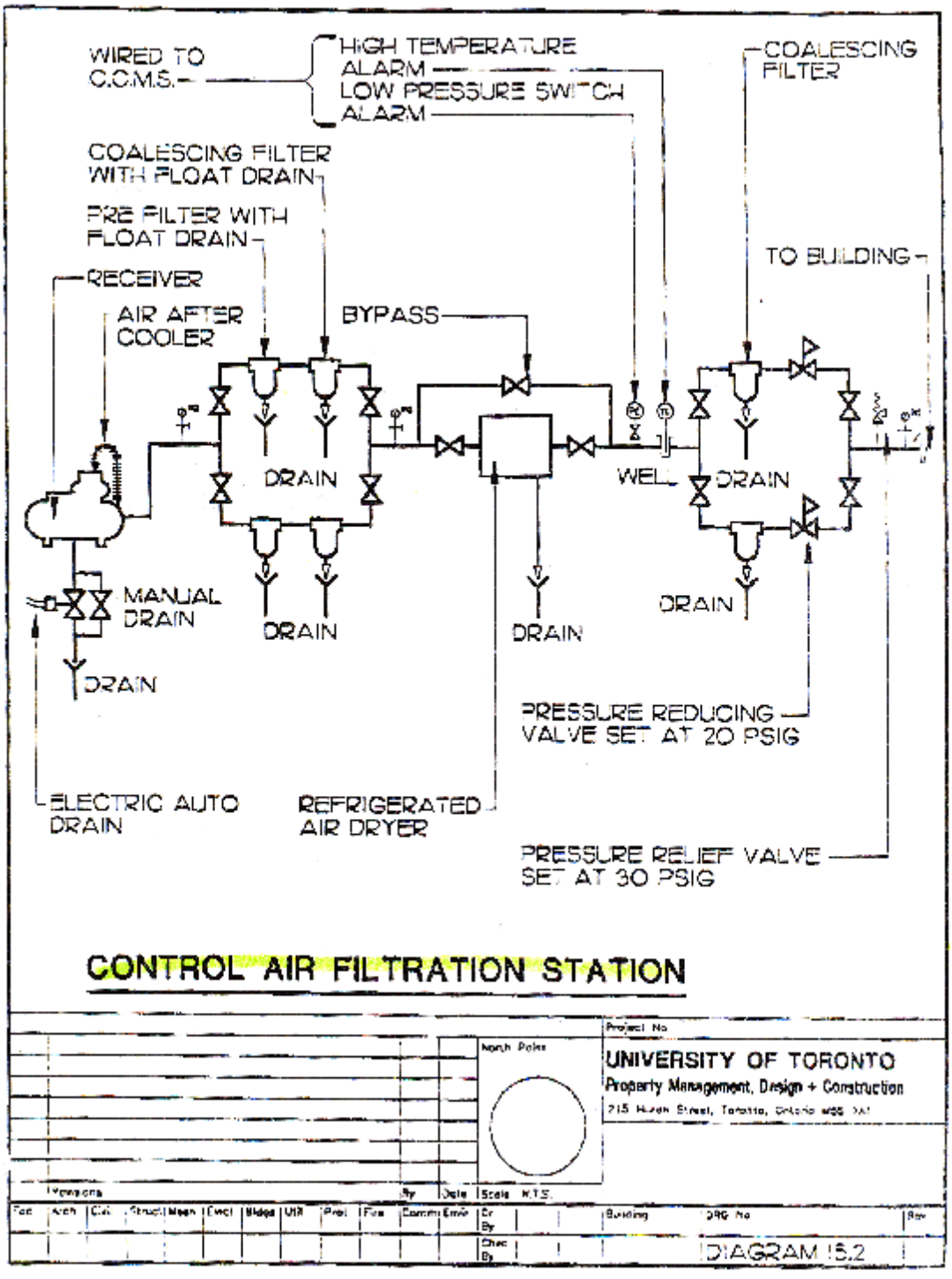
PREFERRED/MANDATORY MANUFACTURERS				
Canadian Master Format		Page #	Item # and Name	Manufacturers and Models
1995	2004			
15410	221000	12	Mixing Valves	*Mandatory* Manufacturer: **DELTA** Models: R2900MIX; R2470MIX
15426	224713	13	#1 Drinking Fountains	*Mandatory* Manufacturer: **Elkay** Model: EZH20
15440	224700	13	#1 Sump Pumps	Manufacturer: **Gorman Rupp**, or **Gould Pumps**, or equivalent
15545	232500	16	#2.3.5 Cooling Tower Control	*Mandatory* Manufacturer: **Micrologics Control System**
15545	232500	16	#2.3.7 Chemical Feed Pumps	*Mandatory* Manufacturer: **Pulsatron**
15545	232500	16	#2.3.8 Make Up Water Meters	*Mandatory* Manufacturer: **Jesco**
15720	237323	19	#16 Air Handler Unit: Pressure Gauges	*Mandatory* Manufacturer**: Dwyer** Model: Magnehelic

Appendix 'B'

Diagram 15.1: Chilled Water Coil Moisture



Appendix 'C'
Control Air Filtration Station



Appendix 'D'
Sample installation condensate meter