The following general requirements for **FACILITY SERVICES SUBGROUPS - (FSS-G)** shall be applied as applicable to all related Sections in Divisions 20-29 specified herein or otherwise required within the Project Design Brief provided. Ensure that these requirements are met and coordinated as required with all other specific Facility Services Subgroup Divisions.

1. FACILITY SERVICES SUBGROUP - GENERAL (FSS-G)

1.1 General Mechanical Requirements

1.1.1 Varying, or deviating from any item(s) indicated in this document must be approved by DTIR. DTIR will not grant a deviation from these requirements unless the deviation has been submitted in writing for review and approved prior to proceeding with the design.

1.1.2 Mechanical installations shall be consistent with accepted practice for the type of facility with respect to quality and application of materials. There shall be no varying from this document on any items unless written request is made to DTIR and written permission is obtained from DTIR.

1.1.3 Installation*s* shall provide for safe maintenance procedures for maintenance personnel with minimum contact with the general population along with minimum disruption of services.

1.1.4 Equipment and materials shall be new and CSA certified for the application. Work and materials shall be in accordance with all authorities having jurisdiction, whichever is more stringent.

1.1.5 Supply tools, equipment and personnel to demonstrate and instruct building operating and maintenance personnel in operating, adjusting, trouble-shooting and servicing of all systems and equipment. In addition to where training is specified elsewhere in Facility Services Subgroup Divisions 20-29, factory trained personnel shall provide on-site instruction in operation and maintenance as follows:

1.1.5.1 Air Distribution Systems - min. 8 hours pre-substantial, min. 2 hours during warranty

1.1.5.2 Dust Collection System - min. 4 hours pre-substantial, min. 4 hours during warranty

1.1.5.3 Heating Systems - min. 4 hours pre-substantial, min. 2 hours during warranty

1.1.5.4 Boilers - min. 4 hours pre-substantial, min. 2 hours during warranty

1.1.5.5 Plumbing Systems - min. 4 hours pre-substantial, min. 2 hours during warranty

1.1.5.6 Fire Protection Systems - min.4 hours pre-substantial, min 2 hours during warranty

1.1.5.7 Control Systems - min. 24 hours (min. of 3 sessions a minimum of 30 days apart)

1.1.6 Complete operations manuals and record drawings for all equipment and systems shall be provided by the contractor.

1.1.7 Mechanical design engineer shall coordinate with the architect to ensure designated fire rated walls and/or partitions have not been compromised by the mechanical systems.

1.1.8 All electrical equipment supplied as part of mechanical equipment packages (e.g. motors/starters part of a fan, air handling unit or pump package) shall meet the requirements of all Electrical specifications of the DC350.

1.1.9 Provide spare parts as follows:

1.1.9.1 One set of belts for each piece of machinery.

1.1.9.2 One set of filters for each filter bank.

1.1.9.3 One glass for each gauge glass.

1.1.9.4 One set of packing seals for each pump.

1.1.9.5 Two pressure gauges and two thermometers for each type and range used on the project.

1.1.9.6 Enzymatic for grease interceptors.

1.1.9.7 Keys for vandal resistant outlets.

1.1.10 Provide one set of tools required to service equipment as recommended by the manufacturers. Also furnish one grease gun with adapters to suit the various types of greases and grease fittings.

1.1.11 Electrical equipment and wiring supplied by Mechanical (eg. as part of or serving a pump, fan or air handling unit) shall also meet the Electrical requirements of the DC350.

1.1.12 All electrical components of mechanical equipment are to be rated 75 degrees Celsius as a minimum.

1.1.13 Refer to Section 07 90 00 - Joint Protection for sealant requirements for joints and penetrations in slab-on-grade, to protect from radon infiltration.

1.2 System Selection and Design Criteria

1.2.1 Mechanical systems shall:

1.2.1.1 Be compatible with architectural, structural, electrical and other projects systems.

1.2.1.2 Be simple, proven systems selected to provide maximum reliability and maintainability with consideration for the availability of parts and service.

1.2.1.3 All mechanical systems shall be designed to be energy-efficient and to minimize owning, operating and maintenance costs for both summer and winter load requirements. Analyze these life cycle costs when evaluating system and equipment alternatives.

1.2.1.4 Use a minimum amount of new energy consistent with required performance standards.

1.2.1.5 Be installed with adequate space for proper maintenance. See "Accessibility for Operation and Maintenance".

1.2.1.6 Have consolidated layouts using minimum space consistent with maintenance and servicing requirements.

1.2.1.7 Have adequate provisions for testing, adjusting and balancing (TAB) and all other phases of commissioning.

1.2.1.8 Have space heating system independent of air distribution system. Exception: Hydronic reheat coils are permitted in ductwork to Small Work Rooms in schools.

1.2.1.9 Have accessible distribution runs allowing inexpensive alterations.

1.2.1.10 Be fail-safe with all equipment of a quality consistent with anticipated building life expectancy and/or required reliability of service.

1.2.1.11 Professional judgment shall be used in the application of these criteria with respect to economy, safety and legal aspects.

1.3 Layouts of Mechanical Systems

1.3.1 All piping, ducting and other services, except gas piping and fuel oil lines, shall be concealed in ceilings, chases, shafts, furred spaces or partitions. This shall not apply in boiler rooms, chiller rooms, mechanical equipment rooms, basements or storage spaces not occupied by personnel. Also, run pipe and duct mains in corridors rather than above normally occupied rooms. Exceptions may be permitted in exposed ceiling spaces of cafeterias, gymnasiums and libraries with written permission from DTIR.

1.3.2 Exposed will mean "not concealed". “Concealed” shall include mechanical services in ceiling spaces, trenches, chases, shafts, furred spaces or partitions. Services in tunnels are not considered to be concealed.

1.3.3 Seal all voids and openings and provide fire-stopping at fire rated walls and floors. All pipe penetrations of masonry walls and floors are to be sleeved with 16 gauge metal. Pipe sleeves shall be 12.7mm (1/2") larger in diameter than the insulated pipe. Fill all voids between sleeve material and pipe. Insulation shall be continuous through walls and floors. Both sides of wall must be sealed

1.3.3.1 Where pipes or ducts pass through non fire-rated walls, floors, and partitions seal openings between pipes, ducts and the construction and make air-tight (smoke and/or acoustic seal) by applying appropriate insulation and caulking compound. Both sides of the wall must be sealed.

1.3.3.2 Where pipes or ducts pass through fire-rated walls, floors and partitions maintain fire rating integrity. See also Ductwork section. Both sides of wall must be sealed.

1.3.4 Unless otherwise specified, terminate sleeves flush at walls and ceilings. Slabs in potentially wet areas (e.g. mechanical rooms, kitchens, laboratories) are to be sleeved with Schedule 40 pipe extending 25mm (1") above the finished floor. This does not apply to concrete floors on grade.

1.3.5 Piping and ductwork shall not be installed in any space used as an electrical switchgear or transformer room or electrical closet, except if required to service the space.

1.3.6 Piping or ductwork installed above motor control centres or surface mounted panel boards is discouraged. If no other routing is possible, maintain a minimum 61cm (24") clearance, with all piping to have a drip tray installed underneath.

1.3.7 Water and waste pipes shall not be installed in exterior walls.

1.3.8 Pipes, ducts and other utilities shall not be embedded in fireproofing or any column or other structural member. Neither shall they run between the fireproofing and the structural member so protected.

1.3.9 Layouts shall be fully coordinated with all other disciplines, trades and sub-trades.

1.3.10 The number of openings through waterproof membranes shall be kept to an absolute minimum. Openings through waterproof membranes subject to hydrostatic pressures shall be fully coordinated with structural designs.

1.4 Spatial Considerations for Mechanical Equipment

1.4.1 The allocation of space for boilers, chillers, mechanical equipment and distribution systems shall comply with the requirements of this section.

1.4.2 The number and locations of mechanical equipment rooms shall be determined by project requirements.

1.4.3 Locate all mechanical equipment, including but not limited to air handling (HVAC) units, boilers, chillers, etc. in mechanical rooms or mechanical penthouses.

1.4.4 All flammable or combustible materials not directly related to the furnace or boiler shall be kept and handled in separate rooms.

1.4.5 Boiler and Chiller Rooms

1.4.5.1 Boiler rooms shall be separate from mechanical equipment rooms containing air handling equipment, so as to eliminate any possibility of fumes from combustion equipment entering HVAC systems.

1.4.5.2 Consideration shall be given to providing a separate room housing both boilers and chillers. This will reduce the construction costs to satisfy code requirements for fire separations between the boiler and/or chiller rooms and the remainder of the building.

1.4.6 Air Handling Equipment Rooms/Rooftop Mechanical Equipment

1.4.6.1 Refer to Ventilation Design Considerations below.

1.4.7 Sizes

1.4.7.1 In determining sizes of boiler rooms, chiller rooms and mechanical equipment rooms, consideration shall include, but not necessarily be limited to, minimum requirements for installation, maintenance, servicing, removal and replacement of mechanical equipment. See also "Accessibility for Operation and Maintenance".

1.4.8 Some of the criteria which will affect consideration of locations include, but are not necessarily limited to, the following:

1.4.8.1 Proximity to heating and cooling loads and the requirement to minimize energy transport factors and the size and complexity of the conveyance system (e.g. air ducts and heating piping).

1.4.8.2 Accessibility for installation, operation, maintenance, servicing, removal and replacement. See also "Accessibility for Operation and Maintenance", below.

1.4.8.3 Provision for future increases in plant capacity and building expansion with minimum of changes to the initial plant and to the structure.

1.4.8.4 Isolation of noise and vibration generating equipment from conference rooms, audio facilities and other sensitive areas.

1.4.8.5 Need for, and restrictions in the location and height of, a chimney.

1.4.8.6 Quality of outside air and location of outside air intakes.

1.4.8.7 Quality of air to be exhausted and location of exhaust air terminals.

1.4.8.8 Relative locations of associated mechanical equipment. For example: chillers to cooling towers.

1.4.8.9 Requirements of applicable codes, standards and regulations.

1.4.8.10 Aesthetic considerations. For example, a penthouse equipment room may help to conceal an elevator penthouse.

1.4.8.11 If a mechanical penthouse is utilized, it shall be accessible by a permanent set of stairs and without crossing the roof of the building. Stairs for this purpose are defined as a maximum rise of 175 mm (7") with a minimum tread of 225 mm (9").

1.4.8.12 Necessity for safety to the building population.

1.4.8.13 Air handling units shall not be located over or beside learning spaces, conference rooms, sleeping quarters, broadcasting, or similar audio facilities. In addition, they shall not be located over administration areas, cafeterias or gymnasiums. Other spaces such as washrooms, storage rooms etc. shall be used as sound and vibration buffers.

1.4.8.14 Boiler rooms shall be located on the lowest building level. Other arrangements may be considered but will be allowed only with written permission from DTIR.

1.5 Ventilation Design Considerations

1.5.1 Fuel fired equipment (e.g. boilers, generators) shall be kept in separate rooms from air handling equipment. For ventilation of rooms with fuel fired equipment, provide a fixed combustion air opening, along with separate openings using thermostatically controlled equally balanced supply and exhaust fans c/w motorized dampers, so that a space temperature of 35 deg. C (95 deg F) at design summer conditions is not exceeded. The fans shall be interlocked so that one cannot run without proof the other is operating correctly.

1.5.2 Also provide thermostatically controlled ventilation in other mechanical rooms (e.g. air handling equipment rooms) so that a temperature of 35 deg. C (95 deg F) at design summer conditions is not exceeded. Provide an exhaust fan along with an outside air louvre c/w motorized damper interlocked with the exhaust fan and its motorized damper.

1.5.3 Provide thermostatically controlled ventilation in transformer and electrical rooms to the latest Canadian Electrical Code, Nova Scotia Power Inc. (NSPI) and local electrical authority requirements. Coordinate with the electrical design engineer. Provide an exhaust fan along with an outside air louvre c/w motorized damper interlocked with the exhaust fan and its motorized damper

1.5.4 Give consideration to heat and noise transmission from equipment to occupied spaces.

1.5.5 If a roof is the chosen location for air handling units, then the units shall be housed in penthouses with permanent stair access. Ancillary equipment (where appropriate) shall also be housed in penthouses with permanent stair access. See above for stair definition and access requirements.

1.5.6 Roof top (exposed on the roof) air handling units and ancillary equipment will not normally be allowed and will be permitted only if specific written permission is obtained from DTIR. If permission is obtained from DTIR to use rooftop machinery, then factors which are to be taken into account shall include, but not be limited to, the following:

1.5.6.1 Snow accumulation; the vertical distance between the finished roof surface and the bottom of the air intake louvre shall be at least 76cm (30 inches), and more when drifting of snow may be anticipated.

1.5.6.2 Integrity of the roof waterproof membrane; this will normally require the installation of sleepers to support the equipment; all penetrations of the waterproof roofing membrane shall be properly designed, flashed and sealed.

1.5.6.3 Safety of maintenance personnel; this requires walkways, railings and other safety features, as well as maintenance platforms.

1.5.6.4 Noise from the equipment causing disturbance and annoyance to occupants of nearby properties.

1.5.6.5 Exposure to ambient conditions; heat losses from, or heat gains to, the equipment may be greater than for similar equipment installed in a mechanical equipment room.

1.5.7 Kitchen facilities shall be ventilated with outside air. Kitchens with exhaust hood volumes 42 m3/min (1500 cfm) and above shall be ventilated directly with a dedicated 100% outside air unit sized to meet the exhaust volume.

1.5.8 Kitchens with exhaust hood volumes less than 42 m3/min (1500 cfm) may be ventilated with outside air from the air handling unit that serves the cafeteria with the air handling unit providing additional outside air to meet the exhaust hood volume via an interlock with the exhaust hood fan. Also provide an interlock to automatically bring on this air handling unit if the kitchen hood exhaust fan is turned on when the air handling unit is scheduled off.

1.5.9 Provide kitchen ventilation and use a dedicated general exhaust fan for removal of heat generated from equipment and to maintain air movement through the kitchen when the exhaust hood is off (the exhaust fan shall run continuously during occupied periods). Do not use the exhaust hood for general ventilation purposes. All return/exhaust air from the kitchen shall be ducted directly to the outside (not through an air handling unit).

1.5.10 Air handling units serving kitchen/cafeteria areas are not permitted to also serve spaces such as offices, classrooms, gymnasiums or administration areas. Arrangements where the air handling unit serves kitchen/cafeteria areas as well as other spaces may be considered but will be permitted only if specific written permission is obtained from DTIR. To be considered, the unit shall provide 100% outside air (no return air) and, as noted above, all return/exhaust air from the kitchen shall be ducted directly to the outside, not through the air handling unit

1.5.11 For spaces with wide variations in occupancy (e.g. gymnasium used periodically as an assembly or performance space) provide an automated method for varying the outside air volume. This is usually accomplished using return air carbon dioxide level control. Ensure the carbon dioxide sensor is installed in a location easily accessible to maintenance personnel (e.g. the mechanical room).

1.5.12 Provide mechanical cooling (also utilize free cooling with outside air when conditions permit) when necessary to maintain health and comfort conditions in a space. (e.g. rooms with computers may require cooling equipment to achieve an acceptable environment)

1.5.13 Provide cooling by mechanical means only with no free cooling to protect temperature and humidity sensitive equipment such as server room computers or objects such as artworks in a controlled storage area. Communication Rooms and Server Rooms shall not be ventilated or cooled with air from an adjoining space (e.g. corridor).

1.5.14 When equipment such as mechanical cooling condensers are installed on the roof, mount the equipment on pre-manufactured welded galvanized angle iron stands that give a minimum clearance of 46cm (18") between the finished roof surface and the underside of the equipment. The stands shall be mechanically fastened to the roof structure (e.g. Thaler anchors). Pressure treated blocking on the roof surface is not permitted.

1.6 Air Distribution Design Considerations

1.6.1 General

1.6.1.1 All supply, return and exhaust air systems shall be completely ducted from the air handling equipment to the ceiling supply diffusers and ceiling return/exhaust grilles.

1.6.1.2 The location of air intake louvres shall be carefully considered relative to prevailing wind pressure and direction. Ensure that air intakes are not adversely affected by hot roof surfaces or by foul and hazardous exhaust discharge such as car, truck and bus exhausts, chimneys and building exhaust louvres. Also locate intakes to avoid drawing in combustive material and to minimize the hazard from fires in other structures.

1.6.1.3 The air distribution system may be used for smoke control providing it meets with Fire Marshal approval.

1.6.1.4 No stairwell, ramp, or other portion of the exit facilities of the building involved in the vertical portion of the exit pattern, or in a protected hallway leading from the discharge point of a vertical exit to the outside of the building, shall be used for the distribution of air.

1.6.2 Exhaust Systems

1.6.2.1 Spaces which house sources of odours and/or contaminants shall be ventilated mechanically by exhaust systems which are not part of other building ventilation systems.

1.6.2.2 Whenever a stack, ductshaft, or other enclosed ventilation means are used, adequate access shall be provided so that the entire system has a proper access opening a maximum of 6m (20 feet) apart.

1.6.2.3 Any system used to prevent the hazardous accumulation of vapours, dust, fumes, grease, etc., shall not be interconnected or form part of any other ventilation, air conditioning, or exhaust system. (e.g. provide a dedicated exhaust fan and ductwork for a kitchen grease hood, run directly to the outside)

1.6.2.4 Exhaust fans shall be located near the point of air discharge to the outside, so that the exhaust ductwork is maintained at a negative pressure, thereby reducing the probability of contaminants infiltrating into the building.

1.6.2.5 Odourous/contaminated exhausts, for example, washrooms, janitors closet, boiler room and recycle room exhausts, shall discharge at the building roof and are not permitted to be sidewall exhausted. However, small individual washroom exhausts (excluding assistive care washrooms) may be sidewall exhausted, provided that the exhaust outlet is a minimum of 3m (10 feet) from any building opening (including windows, air intakes etc.)

1.7 Heating Design Considerations

1.7.1 General

1.7.1.1 Zone for most economical sizes and flow arrangements, and for effective thermostatic control of space temperatures.

1.7.1.2 Piping systems shall be designed using the two pipe reverse return principle, unless written permission to do otherwise is obtained from DTIR.

1.7.1.3 Systems shall be designed and installed to prevent thermal shock to the heating boilers. Piping layout and equipment shall be provided to ensure proper mixing and maintain a minimum water flow and temperature through the heating boilers, in no circumstances less than the boiler manufacturer’s recommendations. See also Section 23 52 00 - Boilers and Division 25 - Integrated Automation.

1.7.2 Provide separate circulation loops (c/w three way valve and pump) for:

1.7.2.1 Air handling unit coils

1.7.2.2 Unit, convection, wallfin, forceflow heaters and radiant ceiling panels

1.7.2.3 Radiant floor systems

1.7.2.4 Domestic hot water systems

1.7.3 Provide 100 % standby pumping back-up on circulation loops to space heating units. Provide 100 % standby pumps or utilize parallel pumping on the main pumps serving the air handling unit coils (both water and glycol sides).

1.7.4 Water Temperature and Flow Rates

1.7.4.1 To determine system flow rate use diversity factor where applicable.

1.7.4.2 For each terminal unit, select the smallest flow rate and highest temperature which will provide desired capacity and satisfy air purging requirements.

1.7.5 System Pressure Drops and Flow Balance

1.7.5.1 Where coils have widely different design flow rates, select or specify internal coil circuiting to provide equal coil water pressure drops at design flow rates.

1.8 Accessibility for Operation and Maintenance

1.8.1 General

1.8.1.1 All mechanical equipment and components shall be located so as to be readily accessible for servicing and maintenance, and so as to be easily isolated, removed and replaced (e.g. infloor heating manifolds).

1.8.1.2 Interference to building occupants: Maintenance and servicing of mechanical equipment and services shall be performed without undue interference with normal work performed by the building occupants.

1.8.2 Accessibility

1.8.2.1 Space for tube bundle withdrawal and cleaning of tubes shall be provided. Layouts shall be arranged so no other piece(s) of equipment need to be distributed nor systems shut down, when withdrawal or servicing is carried out.

1.8.2.2 Mechanical systems shall be designed, and mechanical rooms shall be laid out, and space requirements for maintenance and servicing (e.g. tube, coil or filter withdrawal space) shall be sufficient so as to permit all qualified manufacturers and suppliers to participate in competitive bidding. In addition, these factors shall permit the use of standard cleaning equipment and procedures. Design drawings shall indicate tube, coil and filter removal requirements.

1.8.3 Access Doors and Panels

1.8.3.1 Access doors or panels shall be installed wherever valves, water hammer arresters, plumbing cleanouts, trap primers, drain points, automatic and manual air vents, controllers, controlled devices, volume dampers, duct access doors and panels and where any equipment and system components

requiring servicing, inspection or adjusting etc. are not accessible. Where equipment may be required to be removed for repair or servicing, adequate access must be provided.

1.8.3.2 Access to space above lay-in tile ceilings shall be by removal of lay-in tiles.

1.8.3.3 All openings shall be of sufficient size for both removal and maintenance of the concealed equipment, and shall be a minimum size of 30cm x 30cm (12" x 12") for hand access and 61cm x 61 cm (24" x 24") for body access.

1.8.3.4 Doors shall open greater than 90 degrees, have concealed hangers, anchor straps, and Allen head cam locks (due to paint over).

1.8.3.5 Doors in block walls or in tile shall be sized to suit masonry unit module.

1.8.3.6 In fire rated walls and ceilings, access doors and panels shall be fire rated.

1.8.3.7 Provide stainless steel access doors for tile, marble or terrazzo surfaces.

1.8.3.8 Provide insulated access doors when installed in insulated ductwork.

1.8.4 Mechanical Equipment

1.8.4.1 Where possible, all piping connections, filter access, electrical wiring connections, motor and drive shall be on the same side of the equipment.

1.8.4.2 Minimum clearance around each item of equipment for servicing, maintenance, removal and replacement shall be the greater of either 376cm (48" or 20") plus the size of the largest replacement component. For example:

1.8.4.2.1 Space around filter bank – 51cm (20 inch) plus size of largest filter unit.

1.8.4.2.2 Space around pump – 51cm (20 inch) plus size of motor or pump (whichever is larger).

1.8.4.2.3 There shall be a minimum of 46cm (18 inch) clearance between equipment and walls, regardless of whether maintenance access openings are present on wall side of the equipment.

1.8.4.3 In addition, adequate space shall be provided all round each item of equipment for operation, maintenance and servicing, such as boiler and chiller tube cleaning, withdrawal and replacement, firetube boiler and door swing space, heating convertor and domestic hot water storage heater tube bundle withdrawal ERV door swing space.

1.8.4.4 Equipment maintenance drains (e.g. pump drains) shall be provided with cap and chain.

1.8.4.5 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.

1.8.5 Ceiling Spaces

1.8.5.1 Ceiling space mounted equipment (e.g. exhaust fans, fan coils, heat pumps, motorized dampers) are to be within 91cm (36") of the finished ceiling so that they can be safely accessed.

1.8.6 Piping Connections

1.8.6.1 Piping connections shall be arranged so that the component can be isolated (with isolation valve where required), removed and replaced simply by dismantling unions or flanges on the equipment in question, without disturbing, dismantling or shutting down any other services.

1.8.6.2 All control valves and tempering valves shall be installed with flanges or unions.

1.8.7 Electrical Equipment

1.8.7.1 Minimum clearances around electrically fed equipment supplied by Divisions 21 - 28 (e.g. control panels) shall be the greater of that required by this Article (Accessibility For Operation and Maintenance) or that required by the latest edition of the Canadian Electrical Code.

1.8.8 Space for Removal and Replacement

1.8.8.1 There shall be adequate aisle space and paths of egress, including corridors, vestibules, elevators, areaways, light wells, etc.

1.8.8.2 Elements of equipment shall be located so that they can be serviced or replaced without dismantling any other services or elements.

1.8.8.3 Avoid service and replacement access interference with removable partitions.

1.8.8.4 Equipment Connection

1.8.8.5 Provide piping with isolating shut-off valves, so that servicing of components does not interfere with the building services.

1.8.8.6 Provide unions or flanges to permit coil or terminal unit removal.

2. COMMISSIONING OF FACILITY SERVICES

2.1 Related Sections:

2.1.1 Refer also to Section 01 70 00 - Contract Closeout for General Commissioning and FPTP requirements, Section 25 01 11 for testing and commissioning requirements for integrated automation (BAS) and Section 26 08 00 for Electrical Commissioning Requirements.

2.2 Mechanical System Functional Performance Testing Program.

2.2.1 Upon receipt of written verification that all systems are complete, started-up and operational in all respects, all specified documents have been submitted and approved, and that all demonstrations have been completed and documented, DTIR will commence a program of functional performance testing. This program is separate from the design engineer's and contractor's inspections and verifications. In no way shall the contractor, subcontractors or design engineer rely on the functional performance testing by DTIR to determine the readiness of the mechanical systems.

2.2.2 During this program period, a department team will inspect equipment, operate systems and assess operation and performance as deemed necessary. The testing process may involve real or simulated conditions to determine the system's full operational capabilities and sequences. Copies of all specified mechanical and controls reports and documents are to be made available by the contractor in advance for use by the team during the testing program.

2.2.3 DTIR will provide all typical HVAC test equipment and laptop computers required for their own use during the program. Where mechanical equipment is specified to interface with personal computers, the contractor shall provide the required connectors and any necessary interface software. The contractor shall ensure that subcontractors or equipment suppliers provide the specialized test equipment required for the functional testing program as per the individual mechanical specifications.

2.2.4 During the testing process, the on-site foreman of the mechanical sub-trade involved in the supervision of the work plus any equipment suppliers representatives as required, are to be available on site within forty-eight hours notice and by telephone at other times to provide assistance to the team. Likewise, the mechanical design engineer shall be available via telephone for consultation on design related issues arising during the test program.

2.2.5 The contractor shall commence correcting deficiencies or discrepancies discovered during the functional performance testing process immediately after the test result are presented in writing. The contractor shall return copies of the deficiency lists to DTIR via the design engineer with all corrected items signed off.

2.2.6 Although a majority of the functional performance testing will be conducted as quickly as possible when the building is ready, the program will not be considered complete until a variety of seasonal weather conditions are encountered during testing, and until all deficiencies are corrected.

2.2.7 Tests – General

2.2.7.1 The following are supplementary conditions to tests specified in other sections of this document.

2.2.7.1.1 Insulate and conceal work only after testing and approval by the mechanical design engineer. Conduct tests in presence of mechanical design engineer or person authorized by mechanical design engineer.

2.2.7.1.2 Bear costs including retesting and making good. Replace defective material or equipment and repair joints using new material.

2.2.7.1.3 Prior to tests, isolate all equipment or components which are not designed to withstand test pressures or test medium.

2.2.7.1.4 Pipe Pressure

2.2.7.1.4.1 General - maintain test pressure without loss for a minimum of two hours unless otherwise specified.

2.2.7.1.4.2 Test fuel oil systems to CSA B139 (CSA B139 SERIES:19) and authorities having jurisdiction.

2.2.7.1.4.3 Test drainage, waste and vent piping to the latest National Plumbing Code of Canada and authorities having jurisdiction. Ensure a minimum 3m (10') head of water is provided above the highest point of the DWV system. DWV piping shall be tested for a minimum of one hour with water, or two hours with air. In addition, an underground piping ball test shall be conducted in the presence of the mechanical design engineer and DTIR mechanical inspector, preferably before the piping is backfilled. Provide a minimum of four working days notice of the time for this test.

2.2.7.1.4.4 Test domestic hot, cold and recirculation water piping at 1-1/2 times the system operating pressure or minimum 862kPa (125 psi), whichever is greater.

2.2.7.1.4.5 Test all hydronic systems at 1-1/2 times the system operating pressure or minimum 862kPa (125 psi), whichever is greater.

2.2.7.1.4.6 Fire systems in Division 21 shall be tested in accordance with authorities having jurisdiction and as noted in Division 21.

2.2.7.1.4.7 Test propane systems to CSA B149 (CSA B149-15) and authorities having jurisdiction.

2.2.7.1.5 Test backflow preventers in accordance with local water utility or municipality.

2.2.7.1.6 Test domestic water quality as specified in Division 01 and Division 21 & 22.

2.2.7.1.7 Test boilers as specified in Section 23 52 00.

2.2.7.1.8 Test chemical treatment and anti-freeze solutions and provide written reports indicating required parameters have been obtained.

2.2.7.2 All tests and inspections are to have a minimum of four working days notice. If test is cancelled, a minimum of four additional working days notice is required.

2.3 Commissioning of Plumbing

2.3.1 Cleaning and Disinfection

2.3.1.1 After system pressure testing is complete, flush and disinfect domestic water system to requirements of authorities having jurisdiction.

2.3.2 Maintain manual and automatic valves in full open position during cleaning process.

2.3.3 Upon completion, contractor to provide laboratory test results on the domestic water quality (tests as per authorities having jurisdiction) to mechanical design engineer. Tests shall be as per the requirements of the Nova Scotia Department of Environment and Labour. Mechanical design engineer shall review the test results and forward recommendations to DTIR on the acceptability of the domestic water system.

2.4 Mechanical (HVAC) - Testing, Adjusting and Balancing

2.4.1 Air Distribution Systems

2.4.1.1 Test and balance all air supply, return, and exhaust systems. Balancing must be performed by trained personnel who shall keep records on each trial balance.

2.4.1.2 Balancing shall be accomplished by means of pitot tube traverse on all main and branch ducts. Fan speeds and dampers shall be adjusted until proper air quantities are obtained.

2.4.1.3 Each outlet shall be adjusted by anemometer, voltmeter readings to provide specified air quantities. Each supply outlet shall be adjusted to provide proper throw and distribution in accordance with requirements.

2.4.1.4 All necessary equipment including gauges, pitot tubes, anemometers, voltmeters, etc. required for the testing and air balance shall be furnished and of quality and capacity to ensure proper accuracy.

2.4.1.5 Upon completion of the balancing, supply three (3) complete records which shall include air quantities at each outlet. Provide if requested, a spot check on each system. If actual quantities do not agree with the balance report,

this contractor may be called upon to completely re-balance the systems until satisfactory to the Engineer.

2.4.1.6 Adjust air flow at registers and grilles to equalize volume supplied and withdrawn from each room or as indicated on the plans. Balancing to be performed using duct balancing dampers, grille dampers to be used for fine tuning only.

2.4.1.7 Provide the following information as part of the balancing report:

2.4.1.7.1 System No.

2.4.1.7.2 System Location

2.4.1.7.3 Area System Serves

2.4.1.7.4 Specified CFM

2.4.1.7.5 Actual CFM

2.4.1.7.6 Specified Suction S.P.

2.4.1.7.7 Actual Suction S.P.

2.4.1.7.8 Specified Discharge S.P.

2.4.1.7.9 Actual Discharge S.P.

2.4.1.7.10 Specified Total S.P.

2.4.1.7.11 Actual Total S.P.

2.4.1.7.12 Type of Sheave and Location (Motor or Fan)

2.4.1.7.13 Position of Sheave (i.e. Maximum or Minimum RPM)

2.4.1.7.14 Motor HP

2.4.1.7.15 Fan Rated HP

2.4.1.7.16 Amp Draw on each Phase

2.4.1.7.17 Measured voltage

2.4.1.7.18 Motor RPM

2.4.1.7.19 Fan RPM Specified

2.4.1.7.20 Fan RPM Actual

2.4.1.7.21 Individual diffuser reports shall include:

2.4.1.7.22 Diffuser type

2.4.1.7.23 Velocity ft/min

2.4.1.7.24 Diffuser Multiplier

2.4.1.7.25 Specified CFM

2.4.1.7.26 Actual CFM

2.4.1.8 Provide fan curves for each fan showing plotted design and field conditions, static pressure readings across filter banks, coil banks of each air handling system, showing design and actual readings.

2.4.1.9 Provide a detailed summary of velocity traverses and calculated air quantities for each fan and branch ductwork Provide schematic diagrams for all systems with all outlets numbered. All openings shall be closed using removable gasketed plugs. All balancing shall be done to AABC Standards.

2.4.2 Water Circulating Systems

2.4.2.1 Balance water flow through all equipment including heating coils, cooling coils, chillers, etc. Upon completion of the balancing, and supply three (3) copies of the balancing reports. Contractor may be called upon to completely re-balance the systems. Record design and actual temperatures, pressures and flow rates.

2.4.2.2 Use the metering stations to obtain water flows in main piping systems. Provide pump curves for each pump showing plotted design conditions and field conditions and water on and off temperatures at each major piece of equipment. Provide schematics for all systems with all metering points numbered.

2.4.3 Mechanical Designer's Verification

2.4.3.1 Mechanical design engineer shall verify in writing a minimum of 30% of each type of measurement provided in the balancing reports.

END