The City of Winnipeg

Winnipeg Sewage Treatment Program

Building Mechanical Design Guideline

Document Code:

Revision: 03

Approved By:	Linda McCusker	February 28, 2025
	Linda McCusker, P. Eng., Project Director – Winnipeg Sewage Treatment Program	Date

REVISION REGISTER				
Rev.	**Description**	**Date**	**By**	**Approved**
00	Issued for Use	2015-08-12	C. Reimer / K. Anwar	D. Griffin
01	Issued for Use	2018-05-23	D Allen C. Reimer	D. Griffin
02	Revisions	2022-12-15	Andrew Blanchette	C. Javra
03	2024 Update	2024-12-31	Various	Linda McCusker

Table of Contents

1 INTRODUCTION

This document identifies the standard building mechanical design guidelines that are applicable to any work within the City of Winnipeg (City) wastewater treatment facilities.

1.1 Scope of the Standard

These design requirements shall apply to the following facilities:

- Wastewater treatment plants

1.2 Application

The scope and intent of this document is to convey general design guidance and expectations regarding building mechanical systems. This document does not address specifics related to design type, selection, and configuration; however, the indicated requirements are presented without knowledge of the specific building mechanical system implementation. It is not within the scope of this document to provide detailed design direction and it will be the responsibility of the respective Building Mechanical Design Team to fully develop the system details with general conformance to the concepts presented herein. This standard shall not be construed as comprehensive engineering design requirements or negate the requirement for professional engineering involvement. Any design must be executed under the responsibility and seal of the engineer in each instance and must be performed in conformance with all applicable Codes and standards, as well as good engineering practice.

Existing facilities do not necessarily comply with this standard. The expectations regarding the application of this standard to maintenance and minor upgrades at existing facilities must be assessed on a case-by-case basis; however general guidelines for application are presented as follows:

- All new buildings are expected to comply with this standard.
- All major upgrades to a building are expected to comply with this standard; however, in some cases, compromise with the configuration of the existing facility design may be required.
- All minor upgrades should utilize this standard as far as practical for new work; however, in some cases, compromise with the configuration of the existing facility design may be required.

1.3 Deviations from Standard

It is expected that there will be occasional situations where the design architect/engineer will propose a deviation from this design guideline. The rationale for potential deviations from the design guideline may include:

- Evolution of technology,
- Updates to standards and regulations,
- Practical limitations due to existing conditions on site, or
- Significant cost benefits to the City due to specific project constraints.

For each proposed deviation from this standard, a *WSTP Standards Deviation Form* shall be completed in full and submitted to the City Project Manager for approval. Do not proceed with the proposed deviation unless approval is received from the City Project Manager.

1.4 Acronyms and Abbreviations

ACH	Air Changes per Hour
AFUE	Annual Fuel Utilization Efficiency
AHU	Air Handling Unit
ACGIH®	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
API	American Petroleum Institute
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
CGA	Canadian Gas Association
CHP	Combined Heat and Power
CHR	Chilled Water Return
CHS	Chilled Water Supply
CO	Carbon Monoxide
CSA	Canadian Standards Association
DHW	Domestic Hot Water
DHR	Domestic Hot Water Return
DX	Direct Expansion
FRP	Fiber Reinforced Plastic
GR	Glycol Return
GS	Glycol Supply
H_2S	Hydrogen Sulphide
HVAC	Heating Ventilation and Air Conditioning
HWS	Hot Water Heating Supply
HWR	Hot Water Heating Return
MAU	Make-up Air Unit
MCC	Motor Control Center
MECB	Manitoba Energy Code for Buildings
MERV	Minimum Efficiency Reporting Value
NBC	National Building Code
NFC	National Fire Code
NFPA	National Fire Protection Association
NPH	Non-Potable Hot Water
NPW	Non-Potable Water
PCS	Process Control System

P&ID	Process and Instrumentation Diagram
PLC	Programmable Logic Controller
PW	Potable Water
RFI	Request For Information
RH	Relative Humidity
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
TWA	Time Weighted Average
UL	Underwriters Laboratory, Inc.
VFD	Variable Frequency Drive
WSTP	Winnipeg Sewage Treatment Program
WWD	Water and Waste Department

1.5 Definitions

Annual Heat Recovery Ratio	The Heat Recovery Ratio calculated over an entire year of energy usage.
Annual Net Heat Recovery Ratio	The Net Heat Recovery Ratio calculated over an entire year of energy usage.
As-Built Documents	Drawings and other design documents that represent the final state of the project, as constructed and commissioned, and are not authenticated by a professional engineer.
Automation Room	A room primarily containing automation equipment, such as Programmable Logic Controllers (PLCs) and control panels, but not typically occupied by personnel for operations functions.
Building Mechanical	All mechanical systems associated with buildings and infrastructure, but not including process mechanical systems. Ventilation associated with odour control systems, but not necessarily the odour treatment system itself, should be considered as part of the Building Mechanical system.
Codes	As defined in Section 2.1.
Commissioning Authority	The person or firm responsible for the delivery of the commissioning process.
Contractor	The entity responsible for constructing the design. In a design-build procurement methodology, this is the design-builder.
Control Room	A room containing Process Control System (PCS) operator workstations and other operator systems for monitoring and controlling the facility.
Design Team	The entity responsible for providing the detailed design of a project. In a design-bid-build procurement methodology, this is typically the consultant. In a design-build procurement methodology, this is the design-builder.

Electrical Room	A room primarily designated to contain electrical equipment, including switchgear, Motor Control Centers (MCCs), and panelboards.
Engineer of Record	The professional engineer ultimately responsible for the design.
Hazardous Location	An area where flammable liquids, gases, vapours, or combustible dusts may exist in sufficient quantities to produce an explosion or fire.
Heat Recovery Ratio	The ratio of heat recovered to the total heat input, as defined in Section 3.4.3.
Net Heat Recovery Ratio	The ratio of heat recovered, minus any losses attributable to the heat recovery system, to the total heat input, as defined in Section 3.4.3.
Non-Process Area	Any area or location either within or outside of a building that is not a Process Area.
Pipe Specification Code	A code to describe the type of piping material used, in the format MMNN where MM is the pipe material as per the WWD Identification Standard and NN is a two-digit code representing the more specific type of material and thickness of the specific material. Pipe specification codes are indicated in Table 4-1.
Process Area	Any area or location either within or outside of a building that contains piping, equipment, or any other asset that contains or handles a process fluid or material, including chemicals. Within a building, a single room or space cannot be divided into both a Process Area and a Non-Process Area.
Server Room	A room that is primarily designated for containing computer and networking equipment.
Short-Term Exposure Limit	The Threshold Limit Value for a short-term (15-minute) exposure limit.
Threshold Limit Value	The maximum level of a chemical substance that a worker can be exposed on an 8-hour work day and 40 hours per week over a working lifetime without adverse health effects.
Threshold Limit Value – Time Weighted Average	The Threshold Limit Value for an 8-hour time-weighted average in accordance with the American Conference of Governmental Industrial Hygienists (ACGIH®).

2 GENERAL

2.1 Design Codes and Standards

All designs shall comply with the latest version of all municipal, provincial, and national codes, regulations and bylaws (the "Codes"). This includes but is not limited to:

- National Building Code of Canada with Manitoba Building Code Amendments
- National Energy Code of Canada for Buildings
- Manitoba Energy Code for Buildings (MECB)
- National Fire Code of Canada
- Province of Manitoba Workplace Health and Safety Act
- City of Winnipeg WWD Hydrogen Sulphide Monitoring Program
- National Plumbing Code of Canada with Manitoba Plumbing Code Amendments
- CSA B149.1 Natural Gas and Propane Installation Code
- ANSI Z358.1, Standard for Emergency Eyewash and Shower Equipment
- CSA B64.4Reduced Pressure Principle (RP) Backflow Preventers
- CSA B64.5Double Check Valve (DCVA) Backflow Preventers

In addition, ensure all designs comply with the following standards:

- ISA-71.04 Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants

The application of NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities shall be as per Section 3.8.

The following standards are to be referenced during the design; however, application of these standards will not necessarily be comprehensive:

- ASHRAE Standard 62.1 Ventilation for Acceptable Indoor Air Quality
- NFPA 90A Standard for the Installation of Air Conditioning and Ventilation Systems
- ASHRAE Standard 90.1 for building energy efficiency
- ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy
- IEC 60079-10-1 Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres

2.2 Other City Standards

1. While not exclusive, ensure that the following City Standards are adhered to, including:
   1.1 Water and Waste Department Identification Standard,
   1.2 WSTP Piping Color Standard,
   1.3 WSTP Architectural Design Guideline,
   1.4 WSTP Automation Design Guide,

1.5 WWD Electrical Design Guide, and

1.6 WSTP Structural Design Guideline.

2.3 Authority Having Jurisdiction

1. National Building Codes: The City of Winnipeg Property, Planning and Development Department, such as: Building Permits, Occupancy Permits, Internal building Fire Protection systems etc.
2. Non-National Building Codes: The City of Winnipeg Water and Waste Department, (water services, sewer services, land drainage and flood protection etc.)

2.4 Units

All drawings and documentation shall use the International System of Units (SI units). Imperial units may be provided in parenthesis after the metric unit, where requested or appropriate. Specific requirements are as follows:

1. All building dimensions shall be in millimeters (nominal).
2. All elevations shall be in geodetic meters, in the format EL. ###.### (example EL. 273.520)
3. All pipe sizes to be in mm.
4. All duct sizes to be in mm.
5. All liquid flow rates shall be L/s.
   5.1 Alternate units may be considered for flows less than 0.1 L/s or greater than 10,000 L/s.
6. All airflow rates shall be in L/s, except as follows.
   6.1 Units of m3/s may be used for flows > 10,000 L/s.
   6.2 Design airflow rates shall also be expressed in ACH for Process Areas.
7. All liquid pressures shall be in kPa (kilopascals).
8. All HVAC air pressures shall be in Pa (Pascals).
9. All gas flow rates and pressures shall be:
   9.1 Units of m3/hr
   9.2 Gas pressures shall be in kPa (kilopascals)

2.5 Commonality of Equipment

1. Within each project, all similar equipment shall be of a single manufacturer.
2. Design equipment and systems to reduce the number of models and types, with consideration to maintenance requirements, spares, and training.

2.6 Service Life

1. Unless otherwise specified, provide assets with a minimum service life as indicated in Table 2-1. Service life is to be based upon reasonable maintenance being performed in accordance with industry standard / manufacturer recommendations.

Table 2-1: Minimum Service Life of Assets

Asset	**Minimum Service Life (years)**
All assets, except as indicated below:	**30**
Boilers	35
Ductless split systems	15
Ductwork	45
Plumbing / Piping	40
Pumps - Submersible	
< 3.7 kW (5 hp)	10
≥ 3.7 kW (5 hp)	15
Radiant Heaters - Electric	20
Unit Heaters - Electric	20
Unit Heaters – Natural Gas	20

3 HVAC SYSTEMS

3.1 General

3.1.1 General Requirements

1. Ensure the general design concept for the entire system is well defined.
2. Ensure each system is designed to be complete in every respect for a trouble-free operation, including Air Handling Units AHUs, fans, pumps, expansion units, ducting, refrigerant and drain piping, thermal and vapour insulation for ducts and pipes, grilles, registers, diffusers, louvers, dampers, sound attenuators, vibration isolators, air coolers, electric air heaters, air filters, etc.
3. Ensure design includes appropriate redundancy capabilities (see Section 3.4.1) and safety margins.
4. Provide a Heating Ventilation and Air Conditioning (HVAC) design that provides appropriate comfort for personnel and equipment protection as per Table 3-2: Indoor Temperature and Humidity Design Criteria.
5. Provide an HVAC design that is easily maintainable in accordance with good industry practice.
6. Follow ASHRAE and National Fire Code guidelines as well as good practice for ventilation requirements in chemical areas.
7. For Non-Process Areas, auxiliary areas and service areas, ventilation shall follow ASHRAE 62.1 for minimum outdoor air and exhaust.
8. Ensure that ventilation air flow rates into air-conditioned areas are included in the cooling load calculations.

3.2 Design Parameters

3.2.1 Outdoor Design Parameters

1. Ensure outdoor design parameters based on NBC design data for Winnipeg weather conditions are followed in accordance with Table 3-2:

Table 3-1: Outdoor Temperature Design Criteria

Winter:	-35°C DB (Dry Bulb)
Summer:	30°C DB
	23°C WB (Wet Bulb)

3.2.2 Indoor Temperature

1. Design the equipment and temperature control of HVAC systems in accordance with Table 3-2.

Table 3-2: Indoor Temperature and Humidity Design Criteria

Space[6]		Heating[1]		Cooling[2]	
		Design Temp	RH	Design Temp	RH
Automation Room		20°C	-	22°C	30 – 60%
Blower room		18°C	-	35°C / Δ5°C [4]	-
Boiler Room		15°C	-	35°C / Δ5°C [4]	-
Chemical Storage and Processing	Liquid	18°C	-	35°C / Δ5°C [4]	-
	Dry [5]	18°C	-	26°C	30 - 60%
Control Room		22°C	-	24°C	30 - 60%
Corridors	Non-Process Area	22°C	-	24°C	30 – 60%
	Process Area	18°C	-	35°C / Δ5°C [4]	-
Electrical Room	General	18°C		26°C	30 - 60%
	Small & Non-Critical [3]	18°C	-	26°C	-
Process Gallery / Tunnel		18°C	-	35°C	-
Generator Room		18°C	-	35°C	-
Janitor Room		18°C	-	30°C	-
Laboratory		22°C	-	24°C	30 – 60%
Loading Bay		15°C	-	35°C	
Locker Room / Change Room		22°C	-	25°C	-
Lunch Room / Kitchenette		22°C	-	24°C	30 - 60%
Maintenance Shops		20°C		24°C	-
Mechanical Room	General	18°C	-	35°C	-
	Not routinely occupied and no liquid piping	10°C	-	35°C	-
Meeting Room		22°C	30 – 50%	24°C	30 – 60%
Office		22°C	30 – 50%	24°C	30 – 60%
Process Area		18°C	-	35°C / Δ5°C [4]	-
Server Room		20°C	-	22°C	30 – 60%
Stairwell		18°C	-	35°C	-
Storage room		18°C	-	35°C	-
Vestibule / Lobby		18°C	-	35°C	-
Washroom	Near normally occupied spaces	20°C	-	24°C	30 – 60%
	Not near normally occupied spaces	18°C	-	30°C	-

Notes:

1. *The heating design temperatures are minimum indoor temperatures under the coldest design day condition.*
2. *The cooling design temperatures are maximum indoor temperatures under the hottest design day condition. Refer to Section 3.2.2 clause 2. for additional constraints.*
3. *Electrical Rooms may only be considered small if they distribute power for less than 100 KVA of load. Electrical rooms may only be considered non-critical if the loads powered from the room can be turned off at any time for a complete day with minimal consequence. An example of a small electrical room would be an electrical room for a small storage building.*
4. *The maximum indoor temperature shall not exceed the lesser of:*
   - *i. 35°C; or*
   - *ii. 5°C above the outdoor ambient temperature, when the outdoor temperature exceeds 15°C.*
5. *Dry chemical areas require humidity control in summer to prevent excessive moisture from affecting the chemical.*
6. *The requirements indicated are for general application. In the event that the specific process or equipment requires different temperature control, the more stringent temperature design requirements shall apply.*

2. The HVAC heating design shall be based upon minimum heat rejection from the equipment in the space. For example, the heating design for an electrical room shall be based upon no electrical heat rejection.
3. The HVAC cooling design shall account for all equipment heating loads in the space under peak operating conditions. For example, the ventilation design for a blower room shall be based upon peak blower operation.
4. The design shall allow for occupied and unoccupied temperature setpoints, which may be outside the bounds of the values indicated in Table 3-2.
   - 4.1 Provide recommended initial setpoints for occupied and unoccupied states in both heating and cooling modes.
5. Ensure the minimum and maximum temperature setpoints are specified and set to protect the assets.
   - 5.1 Ensure that the minimum temperature setpoint protects against freezing and protects the asset to achieve the expected asset life.
   - 5.2 Ensure the maximum temperature setpoint is set to provide the minimum service life.
6. Ensure the average temperature of the space (not time-averaged) is continuously maintained within +/-2°C of the temperature setpoint in frequently occupied spaces. Frequently occupied spaces shall include but not be limited to:
   - 6.1 Control Rooms,
   - 6.2 Corridors within Non-Process Areas,
   - 6.3 Offices, and
   - 6.4 Meeting rooms.

7. Ensure the temperature profile within each space minimizes the temperature deviation. The temperature deviation from the setpoint temperature, for any location within the space, shall not exceed:
   7.1 2°C for frequently occupied spaces; and
   7.2 4°C for other spaces.

3.2.3 Humidity Control Criteria

1. Provide humidity control in accordance with Table 3-2.
2. Provide humidity control in areas with dry powders and chemicals that are affected by humidity, including but not limited to polymer.

3.2.4 Noise Criteria

1. Refer and adhere to the noise control criteria as defined in the WSTP Architectural Design Guideline.
   1.1 Provide noise attenuation such as acoustical enclosures when the equipment has a high noise level and is located in a regularly accessed area which would impact on operations. It shall be noted that fan selection shall not be based solely on noise generation.
2. Ensure HVAC background noise levels are in accordance with Table 3-3.
3. Ensure that the air handling units and make-up air units are equipped with internal vibration isolators or pads and insulation on casing.
4. Provide duct silencers for the exhaust/supply fans if required to minimize the HVAC equipment noise level.
5. Provide silencers for generator rooms and blower room air intake and exhaust louvers to meet the design criteria.
6. Specify equipment noise limits based upon acceptable noise levels for the space, adjacent and connected spaces, and neighboring spaces.
7. Ensure the design considers the cumulative noise impact of all equipment operating simultaneously.

Table 3-3: HVAC Related Background Sound Criteria

Room Type	Octave Band Analysis (NC)		Overall Sound Level (dBA)	
	Target	Maximum	Target	Maximum
Automation Room	50	55	55	60
Control Room - (area, intermittent occupancy)	35	40	40	45
Control Room - (primary, frequent occupancy)	30	35	35	40
Corridors – Office area	40	45	45	50
Corridors – Process Areas	45	50	50	55
Electrical Room	50	55	55	60
Meeting Room	30	35	35	40
Office	30	35	35	45
Process Areas	55	60	60	65
Server Room	50	55	55	60
Washrooms	35	40	40	45

Note: The Architectural Design Guide maximum sound levels include all noise sources and thus the maximum values are different than 3, which only includes HVAC noise.

3.3 Space Pressurization

1. Ensure spaces are pressurized such that leakage airflow is from the cleanest space to the most odorous or dusty space.
2. Utilize NFPA 820 as a guide for space pressurization. Where NFPA 820 is not applicable, utilize ASHRAE standards.
3. Ensure that a negative space pressure (approx. -25 Pascal) relative to ambient air pressure is maintained for Hazardous Locations, chemical rooms, and Process Areas where odour or off-gas occurs.
4. Ensure that spaces adjacent to, or at risk of air transferring from, Hazardous Locations, chemical rooms, and Process Areas where odour or off-gas occurs are maintained at a positive pressure of +25 Pascal, relative to ambient air pressure, under all operating conditions.
5. Electrical, Automation, Server, and Control Rooms shall always be positively pressurized.
6. Ensure that harmful gases do not migrate into, or collect in, stairwells or escape routes.
7. Space pressurization requirements are for the case where doorways are closed. Provide automatic closers and PCS monitored alarm contacts for all doorways where an open doorway could cause hazardous, corrosive, or toxic gases to migrate to other indoor locations.

3.4 Equipment Design Requirements

3.4.1 Equipment Redundancy

1. Provide HVAC system redundancy where required. Minimum requirements are as follows:
   1.1 For routinely occupied areas (frequency of daily) with a direct source of odorous, toxic, or combustible gases (such as open tank areas), ensure that at minimum 50% of the maximum ventilation rate can be provided with any single point of mechanical failure. Provide parallel fans as required.
   1.2 For electrically classified spaces, supply and exhaust fans shall be redundant such that at minimum 50% of the maximum design ventilation rate is provided upon fan failure. Higher level of redundancy requirements shall be evaluated on a case-by-case basis.
   1.3 Provide at minimum 50% redundancy of the maximum design ventilation rate where a single point of failure would potentially create a hazardous area.
   1.4 Provide at minimum 50% redundancy of the maximum design ventilation rate where in the event of failure of the mechanical ventilation equipment, the repair of such equipment would require the provision of temporary ventilation to provide a safe working environment.
   1.5 Provide ancillary systems redundancy where:
      1.5.1 The ancillary systems are required to maintain the redundancy of the HVAC systems. For example, glycol pumping systems would require redundancy if feeding redundant systems; and
      1.5.2 The ancillary system ultimately serves more than one space or more than 1000 m^2.
   1.6 Provide redundant cooling systems where failure of the cooling could result in unsafe conditions for personnel in the space or significantly reduced equipment service life.

3.4.2 Heating Systems

1. Coordinate heating systems with the design of the heat recovery systems.
2. The use of hot water boilers to service the heating loads of sewage treatment facilities is preferred.
   2.1 Centralized or semi-centralized boiler systems are preferred.
   2.2 Ensure that sufficient boiler capacity is provided to utilize all available biogas (not utilized within CHP or comparable use) within boilers (with N+1 redundancy). All biogas boilers shall be capable of being fueled with either biogas or natural gas, such that a complete loss of biogas will not limit design capacity.
   2.3 Hot water coils shall not be utilized for applications heating outdoor air. Utilize a heat exchanger loop with glycol running through coil to prevent coil freezing in event of a system failure.
   2.4 Boiler water treatment is required for all boiler systems.
3. Provide automation for gas-fired air handling units and make up air units as per the Automation Design Guideline.
4. Electric heat may be utilized only where:
   4.1 Hydronic or gas-fired heating is not practical; and
   4.2 For any electric heating unit >= 5 kW a lifecycle calculation is prepared and submitted to the City that demonstrates that the electric heating unit will have a lower lifecycle

cost over 20 years, including realistic fuel / electricity inflation rates acceptable to the City and replacement based upon the expected service life.

5. Unit heaters shall utilize appropriately located wall-mounted temperature sensors and not integrated sensors. Where unit heaters serve a space also provided with mechanical cooling, provide automatic interlocks to prevent simultaneous heating and cooling. Provide PCS monitoring and control in accordance with the Automation Design Guide.

6. Ensure all heating elements, including coils, natural gas burners, and electric heating elements are designed to resist corrosion in the specific installed atmosphere.

3.4.3 Heat Recovery

1. Except for projects with total airflow requirements of 200 L/s or less, provide heat recovery as per the following.

2. Provide heat recovery systems on supply airflows installed or modified by the project as required to achieve a minimum total Annual Heat Recovery Ratio of 60% for the project, where:

$$\text{Heat Recovery Ratio} = \frac{\text{Heat energy from recovery systems}}{\text{Total heat input in supply air}}$$

3. Minimize the energy consumption and leakage of heat recovery systems and achieve a minimum total Annual Net Heat Recovery Ratio of 55% for the project, where:

$$\text{Net Heat Recovery Ratio} = \frac{\text{Heat energy from recovery systems – (energy for heat recovery systems, leakage, losses, etc.)}}{\text{Total heat input in supply air}}$$

4. Heat recovery systems may recover heat from exhaust air streams or flushing water (plant effluent). Alternate sources of heat require the approval of the City.

5. The use of biogas shall not be considered as heat recovery.

6. Ensure the heat recovery technology utilized is compatible with the airstream it serves.

7. Ensure the heat recovery technology utilized does not significantly increase operational and maintenance requirements.

8. Ensure that heat recovery systems do not interrupt or cause ventilation to be interrupted for defrosting of coils or any other purpose, except brief interruptions are permissible for systems that:

   8.1 Serve Non-Process Areas;

   8.2 Are implemented in accordance with Codes and standards; and

   8.3 Are implemented in accordance with Good Industry Practice.

9. Provide complete automation of all heat recovery systems in accordance with the Automation Design Guide. Ensure heat recovery systems are fully automated for optimized operation without operator intervention.

   9.1 Provide instrumentation and PCS integration as required to measure and log the Heat Recovery Ratio.

10. Ensure ventilation to spaces is not impeded by failure or shutdown of heat recovery systems. Provide redundancy as required.

3.4.4 Air Conditioning Systems

1. Provide DX split AC units or air handling units with built-in DX refrigerant coil and outdoor air-cooled condenser for spaces, as required to meet Table 3-2.
   1.1 Ductless split systems are permitted in electrical, Server, Automation, and Control Rooms and other clean spaces, provided they:
      1.1.1 meet other design criteria including noise and service life as applicable;
      1.1.2 have monitoring and control integrated into the PCS;
      1.1.3 are configured with redundancy such that failure of a unit will result in a minimum of 2/3 of the maximum design requirements for ventilation, heating, and/or cooling being provided; and
      1.1.4 are configured with each system being completely independent with no shared mechanical or piping components.
2. Size air conditioning system based on the heat gains from the electrical and control equipment in the associated space plus the ventilation loads and base loads from the building structures.
3. Ensure sufficient safety margin is considered in all design calculations but ensure adequate cycle times of units to prevent operational issues such as frosting.
4. Provide appropriate staging of compressors for temperature control and energy efficiency.
5. Where a space has a high internal heat gain or seasonal solar gain, consider the implications of AC units operating at low outside air temperatures. Ensure that required cooling is provided under all outdoor conditions.

3.4.5 Boilers

1. All boilers shall be industrial grade.
2. All boilers shall have an Annual Fuel Utilization Efficiency (AFUE) of 90% or greater.
3. Boilers shall be configured to operate on natural gas. In addition, boilers shall be configured to operate on biogas, where biogas is available.
4. Design the boiler system to:
   4.1 Provide duty capacity to generate heat to maintain required building space temperatures and other plant processes (eg. Digesters) under all conditions;
   4.2 Provide N+1 redundancy.
      4.2.1 Where boilers are fueled with biogas, ensure that N+1 redundancy is also provided for boilers capable of biogas.
   4.3 Provide an expansion tank for each boiler.
   4.4 Provide a natural gas feed line to each boiler unit equipped with two pressure-reducing valves in series and an isolation valve from the main natural gas feeder.
   4.5 Equip each boiler unit with an exhaust to outdoors.
   4.6 Equip each boiler unit with a condensate neutralization tank.

3.4.6 Natural Gas Heating

1. Direct-fired air handling and make-up air units may only be utilized where:
   1.1 Serving Process Areas;
   1.2 Permissible by Codes;

1.3 They do not serve or are not located in an environment where there is a potential for an explosive atmosphere; and

1.4 They do not serve an area where the ventilation is such that carbon monoxide could build up (ventilation requirements not to be increased to allow for use of the direct-fired air handlers).

2. Gas direct fired unit heaters are not permissible.

3. All indirect gas-fired heaters shall have a minimum efficiency of 80%.

3.5 Energy Efficiency

1. Size HVAC equipment to ensure design safety factors while taking whole life cycle costing into consideration for optimal energy efficiency. Coordinate with the architectural discipline to minimize building ventilation leakage rates through both material and component selection and construction methods.

2. Provide variable speed drives as appropriate to provide energy savings, where:

   2.1 Required for functional reasons; or

   2.2 The simple payback period of the additional capital cost (excluding engineering) is ten (10) years or less.

3. Under no condition shall any airflow or space be simultaneously, or near simultaneously, heated and cooled in any manner to waste energy.

3.6 Corrosion Protection

3.6.1 Protection of Electrical and Automation Components

1. Design spaces and associated ventilation systems to minimize corrosion of electrical and automation components. Ensure the following spaces maintain a G1 – Mild classification as per ISA 71.04:

   1.1 Electrical Rooms;

   1.2 Control Rooms;

   1.3 Automation Rooms;

   1.4 Server Rooms; and

   1.5 Any other spaces with significant spaces electrical and automation components.

2. Where required, install a scrubber or chemical filters to address corrosive gases.

3. As part of project commissioning, install and test corrosion coupons, in accordance with ISA 71.04, in all spaces requiring a specific ISA 71.04 classification. Provide a report demonstrating compliance.

3.6.2 Protection of HVAC Equipment

1. Ensure all HVAC equipment is constructed of suitable materials for the environment in which they are being placed to resist corrosion and provide the specified service life.

2. Provide corrosion resistance for HVAC equipment in corrosive environments by using:

   2.1 Chemical resistant coatings; or

   2.2 Fiber Reinforced Plastic (FRP) or stainless-steel equipment.

3.7 Equipment and Material Design Requirements

3.7.1 General Layout Requirements

1. Ensure all equipment is accessible and has clearance to allow for maintenance including the breaking of flanged connections, unions, equipment mounting bolts, equipment alignment bolts, etc.
2. Provide sufficient clearance and access for equipment on all sides requiring service access.
3. Provide a minimum of 1000 mm clearance in front of all equipment requiring service access.
4. For all equipment with a motor power rating of 3.7 kW (5 hp) or greater, provide a minimum clearance of 800mm between the outermost extremities of adjacent pieces of equipment, and between a wall and the equipment.
5. Provide a minimum of 800mm clearance between open doors (including electrical panel doors) and adjacent pieces of equipment, walls, or obstacles. For clarity, the clearance shall be calculated from the edge of the door, at the closest point of the door swing travel.
6. Ensure adequate clearance above or below units is provided for the lifting/removal of equipment for repair or replacement. Ensure clearance is provided for anchored/load rated lifting devices.
7. Provide sufficient clearances for removal and refitting of the serviceable components of all installed equipment without removal or dismantling of other equipment or assets. For clarity, this includes planned service requirements throughout the life of the asset and non-routine unplanned failures.
   - 7.1 Provide sufficient clearances to replace AHU and MAU filters.
8. Provide sufficient clearances to replace AHU and MAU coils and fans.
9. Coordinate clearances with all engineering disciplines to ensure that the final commissioned installation meets all clearance requirements.
10. Locate equipment outside of corrosive locations, except as follows:
    - 10.1 Small HVAC components, such as dampers, diffusers, and grilles, which cannot practically be installed outside the corrosive location, may be installed in locations where there is potential for corrosion, provided that the design and materials selected prevent corrosion.
11. The following HVAC air supply equipment applications are viewed by the City to be more critical and shall be located in a heated indoor space to improve reliability and maintainability:
    - 11.1 Equipment servicing spaces having a Class I, Zone 1 electrical classification, except equipment servicing raw sewage wet well spaces;
    - 11.2 Equipment servicing spaces having a Class I, Zone 2 electrical classification, except equipment servicing raw sewage wet well spaces;
    - 11.3 Equipment servicing spaces having an unclassified electrical classification, where ventilation is required by NFPA 820 to obtain the unclassified electrical classification;
    - 11.4 Equipment servicing spaces having toxic, hazardous, or biological hazards;
    - 11.5 Equipment servicing critical equipment, where a failure of the HVAC equipment, if redundancy is not provided, would affect the process within four hours;
    - 11.6 Equipment with high levels of maintenance requirements (equaling or exceeding one (1) maintenance inspection or activity per week); and
    - 11.7 Equipment containing chemical media filters.

12. All HVAC air supply and return air equipment with a capacity greater or equal to 4000 L/s shall have all routinely serviceable components accessible from a heated, ventilated service corridor.
13. All HVAC equipment located indoors shall be located in mechanical rooms, separate from the spaces that they serve, except as indicated below:
    - 13.1 Small fans less than 0.75 kW (1 hp) may be located in either served spaces or adjacent spaces; and
    - 13.2 Process Areas that are clean, not likely to contain any dust or contaminant related to the process, dry, non-corrosive and not electrically classified may contain the HVAC equipment associated with the served Process Area, provided that neither operation or maintenance of the HVAC equipment or the process and is impeded by the location of the HVAC equipment.
14. Where HVAC equipment serves electrically classified locations, the requirements of that classified area shall be met.
15. HVAC equipment located outdoors may be on a grade level foundation, provided that:
    - 15.1 The space required by the HVAC equipment does not impede future expansion of the facility;
    - 15.2 The equipment is located above the flood protection level, as clarified in the Civil Design Guideline, and is in no danger of overland flooding;
    - 15.3 The equipment is not susceptible to potential physical damage from vehicles or other sources; and
    - 15.4 Air handling equipment located at grade is in a fenced a fenced enclosure around the HVAC equipment, that also acts as a wind-break for maintenance personnel; and
    - 15.5 All HVAC equipment is visually obscured from public facing areas with an aesthetically pleasing barrier, consistent with the public facing materials used on the site.
16. HVAC equipment accessibility shall be as shown in Table 3-4.
17. All mechanical equipment (including but not limited to; Condensing Unit, Hot Water Tanks, Strainers) shall be designed to be adequate to the current quality of the input (ex. Flushing Water). The designer should request water quality data from the Operations at the time of design. Ensure additional softening, chemical treatment, and filtration is not required.

Table 3-4: HVAC Equipment Accessibility

Maintenance Activity Interval (See Note 1)	**Motor size**	**Minimum Accessibility**
Greater than six (6) months	< 0.746 kW (1 hp)	Portable ladders or lifts (See Note 3)
	>= 0.746 kW (1 hp)	Permanent ladder and platform
Less than or equal to six (6) months and greater than three (3) months	Any	Permanent ladder and platform
Less than or equal to three (3) months. This includes any air handlers with filters.	Any	Grade-level or a stairway accessible level

Note(s):

1. *Maintenance Activity Interval includes all maintenance activities including inspections, as per typical industry manufacturer's recommendations or the specific equipment installed, whichever is more frequent.*
2. *A design that requires the use of scaffolding for maintenance accessibility of any HVAC equipment is not an acceptable requirement.*
3. *Where portable ladders or lifts are to be utilized, the design shall provide clear, even supporting surfaces and access for a correctly sized ladder or motorized lift.*

18. Locate equipment such that accumulation of snow under normal or extreme snow conditions (up to 300mm single day accumulation on top of 300mm previous accumulation, plus drifting) does not hinder their operation. Ensure that the equipment is maintainable under extreme snow conditions, with snow drifting at access points minimized and means provided for personnel to effectively remove snow using mechanical means.
19. Provide all required facilities to allow for safe maintenance access of equipment. Provisions for routine maintenance shall not require the installation or provision of temporary facilities. Equipment should be located at sufficient distance from the edge of roofs to avoid use of temporary barricades for routine operation and maintenance activities. Alternately, provide permanent guardrails to allow for safe working access to all routine operational and maintainable aspects of the equipment. Fall anchor points shall be provided for non-routine maintenance activities where other protection is not provided. Manitoba Workplace Safety and Health Act Regulation requirements shall be maintained, but do not necessarily represent the minimum requirement.
20. Condensation and Leakage

    20.1 Locate equipment and piping to avoid leakage and condensation on equipment or materials that may be affected by liquids, including but not limited to electrical and computer equipment and dry chemicals. Drip trays shall not be utilized as a strategy to avoid proper placement of equipment and piping.

    20.2 Centrifugal fans supplied with hollow airfoil blades shall have "blade weep holes" to prevent the build up of condensation on the inside of the blades.
21. All centrifugal fans with motors >=22 kw to be built with a split housing for the ease of maintenance and removal of internal components without the need to disassemble adjacent ducting.

3.7.2 Outdoor Air Filtration Criteria

1. Provide minimum outdoor air filtration in accordance with Table 3-5. Increase filtration requirements as required to protect the equipment or process.

Table 3-5: Minimum Outdoor Air Filtration Criteria

Filtration Type	Description	Typical Application
A	Pre-filter MERV[1] 8 (30~35 percent efficiency), Chemical Filters Stage 1 & Stage 2, After-filter and Final filter MERV[1] 13 (80~90 percent efficiency)	Automation Rooms, Control Rooms, Server Rooms & Electrical Rooms where corrosive gases may be present
B	Pre-filter MERV[1] 13 (80~90 percent efficiency)	Administrative Areas Automation Rooms, Control Rooms, Server Rooms & Electrical Rooms where corrosive gases are not typically present
C	Pre-filter MERV[1] 8 (30~35 percent efficiency)	Process Areas

2. Minimum Efficiency Reporting Value (MERV) for filters as per ASHRAE Standard 52.2.
3. *Provide bird screens for rooftop air handling unit intake louvers.*
4. Where possible, select filters to minimize types of filters and reduce inventory stock requirements.
5. *Provide filter instrumentation and PCS monitoring in accordance with the Automation Design Guide.*
6. *Where there is a potential for corrosive gases, ensure suitable media filters are provided for Automation Rooms, Control rooms, Electrical Rooms and Server Room air handling units or pressurization units to filter the corrosive gases in the air intake stream.*
   - 6.1 *Provide additional filter stages as required to address the atmosphere present.*
   - 6.2 *Where possible, coordinate with the City to ensure the filter size is compatible with existing equipment to reduce the number of filter types the City needs to manage.*

3.7.3 HVAC Equipment Selection Criteria

1. Provide premium efficiency motors.
2. Supply removable insect screens for any air intake dampers, supply fans and vent ducts/pipes as required.
3. Provide AMCA Type A or Type B spark resistant fans in all fans serving electrically classified spaces. If fans are located within the classified area, motors shall be Explosion Proof, in addition to the AMCA Type A or Type B Construction.

3.7.4 Equipment Design Requirements

1. Outdoor equipment shall not require the use of tools for regular inspections and basic changes such as filter replacement.
2. Fans serving corrosive gases shall not have motors in their airstream.
3. Where there is a danger of the liquid coils freezing, provide heat trace cable complete with the appropriate controls.
4. HVAC equipment shall have electrical disconnect switch within three (3) meters for maintenance or replacement.

3.7.5 Ductwork

1. Provide ductwork as required based upon the environment and the required service life. Minimum material requirements for ductwork are indicated in Table 3-6.

Table 3-6: Minimum Material Requirements for Ductwork

Location	High Humidity	Corrosive Gases or Chemicals	Material	Notes
Process Areas	No	No	Aluminium	
	Yes	No	Aluminium	
	Yes	Mild H_2S	Aluminium	
	Yes	Yes	FRP Stainless Steel	Potential for corrosion. Select appropriate corrosion resistant material.
Non-Process Areas.	No	No	Aluminum or Galvanized steel	

2. Ductwork specifications shall be written such that Sheet Metal and Air Conditioning Contractors National Association (SMACNA) standards for duct construction are adhered to. This standard stipulates duct thickness based on size and pressure ratings.
3. Utilize round ductwork wherever possible. Where rectangular ductwork is required, limit aspect ratios to a maximum of 4:1.
4. Ensure that the maximum duct pressure drop is 25 Pascal per 30 metres of duct with a maximum duct velocity of 6 m/s
5. Provide access doors where required for inspection and maintenance, including but not limited to control dampers and fire dampers.
6. Provide condensate drains as required, including on outdoor ducting. Where there is outdoor ducting ensure to design for insulation and heat trace against environmental conditions.

3.7.6 Dampers

1. Ensure dampers and damper actuators are accessible for maintenance.
2. Provide hinged access doors for actuated dampers to allow for maintenance.
3. Locate motorized dampers (and pneumatic dampers where applicable) in indoor locations. Outdoor applications of motorized dampers should be avoided if possible.
4. Provide motor to damper connections that avoid slippage between the two devices. Use of a keyed shaft or hex shaft is preferred.
5. For all dampers in critical applications, including but not limited to those specified in Section 3.8.4, ensure the limit switch(es) prove operation of the damper. Actuator mounted limit switches are not acceptable for critical applications.
6. For dampers located at exterior walls for supply or exhaust applications, provide thermally broken insulated type.

3.8 Combustible and Explosive Gases and Dusts

3.8.1 Hazardous Locations

1. All Hazardous Locations shall be defined as per the IEC Zone system in the Canadian Electrical Code.
2. Coordinate with the electrical discipline and the WWD Electrical Design Guide for additional requirements and guidance relating to electrical classification.
3. Designers should also consider API 500 for determination of classified locations as appropriate.

3.8.2 Application of NFPA 820

1. Hazardous Locations and associated ventilation shall be defined in accordance with NFPA 820. Application of NFPA 820 shall be comprehensive, except as indicated within this document or otherwise indicated by the Contract. Deviations include, but are not limited to:
2. Existing areas:

   2.1 For existing areas, where the occupancy and primary use of the building/structure is not being fundamentally changed, apply NFPA 820 only for items being replaced or significantly modified by the work. The simple replacement of selected equipment within an area should not automatically trigger complete NFPA 820 compliance for the entire building, except as specifically required by the Contract or as required to provide a safe installation.

   Note that NFPA 820 clause 1.4.1 indicates:

   Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

   2.2 In the event that some equipment is being replaced within and area addressed by NFPA 820, but the overall occupancy and electrical classification of the space is not being changed, at minimum ensure that the electrical classification of the new equipment is appropriate for a potential future upgrade of the space to more complete NFPA 820 compliance. For example, if replacing an instrument within a primary clarifier space that is currently not designated as a hazardous location, ensure that the replacement instrument is appropriately rated for a hazardous location.

3. Electrical classification vs. ventilation:

3.1 For many spaces, NFPA 820 permits a lower ventilation rate under the condition that a higher level of electrical classification is provided. Utilize the guidance provided in Table 3-7 for selection.

3.2 Ensure that:

3.2.1 The proposed ventilation rate will provide adequate ventilation to remove any toxic gases, including H_2S, to a safe working level in any area that is routinely occupied; and

3.2.2 The proposed ventilation rate and electrical classification does not impede maintenance activities.

Table 3-7: NFPA 820 Alternative Selection Guidance

Case [1]	**NFPA 820 Alternative**	**Ventilation** [2]	**Electrical Classification**	**Acceptable Applications**
1	A	< 12 ACH	Class I, Division 1 (Zone 1)	Raw sewage wet wells with a minimum of 2 ACH base ventilation and 30 ACH purge ventilation to allow for personnel entry is provided.
				Other applications, provided that personnel occupancy is only required < 1 per month and maintenance requirements are minimal.
	B	12 ACH	Class I, Division 2 (Zone 2)	Raw sewage wet wells, if demonstrated to have a lower lifecycle cost compared to Alternative A.
				Applications with significant maintenance requirements or regular personnel occupancy. Examples: screen room, primary clarifiers.
2	D	< 6 ACH	Class I, Division 2 (Zone 2)	Where lifecycle cost savings are provided and personnel occupancy is typically less than once per day.
	C	6 ACH	Unclassified	Where occupancy is equal or greater than once per day or where lifecycle cost savings are provided.

Note(s):

1. *The Case is related to the selection of alternatives, as per NFPA 820, for a given type of occupancy / process. For example, primary clarifier spaces would be Case 1, while pumping station drywells would be Case 2.*
2. *Reduced ventilation rates, as per NFPA 820 when certain conditions exist, are not indicated in this table, but are acceptable and required.*

4. Provide the capability and all associated features to reduce the ventilation rate and/or recirculate the air in accordance with the conditions and requirements of NFPA 820.

3.8.3 Adjacent Spaces

1. Minimize the electrical classification and ventilation of spaces adjacent to the sources of gasses and combustible dusts, while providing safety. Provide appropriate means to prevent migration of gasses and combustible dusts between adjacent spaces.
2. Provide appropriate means to allow personnel to travel between adjacent spaces, as required. Do not require personnel to travel outdoors or significant additional distance to minimize the installation of systems to prevent the migration of gasses.
3. Where a Class I, Zone 1 location is adjacent to a Class I, Zone 2 location, provide appropriate means to prevent migration of gasses from the Zone 1 location to the Zone 2 location, including, but not limited to, pressurization and sealing.
4. Where a Class I, Zone 1 location is adjacent to an unclassified location, provide all necessary means to prevent the migration of gases from the Zone 1 location to the unclassified location. As required, provide appropriate pressurized vestibules, rated as a Class I, Zone 2 locations, to allow personnel to travel between the two locations.
5. Where a Class I, Zone 2 location is adjacent to an unclassified location, provide appropriate means to prevent migration of gasses from the Zone 2 location to the unclassified location, including, but not limited to, pressurization and sealing.
   5.1 NFPA 820 indicates that classified and unclassified spaces should be physically separated, with no means of communication between the spaces. However, the standard makes no differentiation between Class I, Division 1 (comparable to Zone 1) and Division 2 (comparable to Zone 2) spaces. Avoiding all communication between unclassified and Class I, Zone 2 locations has both cost and operational implications. Thus, unless mandated by the AHJ, it is not a requirement to ensure no communication between classified and unclassified spaces, provided the requirements in this section, based upon IEC 60079-10-1 are adhered to. Reference IEC 60079-10-1 and Table 3.8, 3.9 and 3.10 for detailed guidance regarding electrical classification associated with openings between spaces.

Table 3-8: Type of Openings

Opening Type	Description	Examples
A	Openings that do not conform to Types B, C or D	Open passages, ventilation outlets, unsealed penetrations for cables and pipes.
B	Openings that are normally closed and infrequently opened	A standard door with a self-closing mechanism
C	Openings that are normally closed, infrequently opened, and incorporate a gasket seal around the perimeter of the closure device.	A door with a full gasket seal and a self-closing mechanism.
D	Openings that meet the requirements of Type C and can only be opened by special means or in an emergency.	A “Type C” emergency door incorporating an alarm circuit.

Note(s):

1. *Table based upon IEC 60079-10-1*

Table 3-9: Grade of Release Descriptions

Grade of Release	Description
Continuous	A release that is continuous or nearly so, or that occurs frequently and for short periods (~ > 1000 hours per year).
Primary	A release which is likely to occur periodically or occasionally in normal operation (~ 10 - 1000 hours per year).
Secondary	A release which is unlikely to occur in normal operation, and if it occurs will only do so infrequently and for short periods (~ 10 - 1000 hours per year).

Note(s):

1. *Table based upon IEC 60079-10-1.*

Table 3-10: Grade of Release based upon Openings

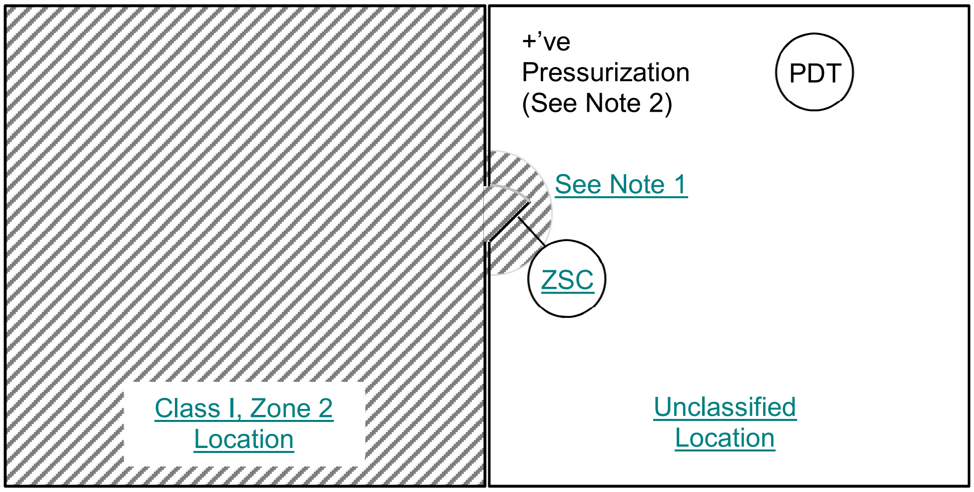
Electrical Classification of Upstream Opening	Opening Type	Grade of release of openings considered as sources of release
Zone 0	A	Continuous
	B	(Continuous)/primary
	C	Secondary
	D	Secondary
Zone 1	A	Continuous
	B	(Continuous)/secondary
	C	(Secondary)/no release
	D	No release
Zone 2	A	Secondary
	B	(Secondary)/no release
	C	No release
	D	No release

Note(s):

1. *Table based upon IEC 60079-10-1.*
2. *For the grades of release shown in brackets, the frequency of operation of the opening should be a consideration in design.*

6. In accordance with Table 3-8, Table 3-9, and Table 3-10, Figure 3-1 and Figure 3-2, provide gasketed doors with self-closers to segregate spaces with different levels of electrical classification. In addition to the door, the following shall apply:
   - 6.1 Provide positive space pressurization for the unclassified location and negative pressurization for the classified location.
   - 6.2 Provide differential pressure transmitter detection of positive pressurization of the unclassified location, and alarming on the failure of such pressurization.
   - 6.3 Provide signage on both sides of each door with the wording such as:
     - 6.3.1 “WARNING – Do not prop door open. Potential explosive gas hazard.”

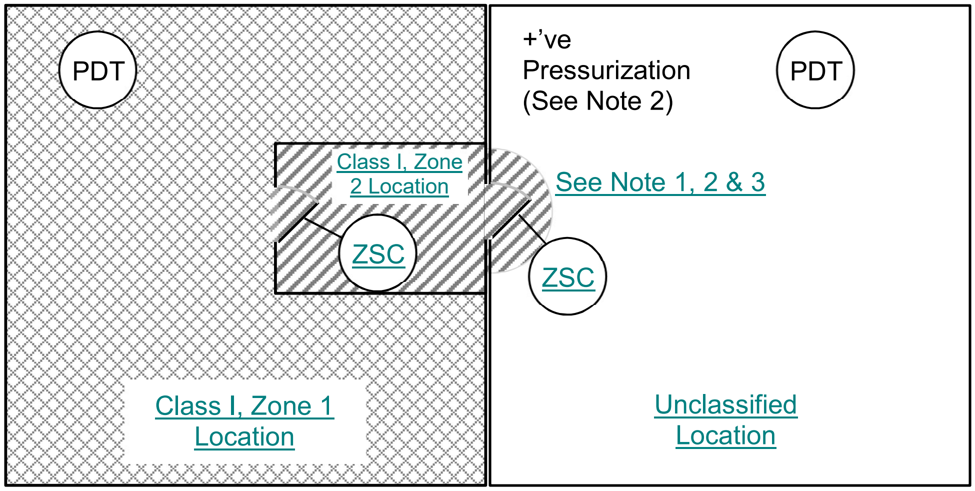
Figure 3-1 : Requirements for Doorway between Class I, Zone 2 and Unclassified Location



Notes:

1. *Each door shall be gasketed, with an automatic closure and a closed limit switch connected to the PCS for alarming. Electrically classify the space within 0.9 m of the door, on the positively pressurized side of the door, as a Class 1, Zone 2 location.*
2. *Each unclassified location connected to a classified location shall be positively pressurized, with a pressure differential transmitter connected to the PCS with alarming upon loss of pressurization.*

Figure 3-2 : Requirements for Doorway between Class I, Zone 1 and Unclassified Location



Notes:

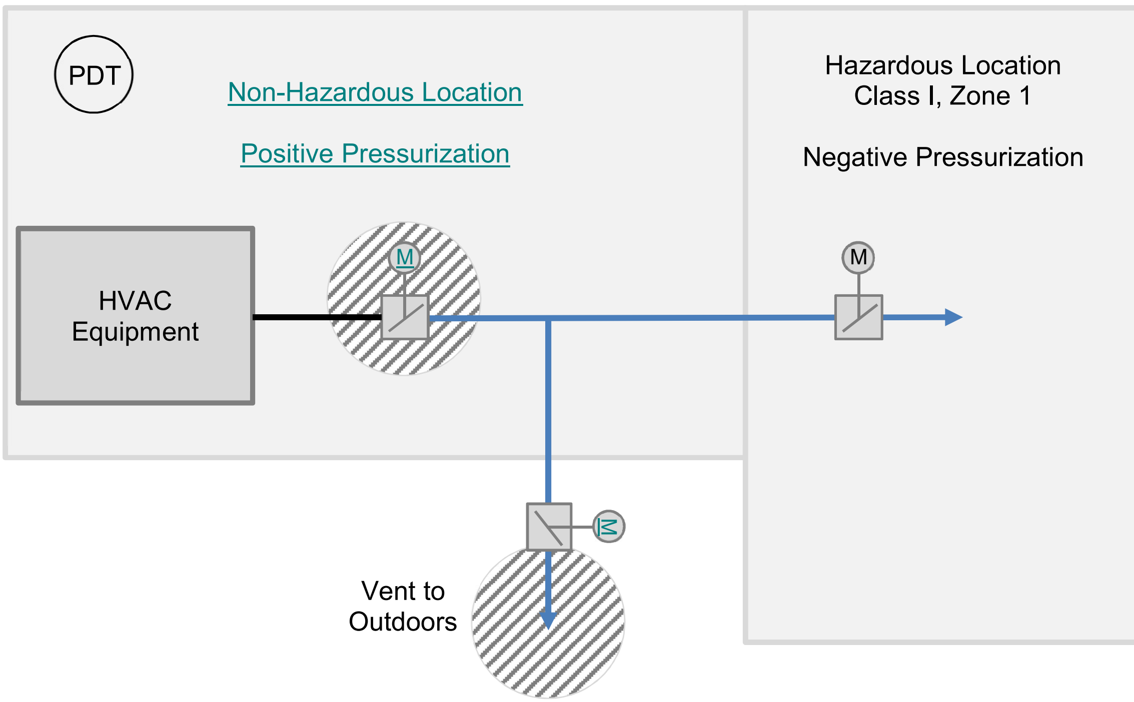
1. *Each door shall be gasketed, with an automatic closure and a closed limit switch connected to the PCS for alarming. Electrically classify the space within 0.9 m of the door, on the positively pressurized side of the door, as a Class 1, Zone 2 location.*
2. *Each unclassified location connected to a classified location shall be positively pressurized, with a pressure differential transmitter connected to the PCS with alarming upon loss of pressurization.*
3. *The vestibule shall be ventilated and pressurized relative to the Class I, Zone 1 location, but less positively pressurized relative to the unclassified location.*
4. *All rooms that are entirely Class I, Zone 1 shall have a pressure differential transmitter connected to the PCS with alarming upon loss of pressurization.*

3.8.4 Configuration and Location of HVAC Equipment

1. Locate equipment servicing Hazardous Locations in accordance with Section 3.7.1 - General Layout Requirements.
2. Where mechanical equipment is located outside of the Hazardous Location, the design of the system shall be such that the hazard cannot migrate into another area during the course of normal operation, abnormal operation, or maintenance.
3. Where indoor mechanical equipment in a non-hazardous location services a Class I, Zone 1 location, the minimum requirements shall include a system of actuated and monitored tight

shut-off dampers used to create a double block and bleed arrangement in accordance with Figure 3-3.

Figure 3-3 : Equipment Servicing Class I, Zone 1 Location

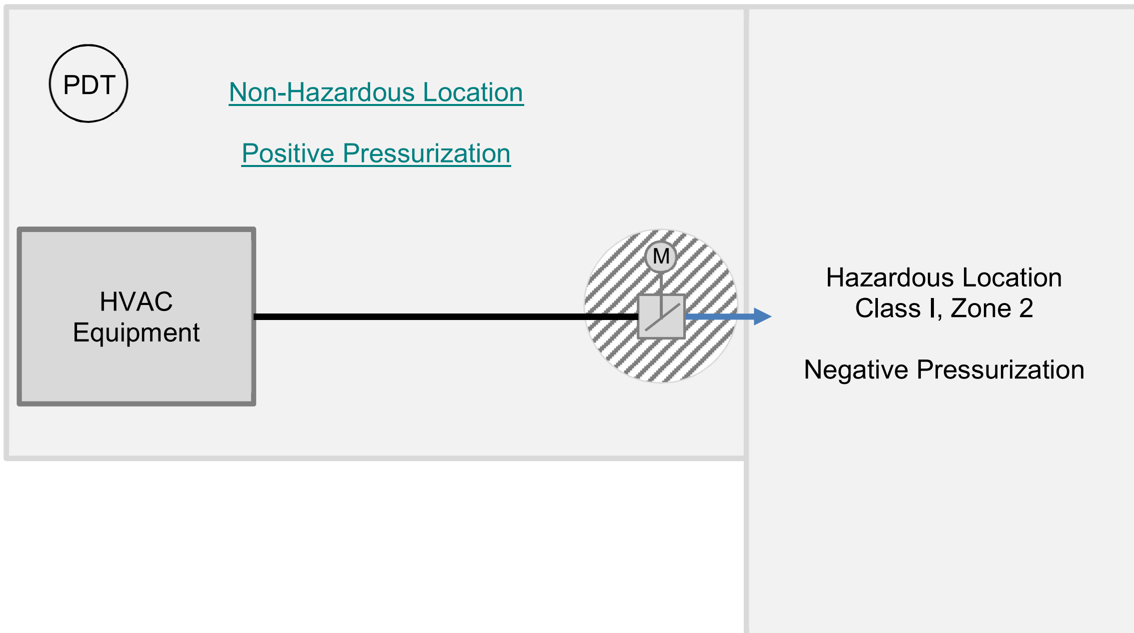


Notes:

1. *All dampers shall be tight fitting (AMCA 511 Class I leakage or better), spring return with appropriate fail-closed or fail open positions, and a connected to the PCS for alarming. The damper shall close automatically upon ventilation failure.*
2. *Electrically classify the space within 0.9 m of the dampers within the non-hazardous location, as a Class 1, Zone 2 location.*
3. *The bleed shall discharge to the outdoors in a safe location. Electrically classify the area within 0.9 m of bleed discharge as a Class 1, Zone 2 location.*
4. *All ductwork within the non-hazardous location that is within and downstream of the block-and-bleed damper arrangement shall be sealed.*
5. *Each unclassified location connected to a classified location shall be positively pressurized, with a pressure differential transmitter connected to the PCS with alarming upon loss of pressurization.*

4. Where indoor mechanical equipment in a non-hazardous location services a Class I, Zone 2 location, the minimum requirements shall include an actuated and monitored tight shut-off damper accordance with Figure 3-4.

Figure 3-4 : Equipment Servicing Class I, Zone 2 Location



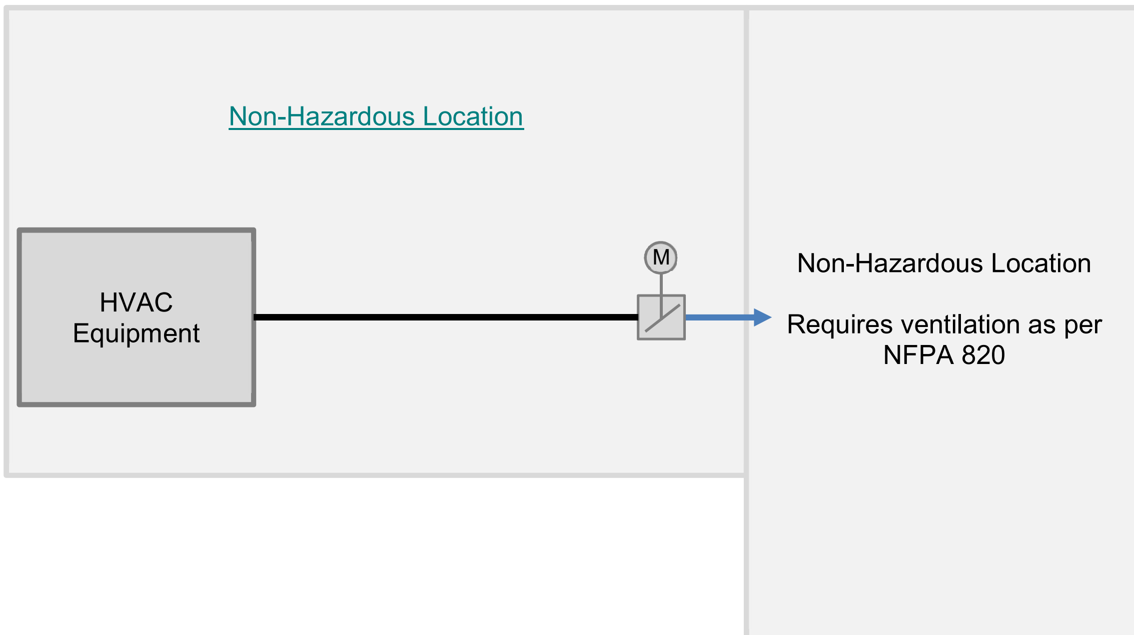
Notes:

1. *All dampers shall be tight fitting (AMCA 511 Class I leakage or better), spring return with appropriate fail-closed or fail open positions, and a connected to the PCS for alarming. The damper shall close automatically upon ventilation failure.*
2. *Electrically classify the space within 0.9 m of the damper within the non-hazardous location, as a Class 1, Zone 2 location.*
3. *All ductwork within the non-hazardous location that is downstream of the damper shall be sealed.*

Each unclassified location connected to a classified location shall be positively pressurized, with a pressure differential transmitter connected to the PCS with alarming upon loss of pressurization.

Where indoor mechanical equipment in a non-hazardous location services an unclassified location and ventilation is required by NFPA 820 to obtain the unclassified electrical classification; the minimum requirements shall include an actuated and monitored tight shut-off damper accordance with Figure 3-5.

Figure 3-5 : Equipment Servicing Unclassified Location



Notes:

1. *All dampers shall be tight fitting (AMCA 511 Class I leakage or better), spring return with appropriate fail-closed or fail open positions, and a connected to the PCS for alarming. The damper shall close automatically upon ventilation failure.*
2. *All ductwork within the non-hazardous location that is downstream of the damper shall be sealed.*

3.8.5 Equipment Suitability

1. HVAC systems located in Hazardous Locations will be approved for the location and the hazard (area classification and temperature as applicable).
2. HVAC systems serving Hazardous Locations will be appropriate for the service and the hazard and will not have any source of ignition in the airstream.
3. Direct fired natural gas air handlers may not service Hazardous Locations.

3.9 Toxic, Hazardous, and Biological Hazards

3.9.1 General Requirements

1. Provide appropriate ventilation to address toxic, hazardous, and biological hazards to allow personnel to enter all spaces requiring routine access without special entry requirements. This may require ventilation over and above that required in other sections of this document.
2. Where practical, utilize exhaust ventilation at the source of the hazard to minimize overall ventilation requirements.

3.9.2 Exposure Limits

1. Provide HVAC equipment, monitoring and controls (including fixed gas detection in accordance with the Automation Design Guide) as required to demonstrate compliance with the higher standard (lower exposure limit) of:
   1.1 Table 3-11; or
   1.2 Manitoba Workplace Safety and Health Act and Regulations.

Table 3-11: Toxic and Hazardous Substance Exposure Limits

Substance	**TLV-TWA (See Note 1)**	**TLV-STEL** (See Note 2)
Carbon Monoxide	25 ppm	75 ppm
Hydrogen Sulphide	1 ppm	5 ppm

Note(s):

1. *TLV-TWA represents the threshold limit value for an 8-hour time weighted average in accordance with American Conference of Governmental Industrial Hygienists (ACGIH).*
2. *TLV-STEL represents the threshold limit value for a short term (15 minute) exposure limit.*

2. All areas, including Process Areas, that are occupied on average of once per day, for any duration, shall provide appropriate engineering controls to limit the concentration of all toxic and hazardous substances to below the applicable TLV-TWA.
3. When evaluating the potential exposure to toxic and hazardous substances, ensure that consideration of the combined sewer collection system and the associated hazards is included. Spills of hazardous substances into the collection system may occur and Good Industry Practice shall be utilized in providing safety for personnel.
4. As part of the project commissioning, demonstrate compliance with this section. This may require the provision of additional temporary instrumentation for commissioning purposes.

3.10 Chemical Rooms

1. Provide low and high-speed control ventilation system for chemical areas with dual ventilation rates via Variable Frequency Drive (VFD) control to meet ventilation requirements as per National Fire Code and ASHRAE standards.

4 PLUMBING SYSTEMS

4.1 General Requirements

1. Comply with the National Plumbing Code of Canada with Manitoba Code amendments for sanitary drainage, storm drain, potable water, and plant service water system design.
2. Protect all piping from freezing under all weather and operating scenarios.

4.2 Potable Water Systems

1. Provide potable water for washroom/janitor rooms plumbing fixtures and for combination or stand-alone shower/eyewash stations.
2. For interior hose valves in Process Areas, provide 25mm or 40 mm globe valves with hose thread adapters. Provide vacuum breaks for all potable water hose bibs.
3. For potable hot water, selection of hot water heating shall be as follows:
   3.1 Utilize electric heating for all low usage requirements.
   3.2 Consider the use of gas water heaters for high-usage requirements such as locker rooms. Review and make recommendations based upon the life-cycle cost of the equipment.

4.2.2 Water Conservation

1. Specify and install low water consumption plumbing fixtures and trim in accordance with the higher standard of the Manitoba Building Code or this document.
2. Provide high-efficiency plumbing fixtures for water use reduction.
3. Provide water meters and sub-meters, connected to the PCS to allow instantaneous and totalized historical readings, for:
   3.1 Each building, unless it can be demonstrated that the building has an average water demand < 400 L/d;
   3.2 Each process that has an average water demand ≥ 3271 L/d; and
   3.3 Each equipment that has an average water demand > 3271 L/d.
4. Provide water meters for main water usage facility as per City Standards – CW 2110 - Watermains.

4.2.3 Cross-Connection Control

1. Provide cross-connection control in accordance with the CSA standards.
2. Install backflow prevention assemblies for the following: potable cold-water main entrances into each new building with a double check valve back-flow prevention assembly and non-potable water main entrance into each new building with a reduced pressure backflow prevention assembly. Coordinate with the City Water Services for final design.
3. Provide vacuum breaks on all potable water hose bibs.
4. Provide local reduced pressure backflow preventers for the HVAC heating system and glycol heat recovery system make-up water connections to potable water systems.

4.3 Sanitary Drainage Systems

1. Separate sanitary drainage systems from storm water, weeping tile, and other “clean” water drainage.
2. Process drains may be integrated into sanitary drainage systems provided that all risk of process drains backing up sanitary drainage systems is eliminated.
3. Where possible, direct all sanitary drainage to the headworks of the treatment plant, prior to any treatment process (including screening and grit removal), but after any flow metering and raw sewage sampling. Where this is not possible, sanitary drainage shall be directed to the headworks of the plant and be provided with dedicated flow measurement connected to the PCS.
4. Design sanitary systems to utilize gravity drains wherever possible. Minimize the installation of pumping systems.
5. Where sanitary systems are pumped, provide a minimum of duplex sanitary sump pumps, each sized to handle the design flow.
6. Where gravity systems to sump locations cannot be used, design all sanitary drains and wash down gutter/floor drains to be collected in sanitary sumps in the basement.
   - 6.1 Provide sump pump systems to pump the sanitary drainage to the discharge location.
   - 6.2 Ensure provision of high sump level alarms to be sent to plant PCS.
   - 6.3 Ensure the sump pumps are discharged into an appropriate location in the plant. City approval is required for all discharge locations other than the headworks.
7. Install backflow prevention assemblies in all sanitary lines exiting the building or area.
8. Provide gutter drains for basement tunnels, pipe galleries, perimeter walls, and other spaces as required to collect floor wash down drainage.
9. Provide floor drains for Process Areas, mechanical rooms, washrooms, janitor rooms, and locker rooms as required.
   - 9.1 Minimum size of floor drains shall be 50mm.
   - 9.2 Coordinate with the structural discipline to ensure that floors are sloped to the drains.
   - 9.3 For Process Areas, ensure that floor drains have sufficient capacity to cope with flows associated with washing floors with industrial hoses up to 25 mm diameter.
   - 9.4 Provide additional floor drainage in Process Areas associated with sludge pumping and / or processing, and inlet screening.
   - 9.5 Provide trench drains with industrial quality gratings in areas where routine wash down is expected or heavy spillage in preparation for maintenance activity could occur. Areas subject to infrequent spillage may have point drainage.
   - 9.6 Provide mechanically secured gratings for all drains.
10. Provide hub drains for mechanical equipment including air conditioning units to collect overflow drain and condensate drain as required.
11. All floor/gutter drains and hub drains that are infrequently used shall have primed P-traps.
12. Water source for trap priming shall be:
    - 12.1 Non-potable water in general areas of the facility; and
    - 12.2 Flushing water (plant effluent) in Process Areas.
13. Provide ganged traps where allowed by Codes, otherwise provide individual traps for floor drains/gutter drains and hub drains.

4.3.2 Rain / Storm Water Drainage

1. Provide conventional (not siphoned) roof drains and overflow drains for all new buildings. Design individual rain water leaders to discharge to:
   1.1 Grade; or
   1.2 The plant storm drainage system, if available.
2. Install building weeping tile systems to the same location as roof drains.
3. Provide dedicated sump pits for weeping tile systems of below grade buildings and structures, including tunnels. Weeping tile sump pits shall be separate from sanitary drain systems unless it can be demonstrated that the average annual weeping tile flow for the building / structure is less than 10 m^3 per year.
4. Refer to the Automation Design Guide for instrumentation and control requirements associated with sumps.

4.4 Plumbing Fixtures

1. In buildings designed in accordance with building code requirements for accessibility for persons with disabilities, provide water closets and lavatories in the washroom with barrier-free plumbing fixtures for the physically disabled.
   1.1 As per the WSTP Architectural Design Guideline, only buildings having administration functionality will be designed in accordance with building code requirements for accessibility for persons with disabilities.
2. Provide toilets, wall-mounted or floor-mounted, flush-valve-type complete with dual-flow control.
3. Provide mop sinks for janitor rooms.
4. Provide lavatory sinks with automatic infrared faucet controls.
5. Provide wall-hung, automatic infrared flushing urinals for all male washrooms.
6. Provide local isolation / shut-off devices for all plumbing fixtures.

4.5 Emergency Showers and Eyewash Stations

1. Provide emergency eyewash and shower stations with control mixing valves for tempered water for Process Areas and chemical areas, wherever required for safety protection.
2. Emergency showers and eyewash stations shall be provided in accordance with ANSI Z358.1.
3. Provide circulation loops as required to ensure prompt delivery of tempered water.
4. Design the system to provide a minimum of a 15-minute flush/rinse, or longer as required / recommended by good industry practice or the Safety Material Data Sheets of the contaminant.
5. Design the system to deliver water at 26.7 deg. Celsius (80 deg. Fahrenheit) and ensure that the safety mixing valve is pre-set by the manufacturer for the mixing temperature of cold and hot water supply.
6. Provide a flow switch for the safety shower/eyewash.
   6.1 An alarm signal shall be sent to the plant PCS to notify staff in the Control Room that the equipment is being used.

7. Insulate and heat trace piping associated with outdoor emergency showers to prevent piping freezing.
8. Provide dust covers on all eye-wash stations.

4.6 Hot Water

1. Provide gas or electric domestic hot water heaters/tanks for potable hot water to washrooms/janitor rooms and to emergency shower/eyewash station mixing valves.
   1.1 Install hot water recirculation pumps to compensate for hot water piping heat loss for remote plumbing fixtures and safety shower/eyewash station as required.
2. Where practical and natural gas is available, preference shall be given to natural gas hot water heaters.
3. Provide recirculated systems where the return line runs within 150mm of each fixture or final fixture on a bank of fixtures.

4.7 Natural Gas

1. Comply with CSA B149.1 for natural gas piping system design.
2. Provide natural gas piping and regulators to each natural gas appliance as required.
   2.1 Install natural gas piping either underground (buried) or, if possible, on building roof. Installation of natural gas piping within the basement tunnels/galleries will not be accepted without approval of the City.
3. Coordinate the natural gas meter and gas regulator at the plant gas main with Manitoba Hydro for new gas loads.
4. Provide natural gas sub-metering, connected to the PCS, on a building basis for all buildings greater than 100 m^2 in area.

4.8 Valves

1. Provide valves to isolate all branch piping.
2. Provide valves constructed of suitable materials for the application.
3. Ensure all isolation and bleed valves are lockable.
4. Provide blanking, blinding or double block-and-bleed systems for all isolation points of pipes that carry harmful substances under pressure.
5. In accordance with Section 8.4, provide flow coefficient calculations for all control valves.

4.9 Piping

1. Pipe Specification Codes are provided in Table 4-1. These specifications are not comprehensive and only indicate general, high level, minimum requirements. Provide complete pipe specifications as appropriate for the application requirements. Where a new

type of piping is required, not indicated in Table 4-1, coordinate with the City regarding the pipe specifications.

2. Provide piping material in accordance with Table 4-2. The Design Team shall confirm suitability of all piping with the application, and where the indicated material types are not deemed to be suitable, shall advise the City along with the proposed alternate product.
3. Piping and appurtenance material section shall be appropriate for the location to ensure corrosion resistance. This may require a higher grade of material than that indicated in Table 4-2.
4. Provide corrosion resistant piping on sump pump suction lines. Standard of acceptance is stainless steel.
5. Provide water hammer arrestors complete with isolation valves where quick closing valves are used including plumbing fixture flush valves.
6. Ensure piping is primed and painted in accordance with the WSTP Piping Color Standard.
7. Provide pipe labelling, including the commodity code, description, and flow arrows.

Table 4-1: Pipe Specification Codes

Pipe Specification Code	Material	Size	Characteristics [1]	Minimum Schedule / Thickness [2]
CI01	Cast Iron (Soil Pipe)	≤ 150 mm	Hub-less, CISPI 301, service weight (SV), no-hub ends	SV
		≥ 75 mm	Hub and spigot, CAN/CSA-B70, ASTM A74, service weight (SV), single hub and spigot.	SV
CS01	Carbon Steel	≤ 150 mm	Black carbon steel, ASTM A106/A106M Grade B seamless, or ASTM A53/A53M Grade B seamless or ERW, conforming to ASME B36.10M.	Sched. 40
		200 - 400 mm		Sched. 30
		≥ 450 mm		Sched. 20
CS02	Carbon Steel	≤ 150 mm	Black carbon steel, ASTM A106/A106M Grade B seamless, or ASTM A53/A53M Grade B seamless or ERW, conforming to ASME B36.10M.	Sched. 80
		200 - 400 mm		Sched. 40
		≥ 450 mm		Sched. 30
CS11	Carbon Steel	≤ 150 mm	Black carbon steel, ASTM A106/A106M Grade B seamless, or ASTM A53/A53M Grade B seamless or ERW, conforming to ASME B36.10M. External coating: Liquid Epoxy: Factory Applied Primer, 75-100 micron (AWWA C210), Field Applied Finish Coat	Sched. 40
		200 - 400 mm		Sched. 30
		≥ 450 mm		Sched. 20
CS12	Carbon Steel	≤ 50 mm	Black carbon steel, ASTM A106/A106M Grade B seamless, or ASTM A53/A53M Grade B seamless or ERW, conforming to ASME B36.10M. External coating: Liquid Epoxy: Factory Applied Primer, 75-100 micron (AWWA C210), Field Applied Finish Coat	Sched. 40
		> 50 mm		Sched. 10
CS31	Carbon Steel	≤ 150 mm	Black carbon steel, ASTM A106/A106M Grade B	Sched. 40
		200 - 400 mm		Sched. 30

Pipe Specification Code	Material	Size	Characteristics [1]	Minimum Schedule / Thickness [2]
		≥ 450 mm	seamless, or ASTM A53/A53M Grade B seamless or ERW, conforming to ASME B36.10M. Lined with Liquid Epoxy: Factory Applied, AWWA C210, NSF 61 certified External coating: Liquid Epoxy: Factory Applied Primer, 75-100 micron (AWWA C210), Field Applied Finish Coat	Sched. 20
CU01	Copper	10 – 65 mm	hard drawn	Type L
CU02		10 – 65 mm	hard drawn Tape Wrap: Factory Applied, AWWA C209 and AWWA C214	Type K
GS01	Galvanized Steel	All	ASTM A53 Gr B, Type E or Type S, Dim. per B36.10 Hot-Dipped, Zinc-Coated, Welded and Seamless	Schedule 80
GS02	Galvanized Steel	≤ 600 mm	ASTM A53 Gr B, Type E or Type S, Dim. per B36.10 ,Hot-Dipped, Zinc-Coated, Welded and Seamless	Schedule 40
PD01	HDPE	≥ 25 mm	ASTM D3350	SDR 11
PP01	Polypropylene (PP-R)	10 - 20	NSF 14, ASTM F 2389	SDR 7.4
		25 - 100		SDR 11
PP02		10 - 20	NSF 14, NSF 51, NSF 61, CSA B137.11	SDR 7.4
		25 - 100		SDR 11
PV01	PVC	All	Type I, Grade I, or Class 12454-B conforming to ASTM D1784 and ASTM D1785.	Schedule 80
PV02	PVC	All	PVC DWV, Class 12454B as identified in ASTM D1784 conforming to ASTM D 1785, ASTM D2665 and ANSI/NSF Standard 14.	Schedule 40
PV03	CPVC	All	Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441.	Schedule 80
PV04	PVDF	All	Double Wall PVDF to ASTM F1673	Schedule 80

Pipe Specification Code	Material	Size	Characteristics [1]	Minimum Schedule / Thickness [2]
SS01	Stainless Steel	10 – 50 mm	Stainless Steel, ASTM A312/A312M, Type 316L	Schedule 40S
		65 – 750 mm	Stainless Steel, ASTM A778, Type 316L	Schedule 10S
		≥ 900 mm		9.5 mm wall thickness

Notes:

1. *This table is used to characterize the major attributes of each specification code and is not comprehensive. The Design Team is responsible for the specification details.*
2. *The minimum schedule / thickness indicated is not necessarily suitable for each application. Provide appropriate pipe schedule / thickness for the application.*

Table 4-2 : Acceptable Piping Materials

Commodity	Commodity Codes	Application	Line Size	Acceptable Material Codes (See Table 4-1)
Condensate	CON	Indoor	10 – 65 mm	CU01
Heating and Cooling Pipe	CHS CHR HWS HWR GR GS	Indoor Outdoor–Exposed	12 – 600 mm	CS11
Potable and Non-Potable Water (Hot and Cold)	DHW DHR PW NPH NPW	Indoor Outdoor-Exposed	10 – 65 mm	CU01
			10 – 100 mm	PP01
			≥ 10 mm	SS01
			75 – 600 mm	CS31
		Buried	10 – 65	CU02
			10 – 600 mm	CS31
			≥ 10 mm	SS01
Flushing Water	FSW	Indoor Outdoor-Exposed	≤ 75 mm	CU01
			≤ 100 mm	PP01
			All	CS11
			All	SS01
		Buried	≥ 25 mm	PD01
Natural Gas	NG	Indoor Outdoor-Exposed	All	CS01
Sanitary / Vent	SAN VTA	Indoor / Outdoor / Buried (except sump pump suction)	All	CI01
		Indoor gravity systems, not subject to physical damage	All	PV02
		Base mounted sump pump suction	All	SS01
		Indoor / Outdoor / Buried (non-chemical service)	≥ 25 mm	SS01
		Indoor - General	≤ 100 mm	PP01
			≥ 25 mm	SS01
Rain Water	RW	Indoor / Outdoor / Buried – Process and Non-Process Areas	All	CI01
		Process Areas	All	PV02

Commodity	Commodity Codes	Application	Line Size	Acceptable Material Codes (See Table 4-1)
Land Drainage Sewer and Weeping Tile Systems	LDS	Buried – Gravity and Pressure piping	≥ 25 mm	PD01
		Base mounted sump pump suction	All	SS01
		Pressure piping - Indoor	≤ 100 mm	PP01
			≥ 25 mm	SS01
Diesel Fuel	DF	Buried	All	PV04
		Above Grade	All	GS01
Fire Protection System	FPS	Buried	≤ 600 mm	GS02
		Indoor (Dry/Wet) or Outdoor (Exposed)	All	CS12

Notes:

1. *More than one material may be acceptable for a given application.*
2. *The Design Team shall evaluate the suitability of the approved materials for the application. In the event that the indicated materials are not suitable for the application, the Design Team shall submit the proposed material to the City, along with a complete evaluation of its suitability and the non-suitability of the existing approved materials. Use of the alternate material is subject to the approval of the City.*
3. *For buried Diesel Fuel piping to have no buried joints. All joints within a transition sump are to be installed in secondary access pipe. The access pipe is there for mechanical protection of the actual fuel-carrying pipe and will be at least 0.25mm larger in diameter than the actual fuel-carrying pipe itself. The fuel-carrying pipe is double-walled with leak detection tape.*

4.10 Insulated Plumbing Piping

1. Provide insulation for the following pipes:
   - Pipes located outdoors
   - Cold potable water
   - Cold non-potable water (including pump seal water)
   - Hot Potable Water and Recirculation
   - Refrigerant and Gas Piping
   - Roof/Overflow Drain Pipes (within buildings)
2. Insulation for plastic cold-water piping may be eliminated where piping material characteristics will reasonably eliminate condensation and not cause any personnel safety or asset damage.
3. Provide heat tracing for outdoor piping or any other piping at risk of freezing as required.

5 FIRE PROTECTION SYSTEMS

1. Co-ordinate with the architect for the design of sprinkler systems and standpipe system for locations of required fire pump and fire protection water supply.
2. Determine if fire pump is required to boost the fire protection water pressure to meet the required pressure for sprinkler system or standpipe system.
3. Prepare the detailed design and installation of sprinkler system and standpipe system and ensure that it is sealed by a Fire Protection Engineer registered in the Province of Manitoba.
4. Ensure the requirements of NFPA 820 associated with fire protection systems are met.
5. Provide a comprehensive design for portable fire extinguishers as required and coordinate with the architectural drawings. All fire extinguishers shall be identified as per the City WWD Identification Standard.
   5.1 Supply of the portable fire extinguishers will be by the City, based upon the design provided.
6. Ensure provision of fire dampers on the ductwork penetrating any fire-rated walls, and floor slabs as required per Codes, including access doors and other provisions required for inspection.
7. Where duct smoke detectors are required, ensure smoke detector alarm contact is connected to the fire alarm panel.
8. Ensure that appropriate facilities to drain water, associated with testing of fire protection systems, are provided.

6 MONITORING AND CONTROLS

1. All monitoring and controls shall be in accordance with the WSTP Automation Design Guide.

2. Except as noted in the WSTP Automation Design Guide, all Building Mechanical systems shall be monitored and controlled by the plant PCS. An independent, commercial-grade Building Management System (BMS) shall not be utilized.

7 SPARE PARTS AND CONSUMABLES

1. Review the equipment and practises in use at the City's existing wastewater treatment facilities and, where possible, specify similar equipment and materials to utilize common spare parts and consumables. Items to review include:

    1.1 Air filter types and sizes;

    1.2 Scrubber filter types and sizes and/or media;

    1.3 Lubricants; and

    1.4 Spare drive belts for belt driven equipment

8 BUILDING MECHANICAL DESIGN TEAM RESPONSIBILITIES

8.1 General

1. Responsibility for deliverables
   1.1 All drawings and other deliverables related to a design are the responsibility of the Design Team.
   1.2 The responsibility for deliverables shall not be passed on to other entities. For example, in a design-bid-build procurement environment, the Design Team shall not pass responsibility for items indicated in this section to the Contractor.
2. Ensure all building mechanical deliverables are sealed by a qualified professional engineer registered in Manitoba.
3. Completeness of drawings:
   3.1 All drawings shall be comprehensive in nature to allow for effective use in construction.
4. Update of existing drawings:
   4.1 If the project is an addition, expansion, upgrade, or modification to an existing site or facility, existing drawings may require up-dating. Coordinate with the City to understand the specific requirements. Typical requirements include but are not limited to.
   - Updating existing building floor plans.
   - Updating Process and Instrumentation Diagrams (P&ID) drawings.
   - The update of detail drawings for existing works is not expected or required.
5. Design reviews:
   5.1 Arrange internal reviews of all design documents (including drawings) by an engineer qualified and experienced in design of equivalent systems before submitting to the City.
   5.2 Issue the design documents to the City for review at appropriate intervals in accordance with Contract requirements.
   5.3 Incorporate City comments into the design. Where a City comment is not accepted by the Design Team, provide a complete response, including rationale, to the City.
6. As-Built Documents:
   6.1 All building mechanical deliverables shall be updated to “as-built” status at the end of the project. The As-Built Documents shall incorporate Contractor mark-ups, inspections performed by the Design Team, change orders, Requests For Information (RFIs), and other communication between the Contractor and the Design Team.
   6.2 Unless otherwise specified by the Contract, As-Built Documents are not required to be sealed (Otherwise known as record drawings).
7. External, 3rd Party Consultants:
   7.1 Expertise and assistance may be required from external 3rd party specialized consultants outside of the primary Design Team.
   7.2 Areas where an external 3rd party consultant may be appropriate include:
   - Fire protection systems.
   - Acoustic systems.
   - Corrosion systems.

7.3 The Design Team shall be responsible for monitoring the activities and progress of each 3rd party consultant and ensuring the deliverable meets Contract requirements.

7.4 It is the responsibility of the Design Team to ensure that the deliverables follow all City standards and guidelines.

8. Site Visits:

8.1 The Design Team is responsible for ensuring that a sufficient number of site visits occur to facilitate the understanding of specific field conditions or status of existing facilities and buildings.

9. Demolition Requirements:

9.1 The Design Team is responsible for the associated demolition works required to implement the scope of work. Clearly indicate all demolition requirements on the drawings and in the specifications.

9.2 Show small demolition works (less than ~1/3 of the drawing) by revision of existing drawings. Where demolition requirements are significant (approximately more than 1/3 of a drawing), create dedicated demolition drawings.

8.2 Drawings

Provide a comprehensive set of drawings to detail the Building Mechanical construction requirements. The drawings indicated in this section are minimum requirements.

8.2.1 General Requirements

1. All Building Mechanical drawings are to be produced on a standard ANSI D size drawing.
2. Except for schematic style drawings and as otherwise indicated, all Building Mechanical drawings shall be to scale.
3. All dimensions required for construction shall be shown.
4. Indicate north direction on all plan drawings.
5. Provide scale bars on drawings to allow for simplified scale takeoff on the drawings.
6. Differentiate new work from existing work via bold lines.

8.2.2 Legend

1. Requirement:

1.1 Provide a legend drawing showing the symbols and abbreviations utilized. Coordinate with the City regarding re-use of any existing legend drawings.

2. Content:

2.1 Ensure that the legend is consistent with the City’s practices. Symbols shall be the same as process mechanical symbols for common items (i.e. valves).

3. Format:

3.1 Produce drawings in ANSI D size format.

8.2.3 Process and Instrumentation Diagrams (P&IDs)

1. Requirement:

    1.1 Provide P&ID's for the complete HVAC system, including all hydronic systems, unit heaters, and associated controls.

    1.2 Provide P&IDs for the complete plumbing system. All components shall be shown on the P&IDs except for floor drainage systems.

2. Content:

    2.1 P&ID's shall depict all equipment and ductwork, including AHUs, fans, cooling coils, heating coils, filters, dampers, etc.

    2.2 All automation and control components including instrumentation such as pressure gauges, temperature sensors, RH sensors and manometers shall also be indicated.

    2.3 Indicate the appropriate Pipe / Duct identification codes for all pipework and ductwork, as per the WWD Identification Standard.

3. Format:

    3.1 Produce drawings in an A1 size format.

    3.2 The P&IDs shall be in the same format as the process P&IDs.

    3.3 The P&IDs shall be in a format compliant with the City WWD Identification Standard and ISA 5.1.

8.2.4 Schematic Airflow Diagram

1. Requirement:

    1.1 Provide a schematic airflow diagram for the complete HVAC system.

2. Content:

    2.1 Show all ventilated spaces and flow of air through each space.

    2.2 Show all airflow rates.

    2.3 Show room pressurization.

    2.4 Show all fans and air handling units.

3. Format:

    3.1 Produce drawings in ANSI D size format.

8.2.5 Building Mechanical Plan Drawings

1. Requirement:

    1.1 Building mechanical plan drawings are required for every floor elevation, including the roof, basements, and crawlspaces.

2. Content:

    2.1 Show the arrangement of all HVAC equipment, including ductwork and piping.

    2.2 Show all AHU's, condensing units, volume control dampers, fire dampers, grilles, registers, unit heaters, ventilation fans, and all other accessories.

    2.3 Show duct sizes and duct elevations.

    2.4 Indicate the appropriate Pipe / Duct identification codes for all pipework and ductwork, as per the WWD Identification Standard.

2.5 Provide a scale bar to allow for scale takeoffs.

3. Format:

3.1 Produce drawings in ANSI D size format.

3.2 Scale:

3.2.1 Recommended: 1:75

3.2.2 Maximum: 1:100

8.2.6 Building Mechanical Section and Detail Drawings

1. Requirement:

1.1 Provide building mechanical section and detail drawings to completely make clear the required installation of the mechanical systems.

2. Content:

2.1 Ensure all materials of construction and dimensions are clearly identified.

2.2 Indicate the appropriate Pipe / Duct identification codes for all pipework and ductwork, as per the WWD Identification Standard.

2.3

3. Format:

3.1 Produce drawings in ANSI D size format.

3.2 Scale:

3.2.1 Recommended: 1:50

3.2.2 Maximum: 1:100

8.2.7 Schedule Drawings

1. Requirements:

1.1 Provide schedule drawings for all building mechanical equipment.

2. Content:

2.1 The content of the schedule drawings shall include, but not be limited to:

2.1.1 AHU schedules

2.1.2 Fan schedules

2.1.3 Grille/louvre/diffuser schedules

2.1.4 Unit heater schedules

2.1.5 Heat exchanger schedules

2.1.6 Pump schedules

2.1.7 Expansion tank schedules

2.1.8 Heater schedules

2.1.9 Air conditioning unit schedules

2.1.10 Condensing unit schedules

2.1.11 Damper schedules

3. Format:

3.1 Produce drawings in ANSI D size format.

8.2.8 Pipe Work Layout Drawings

1. Requirements:
   1.1 Provide drawings clearly showing piping layouts and associated pipe accessories.
   1.2 Provide isometrics for piping.
2. Content:
   2.1 Include pipe schedules and sizes.
3. Format:
   3.1 Produce drawings in ANSI D size format.
   3.2 Scale:
      3.2.1 Recommended: 1:75
      3.2.2 Maximum: 1:100

8.2.9 Fire Fighting Layout Drawings

1. Requirements:
   1.1 Provide drawings showing the firefighting equipment and piping layouts.
   1.2 Provide fire extinguisher, fire hose reel, and hydrant schedules.
2. Format:
   2.1 Produce drawings in ANSI D size format.
   2.2 Scale:
      2.2.1 Recommended: 1:75
      2.2.2 Maximum: 1:100

8.2.10 Installation Detail Drawings

1. Requirements:
   1.1 Provide piping detail drawings.
   1.2 Provide plumbing detail drawings.
   1.3 Provide HVAC detail drawings.
   1.4 Existing City piping detail drawings may be referenced if available and appropriate for the project.
2. Content:
   2.1 Content requirements include, but are not limited to:
      2.1.1 Typical duct support requirements for all duct configurations.
      2.1.2 Duct connection details, including odour control connections to tanks and channels.
      2.1.3 Duct insulation details.
      2.1.4 Fan installation details (i.e. roof mounted fan).
      2.1.5 Typical pipe supports for all piping configurations.
      2.1.6 Piping floor/wall/roof penetration installation details.
      2.1.7 Duct floor/wall/roof penetration installation details.
      2.1.8 Piping flushing connection details.

2.1.9 Instrumentation installation details.

2.1.10 Pipe marking details.

2.1.11 Hose rack and other appurtenances details.

2.1.12 Pipe insulation details.

3. Format:

3.1 Produce drawings in ANSI D size format.

8.2.11 3D Model

1. A 3D model is required in the event of any of the following:

1.1 A 3D model is required by the Contract (including proposals by proponents);

1.2 The total construction costs (including all disciplines) are estimated to exceed $5M CAD;

2. Where a 3D model is required:

2.1 The 3D model shall include all pipework, ductwork, and equipment to allow for full representation of the entire facility, including all other disciplines.

2.2 In addition to the 3D model provide:

2.2.1 3D elevation and section drawings to convey the complete building mechanical configuration.

2.2.2 3D detail drawings of all areas with significant interdisciplinary coordination requirements.

2.3 3D drawings shall be rendered. Simple 3D line representations are not acceptable.

2.4 The use of a 3D model does not eliminate any other requirements of this document. While some of the drawings may incorporate elements generated from the model, the type, number, or content of the drawings shall in no way be reduced through the use of the model.

8.2.12 Coordination with Other Disciplines

1. Structural / Architectural

1.1 Ensure that openings for ductwork, louvres, and other openings are coordinated with and shown on the structural and architectural drawings.

1.2 Ensure all equipment weights are coordinated with the structural design.

1.3 Where new equipment is installed on an existing floor/roof, the engineer is responsible for coordinating the appropriate structural review to ensure that the weight of the equipment is supported. Upgrade the existing structure as required.

1.4 Where new penetrations are made to an existing structure, ensure that structural elements are not affected. Coordinate the appropriate structural review and upgrade as required.

1.4.1 Where penetrations are made through reinforced concrete, care should be taken during the design planning and construction stages to minimize the cutting of reinforcement.

2. Electrical

2.1 Ensure all new and modified electrical loads are coordinated and electrical drawings and models are updated accordingly.

3. Automation

3.1 Ensure all new and modified mechanical systems are coordinated with the automation design in accordance with the Automation Design Guide.

8.3 Studies and Reports

8.3.1 Energy Report

1. Provide an energy report indicating the estimated energy usage for all Building Mechanical systems.
2. Indicate the energy usage for each month of the year, based upon average environmental conditions for each month.
3. Provide data and calculations for the Annual Heat Recovery Ratio and Annual Net Heat Recovery Ratio for each system and the entire project.
4. Apply to local utilities and any other available sources of rebates and funding for energy efficiency / recover on behalf of the City and ensure that the City receives the full financial benefit of such programs.
5. Validate and update the Energy Report as part of the commissioning.

8.4 Design Calculations

1. As a minimum, provide the following non-exhaustive list of HVAC and building mechanical design data and calculations:
    - Tabulation of interior heat loads (heat dissipation).
    - Calculation of heating load.
    - Calculation of hydronic heating and chilled water system utilization and capacity for all new and modified installations, including any load changes.
    - Calculation of the cooling load.
    - Calculation of air flow rates.
    - Calculation of make-up air flow rates for the building pressurization.
    - Calculation of static duct pressure drops.
    - Sizing of ducts, grilles, registers, diffusers, valves, dampers, louvers, filters, cooling coils, air heaters, fans, compressors, condensers, refrigerant and drain pipes.
    - Flow coefficient calculations for all control valves.
    - Plumbing and firefighting piping and equipment design calculations.

9 COMMISSIONING

1. Unless a third-party Commissioning Authority is designated in the Contract, the Design Team shall provide a Commissioning Authority to lead, review, and oversee the completion of the commissioning process activities.

    1.1 The Commissioning Authority shall be a subcontractor or employee(s) who are not members of the Design Team (designers on the project), except if:

        1.1.1 The project total ventilated / conditioned footprint is < 10,000 m^2;

        1.1.2 The project total construction cost is estimated to be < $10M CAD; and

        1.1.3 LEED is not a requirement of the contract.

2. The Commissioning Authority shall review the project documents for clarity and completeness. The Design Team shall update deficiencies in the documents identified by the Commissioning Authority.

3. The Commissioning Authority shall develop commissioning requirements in construction documents.

4. The Commissioning Authority shall develop a commissioning plan.

5. The Commissioning Authority shall verify installation and performance of systems. Various tasks, including pre-commissioning may be delegated to the Contractor; however, the Commissioning Authority retains overall responsibility.

6. The Commissioning Authority shall complete a summary commissioning report.