The City of Winnipeg

Winnipeg Sewage Treatment Program

Process Mechanical Design Guideline

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CAUTION

This document is currently in a draft state. All design shall be based upon the approved issue of this document, which will be provided prior to award.

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1 INTRODUCTION

This document identifies the standard design requirements that are applicable to any process mechanical work within the City of Winnipeg wastewater treatment facilities.

1.1 Scope of the Standard

These design requirements will apply to the following facilities:

- Wastewater treatment plants

1.2 Application

The scope and intent of this document is intended to convey general design guidance and expectations regarding process mechanical systems. This document does address specifics related to design type, selection, and configuration; however the indicated requirements are presented without knowledge of the specific building implementation. It is not within the scope of this document to provide detailed design direction, and it will be the responsibility of the respective process mechanical designers to fully develop the process mechanical design details with general conformance to the concepts presented herein. This standard shall not be construed as comprehensive process mechanical engineering design requirements or negate the requirement for professional engineering involvement. Any design must be executed under the responsibility and seal of the respective 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 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 rational 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, fully complete a *WSTP Standards Deviation Form* and submit 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

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BEP	Best Efficiency Point
CGA	Canadian Gas Association
CLDI	Cement Lined Ductile Iron
CSA	Canadian Standards Association
FRP	Fiber Reinforced Plastic
HI	Hydraulic Institute
NFC	National Fire Code
NPSHA	Net Positive Suction Head Available
NPSHR	Net Positive Suction Head Required
OSHA	Occupational Safety and Health Administration
PP	Polypropylene
PVC	Polyvinyl Chloride
PVFD	Polyvinyledene Difluoride
TDH	Total Dynamic Head
WSTP	Winnipeg Sewage Treatment Program

2 GENERAL

2.1 Design Codes and Standards

Ensure all designs shall comply with municipal, provincial, and national codes and bylaws. This includes but is not limited to:

- Manitoba Workplace Safety and Health Act and Regulations
- Canadian Standards Association (CSA)
- National Fire Code of Canada (NFC)
- American Society of Mechanical Engineers (ASME)
- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- American Water Works Association (AWWA)
- National Fire Protection Association (NFPA)
- Hydraulic Institute (HI)

2.2 Referenced Standards

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

2.3 Other City Standards

1. While not exclusive, ensure that the following City Standards are adhered to:
    1.1 Water and Waste Department Identification Standard
    1.2 WSTP Piping Color Standard

2.4 Units

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

1. All building dimensions are to be in millimeters.
2. All elevations are to be in meters, in the format EL. ###.### (example EL. 273.520).
3. All pipe sizes to be in mm.
4. All liquid flow rate units shall be consistent for a given process or system and general selected using the following criteria:
    4.1 Flows may be expressed in m^3/s for flows in the range of approximately 0.5 - 10,000 m^3/s.
    4.2 Flows may be expressed in m^3/min for flows in the range of approximately 0.5 - 10,000 m^3/min.
    4.3 Flows may be expressed in L/s for flows in the range of approximately 0.5 - 10,000 L/s.
5. All airflow units shall be consistent for a given process or system and general selected using the following criteria:

5.1 Airflows may be expressed in L/s for flows in the range of approximately 1 - 10,000 L/s.

5.2 Airflows may be expressed in m^3/s for flows in the range of approximately 1 - 10,000 m^3/s.

5.3 Airflows may be expressed in m^3/min for flows in the range of approximately 1 - 10,000 m^3/min.

6. All liquid pressures are to be in kilopascals.

3 EQUIPMENT SELECTION

3.1.1 Design-Bid-Build Projects

1. For design-bid-build projects, the following requirements apply.
2. Provide a design where multiple equipment manufacturers can be utilized to meet the design requirements. Exceptions are only permitted as follows:
   - 2.1 Where the equipment has been standardized through an approved City process;
   - 2.2 Where the equipment has been approved by the City to be sole-sourced; or
   - 2.3 Where the equipment has been preselected via a separate Bid Opportunity.
3. Where there are significant differences between equipment manufacturers, such that the design must be based upon a specific manufacturer, the following shall apply:
   - 3.1 As part of the preliminary design, provide a technical memorandum to the City to describe the applicable manufacturers and the key differences between the equipment performance, layout, and cost. Make a recommendation to the City regarding the proposed equipment selection and design approach.
   - 3.2 If approved by the City, the design may be based upon a single manufacturer provided that a means to allow for alternates is included in the design and procurement strategy.

4 LAYOUT AND ACCESS

4.1 General Requirements

1. Design the system layout with the following considerations:
   1.1 Safety of operating personnel
   1.2 Ease of operations
   1.3 Cost
2. Ensure coordination with all other disciplines is provided. Use of 3D models is preferred, but only mandatory where specified by the City or indicated in the design proposal.

4.2 Operating Aisles and Platforms

1. All at-grade aisles and platforms shall have the following minimum dimensions:
   1.1 Clear height: 2100 mm
   1.2 Clear width:
      1.2.1 Regular Access: 1000 mm
      1.2.2 Occasional Access (not more than once per day): 800 mm
2. All platforms and suspended walkways shall have the following minimum dimensions:
   2.1 Clear height: 2100 mm
   2.2 Clear width: 800 mm

4.3 Equipment

4.3.1 General Clearances

1. Provide adequate clearance for equipment operation, maintenance, removal, and replacement.
2. Mount equipment and panels on concrete housekeeping pads to protect them from wash-down water.
3. Provide sufficient equipment clearances to ensure maintainability of equipment. Minimum equipment clearances as indicated in Table 4-1; however the engineer is responsible for providing sufficient clearances for each specific application. All clearances are from the outermost extremities of the equipment to the nearest obstruction, which may be a wall, another piece of equipment, pipe, or other interference.

Table 4-1: Minimum Equipment Clearances

Equipment Type / Size	Rating	Front	Side	Rear
Rotating equipment such as pumps	< 7.5 kW (10 hp)	1000 mm	300 mm	NR
	7.5 kW (10 hp) – 37 kW (50 hp)	1200 mm	800 mm	300 mm
	37 kW (50 hp) – 75 kW (100 hp)	1200 mm	1000 mm	600 mm
	> 75 kW (100 hp)	1200 mm	1200 mm	1000 mm
Pressure vessels	Any	1200 mm	Walls: 600 mm Other Pressure Vessels: 1000 mm	100 mm
Other equipment	Any	1000 mm	As rqd.	As rqd.

4. Coordinate clearances with all engineering disciplines to ensure that the final commissioned installation meets all clearance requirements.
5. Ensure adequate clearance above or below units is provided for the lifting / removal down of equipment for repair or replacement.
   5.1 For heavy equipment, ensure clearance is provided for anchored/load rated lifting devices.
6. 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. Where maintenance by portable manual equipment (A-frames, hand trucks, dollies, portable ladders or similar equipment) is proposed, provide the minimum clearances for access:
   7.1 Horizontal clearance: 1.0m
   7.2 Vertical clearance: 2.5m
8. For pumps, compressors, and other rotating equipment where multiple parallel units are provided, ensure the orientation of the drive and the direction of rotation is identical to provide for reduced spare parts. All exceptions shall be approved by the City.
9. Arrange pumps used for sludge pumping to minimize the distance and number of bends through which the liquid must be conveyed to the pump suction.
10. Provide ladders, service platforms, and access hatches where necessary to facilitate equipment maintenance and removal.
11. Ensure adequate lifting headroom is provided for equipment, including an allowance for slings or lifting beams between equipment lift points and crane or hoist hook.
12. Locate wash-down in logical areas to facilitate equipment clean-up and pipe flushing.

4.3.2 Pumps

1. Locate pump as close as possible the suction source.
2. Top suction and discharge lines either should be routed to provide clearance for overhead maintenance requirements, or should be made up with removable spool pieces.

4.3.3 Compressors

1. Locate compressor as close as possible the suction source.
2. Top suction and discharge lines either should be routed to provide clearance for overhead maintenance requirements, or should be made up with removable spool pieces.

4.4 Piping and Valves

1. Ensure that piping is located so that it is not a tripping hazard, a head-banger, or a barrier to equipment access.
2. Care shall be taken to make sure piping is not located directly above blowers, compressors, or pumps such that it interferes with equipment lifting and removal.
3. In general, it is preferred to locate piping close to walls where it can be readily supported.
4. If piping must be run close to a wall but not supported from it, maintain a minimum clearance of 600 mm between the outermost pipe flange and the wall.
5. To facilitate purging of air from pipelines while they are being filled, locate manual vent valves at high points of all pipelines carrying liquids and/or to be hydrostatically tested.
6. To facilitate drainage of pipelines, provide manual drain at the low points of all pipelines carrying liquids and/or to be hydrostatically tested.
   - 6.1 Drain valves shall be positioned as close as possible to the bottom of the pipe. Minimize the drop leg.
7. To facilitate flushing of equipment and pipelines for maintenance, provide flushing connections on pipelines carrying sewage or sludge at each side of mainline and branch shut-off valves, and at pump suction and discharge isolation valves.
   - 7.1 Flushing water connections shall be permanently piped for points that will be utilized at a frequency of once per month or greater.
   - 7.2 Ensure that appropriate valve isolation is provided to allow for flushing flexibility.
   - 7.3 Angle flushing point connections as appropriate to direct the flushing flow.
8. Scum pipes shall be as short as possible and provided with access points for roto-rooter or high pressure cleaning.
   - 8.1 Angle cleaning access points to facilitate cleaning operations. Utilize 45° angle minimum, 30° preferred.
9. Ensure adequate space is available for installation of pipe supports and seismic bracing
10. Provide flexible connections or pipe couplings where appropriate to facilitate assembly and disassembly of piping and connections to equipment.
11. Show locations of pipe anchors and expansion joints on the drawings.

12. Ensure reducers on the suction side of pumps are installed flat-on-top to prevent air or gas entrapment.

    12.1 Exception: reducers for sand ballasted systems shall be installed flat-on-bottom to prevent sand accumulation.

13. Wall penetrations shall be perpendicular to the wall. Make provisions to include a puddle flange and a flanged end on both sides of the wall where ever pipes penetrate through concrete wall. Provide cored penetrations with Linkseal or double Linkseal as appropriate for the installation.

14. Provide appropriate valve isolation such that any pipe segment may be taken out of service without affecting other pipe segments.

    14.1 Provide valves on branches off main headers.

15. Install manually operated valves within operator reach (less than 2,000 mm above the operating floor). Ensure valves located more than 2,000 mm above the operating floor are provided with a chain operator.

16. On sewage and sludge service, do not install swing check valves in vertical piping runs to prevent the accumulation of solids on the downstream side of the flapper. Ensure they are located on horizontal runs.

17. Ensure provision of an easy disassembly coupling or pipe joint within four pipe diameters of valves, flow meters, and other inline devices.

18. Provide thrust restraint for sleeve and other couplings that are not self-restraining.

19. Ensure adequate space is provided for valve and gate actuators.

20. Provide adequate clearance for the operators of rising stem valves and gates for ease of operation.

21. On the upstream and downstream side of flow meters and other instrumentation, provide sufficient straight pipe runs.

22. Actuated modulating valves shall be accessible without any temporary ladders or lifts. Permanent platforms shall be provided for access.

4.5 Heat Exchangers

1. Shell and tube heat exchangers shall have a maintenance clearance equal to the bundle length plus 1.5m to allow for tube removal.

2. Provide 300mm clearance around flanges to the nearest wall, structural member, pipe, or other obstruction.

5 LIFTING AND EQUIPMENT REMOVAL

5.1 General Requirements

1. The design engineer is responsible for providing a comprehensive design that includes the capability to maintain, lift, and remove all equipment. The requirements of this section shall apply to all equipment directly or indirectly connected to a motor and all other equipment requiring service at intervals less than ten years.
   1.1 Any potential scenario where equipment removal is not included in the design shall be approved by the City.
   1.2 Provide a technical memorandum to the City identifying the proposed lifting and equipment removal methodology of each piece of equipment.
2. Ensure all applicable equipment is provided with lifting eyes or other appropriate means to connect a lifting device.
3. All lifting devices, components and anchorage points shall be labelled with the applicable Safe Working Load.

5.2 Manual Lifting

1. All manual lifting shall be in compliance with:
   1.1 Manitoba Workplace Safety and Health Regulation MR217/2006
   1.2 NIOSH Work Practice Guide For Manual Lifting
2. Manual lifting shall allow for a maximum of two people to perform the lift.
3. The maximum weight limit where manual lifting may be considered is 23 kg (50 lb), under optimal conditions.

5.3 Portable Lifting Devices

1. Portable lifting devices may be utilized for maintenance purposed for equipment component weights less than 1,000 kg.
   1.1 Portable lifting devices are not acceptable for operational use of moving chemicals or other commodities without approval of the City.
2. Where portable lifting devices are proposed, ensure that appropriate clearances and access to the equipment is provided.
3. Portable lifting devices may include:
   3.1 Moveable gantry cranes;
   3.2 Portable davits with a fixed base;
   3.3 Hand operated hoists (i.e. chain hoist) with a permanent attachment point.
4. Where moveable gantry cranes are proposed, ensure that appropriate access to the equipment and a storage location for the portable gantry crane is provided. Show the moveable gantry crane in the proposed storage location on the drawings.
   4.1 Moveable gantry cranes are not accepted as a lifting means outdoors without approval of the City. Movement in winter with snow accumulation would be difficult.

5. Where portable davit basis are proposed, ensure that an engineered davit base is included in the design.
    - 5.1 Floor mounted davit bases shall be flush with the floor unless it can be proven that there is no possibility for the davit base to become a trip hazard.
    - 5.2 All davit bases shall be shown on the drawings.
    - 5.3 Davit basis shall be constructed of material suitable for the environment.
    - 5.4 Ensure compatibility of appropriate davits and davit bases on site.
    - 5.5 Where multiple lifts will be required, provide a second lifting attachment point on the davit arm.
    - 5.6 Floor davit bases shall be engineered and sealed by a professional engineer.
6. Where hand operated hoists are proposed, ensure that an engineered attachment point is included in the design.
    - 6.1 Ensure all lifting points are reasonably accessible to maintenance personnel, considering the frequency of maintenance.
    - 6.2 Where multiple lifts will be required, provide a second lifting attachment point.
    - 6.3 All lifting points shall be shown on the drawings.
    - 6.4 Lifting eyes and other attachment points shall be constructed of material suitable for the environment.
    - 6.5 Lifting eyes and other attachment points shall be engineered and sealed by a professional engineer.
7. The use of rented boom cranes shall only be considered for maintenance scenarios which will have a frequency of greater than five years.
8. Ensure the provision of all required portable lifting devices under the project.
    - 8.1 The Design Engineer shall coordinate with City Operations to determine existing portable lifting devices and their practical area of use. Identify any additional lifting devices required to meet operational and maintenance requirements.
    - 8.2 Specify and procure the required portable lifting devices under the project.

5.4 Permanent Lifting Equipment

1. Provide permanent motorized hoists, monorails, or cranes where:
    - 1.1 Equipment component weights exceed 1,000 kg; or
    - 1.2 Lift frequency for maintenance may exceed bi-weekly.
    - 1.3 Lifting is for operational purposes, such as movement of polymer tote bags.

6 PUMPING SYSTEMS

6.1 Pump Types and Applications

6.1.1 Centrifugal Pumps - General

Where large flows at low to moderate heads are required, preference shall be given to centrifugal pumps. Generally speaking, the use of centrifugal pumps shall be explored before considering positive displacement pumps.

In general, closed impellers shall be used for pumping clear and reasonably clear fluids, while open impellers shall be used for pumping sludge and slurries.

1. Non-Clog Dry Pit Centrifugal Pumps
    - 1.1 Non-clog dry pit centrifugal pumps shall be considered typically for pumping sludge and slurries.
    - 1.2 Impellers and pump casings made of hardened alloy steel for increased wear resistance shall be utilized for very abrasive services, such as grit slurry.
    - 1.3 For return activated sludge and where steeper performance curves, higher efficiencies and gentler pumping action is required, screw type impellers shall be utilized.
    - 1.4 On scum pumping application and on sludge fermenters where risk of plugging of downstream piping exists, preference shall be given to the use of chopper type pumps with sharpened vanes rotating against a cutter bar in the pump intake.
2. Submersible Non-Clog Pump
    - 2.1 For pumping raw sewage, effluent and sump pump applications, submersible pumps shall be considered. Preference shall also be given to submersible pumps where a separate drywell is not feasible due to economic and technical reasons.
    - 2.2 Motor cooling shall be by circulation of a liquid through a cooling jacket surrounding the motor housing.
3. Horizontal End-Suction Centrifugal Pumps
    - 3.1 For typical applications for pumping clear or reasonably clear water horizontal end suction centrifugal pumps shall be given considered.
    - 3.2 For chemical transfer applications, non-metallic fiberglass reinforced plastic (FRP) pump shall be utilized.

6.1.2 Vertical Turbine Pumps

1. For applications where high pressure requirements need to be achieved for pumping clear or reasonable clear water, vertical turbine pumps shall be utilized.

6.1.3 Submersible Propeller Pumps

1. Where a large volume of clear or reasonably clear water needs to be pumped at low heads, submersible propeller pumps shall be utilized. Care shall be taken not to use submersible propeller pumps in applications with fluids containing stringy or fibrous material to prevent such material from catching on to the propeller and guide vanes.

6.1.4 Positive Displacement Pumps - General

Consideration shall be given to the use of positive displacement pumps for low to medium flow rates at low to high heads, for pumping viscous fluids and where precise or constant flow rate is required.

1. Progressive Cavity Pumps

   Preference shall be given to the use of progressing cavity pumps for pumping thick sludge's, such as thickened waste activated sludge, and for liquid polymer transfer and feed.

2. Rotary Lobe Pumps

   Rotary lobe pumps shall be considered for pumping scum and sludge. Due to the very close fit between the rotors, a grinder shall be used on the suction side of the pump to minimize the chance of the rotors binding.

3. Peristaltic (Hose) Pumps

   Applications requiring very steady non pulsating flow while pumping chemicals and sludge shall consider the use of peristaltic pumps.

4. Metering Pump

   Where metering of chemical is necessary, metering pumps shall be utilized.

6.2 Pump Construction

6.2.1 Pump Shaft Sealing

1. Generally, pumps shall be furnished with mechanical seals, not packing.
2. Double seals shall be considered for sludge and chemical services where the shaft cannot be sealed with the pumped fluid or where contamination of the pumped fluid with the seal fluid would be unacceptable.
3. Packing shall not be considered for pump shaft sealing because of generally higher maintenance requirements than for mechanical seals.
4. Where available and appropriate for the application, oil lubricated seals shall also be considered in order to minimize water consumption.
5. Mechanical seals shall be high quality, split mechanical, cartridge type.
6. For sludge and chemical pumps with a gearbox, provide a seal that has an open cavity from the gearbox.
7. For applications with five percent or higher solids by weight in the pumped fluid, both seal faces shall be hard. Otherwise, a hard-soft face combination shall be specified.
   - Acceptable hard seal face materials include sintered or reaction bonded silicon carbide, or graphitized silicon carbide.
   - Acceptable soft seal face material is carbon-graphite.

6.2.2 Bearings

1. In general, grease lubricated bearings shall be specified for ball and roller type bearings, both guide and thrust.
2. Grease lubricated fittings shall be fitted with grease addition and relief fittings.
3. For large equipment the manufacturer shall be consulted for lubrication requirements.

6.2.3 Shaft Couplings

1. Shaft couplings shall be spring grid or gear type flexible couplings for pumps which carry their own thrust load.
2. Spacer couplings shall be used for pumps which transmit the impeller thrust to the motor bearings, such as vertical turbine pumps.
3. Vertical turbine pumps with hollow shaft motors shall be furnished with non-reverse ratchet type couplings to protect the pump and motor against backspin during shutdown and power failure.
4. Provide OHSA approved shaft and coupling guards for all rotating equipment.

6.2.4 Materials

1. Pump materials shall be selected for their particular service.
2. For water and sewage applications they shall generally be cast iron or ductile iron construction with bronze or stainless steel trim.
3. Certain applications may require selection of special materials for corrosion, chemical, or abrasion resistance.
4. Pump materials shall be finalized during subsequent design phases.

6.3 Hydraulic Design

6.3.1 Pump Selection and Hydraulic Calculations

1. Provide hydraulic calculations for all pump applications using appropriate software. Prepare single-line isometric schematics from the pump suction piping origin to the point of system discharge to facilitate development of the hydraulic model.
2. Develop system curves for both the minimum head condition (minimum static head and friction loss) and the maximum head condition (maximum static head and friction loss), from the minimum required flow to the maximum required flow, to establish the required operating range of the pump.
    - The system curves shall be superimposed on the performance curves of the candidate pumps to ensure that the required operating range falls within the manufacturer’s recommended allowable operating region of the pump.

3. The design rated capacity shall be centered as near as possible to the pump best efficiency point (BEP) at the design condition.
   - Where possible, the required operating range shall be within 70 percent and 120 percent of the BEP.
   - Caution shall be exercised in selecting pump operating points near the extremes of the performance curve due to possible excessive pump shaft radial loading, reduced bearing and seal life, and possible shaft failure.
4. Care shall be exercised in providing adequate overlap of pump performance for multiple parallel pump applications. Ensure proper pump sequencing so that pumps have sufficient performance overlap to allow smooth transition without flow surges when adding or dropping pumps in operation.

6.3.2 Net Positive Suction Head

1. Suction lines shall be kept as short and straight as possible and the NPSHR of several pump manufacturers shall be checked.
2. The design shall provide adequate NPSHA, plus a margin of safety.
3. NPSH calculations for centrifugal and vertical pumps shall comply with HI standard ANSI/HI 9.6.1, Centrifugal and Vertical Pumps for NPSH Margin.

6.3.3 Sump and Wet Well Design

1. Utilize HI standard ANSI/HI 9.8, Pump Intake Design, as a reference and guide in the design of sumps and wet wells. Adequate pump suction submergence and approach velocities shall be provided.
2. Ensure sufficient wet well volume to provide system control stability. Where feasible, the following general guidelines shall be used in the design:

   2.1 Where continuous level control is required, size the wet well surface area to prevent motion (rising or falling) exceeding 300 mm per minute.

   2.2 For constant speed pumps, size the wet well volume in a way such as to prevent pump cycling (starting) more frequently than can be tolerated by its drive motor.

   2.3 Ensure the location for level measurement is in a region of low turbulence, wave action, or vortex, or provided with a stilling well, to avoid a widely fluctuating or unstable level signal.

7 STORAGE TANKS

7.1 Material Selection

1. Select the storage tank material based upon the characteristics of the liquid or gas that is to be stored. Ensure selection of the material is made such that it does not corrode or deteriorate the storage tank over time. Acceptable tank materials of construction are listed in Table 7-1. Other materials require approval of the City.
2. Typical materials for storage tanks for process applications shall include:
   - Concrete
   - Stainless steel
   - Steel (rubber lined, plastic lined)
   - Aluminum,
   - Plastic (PVC, FRP, PVDF, PP)
   - Ductile-iron (cement lined, glass lined)
3. Typical materials for storage tanks for non-process applications shall include:
   - Mild steel
   - Copper
   - Cast iron
   - Plastic

Table 7-1 : Acceptable Tank Materials

Application	**Acceptable Material of Construction**
Ferric Chloride – 39%	Fibre-reinforced plastic (FRP)
Scum	TBD
Sludge	Reinforced concrete
Sodium Bisulphite – 38%	Fibre-reinforced plastic (FRP)
Sodium Hypochlorite – 12%	Fibre-reinforced plastic (FRP)
Sodium Hydroxide – 50%	Fibre-reinforced plastic (FRP)
Wastewater	Reinforced concrete

Note:

1. Other tank materials require approval of the City.

7.2 Tank Features

1. Ensure all tanks are provided with a means to enter the vessel for periodic inspection, unless the vessel is small in which case hand-holes shall be provided for inspection and cleaning.
2. Man ways shall comply with health and safety standards for size and function.
   - Large tanks shall be provided with side and top man ways.
   - In general, man ways shall be minimum 600 mm in diameter with a bolted cover and gasket.
   - Where possible, equip covers with davits or hinges, especially if the pressure rating of the vessel dictates a heavy cover, or if the cover is located such that it is inconvenient to unbolt and bolt up the cover each time.
3. In general, provide tank bottoms with slight slope toward a drain connection.
   - Locate the drain nozzles as near to the tank floor as possible.
   - Locate fabricated flat bottom on housekeeping pads and provided with full bottom support.
   - Where necessary, tank pads shall be blocked out at the location of the drain nozzle to allow room for flanging drain piping to the nozzle.
4. Atmospheric tanks shall be equipped with a vent line, routed to the outdoors where necessary, and fitted with an insect screen. Size vent lines properly to prevent collapsing the tank during pump out or drainage, or over-pressurizing the tank during air purging of the tank fill line.
5. Where feasible or required by code, equip tanks with an overflow line.
   - Route the overflow to a plant drain line or to a containment system where the contents can be safely handled.
   - When two tanks are used in parallel, combine the overflow lines such that one tank will first overflow into the second tank before it overflows to drain or to the containment system.
6. Provide spectacle blinds to isolate out-of-service tanks.
7. Provide ladders and platforms where necessary to access tank man ways, inspection ports, level instruments, relief valves, and other tank accessories.
   - Design platforms and ladders to meet Manitoba's Workplace Safety and Health Act regulations, They shall be suitably sized for the work activity they support.
   - Ensure attachments are made to the tank to securely hold platforms and ladders in place.
8. Provide tanks with labels indicating the tank capacity, the chemical to be stored and its specific gravity.
9. Ensure secondary containment is provided for each chemical or for chemicals that are compatible.

8 PIPING SYSTEMS

8.1 General Requirements

1. Process mechanical piping includes all piping directly associated with the operation of the various treatment processes. The majority of process mechanical piping shall be located within buildings, tunnels, and galleries.
2. Coordinate any concrete encased piping with the structural engineering discipline and any buried process mechanical piping with the civil engineering discipline to ensure proper design for earth loads and traffic loads.

8.1.2 Code Considerations

1. Select pipe materials carefully to ensure that they are suitable for the service intended and meet the applicable code requirements.

8.2 Pipe Specification Codes

1. Pipe specification codes shall be consistently applied as per Table 8-1. Where a new material type is required, coordinate with the City.

Table 8-1 : Pipe Specification Codes

Code	Material Description	Size	Joints	Thickness	Lining	Coating
SS01	Stainless Steel	All	SS03	TBD	-	-
CP01	Concrete Pressure Pipe		Push-on			
CS01	Carbon Steel		Grooved	Sch. 40		
CS02	Carbon Steel					
CU01	Copper	< 75 mm	Soldered	Sch. 40	-	-
DI01	Cement-Lined Ductile Iron					
PE01	HDPE			TBD		
PP01	Polypropylene - Random		Fusion welded			
PV01	PVC		Solvent Welded	Sch. 80	-	-
PV02	PVC – Double Walled		Solvent Welded			

2. Grooved (Victaulic style) pipe joints are preferred by the City for metallic pipes.

8.3 Pipe Material Application

1. Pipe materials shall be applied as per Table 8-2.
    1.1 For other applications, review pipe materials with the City.

Table 8-2 : Pipe Material Application

Code	**Service**	**Size**	**Exposure**	**Specific Application**	**Pipe Spec. Code**
ALP	Air – Low Pressure	All		-	SS03
BLS	Ballasted Sludge	All	Ind	-	CS01
DCW DHR DHW NPW SW TDW	Domestic Cold Water Domestic Hot Water Return Domestic Hot Water Non-Potable Water Seal Water Tempered Domestic Water	< 25mm	IND	-	CU01
		≥ 25 mm	IND	-	PP01
		< 300 mm	BUR	-	PE01
FC	Ferric Chloride	All	Ind	-	PV02
FE	Final Effluent	≥ 350 mm	Bur	-	CP01
FSW	Flushing Water	< 100 mm	Ind	-	PP01
		≥ 100 mm	Ind	-	PP01 or SS0x
GR	Glycol Return	All	Ind	-	CS01
GS	Glycol Supply				
GRS	Grit Slurry	All	Ind	Lengths < 3m adjacent to equipment	SS0x
		All	Ind	Pipelines	PE01
HRS	High-Rate Clarifier Sludge	All	Ind	-	CS01
HWR	Hot Water Return	All	Ind	-	CS01
HWS	Hot Water Supply				
IAS	Instrument Air Supply	All	Ind.	-	SS0x
MP	Mixed Polymer	All	Ind	-	PV01
PD	Process Drain	All	Ind	-	DI01

Code	Service	Size	Exposure	Specific Application	Pipe Spec. Code
RAS	Return Activated Sludge	All	Ind	Lengths < 3m adjacent to equipment	SS0x
			Ind.	Pipelines	PE01
			Bur	-	PE01
RS	Raw Sewage	≥ 350 mm	Bur	-	CP01
SAM	Sample	All	Ind	-	PV01
SBS	Sodium Bisulphite	All	Ind	-	PV01
SC	Scum	All	Ind.	Primary Scum	TBD
			Ind.	Secondary Scum	TBD
			Bur	All	PE01
SHC	Sodium Hypochlorite	All	Ind	-	PV01
SHD	Sodium Hydroxide	All	Ind	-	PV01
SNS	Sand Slurry	All	Ind	-	CS01
SPD	Sump Pump	All	Ind.	Suction	SS0x
				Between pump and check valve	SS0x
				Discharge	PP01
TFS	Thickened Fermented Sludge	All	Ind	Lengths < 3m adjacent to equipment	SS0x
			Ind.	Pipelines	PE01
			Bur	-	PE01
TWAS	Thickened Waste-Activated Sludge	All	See TFS		
WAS	Waste-Activated Sludge	All	See RAS		

Note:

1. All deviations from the above table require approval of the City.

8.2 Pipe Flow Velocities

1. In general pipelines shall be sized to provide velocities as shown in Table 8-3.

Table 8-3 : Pipe Flow Velocities

Type	Velocity
Gravity Pipelines	• an average velocity of 1.2 to 1.5 m/s, • a minimum velocity of 0.6 m/s (to prevent settling of solids); • a maximum velocity of 2.4 to 2.7 m/s (to minimize erosion and head loss).
Pressure Pipelines	• an average velocity of 1.5 to 2.4 m/s, • a minimum velocity of 0.6 to 0.9 m/s; and • a maximum velocity of 3.0 to 3.6 m/s.
Air Pipelines	• 6 to 9 m/s for sizes 75 mm diameter and smaller, • 9 to 15 m/s for sizes 100 to 250 mm, • 15 to 19 m/s for sizes 300 to 600 mm; and • 19 to 33 m/s for sizes 750 mm and larger.

8.3 Thermal Expansion and Flexibility

1. The potential thermal expansion and contraction movement shall be calculated with consideration of the pipe length, material properties, and range of temperatures that the piping will be exposed to once the piping has been laid out.
2. In general avoid the use of expansion joints, couplings, or compensators where the calculated movement is within the allowable flexure and allowable stress of the pipe material, and where the support system does not hinder movement.
3. Determine the allowable flexure and stress range in accordance with the applicable ASME codes.
4. Develop details regarding piping expansion and flexibility during detailed design.
5. Where expansion joints or couplings are part of the piping system design, the pipe support system shall be designed and detailed as necessary to include pipe anchors, pipe guides adjacent to expansion joints and rolling or sliding supports to allow movement of the pipe.
6. Anchor loads for piping with expansion joints shall be calculated to determine if special structural design is required for the structural attachment, or if a special design is required for the anchor attachment to the pipe.

8.4 Pipe Supports

1. For piping 600 mm and larger, the engineer shall provide a comprehensive design for the pipe supports including:
   1.1 Provide a complete support design of each support.
   1.2 Show the locations and complete details of all supports on the drawings, and 3d model as applicable.
   1.3 Provide a comprehensive structural and mechanical design. Under a design-bid-build contracting strategy, the contractor shall not be expected to perform any design for these pipe supports.
2. For piping smaller than 600 mm, the engineer shall provide a design for the pipe supports including:
   2.1 Provide a complete support design where there are changes in direction in the pipeline and adjacent to heavy inline components such as valves and flow meters.
   2.2 Provide a complete support design of each support for each type and size of piping. Typical standard details may be utilized as appropriate.
   2.3 Ensure thrust restrain is provided.
   2.4 For each piping run, ensure it is clear if the piping is to be supported from the ceiling, wall, or floor. Coordinate with the structural discipline to ensure the structure can appropriately support the piping load.

   Under a design-bid-build contracting strategy, the contractor may be utilized to perform the final piping support calculations, provided they are performed by a professional engineer.
   2.5 Ensure shop drawings are provided during construction and review to ensure appropriate pipe support.
3. Ensure that pipe supports for plastic pipes meet the requirements of all applicable manufacturer and industry guidelines.
   3.1 Ensure appropriate saddle-type supports of the appropriate width are provided.
   3.2 Ensure appropriate support spacing.
4. Take into consideration future maintenance operations, requiring removal and replacement of piping and valves, in the selection of appropriate supports and their locations.
5. Specify channel-type support systems for small diameter piping.
   5.1 Ensure corrosion resistant alloy and FRP versions are specified for damp and corrosive areas.
6. Provide sway struts and braces to restrain piping seismic forces as required by the Manitoba Building Code for post disaster structures.
7. Follow ASME standards for piping that require registration with the Office of the Fire Commissioner – Inspection and Technical Services Manitoba.

8.5 Thrust Restraint

1. Provide thrust restraint by means of pipe anchors, tie rods, and restrained joints.
2. Provide expansion joints with extension limiting rods to protect the bellows from over extension.
3. Thrust tie and welded lug assemblies for steel pipe shall be covered by standard detail.

4. Provide thrust restraint for buried by proprietary restrained joints or individually restrained joints with tie rod assemblies.
5. Where adequate soil bearing pressure is available thrust restraint may be carried by concrete thrust blocks.
6. In general, avoid the use of thrust blocks where future excavations near the thrust block may compromise its restraining ability.

8.6 Piping Identification

1. All piping shall be properly identified with permanent labels in accordance with the City's standards, indicating the contents and direction of flow.
2. Reference shall be made to the City of Winnipeg Water and Waste Department Identification Standard related to piping.

9 VALVES

9.1 Valve Types

1. Valve types shall be as per Table 9-1.

Table 9-1 : Valve Types

Code	Service	Size	Application	Type
ALP	Air – Low Pressure	<= 25 mm	Isolation	Ball
		25 mm to 500 mm	Isolation	Butterfly
		>= 600 mm	Isolation	Butterfly
BLS	Ballasted Sludge	All		
DCW DHR DHW NPW SW TDW	Domestic Cold Water Domestic Hot Water Return Domestic Hot Water Non-Potable Water Seal Water Tempered Domestic Water	<= 65 mm	Isolation	Ball
		<= 65 mm	Hose	Globe
		75 to 300 mm	Isolation	Gate
		>= 350 mm	Isolation	Gate
FC	Ferric Chloride	All	Isolation	Ball
FE	Final Effluent	TBD	Isolation	Gate
FSW	Flushing Water	<= 65 mm	Isolation	Ball
		>= 75 mm	Isolation	Gate
GR GS	Glycol Return Glycol Supply	<= 65 mm	Isolation	TBD
			Control	Globe
GRS	Grit Slurry	TBD	Isolation	Knife Gate
HRS	High-Rate Clarifier Sludge	All	Isolation	Eccentric Plug Valve
HWR HWS	Hot Water Return Hot Water Supply	<= 65 mm	Isolation	TBD
			Control	Globe
IAS	Instrument Air Supply	<= 50 mm	Isolation	Ball
		> 50 mm	Isolation	TBD
MP	Mixed Polymer	All	Isolation	Ball
PD	Process Drain	<= 65 mm	Isolation	Gate (TBD)
		>= 75 mm	Isolation	Gate (TBD)

Code	Service	Size	Application	Type
RAS WAS	Return Activated Sludge Waste Activated Sludge	<= 65 mm	Isolation	Ball
		>= 75 mm	Isolation	Eccentric Plug Valve
RS	Raw Sewage	< 300 mm	Isolation	Eccentric Plug Valve
		350 to 500 mm	Isolation	TBD
		>= 600mm	Isolation	Gate
SAM	Sample	All	Isolation	Ball
SBS	Sodium Bisulphite	All	Isolation	Ball
SC	Scum	<= 65 mm	Isolation	Ball (TBC)
		75mm - 300 mm	Isolation	Eccentric Plug or Knife Gate (TBC)
SHC	Sodium Hypochlorite	All	Isolation	Ball
SHD	Sodium Hydroxide	All	Isolation	Ball
SNS	Sand Slurry	All	Isolation	Ball or Plug
SPD	Sump Pump	<= 65 mm	Isolation	Ball
TFS TWAS	Thickened Fermented Sludge Thickened Waste-Activated Sludge	TBD	Isolation	Eccentric Plug

Note:

1. All deviations from the above table require approval of the City.

9.2 Manually Operated Valves

1. In general equip manually operated valves in sizes 200 mm and larger with hand wheels. Provide wrench levers for quarter turn valves (plug, butterfly, and ball) for sizes smaller than 200 mm.
2. Ensure operator force shall not exceed 18 kilograms under any operating condition, including initial breakaway. Provide gear reduction operator when force exceeds 18 kilograms.
3. Equip valves located more than 2,000 mm above the operating floor with chain operators having chains dropping to within 1,200 mm of the floor.
4. Provide buried valves with square head operating nuts, extension stems, and valve boxes at grade. Gate valves shall generally be the rising stem type; non rising stems shall be used where space is limited and for buried service.

9.3 Power Operated Valves

1. Determine the need for power-actuated valves based on process control requirements. Additionally, power actuators shall be provided for the following applications:
   - Where valve operation is required at least once per shift.
   - Where quick valve operation may be required because of an emergency condition.
   - Where slow valve operation may be required to prevent water hammer.
   - For large valves where manual operation would be cumbersome.
   - For valves which are difficult to access.

9.3.2 Electric Actuated Valves

1. In general, provide electric motor operators with manual override for power actuated valves, for both open close service and modulating service.
2. Small open close valves (20 mm and smaller) shall be solenoid operated.
3. In general, 120V single-phase actuators shall be used for valves sizes 50 mm and smaller, while 600V three-phase actuators shall be used for valves 100 mm and larger.
4. Coordinate with the City regarding use of standardized electric actuators.
5. Ensure the running and breakaway torque safety factors ratings are appropriate for the specific valve type and service application. Actuators shall be rated at least twice the valve operating torque, or twice the breakaway torque, whichever is greater, unless it can be proven, in writing, that a lower safety factor is sufficient. Minimum safety factors for clean fluid applications are as follows:
   - 5.1 Butterfly Valves: Minimum safety factor of 1.3 (with proof)
   - 5.2 Eccentric Plug Valves: Minimum safety factor of 1.5 (with proof)
   - 5.3 Gate Valve: Minimum safety factor of 1.5 (with proof)
   - 5.4 Sluice / Slide Gate: Minimum safety factor of 2.0
6. Ensure actuator duty rating is greater than the worst case operating scenario.
7. Ensure solid-state modulating actuators are specified for control applications.

9.3.3 Pneumatic Operated Valves

1. Use of pneumatic operated valves shall be limited to the following applications:
   - 1.1 Where a fast opening or closing of the valve is required to meet process control requirements;
   - 1.2 Where a failsafe valve operation is required;
   - 1.3 Retrofits of existing installations; or
   - 1.4 Other special applications as approved by the City.
2. Pneumatic actuators shall be in compliance with AWWA C541 and shall be provided with air sets, exhaust mufflers, speed controls, pilot solenoids and safety vented isolation valves.

9.4 Control Valves

Following general guidelines shall be followed for control valve sizing:

1. The appropriate valve flow characteristic (quick opening, linear, equal percentage, modified parabolic) shall be selected based on the application (pressure relief, pressure control, flow control, level control) and the proportion of total system head loss available as pressure drop across the valve. When in doubt, equal percentage shall be used.
2. The turndown ratio (the ratio of maximum to minimum flow) shall not exceed 5:1.
3. The required valve operating range shall be maintained within 15 to 80 percent of the maximum flow coefficient (C_v) for optimum control. Valves shall be sized to pass the maximum flow at minimum pressure drop with the valve operating at not more than 80 percent of maximum capacity.
4. In a throttled constant speed pump system, the pressure drop across the valve at maximum flow shall be at least 40 percent of the system total frictional loss (including the control valve) when the system static head exceeds 70 of the total dynamic head (TDH), at least 30 percent when the static head is 50 to 70 percent of the TDH, and at least 20 percent when the static head is less than 50 percent of the TDH.
5. In a system where static pressure or head moves liquid from one vessel to another, the pressure drop across the valve at maximum flow shall be at least 10 percent of the system static pressure, or 40 percent of the system total frictional loss (including the control valve), whichever is greater.
6. In all cases, the valve shall be at least 10 percent open at the maximum throttling (minimum flow at maximum pressure drop) position. The preferred minimum opening is 15 percent.

9.5 Check Valves

1. Check valves shall be provided as per: To be completed
2. Provide check valve indicators for the following check valves: To be completed

9.6 Valve Installation

1. Valve Orientation
   - 1.1 Valves shall be installed with the operating mechanism either vertically upward or horizontal wherever possible (never vertically downward).
   - 1.2 Limit installation at an inclined angle above the horizontal to situations where interference must be avoided.

9.7 Slide Gates

1. Stainless steel fabricated slide gates shall be used to isolate flow in tanks and channels.
2. Ensure slide gates meet AWWA C561, Standard for Fabricated Stainless Steel Slide Gates, including allowable leakage rates.
3. In tanks, the gates shall be wall surface mounted with an elastomeric gasket between the gate and the concrete wall.

4. In new channels, the gate frame shall be embedded in the walls and floor of the channel such that the gate invert is flush with the channel bottom and the gate opening is equal to the full width of the channel. In existing channels, the gates frames shall be surface mounted.

5. Gates located near the operating floor level shall generally be the self-contained type, with the gate operator mounted on a yoke attached to the gate frame. Self-contained gates shall be fully assembled and tested at the factory, and the gate operator thrust loads shall be transferred entirely to the gate frame rather than to the concrete structure. Gates located well below the operating level shall generally be the open frame type with extension stems and pedestal mounted operators.

6. Manually operated gates shall be equipped with geared crank type operators, either yoke or pedestal mounted. The crank shall be removable for attachment of a portable electric drill operator. Power operated gates shall be provided for the following applications:

   - Where process control requires remote automated operation of the gate.
   - Where manual gate operation will be required more than once per week.
   - Where rapid response to an emergency condition may be required.
   - For tall gates with a vertical lift of 1,800 mm or greater.
   - For large gates with a nominal area of 3.24 m2 or greater.

7. Power operated gates shall be equipped with electric motor operators with a manual override.

8. In applications with presence of abrasive grit, cast iron or stainless steel sluice gates, which utilize a wedging action at the point of gate closure to provide sealing, shall be utilized.

9. Strong preference shall be given to stainless steel gates over cast iron gates to ensure superior corrosion resistance.

10 PROCESS MECHANICAL DESIGN TEAM RESPONSIBILITIES

10.1 General

1. Responsibility for deliverables
   1.1 All drawings and other deliverables related to a design are the responsibility of the designer / engineer.
2. Ensure all process building mechanical deliverables are sealed by a qualified professional designer / engineer.
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:
   - Updating existing building floor plans and layouts.
   - Updating P&ID drawings.
   - The update of detail drawings for existing works is not expected or required.
5. Design reviews:
   5.1 Issue the design documents to the City for review at appropriate intervals in accordance with the City's expectations.
   5.2 Incorporate all WSTP comments into the design. Where a WSTP comment is not accepted by the design team, provide a complete response, including rationale, to the City Project Manager.
6. As-Built Drawings:
   6.1 All process 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, RFIs, and other communication between the Contractor and Design Team.
   6.2 Unless otherwise specified by the City and agreed to by the Design Team, as-built drawings will not 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 process mechanical design team.
   7.2 The design team shall be responsible for monitoring the activities and progress of each 3rd party consultant.
   7.3 It is the responsibility of the design engineer 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 It is generally required that the engineer is responsible for associated demolition works required to implement the scope of work. Clearly indicate all demolition requirements on the drawings and in the specifications.
   - 9.2 Where demolition requirements are significant, create dedicated demolition drawings.

10.2 Drawings

The drawings indicated in this section are minimum requirements for new construction, unless otherwise approved by the City.

10.2.1 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 consistent with the P&IDs.
3. Format:
   - 3.1 Produce drawings in an A1 size format.

10.2.2 Process Flow Diagrams

1. Requirement
   - 1.1 Provide Process Flow Diagrams for the complete process system. The Process Flow Diagrams shall show all major equipment and flow paths.
2. Content
   - 2.1 P&ID's shall depict all equipment and piping. All major equipment, including all grit and sludge pumps, shall be individually shown.
   - 2.2 It is preferred that one PFD is provided for each process area.
   - 2.3 All equipment shall be fully identified as per the City WWD Identification standard.
   - 2.4 Show major valves / gates utilized for control. Isolation valves / gates are not typically shown.
3. Format
   - 3.1 Produce drawings in an A1 size format.

10.2.3 Process and Instrumentation Diagrams (P&IDs)

1. Requirement

    1.1 Provide P&ID's for the complete process system, including all auxiliary services.

2. Content

    2.1 P&ID's shall depict all equipment and piping.

    2.2 All automation and control components shall be shown.

    2.3 Show all process flow rates.

    2.4 Show all instrumentation ranges.

    2.5 Show all hardwired equipment interlocks.

    2.6 Show all major control loops, regardless if implemented in hardware or software.

3. Format

    3.1 Produce drawings in an A1 size format.

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

10.2.4 Hydraulic Profiles

1. Requirement

    1.1 Provide a comprehensive set of hydraulic provide drawings for all major flow paths, including process bypass.

2. Content:

    2.1 Show elevation on a vertical scale. The graphical elevation shall be shown for the peak instantaneous flow scenario.

    2.2 Show elevation in numerals for each process and flow path. The elevation shall be shown, at minimum, for the following three scenarios:

        2.2.1 Peak instantaneous flow

        2.2.2 Peak daily flow

        2.2.3 Average daily wet-weather flow

        2.2.4 Average daily dry-weather flow

    2.3 Show all weir elevations.

    2.4 Show all tank, conduit and channel elevations.

    2.5 Show max and min control elevations in pumping wet wells and other variable elevation processes.

    2.6 Show design flood elevations.

3. Format:

    3.1 Produce drawings in an A1 size format.

10.2.5 Process Plan Overview Drawings

1. Requirement

 1.1 Where Process Plan Drawings only show a portion of the building / process, Process Plan Overview Drawings are required to show the complete floor elevation for all floors with significant equipment, including the roof if significant equipment is located on the roof.

2. Content:

 2.1 Show the arrangement of all major equipment and piping.

 2.2 Provide a scale bar to allow for scale takeoffs.

3. Format:

 3.1 Produce drawings in an A1 size format.

 3.2 Scale:

  3.2.1 Recommended: 1:100 – 1:150

  3.2.2 Maximum: 1:200

   3.2.2.1 The maximum scale is only permissible in instances where there is limited equipment and piping detail to show.

10.2.6 Process Plan Drawings

1. Requirement

 1.1 Process plan drawings are required for every floor elevation, including the roof if equipment is located on the roof.

2. Content:

 2.1 Show the arrangement of all process equipment, including all piping.

 2.2 Show all pipe supports for all piping 600mm and larger.

 2.3 All equipment and valves shall be identified.

 2.4 Show pipe elevations.

 2.5 Provide a scale bar to allow for scale takeoffs.

3. Format:

 3.1 Produce drawings in an A1 size format.

 3.2 Scale:

  3.2.1 Recommended: 1:50

  3.2.2 Maximum: 1:100

   3.2.2.1 The maximum scale is only permissible in instances where there is limited equipment and piping detail to show.

10.2.7 Process Section and Detail Drawings

1. Requirement

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

2. Content

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

   2.2 Show all pipe supports for all piping 600mm and larger.

   2.3 All equipment and valves shall be identified.

3. Format:

   3.1 Produce drawings in an A1 size format.

   3.2 Scale:

      3.2.1 Recommended: 1:50

      3.2.2 Maximum: 1:100

10.2.8 Piping Support Detail Drawings

1. Requirement

   1.1 Provide process piping support drawings to completely make clear the required piping support installation of the process systems.

      1.1.1 Typical details shall be provided for pipes < 600 mm. The Contractor shall provide sealed shop drawings for all pipe supports < 600 mm.

      1.1.2 Complete comprehensive design shall be provided for all pipes >= 600 mm.

2. Content

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

   2.2 Ensure coordination with the structural discipline is required.

3. Format:

   3.1 Produce drawings in an A1 size format.

   3.2 Scale:

      3.2.1 Recommended: 1:25

      3.2.2 Maximum: 1:50

10.2.9 Equipment Installation Detail Drawings

1. Requirements

   1.1 Provide equipment installation detail drawings as applicable to provide the contractor with sufficient information to bid the work and meet the requirements of the project.

2. Content

   2.1.1 To be completed

3. Format:

   3.1 Produce drawings in an A1 size format.

   3.2 Scale:

   3.2.1 Recommended: 1:25

   3.2.2 Maximum: 1:50

10.2.10 3D Model

1. When 3D design is required by the City, or proposed by the Consultant, this section shall be complied with in its entirety. 3D models and associated drawings are not mandatory for all projects

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

3. In addition to the 3D model provide:

   3.1 3D elevation and section drawings to convey the complete process configuration.

   3.2 3D detail drawings of all areas with significant interdisciplinary coordination requirements.

4. 3D drawings shall be rendered. Simple 3D line representations are not acceptable.

10.2.11 Coordination with Other Disciplines

1. Structural / Architectural

   1.1 Ensure that openings for equipment, pipework 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.

10.3 Other Documents

10.3.1 Equipment List

1. Requirements
   1.1 Provide a comprehensive equipment list.
      1.1.1 It is preferred if the list is organized into a separate document for each process area (area code).
2. Content
   2.1 Include:
      2.1.1 Equipment Identifier
      2.1.2 Equipment Description
      2.1.3 P&ID
      2.1.4 Equipment Datasheet
      2.1.5 Location
      2.1.6 Equipment Type
      2.1.7 Service
      2.1.8 Other information as applicable.
3. Format:
   3.1 Produce equipment lists in Microsoft Excel format.

10.3.2 Equipment Datasheets

1. Requirements
   1.1 Provide equipment datasheets for all equipment.
2. Content
   2.1 Provide complete and comprehensive details to specify the application and supply requirements for the equipment.
   2.2 Include pump curves for pumps.
3. Format:
   3.1 Produce equipment datasheets in Microsoft Word format.
   3.2 A unique datasheet with a unique document number shall be provided for each piece of equipment. The only exception is as follows:
      3.2.1 One datasheet may be utilized for multiple units of equipment where the equipment is 100% identical, including motor size, rotation, etc.

10.3.3 Valve List

1. Requirements
   1.1 Provide a comprehensive valve list.
      1.1.1 It is preferred if the list is organized into a separate document for each process area (area code).
   1.2 Include gates and stop logs in the valve list.
2. Content
   2.1 Include:
      2.1.1 Valve Identifier
      2.1.2 Valve Description
      2.1.3 Valve Type
      2.1.4 Actuator
      2.1.5 P&ID
      2.1.6 Specification / Datasheet
      2.1.7 Location
      2.1.8 Service
      2.1.9 Other information as applicable.
3. Format:
   3.1 Produce valve lists in Microsoft Excel format.

10.4 Design Calculations

1. As a minimum, provide the following non-exhaustive list of process mechanical design data and calculations:
   - Pump Hydraulic Calculations
   - To be developed.