THE CITY OF WINNIPEG

REQUEST FOR PROPOSAL

RFP NO. 384-2020

PROFESSIONAL CONSULTING SERVICES FOR NORTH END SEWAGE TREATMENT PLANT RETURN ACTIVATED SLUDGE PIPING SYSTEM REFURBISHMENT DETAILED DESIGN AND CONTRACT ADMINISTRATION

TABLE OF CONTENTS

PART B - BIDDING PROCEDURES

B1. CONTRACT TITLE

B1.1 PROFESSIONAL CONSULTING SERVICES FOR NORTH END SEWAGE TREATMENT PLANT RETURN ACTIVATED SLUDGE PIPING SYSTEM REFURBISHMENT DETAILED DESIGN AND CONTRACT ADMINISTRATION

B2. SUBMISSION DEADLINE

B2.1 The Submission Deadline is 12:00 noon Winnipeg time, November 6, 2020.

B2.2 The Project Manager or the Manager of Materials may extend the Submission Deadline by issuing an addendum at any time prior to the time and date specified in B2.1.

B3. SITE INVESTIGATION

B3.1 The Project Manager or an authorized representative will conduct a Site investigation tour of the North End Sewage Treatment Plant (NEWPCC) Return Activated Sludge (RAS) piping gallery, located at 2230 Main Street, Winnipeg, MB, for each individual Proponent during the week of October 26 to 30, 2020. Investigations are by appointment only and for a maximum of three (3) attendees per Proponent to maintain safe physical distancing measures related to the COVID-19 pandemic. The tour will be approximately one (1) hour in duration.

B3.1.1 The same information will be provided at each presentation of the Site investigation tour.

B3.1.2 Proponents are required to request a Site investigation by contacting the City's Project Manager identified in D2.

B3.1.3 Directions to the exact NEWPCC Site investigation tour start location and Site access procedures will be provided to the Proponent upon registration for the Site investigation.

B3.1.4 Proponents attending the Site Investigation outlined B3.1 are required to provide their own Personal Protective Equipment; at a minimum hard hat, CSA approved safety footwear, safety glasses, non-medical mask or face covering, and disposable gloves. A non-medical mask or face covering is required when in all City-operated facilities as noted in the poster in Appendix A. Guidelines on how to safely use a non-medical mask or face covering are provided in Appendix B. Gloves are to be washed with soap and water or an alcohol-based hand sanitizer prior to Site entry.

B3.2 All Proponent attendees are required to review the City's latest revision of a COVID-19 Daily Self-Screening Questionnaire and respond in writing (i.e. mark "yes" or "no" to each question, print date and full name, sign questionnaire, and submit via e-mail) to the Project Manager or authorized representative prior to the start of the Site investigation. Failure to provide written confirmation to the Project Manager or authorized representative may result in the Proponent attendee being denied access to the Site Investigation. A sample copy of the COVID-19 Daily Self-Screening Questionnaire is provided in Appendix C.

B3.3 Although attendance at the Site Investigations is not mandatory, the City strongly suggests that Proponents attend.

B3.4 The Proponent shall not be entitled to rely on any information or interpretation received at the Site investigation unless that information or interpretation is the Proponent's direct observation, or is provided by the Project Manager in writing.

B4. ENQUIRIES

B4.1 All enquiries shall be directed to the Project Manager identified in D2.

B4.2 If the Proponent finds errors, discrepancies or omissions in the Request for Proposal, or is unsure of the meaning or intent of any provision therein, the Proponent shall promptly notify the

Project Manager of the error, discrepancy or omission at least five (5) Business Days prior to the Submission Deadline.

B4.3 Responses to enquiries which, in the sole judgment of the Project Manager, require a correction to or a clarification of the Request for Proposal will be provided by the Project Manager to all Proponents by issuing an addendum.

B4.4 Responses to enquiries which, in the sole judgment of the Project Manager, do not require a correction to or a clarification of the Request for Proposal will be provided by the Project Manager only to the Proponent who made the enquiry.

B4.5 All correspondence or contact by Proponents with the City in respect of this RFP must be directly and only with the City's Project Manager. Failure to restrict correspondence and contact to the Project Manager may result in the rejection of the Proponents Proposal Submission.

B4.6 The Proponent shall not be entitled to rely on any response or interpretation received pursuant to B4 unless that response or interpretation is provided by the Project Manager in writing.

B4.7 Any enquiries concerning submitting through MERX should be addressed to:
MERX Customer Support
Phone: 1-800-964-6379
Email: merx@merx.com

B5. CONFIDENTIALITY

B5.1 Information provided to a Proponent by the City or acquired by a Proponent by way of further enquiries or through investigation is confidential. Such information shall not be used or disclosed in any way without the prior written authorization of the Project Manager. The use and disclosure of the Confidential Information shall not apply to information which:

(a) was known to the Proponent before receipt hereof; or

(b) becomes publicly known other than through the Proponent; or

(c) is disclosed pursuant to the requirements of a governmental authority or judicial order.

B5.2 The Proponent shall not make any statement of fact or opinion regarding any aspect of the Request for Proposals to the media or any member of the public without the prior written authorization of the Project Manager.

B6. ADDENDA

B6.1 The Project Manager may, at any time prior to the Submission Deadline, issue addenda correcting errors, discrepancies or omissions in the Request for Proposal, or clarifying the meaning or intent of any provision therein.

B6.2 The Project Manager will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.

B6.3 Addenda will be available on the MERX website at www.merx.com.

B6.4 The Proponent is responsible for ensuring that he/she has received all addenda and is advised to check the MERX website for addenda regularly and shortly before the Submission Deadline, as may be amended by addendum.

B6.5 The Proponent shall acknowledge receipt of each addendum in Paragraph 10 of Form A: Bid/Proposal. Failure to acknowledge receipt of an addendum may render a Proposal non-responsive.

B6.6 Notwithstanding B4, enquiries related to an Addendum may be directed to the Project Manager indicated in D2.

B7. PROPOSAL SUBMISSION

B7.1 The Proposal shall consist of the following components:

(a) Form A: Bid/Proposal (Section A) in accordance with B8;

(b) Fees (Section B) in accordance with B9.

B7.2 The Proposal should also consist of the following components:

(a) Experience of Proponent and Subconsultants (Section C) in accordance with B10;

(b) Experience of Key Personnel Assigned to the Project (Section D), in accordance with B11;

(c) Project Understanding and Methodology (Section E) in accordance with B12; and

(d) Project Schedule (Section F) in accordance with B13.

B7.3 Further to B7.1 all components of the Proposal shall be fully completed or provided in the order indicated, and submitted by the Proponent no later than the Submission Deadline, with all required entries made clearly and completely, to constitute a responsive Proposal.

B7.4 Further to B7.2, all components of the Proposal should be fully completed or provided in the order indicated, and submitted by the Proponent no later than the Submission Deadline, with all required entries made clearly and completely.

B7.5 Proposal format, including number of pages, size of pages and, font, etc., will not be regulated, except that the Proposal should contain a table of contents, page numbering and should be in the Sections identified above. Proponents are encouraged to use their creativity to submit a Proposal which provides the requested information for evaluation and other information which illustrates the strength of their proposed solution.

B7.6 The Proposal shall be submitted electronically through MERX.

B7.6.1 Proposals will **only** be accepted electronically through MERX.

B7.7 Proponents are advised that inclusion of terms and conditions inconsistent with the Request for Proposal, will be evaluated in accordance with B23.1(a).

B7.8 Any cost or expense incurred by the Proponent that is associated with the preparation of the Proposal shall be borne solely by the Proponent.

B8. PROPOSAL (SECTION A)

B8.1 The Proponent shall complete Form A: Bid/Proposal, making all required entries.

B8.2 Paragraph 2 of Form A: Bid/Proposal shall be completed in accordance with the following requirements:

(a) if the Proponent is a sole proprietor carrying on business in his/her own name, his/her name shall be inserted;

(b) if the Proponent is a partnership, the full name of the partnership shall be inserted;

(c) if the Proponent is a corporation, the full name of the corporation shall be inserted;

(d) if the Proponent is carrying on business under a name other than his/her own, the business name and the name of every partner or corporation who is the owner of such business name shall be inserted.

B8.2.1 If a Proposal is submitted jointly by two or more persons, each and all such persons shall identify themselves in accordance with B8.2.

B8.3 In Paragraph 3 of Form A: Bid/Proposal, the Proponent shall identify a contact person who is authorized to represent the Proponent for purposes of the Proposal.

B8.4 Paragraph 13 of Form A: Bid/Proposal shall be signed in accordance with the following requirements:

(a) if the Proponent is a sole proprietor carrying on business in his/her own name, it shall be signed by the Proponent;

(b) if the Proponent is a partnership, it shall be signed by the partner or partners who have authority to sign for the partnership;

(c) if the Proponent is a corporation, it shall be signed by its duly authorized officer or officers;

(d) if the Proponent is carrying on business under a name other than his/her own, it shall be signed by the registered owner of the business name, or by the registered owner's authorized officials if the owner is a partnership or a corporation.

B8.4.1 The name and official capacity of all individuals signing Form A: Bid/Proposal should be entered below such signatures.

B8.5 If a Proposal is submitted jointly by two or more persons, the word "Proponent" shall mean each and all such persons, and the undertakings, covenants and obligations of such joint Proponents in the Proposal and the Contract, when awarded, shall be both joint and several.

B9. FEES (SECTION B)

B9.1 The Proponent shall utilize and submit Form B: Fees, making all required entries to summarize their Fee proposal for the proposed Services. The Proponent shall be responsible to verify and ensure the correctness of the associated submittals.

B9.1.1 Notwithstanding C1.1(b), overhead costs or disbursements typically referred to as Type 1 disbursements or general expenses shall be included in the Hourly Rates.

B9.2 The Proposal shall include a Fixed Fee for the following disciplines and/or phases identified in D6 Scope of Services and as listed in Form B: Fees:

(a) Project Management,

(b) Risk Management,

(c) Detailed Design and Specification Development, and

(d) Procurement Services

B9.2.1 In addition to the Form B: Fees, proposals shall also include detailed description of the Fixed Fees for all disciplines according to the Scope of Services. Details shall include:

(i) the work activities and deliverables of the proposed Services;

(ii) the respective number of hours per work activity per task per each proposed individual;

(iii) name and role of proposed individuals;

(iv) the respective engineering discipline or management function as applicable;

(v) the associated disbursements; and

(vi) information relating to points (i) to (v) above shall be presented in a matrix form that allows easy understanding of their connections, and the associated Form B: Fees summaries shall be issued from a direct traceable compilation of the matrix input.

B9.3 The Proposal shall include a Time Based Fee schedule calculated on a time basis for the following disciplines and/or phases identified in D6 Scope of Services and as listed in Form B: Fees:

(a) Contract Administration: Non-Resident Engineering Services

(b) Contract Administration: Resident Engineering Services

(c) Contract Administration: Commissioning Services

(d) Post Construction Services

(e) Additional Work Allowance

B9.3.1 General Requirements for Time Based Fee Services:

(a) The number of hours is indicated in the RFP for each time-based line item in Form B: Fees to guide the Proponent in developing their fee proposal.

(b) The number of hours indicated for each line item is based upon the Proponent utilizing experienced personnel who are familiar with the City's requirements and procedures performing the work.

(c) The fees proposed by the Proponent in Form B: Fees shall constitute an upset limit. Ensure the hours proposed are sufficient to complete the specified work.

B9.3.2 Form B: Fees – Fee Schedule – Item No. 5 – Contract Administration: Non-Resident Engineering Services

(a) Indicate the proposed hours and fees for Non-Resident Engineering Services as per D6.7.2(a), with resources allocated as per below:
   (i) Project manager: 5% minimum
   (ii) Intermediate and Senior engineers: 50% minimum
   (iii) Administrative: 10% maximum
   (iv) Other engineering / technical resources may be allocated for the remainder.

(b) For Proposal purposes, these fees shall be based on 600 hours of work.

B9.3.3 Form B: Fees – Fee Schedule – Item No. 6 – Contract Administration: Resident Engineering Services Allowance

(a) For purpose of the Fee Proposal, Proponents shall use an allowance of $384,000.00 for Resident Engineering Services in accordance with D6.7.2(b), with resources as per below:
   (i) Project manager: 5% minimum
   (ii) Intermediate and Senior engineers: 75% minimum
   (iii) Administrative: 5% maximum
   (iv) Other engineering / technical resources may be allocated for the remainder.

(b) For Proposal purposes, these fees shall be based on 1,920 hours of work.

B9.3.4 Form B: Fess – Fee Schedule – Item No. 7 – Contract Administration: Commissioning Services

(a) Indicate the proposed hours and fees for Commissioning Services as per D6.7.2(c), with resources as per below:
   (i) Project manager: 5% minimum
   (ii) Commissioning Leader: 50% minimum
   (iii) Administrative: 10% maximum
   (iv) Other engineering / technical resources may be allocated for the remainder.

(b) For Proposal purposes, these fees shall be based on 350 hours of work.

B9.3.5 Form B: Fees – Fee Schedule – Item No. 8 – Post Construction Services

(a) Indicate the proposed hours and fees for Post Construction Services as per D6.8, with resources allocated as per below:
   (i) Project manager: 5% minimum
   (ii) Senior engineers: 15% minimum
   (iii) Administrative: 10% maximum
   (iv) Other engineering / technical resources may be allocated for the remainder.

(b) For Proposal purposes, these fees shall be based on 100 hours of work.

B9.3.6 Form B: Fees – Fee Schedule – Item No. 9 - Additional Work Allowance as per D6.9

(a) The Proponent shall include an Additional Work Allowance of $100,000.00 in their proposal.

(b) The Additional Work Allowance is to be used for engineering and design services which may be required due to unforeseen conditions arising in preliminary stages of the project.

(c) The Additional Work Allowance is to be included in the calculation of total Fees proposed by the Proponent.

(d) The Additional Work Allowance shall only be used with prior written permission of the Project Manager.

B9.3.7 In addition to the Form B: Fees, proposals shall also include detailed description of the Time Based Fees for all disciplines according to the Scope of Services. Details shall include:

(i) the work activities of the proposed Services;
(ii) the respective number of hours per work activity per task per each proposed individual;
(iii) name and role of proposed individuals;
(iv) the respective engineering discipline or management function as applicable;
(v) the applicable hourly rates;
(vi) the associated disbursements; and
(i) information relating to points (i) to (vi) above shall be presented in a Matrix form that allows easy understanding of their connections, and the associated Form B: Fees summaries shall be issued from a direct traceable compilation of the Matrix input.

B9.4 Work under General Requirements in accordance with D6.2 shall be considered incidental to all disciplines and/or phases identified in D6 Scope of Services and as listed in Form B: Fees.

B9.5 Invoicing of Fees is outlined in D12.

B9.6 There will be no fee escalation allowed for yearly adjustments, promotions, etc. Fee scale shall be fixed for the duration of the project.

B9.7 Adjustments to Fees will only be considered based on increases to the Scope of Services.

B9.7.1 The City will not consider an adjustment to the Fees based on:

(a) Changes in the Project budget or the Final Total Construction Cost, or

(b) Changes in the Project schedule

B9.8 If the City requires additional services, the rates to be used will be based on the rates provided in the Proponent’s proposal.

B9.9 Notwithstanding C1.1(b), Fees shall include costs for out of town travel, related meals and accommodations for the duration of the Project and shall not be considered an Allowable Disbursement.

B9.10 The Fee Proposal shall also include an allowance for Allowable Disbursements as defined in C1.1(b), but shall exclude the costs of any materials testing, soils and hazardous materials investigation during construction.

B9.10.1 Further to B9.10, an allowable disbursement of $50,000 associated with Item No. 9 - Additional Work Allowance, as identified in D6.9, has been included in Form B: Fees as the City’s estimate of costs for these disbursements.

(a) The Proponent shall include the Additional Work Allowance disbursement of $50,000 in their Proposal.

(b) The Additional Work Allowance disbursement is to be used for the cost of any associated sampling, materials testing, drilling, hazardous materials investigation, advanced asset condition assessment (i.e. use of more complex and costly non-destructive testing technologies beyond visual inspection only), or any other required tasks related to the uncertainties and critical time constraints associated with this project.

(c) The Additional Work Allowance disbursement is to be included on Form P: Person Hours and in the calculation of total fees proposed by the Proponent.

(d) The Additional Work Allowance disbursement shall only be used with prior written permission of the Project Manager.

B9.11 Notwithstanding C11.1, Fees submitted shall not include the Goods and Services Tax (GST) or Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable.

B9.12 Payments to Non-Resident Consultants are subject to Non-Resident Withholding Tax pursuant to the Income Tax Act (Canada).

B10. EXPERIENCE OF PROPONENT AND SUBCONSULTANTS (SECTION C)

B10.1 The Proposal should include general firm profile information, including years in business, average volume of work, number of employees and other pertinent information for the Proponent and all Subconsultants showing their ability to undertake the current work.

(a) Information submitted relating to B10.1 should be limited to a maximum of four (4) pages total for Proponent and Subconsultant.

B10.2 Proposals should include details demonstrating the history and experience of the Proponent and Subconsultants in providing design, management of construction, and contract administration services on **two (2) projects of similar complexity, scope and value**.

(a) “Similar complexity and scope” means “design services and construction supervision services for an external non-metallic composite repair method applied to a sewage treatment process piping system consisting of approximately six-hundred (600) meters of steel trunk pipework ranging in diameter from 300mm to 900mm with associated valves and pumps.”

(b) If more than two (2) projects are submitted for B10.2, only the first two (2) referenced projects will be evaluated.

B10.3 For each project listed in B10.2, the Proponent should submit:

(a) A clear and comprehensive description of the project – Include project owner, project objectives, size, and other relevant information;

(b) A clear and comprehensive description of the role of the Consultant Services – Provide details of the Consultant Services and details of the role of the project / Subconsultant. This will be evaluated against the relevance to this project and the applicability to all disciplines to this work;

(c) Original and final cost – Provide this information separately for the value of the Scope of the Consultant Services assignment and the construction. Identify the amount of scope changes and the reasons for each of them;

(d) Design and construction schedule – Include anticipated project duration and actual project delivery duration, showing design and construction separately. Provide explanations if there are discrepancies between the projected and the actual durations; and

(e) Reference information (two current names with email addresses and telephone numbers per project).

(i) References should have worked directly on the projects described, such as the Project Manager or Contract Administrator.

(ii) References may be utilized to confirm the information provided in the proposal.

(iii) Other sources not named in references may be contacted to verify the work.

B10.3.1 Where applicable, information should be separated into Proponent and Subconsultant project listings.

B11. EXPERIENCE OF KEY PERSONNEL ASSIGNED TO THE PROJECT (SECTION D)

B11.1 Describe your approach to overall team formation and coordination of team members.

B11.1.1 Include an organizational chart for the Project.

B11.2 Identify the following Key Personnel assigned to the Project:

(a) Project Manager;

(b) Design Lead Process Mechanical;

(c) Design Lead Structural; and

(d) Lead Commissioning

B11.2.1 Multiple Key Personnel positions may be filled by one individual, however for evaluation purposes, be sure to identify the experience and qualifications for each role separately.

B11.3 Identify the following Contract Administration Personnel assigned to the Project:

(a) Resident Contract Administrator; and

(b) Non-Resident Contract Administrator

B11.4 Submit the experience and qualifications of the Key Personnel and Contract Administration Personnel assigned to the Project for projects of similar complexity, scope and value, including the principals-in-charge, the Consultants Representative, managers of the key disciplines and lead designers . Include educational background and degrees, professional recognition, job title, years of experience in current position, years of experience in design and years of experience with existing employer. Roles of each of the Key Personnel in the Project should be identified in the organizational chart referred to in B11.1.1.

B11.5 For each person identified in B11.2 and B11.3, list at least two (2) comparable projects in which they have played a **primary role similar to that proposed for this Project**. If a project selected for a key person is included in B10, provide only the project name and the role of the key person. For other projects provide the following:

(a) Project name and owner;

(b) Description of project;

(c) Role of the person;

(i) Please describe duties and work performed (scope performed by that person) in detail such that parallels can be drawn between the example project and this Project.

(d) Reference information (two current names with email addresses and telephone numbers per project).

(i) References should have worked directly on the projects described, such as the Project Manager or Contract Administrator.

(ii) References may be utilized to confirm the information provided in the proposal.

(iii) Other sources not named in references may be contacted to verify the qualifications, work experience, past projects, applicability of the role, etc.

B11.5.1 If more than two (2) projects are submitted for B11.5, only the first two (2) referenced projects will be evaluated.

B11.5.2 If a key person is assigned to multiple positions, a separate description is still required for each Key Personnel position. The comparable projects may be different for each position.

B11.6 For each Key Personnel identified in B11.2 and B11.3, provide a detailed breakdown of hours proposed in the detailed fee breakdown as requested in B9.2.1 and B9.3.7.

B12. PROJECT UNDERSTANDING AND METHODOLOGY (SECTION E)

B12.1 Describe your firm's project management approach and team organization during the performance of Services using **project specific details**, so that the evaluation committee has a clear understanding of the methods the Proponent will use in the delivery of this Project.

B12.2 Methodology should be presented in accordance with the Scope of Services identified in D6.

B12.3 Describe the collaborative process/method to be used by the Key Personnel of the team in the various phases of the Project which include:

(a) Assessment of the risks associated with applying exterior composite repair methods for a complete piping system measuring hundreds of meters in length;

(b) Design of non-metallic composite refurbishment works for the system noted in (a); and

(c) Contract Administration including Commissioning

B12.4 Proposals should address:

(a) the proposed Project budget indicated in D6.10;

(b) the team's understanding of the Scope of Services and the broad functional and technical requirements;

(c) the deliverables and the associated task requirements of the Project;

(d) the work activities and clearly identify all significant assumptions and interpretations;

(e) the proposed techniques to ensure quality and consistency, and elimination of subjectivity or bias from any condition assessments;

(f) the activities and services to be undertaken by the City and equipment and supplies to be provided by the City;

(g) any potential risks, along with their implications and possible mitigation measures, that could be encountered during inspections and refurbishment works;

(h) any initiative and innovation to be used to perform the Services;

(i) the City's Project methodology with respect to the information provided within this RFP and the City's Project Management Manual at http://winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#2 and templates at http://winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#4 ; and

(j) any other issue that conveys your team's understanding of the Project requirements.

B12.5 The Proposal should include Form P: Person Hours or a table of their own design for all disciplines and or phases identified in D6 Scope of Services.

B12.5.1 The total Fees on Form P: Person Hours or a table of their own design should match Fees submitted in response to B9.

B12.6 Proponents may use Form P: Person Hours or a table of their own design provided it includes all information requested in accordance with B12.5.

B12.7 A sample of Form P: Person Hours can be found at https://winnipeg.ca/matmgt/templates/information.stm

B12.8 For each person identified in B11.2 and B11.3, list the percent of time to be dedicated to the Project in accordance with the Scope of Services identified in D6.

B13. PROJECT SCHEDULE (SECTION F)

B13.1 Proponents should present a carefully considered Critical Path Method schedule using Microsoft Project or similar project management software, complete with resource assignments (key designers), durations (weekly timescale) and milestone dates or events. The schedule should address each requirement of the Scope of Services identified in D6.

B13.2 The Proponent's schedule should include critical dates for review and approval processes by the City and other organizations anticipated during the design and tendering phases of the Project. Reasonable times should be allowed for completion of these processes.

B13.3 Unless otherwise indicated, the review period for City deliverables should be fifteen (15) Business Days and commensurate to the number of pages and complexity of the document. Specific timeframes for certain deliverables are referenced in D6.2.

B13.4 Further to B13.1, B13.2, and B13.3, the Proponent's schedule should also include:

- (a) a work breakdown structure;
- (b) critical dates for review;
- (c) anticipated review and approval periods by the City during the design and tendering phases of the project;
  - (i) fifteen (15) Business Days should be allotted for the City's review of major Project Deliverables;
  - (ii) a twenty (20) Business Day construction tender period should be assumed;
  - (iii) a twenty (20) Business Day construction tender award period should be assumed;
  - (iv) Project meetings; and
  - (v) submission dates for required Deliverables.

B13.5 The Proponent should develop the most effectual schedule attainable using their expertise and experience to meet the requirements of the City. In circumstance that the Proponent's schedule contrasts with any milestone listed in D13 Critical Stages, the Proponent should provide detailed commentary on their justification.

B14. ELIGIBILITY

B14.1 As a result of their involvement in the Winnipeg Sewage Treatment Program (WSTP) in relation to this Project, VWNA Winnipeg Inc. (Veolia) or their affiliates are not eligible to be a Proponent, participate as Team Members of a Proponent, or act as advisors to a Proponent or to any of its Team Members or to otherwise participate in the development and preparation of Proposals for the Project.

B14.2 A Proponent may be disqualified if any of the above-noted ineligible persons participate in the development and preparation of the Proponent's Proposal for Professional Consulting Services for North End Sewage Treatment Plant Return Activated Sludge Piping System Refurbishment Detailed Design and Contract Administration (RFP No. 384-2020).

B15. DISCLOSURE

B15.1 Various Persons provided information or services with respect to this RFP. In the City's opinion, this relationship or association does not create a conflict of interest because of this full disclosure. Where applicable, additional material available as a result of contact with these Persons is listed below.

B15.2 The Persons are:

- (a) Kontzamanis Graumann Smith MacMillan Inc. dba KGS Group Inc.
  - (i) KGS Group was retained by the City under RFP 593-2016 to undertake a condition assessment and preliminary design project to develop refurbishment and replacement options for the NEWPCC RAS piping system.
- (b) Trotter & Morton Industrial Contracting Inc.

(i) Trotter & Morton was retained by the City under RFP 739-2017 to provide on-site inspection and reporting services based on non-destructive testing and destructive testing applied to the NEWPCC RAS piping system.

B15.3 Additional Material:

(a) KGS Group reports generated under RFP 593-2016 as referenced in D5.1(a), D5.1(b), and D5.1(d).

B16. CONFLICT OF INTEREST AND GOOD FAITH

B16.1 Proponents, by responding to this RFP, declare that no Conflict of Interest currently exists, or is reasonably expected to exist in the future.

B16.2 Conflict of Interest means any situation or circumstance where a Proponent or Key Personnel proposed for the Services has:

(a) other commitments;

(b) relationships;

(c) financial interests; or

(d) involvement in ongoing litigation;

that could or would be seen to:

(i) exercise an improper influence over the objective, unbiased and impartial exercise of the independent judgment of the City with respect to the evaluation of Proposals or award of the Contract; or

(ii) compromise, impair or be incompatible with the effective performance of a Proponent's obligations under the Contract;

(e) has contractual or other obligations to the City that could or would be seen to have been compromised or impaired as a result of its participation in the RFP process or the Project; or

(f) has knowledge of confidential information (other than confidential information disclosed by the City in the normal course of the RFP process) of strategic and/or material relevance to the RFP process or to the Project that is not available to other Proponents and that could or would be seen to give that Proponent an unfair competitive advantage.

B16.3 In connection with its Proposal, each entity identified in B16.2 shall:

(a) avoid any perceived, potential or actual Conflict of Interest in relation to the procurement process and the Project;

(b) upon discovering any perceived, potential or actual Conflict of Interest at any time during the RFP process, promptly disclose a detailed description of the Conflict of Interest to the City in a written statement to the Project Manager; and

(c) provide the City with the proposed means to avoid or mitigate, to the greatest extent practicable, any perceived, potential or actual Conflict of Interest and shall submit any additional information to the City that the City considers necessary to properly assess the perceived, potential or actual Conflict of Interest.

B16.4 Without limiting B16.3, the City may, in its sole discretion, waive any and all perceived, potential or actual Conflicts of Interest. The City's waiver may be based upon such terms and conditions as the City, in its sole discretion, requires to satisfy itself that the Conflict of Interest has been appropriately avoided or mitigated, including requiring the Proponent to put into place such policies, procedures, measures and other safeguards as may be required by and be acceptable to the City, in its sole discretion, to avoid or mitigate the impact of such Conflict of Interest.

B16.5 Without limiting B16.3, and in addition to all contractual or other rights or rights at law or in equity or legislation that may be available to the City, the City may, in its sole discretion:

(a) disqualify a Proponent that fails to disclose a perceived, potential or actual Conflict of Interest of the Proponent or any of its Key Personnel;

(b) require the removal or replacement of any Key Personnel proposed for the Services that has a perceived, actual or potential Conflict of Interest that the City, in its sole discretion, determines cannot be avoided or mitigated;

(c) disqualify a Proponent or Key Personnel proposed for the Services that fails to comply with any requirements prescribed by the City pursuant to B16.4 to avoid or mitigate a Conflict of Interest; and

(d) disqualify a Proponent if the Proponent, or one of its Key Personnel proposed for the Project, has a perceived, potential or actual Conflict of Interest that, in the City's sole discretion, cannot be avoided or mitigated, or otherwise resolved.

B16.6 The final determination of whether a perceived, potential or actual Conflict of Interest exists shall be made by the City, in its sole discretion.

B17. QUALIFICATION

B17.1 The Proponent shall:

(a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Proponent does not carry on business in Manitoba, in the jurisdiction where the Proponent does carry on business; and

(b) be financially capable of carrying out the terms of the Contract;

(c) have all the necessary experience, capital, organization, and equipment to perform the Services in strict accordance with the terms and provisions of the Contract;

(d) have or establish and staff an office in Winnipeg for the duration of the Project.

B17.2 The Proponent and any proposed Subconsultant (for the portion of the Services proposed to be subcontracted to them) shall:

(a) be responsible and not be suspended, debarred or in default of any obligations to the City. A list of suspended or debarred individuals and companies is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at https://winnipeg.ca/finance/findata/matmgt/listing/debar.pdf

B17.3 The Proponent and/or any proposed Subconsultant (for the portion of the Services proposed to be subcontracted to them) shall:

(a) have successfully carried out services for the programming; design, management of construction and contract administration for architectural and/or engineering projects of similar complexity, scope and value; and to those required for this Project; and

(b) be fully capable of performing the Services required to be in strict accordance with the terms and provisions of the Contract; and

(c) have a written workplace safety and health program, if required, pursuant to The Workplace Safety and Health Act (Manitoba);

(d) have the knowledge and resources to administer the requirements of The Workplace Safety and Health Act (Manitoba) during the construction works associated with this Contract; and

(e) undertake to meet all licensing and regulatory requirements of the appropriate governing authorities and associations in the Province of Manitoba.

B17.4 The Proponent shall submit, within three (3) Business Days of a request by the Project Manager, further proof satisfactory to the Project Manager of the qualifications of the Proponent and of any proposed Subconsultant.

B17.5 The Proponent shall provide, on the request of the Project Manager, full access to any of the Proponent's equipment and facilities to confirm, to the Project Manager's satisfaction, that the Proponent's equipment and facilities are adequate to perform the Services.

B18. OPENING OF PROPOSALS AND RELEASE OF INFORMATION

B18.1 Proposals will not be opened publicly.

B18.2 After award of Contract, the Contract amount and the name of the successful Proponent and their address will be available on the MERX website at www.merx.com.

B18.3 The Proponent is advised any information contained in any Proposal Submission may be released if required by The Freedom of Information and Protection of Privacy Act (Manitoba), by other authorities having jurisdiction, or by law or by City policy or procedures (which may include access by members of City Council).

B18.3.1 To the extent permitted, the City shall treat as confidential information, those aspects of a Proposal Submission identified by the Proponent as such in accordance with and by reference to Part 2, Section 17 or Section 18 or Section 26 of The Freedom of Information and Protection of Privacy Act (Manitoba), as amended.

B18.4 Following the award of Contract, a Proponent will be provided with information related to the evaluation of his/her submission upon written request to the Project Manager.

B19. IRREVOCABLE OFFER

B19.1 The Proposal(s) submitted by the Proponent shall be irrevocable for the time period specified in Paragraph 11 of Form A: Bid/Proposal.

B19.2 The acceptance by the City of any Proposal shall not release the Proposals of the other responsive Proponents and these Proponents shall be bound by their offers on such Services for the time period specified in Paragraph 11 of Form A: Bid/Proposal.

B20. WITHDRAWAL OF OFFERS

B20.1 A Proponent may withdraw his/her Proposal without penalty prior to the Submission Deadline.

B21. INTERVIEWS

B21.1 The Project Manager may, in his/her sole discretion, interview Proponents during the evaluation process.

B22. NEGOTIATIONS

B22.1 The City reserves the right to negotiate details of the Contract with any Proponent. Proponents are advised to present their best offer, not a starting point for negotiations in their Proposal Submission.

B22.2 The City may negotiate with the Proponents submitting, in the City's opinion, the most advantageous Proposals. The City may enter into negotiations with one or more Proponents without being obligated to offer the same opportunity to any other Proponents. Negotiations may be concurrent and will involve each Proponent individually. The City shall incur no liability to any Proponent as a result of such negotiations.

B22.3 If, in the course of negotiations pursuant to B22.2, the Proponent amends or modifies a Proposal after the Submission Deadline, the City may consider the amended Proposal as an alternative to the Proposal already submitted without releasing the Proponent from the Proposal as originally submitted.

B23. EVALUATION OF PROPOSALS

B23.1 Award of the Contract shall be based on the following evaluation criteria:

(a)	compliance by the Proponent with the requirements of the Request for Proposal or acceptable deviation therefrom:	(pass/fail)
(b)	qualifications of the Proponent and the Subconsultants, if any, pursuant to B17:	(pass/fail)
(c)	Fees; (Section B)	25%
(d)	Experience of Proponent and Subconsultant; (Section C)	15%
(e)	Experience of Key Personnel Assigned to the Project; (Section D)	25%
(f)	Project Understanding and Methodology (Section E)	30%
(g)	Project Schedule. (Section F)	5%

B23.2 Further to B23.1(a), the Award Authority may reject a Proposal as being non-responsive if the Proposal Submission is incomplete, obscure or conditional, or contains additions, deletions, alterations or other irregularities. The Award Authority may reject all or any part of any Proposal, or waive technical requirements or minor informalities or irregularities if the interests of the City so require.

B23.3 Further to B23.1(b), the Award Authority shall reject any Proposal submitted by a Proponent who does not demonstrate, in its Proposal or in other information required to be submitted, that it is qualified.

B23.4 If, in the sole opinion of the City, a Proposal does not achieve a pass rating for B23.1(a) and B23.1(b), the Proposal will be determined to be non-responsive and will not be further evaluated.

B23.5 Further to B23.1(c), Fees will be evaluated based on Fees submitted in accordance with B9.

B23.6 Further to B23.1(c), the Award Authority may reject a Proposal as being non-responsive if it exceeds the funds available as shown in D6.10.

B23.7 Further to B23.1(d), Experience of Proponent and Subconsultants will be evaluated considering the experience of the organization on projects of similar size and complexity as well as other information requested, in accordance with B10.

B23.8 Further to B23.1(e), Experience of Key Personnel Assigned to the Project will be evaluated considering the experience and qualifications of the Key Personnel and Subconsultant personnel on Projects of comparable size and complexity, in accordance with B11.

B23.9 Further to B23.1(f), Project Understanding and Methodology will be evaluated considering your firm's understanding of the City's Project, project management approach and team organization, in accordance with B12.

B23.10 Further to B23.1(g), Project Schedule will be evaluated considering the Proponent's ability to comply with the requirements of the Project, in accordance with B13.

B23.11 Notwithstanding B23.1(d) to B23.1(g), where Proponents fail to provide a response to B7.2(a) to B7.2(d), the score of zero may be assigned to the incomplete part of the response.

B23.12 Proposals will be evaluated considering the information in the Proposal Submission and any interviews held in accordance with B21.

B23.13 Where references are requested, the reference checks to confirm information provided may not be restricted to only those submitted by the Proponent, and may include organizations representing Persons, known to have done business with the Proponent.

B24. AWARD OF CONTRACT

B24.1 The City will give notice of the award of the Contract, or will give notice that no award will be made.

B24.2 The City will have no obligation to award a Contract to a Proponent, even though one or all of the Proponents are determined to be qualified, and the Proposals are determined to be responsive.

B24.2.1 Without limiting the generality of B24.2, the City will have no obligation to award a Contract where:

(a) the prices exceed the available City funds for the Services;

(b) the prices are materially in excess of the prices received for similar services in the past;

(c) the prices are materially in excess of the City's cost to perform the Services, or a significant portion thereof, with its own forces;

(d) only one Proposal is received; or

(e) in the judgment of the Award Authority, the interests of the City would best be served by not awarding a Contract.

B24.3 Where an award of Contract is made by the City, the award shall be made to the qualified Proponent submitting the most advantageous offer.

B24.4 The City may, at its discretion, award the Contract in phases.

B24.5 Further to B24.4 the City reserves the right to negotiate and award future phases to the successful Proponent.

B24.6 Further to Paragraph 7 of Form A: Bid/Proposal and C4, the City may issue an award letter to the successful Proponent in lieu of execution of Contract Documents

B24.6.1 The Contract documents as defined in C1.1(o)(ii) in their entirety shall be deemed to be incorporated in and to form a part of the award letter notwithstanding that they are not necessarily attached to or accompany said award letter.

B24.7 The form of Contract with the City of Winnipeg will be based on the Contract as defined in C1.1(o).

B24.8 Following the award of Contract, a Proponent will be provided with information related to the evaluation of its Proposal upon written request to the Project Manager.

B24.9 If, after the award of Contract, the Project is cancelled, the City reserves the right to terminate the Contract. The Proponent will be paid for all Services rendered up to time of termination.

PART C - GENERAL CONDITIONS

C0. GENERAL CONDITIONS

C0.1 The *General Conditions for Consultant Services* (Revision 2017-03-24) are applicable to the Services of the Contract.

C0.1.1 The *General Conditions for Consultant Services* are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/gen_cond.stm.

C0.2 A reference in the Request for Proposal to a section, clause or subclause with the prefix "**C**" designates a section, clause or subclause in the *General Conditions for Consultant Services*.

PART D - SUPPLEMENTAL CONDITIONS

GENERAL

D1. GENERAL CONDITIONS

D1.1 In addition to the *General Conditions for Consultant Services*, these Supplemental Conditions are applicable to the Services of the Contract.

D1.2 If there is any conflict or inconsistency between the Proposal and the General Conditions for Consultant Services, the General Conditions for Consultant Services shall take precedence.

D1.3 Further to C.1.1 (b) and C11, the following is applicable to Allowable Disbursements:

D1.3.1 Copies of originating merchant/vendor detail receipts shall be provided as backup documentation when invoicing Allowable Disbursements, credit/debit card receipts or statements are not acceptable as backup.

D1.3.2 GST is to be removed from the reimbursable value of merchant/vendor invoices.

D1.3.3 For travel outside of the City of Winnipeg applicable to Time Based Fee portions of the Project:

(a) Booking of transportation and accommodations are expected to take place well in advance to obtain optimal discounted rates;

(b) The acceptable standard for air travel shall be economy class;

(c) Air travel premium fees, such as seat selection premiums etc., will not be reimbursable unless specifically approved by the Project Manager;

(d) The acceptable standard for accommodation will be a single room in a safe environment, conveniently located and comfortably equipped;

(e) The acceptable standard for rental vehicles shall be mid-size;

(f) Car rental premium fees, such as prepaid fuel or re-fueling surcharges etc. will not be reimbursable unless specifically approved by the Project Manager; and

(g) Costs for alcoholic beverages will not be reimbursable and shall not be claimed. Consultants may invoice meal expenses as per diem, up to a maximum of $60 per day.

D1.3.4 The following shall be considered incidental to the Contract and will not be accepted as Allowable Disbursements:

(a) Travel within the City of Winnipeg,

(b) Courier costs, and

D1.4 Meal costs for personnel not travelling outside their normal city of employment.

D2. PROJECT MANAGER

D2.1 The Project Manager is:

Brian Station, P. Eng.

Telephone No. 204 986-7642

Email Address: bstation@winnipeg.ca

D2.2 At the pre-commencement meeting, the Project Manager will identify additional personnel representing the Project Manager and their respective roles and responsibilities for the Services.

D3. DEFINITIONS

D3.1 When used in this Request for Proposal:

(a) ”**AACE**” means AACE International (formerly the Association for the Advancement of Cost Engineering);

(b) ”**Addendum**” means a written addendum to the RFP issued by the City as set out in B6;

(c) ”**ASME**” means the American Society of Mechanical Engineers;

(d) ”**CAD**” means Computer Assisted Drafting;

(e) ”**CHAIR**” means mean Construction Hazard Assessment Implication Review;

(f) “**Class 1 Cost Estimate**” means an estimate within an expected accuracy within -10% to +15%;

(g) ”**Commissioning**” means a process by which equipment, a facility or a plant is tested to verify if it functions according to design and functional requirements;

(h) “**composite**” means a thermoset resin system that is reinforced by fibres;

(i) ”**EGM**” means Engineers Geoscientists Manitoba;

(j) ”**FRP**” means Fiber-Reinforced Polymer

(k) ”**ISO**” means the International Organization for Standardization;

(l) “**Key Personnel**” means an individual designated in a Proponent’s Proposal Submission to perform a lead role in one or more of the proposed key organizational positions indicated in this RFP for the Proponent or its team members;

(m) ”**Native format**” means the original format from which a deliverable was generated (i.e. MS Word, MS Excel, AutoCAD, etc.);

(n) ”**NEWPCC**” means North End Sewage Treatment Plant;

(o) “**NMS**” means National Master Specification;

(p) ”**O&M**” means Operation and Maintenance;

(q) ”**OWAM**” means Oracle Work and Asset Maintenance;

(r) ”**PCN**” means Proposed Change Notice;

(s) ”**PDF**” means Portable Document Format;

(t) ”**Professional Engineer**” means an engineer registered in the Province of Manitoba;

(u) ”**Program Team**” means the team consisting of both City of Winnipeg and Veolia Water North America personnel;

(v) “**RAS**” means Return Activated Sludge;

(w) **“Record Drawings”** means Drawings prepared by the Consultant after verifying in detail the actual conditions of the completed Project;

(x) ”**RFI**” means Request for Information;

(y) ”**RUL**” means Remaining Useful Life as a subjective estimate of the number of remaining years that an item, component, or system is estimated to be able to function in accordance with its intended purpose before warranting replacement;

(z) “**Scope of Services**” means all Services executed under the Contract;

(aa) ”**VDR**” means Vendor Document Requirements;

(bb) ”**WBS**” means Work Breakdown Structure;

(cc) ”**WSTP**” means Winnipeg Sewage Treatment Program; and

(dd) “**WWD**” means Water and Waste Department

D4. BACKGROUND

D4.1 The North End Sewage Treatment Plant (NEWPCC) located at 2230 Main Street is the largest of the three (3) sewage treatment plants servicing the City of Winnipeg. The Return Activated Sludge (RAS) piping system, installed in the late 1980s, is beyond the design service life and numerous leaks have occurred and continue to occur. The system consists of approximately 600 meters of trunk pipework ranging from 300 millimeters to 900 millimeters in diameter with associated valves, flowmeters, and pumps. Reliable operation of the RAS piping system is critical to the operation of the plant.

D4.2 The City of Winnipeg is currently upgrading the NEWPCC through a separate project to accommodate future wastewater flows and loadings to the plant and to provide enhanced treatment capability to address environmental and public health concerns and regulatory requirements. The RAS pipes will be decommissioned during this upgrade project. However, the date at which the RAS system will be decommissioned has not been defined at this point. As such, a preferred extended piping design life of twenty-five (25) years is considered to be conservative in their regard to ensure that it covers the potential remaining service life required for the RAS piping system.

D4.3 The City determined that due to the increasing number of pipe failures, for pipes of large diameter that are beyond internal resources to repair or replace, a pipe condition assessment was required to determine the rehabilitation work necessary to extend the life of these pipes until they are decommissioned. A Pilot Inspection Program was carried out on samples of RAS piping to examine the pipe walls and welds for internal corrosion. The program consisted of non-destructive testing (NDT) performed on in-service RAS pipe samples, followed by destructive testing (DT) of a number of the samples by removal and internal examination. A number of key findings from the Pilot Inspection Program led to a recommendation and decision to forego further NDT inspection of the remaining RAS piping, and to proceed directly to preliminary design for repair or replacement of the entire RAS piping system. These key findings are outlined in the preliminary design report referenced in D5.1(d). Given the nature of corrosion observed during DT of samples from the Pilot Inspection Program, localized repair of leaks is not considered to be a viable option for the proposed 25-year extended service life of the RAS piping. To address the corrosion problem and restore the RAS pipe system to a condition that can provide up to 25 additional years of service, a comprehensive repair or replacement of all in-scope piping was recommended.

D4.4 Based on the analysis outlined in the preliminary design report, it is recommended that the City move forward based on a plan to refurbish the in-scope RAS piping with an engineered external nonmetallic composite repair system. This RFP is for services to design and implement the RAS piping system refurbishment work. The work will include review of the relevant documents and drawings available; completion of a detailed risk management plan which also accounts for outstanding questions from the preliminary design phase; assistance or lead with any additional equipment condition assessments required prior to final design; procurement, administration, and commissioning lead for the construction services required to implement the refurbishment work; and provision of engineering support during the construction and commissioning period.

D4.5 The City has engaged Veolia North America (Veolia) to provide advice to the City during the delivery of this Project. VWNA staff may be in attendance at meetings and workshops and assist with reviews throughout the project. This does not relieve the Consultant of their obligation.

D5. RELEVANT DOCUMENTS AND DRAWINGS

D5.1 The following relevant documents and drawings are available by request to the City's Project Manager after completion of a Non-Disclosure Agreement. These documents and drawings will be released at the sole discretion of the City. Reference Appendix D for the sample Non-Disclosure Agreement. The relevant documents and drawings are as follows:

(a) Kontzamanis Graumann Smith MacMillan Inc. dba KGS Group Inc. "RFP No. 593-2016 - NEWPCC RAS Pipe Assessment and Preliminary Design Project - Project Definition Report", February 2017;

(b) Kontzamanis Graumann Smith MacMillan Inc. dba KGS Group Inc. "RFP No. 593-2016 - Inspection Program Definition Report", July 2017;

(c) Kontzamanis Graumann Smith MacMillan Inc. dba KGS Group Inc. "RFP No. 593-2016 - North End Sewage Treatment Plant Return Activated Sludge Pipe Condition Assessment and Preliminary Design Project – Minutes of meeting for review of Draft Preliminary Design Report with operations and maintenance personnel, and receive comments prior to finalizing the report", meeting date March 19, 2019; and

(d) Kontzamanis Graumann Smith MacMillan Inc. dba KGS Group Inc. "RFP No. 593-2016 - North End Sewage Treatment Plant Return Activated Sludge Pipe Condition Assessment and Preliminary Design Project – Pipe Condition Assessment and Preliminary Design Report", June 2020

D5.2 The following relevant documents and drawings are available publicly.

(a) City of Winnipeg RFP No. 593-2016 "Request for Proposal for Professional Consulting Services for the North End Sewage Treatment Plant (NEWPCC) Return Activated Sludge Pipe Condition Assessment and Preliminary Design" tender documents complete with existing system drawings; Tender Close Date August 8, 2016 (tender document available at https://winnipeg.ca/MatMgt/FolderContents.asp?FOLDER_NAME=593-2016&YEAR=2016); and

(b) City of Winnipeg Bid Opportunity No. 739-2017 "North End Sewage Treatment Plant (NEWPCC) Return Activated Sludge Pipe Assessment Pilot Inspection Program" tender documents; Tender Close Date January 3, 2018 (tender document available at https://winnipeg.ca/MatMgt/FolderContents.asp?FOLDER_NAME=739-2017&YEAR=2017)

D6. SCOPE OF SERVICES

D6.1 The Services required under this Contract shall consist of Professional Consulting Engineering Services for the design, construction, commissioning and turnover required for the refurbishment of all in-scope RAS piping using a non-metallic composite repair system in accordance with the following:

(a) General Requirements in accordance with D6.2;

(b) Project Management accordance with D6.3;

(c) Risk Management in accordance with D6.4;

(d) Detailed Design and Specification Development in accordance with D6.5;

(e) Procurement Services in accordance with D6.6;

(f) Contract Administration Services in accordance with D6.7; and

(g) Post Construction Services in accordance with D6.8.

D6.1.1 The Services required under D6.2, D6.3, D6.4, D6.5, D6.6, D6.7, and D6.8 shall be in accordance with the City's Project Management Manual http://winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#2 and templates http://winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#4 . Notwithstanding the foregoing, the Consultant is being engaged by the City for its professional expertise; the Consultant shall bring to the Project Manager's attention any aspect of the City's Project Management Manual or templates which the Consultant is of the opinion is not consistent with good industry practice.

D6.1.2 The Scope of Services outlined in D6 provides a brief description of the Services and is only to be considered a guideline for Proposal preparation. The Consultant is encouraged to use their initiative when developing their Proposal to refine the Scope of Services activities and propose additional or alternative activities which they consider appropriate or beneficial to the Project.

D6.1.3 Unless otherwise stated, the document titled “Definition of Professional Consultant Services” and attached as Appendix E shall be applicable to the provision of Professional Engineering services for this Project.

D6.1.4 Further to the in-scope and out-of-scope RAS piping system components listed in the Preliminary Design Report D5.1(d) and marked out in process and instrumentation diagrams (P&IDs) appended to the report, several other RAS piping system components, connected piping, and temporary relocation of adjacent equipment and services work shall be included in the Proponent’s proposal as follows:

(a) It is anticipated that it will be more effective to replace certain pipe sections rather than refurbish with a composite pipe wrap. Examples include larger diameter (>DN300) short pipe sections in and around multiple existing valves and flowmeters or smaller diameter (DN300 or smaller) pipe sections which can be readily replaced. The risk threat relates to minimizing the length and/or number of terminations required between a new composite pipe wrap and the existing pipe wall or flange substrate. Increasing the length and number of terminations increases the complexity of the pipe wrap installation thereby increasing the likelihood of failures/leaks from the completed pipe wrap system.

(i) Pipe Sections adjacent to DN500 Flowmeters and Valves adjacent to Oxygen Reactors (DN500 piping immediately upstream of oxygen reactors and between flange from DN500 pipe section embedded into each reactor wall and the flange connecting to the 900x500 reducer teed pipe section for each pair oxygen reactors; reference Section 2 in Drawing No. NEP 1080 included with the RFP 593-2016 tender documents in D5.2(a))

- For the purpose of this RFP, the Proponent shall include the design and contract administration services to replace these pipe spools in their proposal fees.

(ii) WAS Piping (WAS piping immediately downstream of RAS piping and in the RAS piping gallery)

- Sections of Waste Activated Sludge (WAS) piping were removed by plant staff prior to preliminary design (due to leaks in the piping). These sections were stored on site and then analyzed by the same testing staff and methods as applied to the RAS piping samples removed for destructive testing during preliminary design. In general, the level of deterioration observed in the WAS piping was not as severe as that observed in the RAS piping.
- For the purpose of this RFP, during the Detailed Design phase of the project the Consultant shall review the condition assessment information available to date and make recommendations as to whether WAS piping should be included in the RAS piping refurbishment work. If approved by the Project Manager, design and contract administration work associated with either wrapping the WAS piping or replacing the WAS piping will follow and be charged against the Additional Work Allowance outlined in D6.9.

(b) Mechanical and Electrical Appurtenances (all RAS piping system isolation valves and DN500 flow meters only)

(i) Condition assessment of these appurtenances is required.

(ii) Condition assessment of system isolation valves is required to confirm their isolation performance for developing the construction tender requirements for piping system pressure testing post refurbishment works.

- The exact feasible and recommended testing requirements to confirm performance of the new composite pipe wrap system and its terminations to existing pipe wall or flange substrate shall be determined by the Consultant during the “risk assessment” phase in early stages of Detailed Design (as per the design approach outlined in the applicable ISO and ASME standards). Decisions regarding requirements to refurbish or replace any valves will be made following the aforementioned risk assessment.

(iii) Condition assessment and a system adequacy review of existing DN500mm diameter flow meters is required to confirm their viability for the planned extended life of the RAS piping system. Coordination with the Department's Wastewater Services Electrical and Instrumentation staff will be required to confirm the status of known electrical component / transmitter obsolescence issues and plan how the flow meters will continue to function over the extended life of the RAS piping.

(iv) For the purpose of this RFP, the Consultant shall perform the condition assessments referenced in D6.1.4(b)(ii) and D6.1.4(b)(iii) which need to be scheduled in the early stages of Detailed Design. It is anticipated that Department operations and maintenance staff will be busy supporting other major capital upgrade and expansion works on site at the time of this Project. The Consultant shall be responsible for all planning, coordination, resources identification and supply, procurement of special services (e.g. assistance from local valve vendors) and execution of all condition assessment tasks. Department operations and maintenance staff will provide operational support to the Consultant. The Consultant shall develop the condition assessment plan, schedule, and fees and forward to the Project Manager for approval.

(v) If approved by the Project Manager, design and contract administration work associated with replacement of system isolation valves or flowmeters will follow and be charged against the Additional Work Allowance outlined in D6.9.

(c) Temporary Relocation of Adjacent Equipment and Services

(i) Equipment such as temporary supports and hangers as well as electrical and instrumentation service (e.g. power cable, automation wiring, cable trays, etc.) will need to be relocated to install any and all external composite pipe repair materials for the RAS piping system refurbishment work.

(ii) The Consultant shall include planning and coordination for this work in their Proposal as it will be required in the scope of work for the general construction contract.

D6.1.5 Constraints

(a) Access and egress for the work area will require several safety considerations. The RAS piping gallery is located below grade and the majority of the in scope RAS piping to be refurbished is located high off the gallery floor.

(b) The work area is congested with various process piping, pipe supports, pipe hangers, pumps, process instruments, sampling equipment, cable trays, railings, walkways, etc. and requires continuous access by plant operations and maintenance staff

(c) Based on the preliminary design work to date, NEWPCC plant system operation will not be affected by an external composite pipe wrap installation. However, any pipe spools or inline appurtenances (i.e. valves or flow meters) that require replacement based upon further assessment will require a RAS pipe train shutdown(s) which will impact operations. The Consultant shall make allowance for such in their construction schedule.

D6.1.6 Assumptions

(a) Existing active and localized leaks can be repaired with leak repair epoxy or similar means (to ensure the integrity of the non-metallic composite pipe repair system.

(b) Existing isolation valves require condition assessment in the early stages of Detailed Design and some may require replacement if required for pressure testing of the refurbished RAS piping system.

(c) It is not known when the RAS piping system was last shut down and the ability to drain the pipework has not been assessed. It is not known if existing RAS piping drains are either adequate as-is or can be replaced without RAS piping train shutdown(s) prior to installation of the non-metallic composite pipe repair system. This work should be included in the condition assessment outlined in D6.5.2(d).

(d) The condition of existing DN500mm diameter flowmeters has been flagged as a risk following completion of the pilot inspection program referenced in D5.2(b). Condition assessment and system adequacy review of these flowmeters shall be as outlined in D6.1.4(b)(iii). Replacement of these flowmeters, if required and prior to completion of the NEWPCC Phase 3 upgrade/expansion work, shall be as outlined in D6.1.4(b)(v).

D6.1.7 Acceptance Criteria

(a) Confirmation that the refurbished RAS piping system has been constructed as per specifications to meet or exceed the requirements of the latest revision of technical specification ISO/TS 24817 Petroleum, Petrochemical, and Natural Gas – Composite Repairs for Pipework – Qualification and Design, Installation, Testing, and Inspection, standard ASME PCC-2 - Part 4 - Non-Metallic Composite Repair Systems for Pipelines and Pipework, and any equivalent standards approved for use by the Project Manager.

(b) The refurbished RAS piping system shall be engineered with drawings sealed by a Professional Engineer registered in the Province of Manitoba.

(c) The refurbished RAS piping system shall be demonstrated to be leak free.

(d) Operations staff shall be able to access and operate all existing and any new drains and inline appurtenances.

(e) Maintenance staff shall be able to access and maintain all existing and any new drains and inline appurtenances and shall be provided with sufficient knowledge and training to properly add or decommission drains and inline appurtenances embedded in the non-metallic composite pipe wrap system.

D6.2 General Requirements

D6.2.1 General Requirements of Consultant

(a) The Consultant shall ensure that the Scope of Services is performed under direct supervision of a Professional Engineer.

(i) All drawings, reports, recommendations and other documents involving the practice of professional engineering shall bear the stamp or seal and signature of a qualified engineer as required by the Engineering and Geoscientific Professions Act of the Province of Manitoba and By-laws of the Engineers Geoscientists Manitoba.

(ii) Final design documents irrespective of the level of design shall have an engineer's seal.

(iii) Other reports and documents not involving the practice of professional engineering, such as letters of information, minutes of meetings, may be originated and signed by other personnel engaged by the Consultant and accepted by the City.

(b) Progress estimates, completion certificates and other reports related to the technical aspects of this Project, shall be endorsed by the Consultant's Representative in a manner acceptable to the City.

(c) The Consultant shall, at a minimum, utilize the most current industry standard sustainable practices and conform to the latest codes, standards, regulations and legislative requirements in effect. The Consultant shall liaise with the City on the application of codes and standards.

(d) The Consultant shall not substitute or replace Key Personnel throughout the duration of the Project without the prior written approval of the Project Manager. Experience and qualification as specified in B11 Experience of Key Personnel Assigned to the Project (Section D) shall be submitted for all requested substitute(s) and replacement(s).

(e) As sewage treatment is a continuous operation twenty four hours a day, seven days a week, the Consultant shall maintain close coordination between the Project staff including the Project Manager, WWD engineering staff, and NEWPCC operations and maintenance staff so that process disruptions are minimized.

(f) Through the Program Team, the Consultant shall maintain close coordination with the NEWPCC upgrade and expansion project team to minimize conflict with contractors who will be working on contracts for the ongoing NEWPCC Upgrading and Expansion project. There may be other major projects in direct conflict with the Project area including a plant wide control system migration project. NEWPCC resources human resources will be busy servicing all projects on the NEWPCC site so planning and scheduling of task under the Project will need to consider and allow for such coordination throughout the Project duration.

(g) The Consultant shall comply with the following:

(i) WSTP design standards, including but not limited to:

- WSTP Architectural Design Guideline - R01 (Appendix F),
- WSTP Building Mechanical Design Guideline - R01 (Appendix G),
- WSTP Civil Design Guideline - R01 (Appendix H),
- WSTP Process Mechanical Design Guideline - RPB (Appendix I),
- WSTP Structural Design Guideline - R02 (Appendix J), and
- WSTP Wastewater Treatment Facilities Automation Design Guide - R01 (Appendix K)

(ii) Water and Waste Department (WWD) Identification Standard - R04 (Appendix L) – the Consultant shall request clarification from the Project Manager should undefined identification requirements be encountered;

(iii) WSTP Project Document Numbering Standard (DOCUMENT NUMBER: PG-RC-PC-05) - R2016-02-02 (Appendix M);

(iv) WWD Electrical Design Guide - R05 (Appendix N);

(v) WSTP Electrical and Instrumentation Standardization Summary - R05 (Appendix O);

(vi) WSTP Electrical and Instrumentation Standardization Clauses - R04 (Appendix P);

(vii) WWD Sewage Treatment Plant Tag Naming Standard - R00 (Appendix Q);

(viii) WWD Paint Colour Standard - R01 (Appendix R);

(ix) WSTP CHAIR Procedure (DOCUMENT NUMBER: CD-CP-PC-01) - R2013-04-25 (Appendix S) and related appendices;

(x) Operations Manual Specification - (DOCUMENT NUMBER: CD-CP-TO-06) - 2015-12-11; Final Rev A (Appendix T);

(xi) WWD Wastewater Services Division Guideline to Document Asset Registry for Maintenance Project (ONLY) (Document Number: OSB-AM-GUI-0003) - R5 2019-12-06 (Appendix U); and

(xii) Additional City Templates (Appendix V).

(h) The Project Manager shall be notified of any conflict between the documents listed under (g) for resolution.

(i) The Consultant and their Subconsultants, and contractors shall be aware of their obligation as stated in the Wastewater Services Division Environmental Preservation and Compliance statements and the Water and Waste Department Environmental Management Policy attached as Appendix W.

(j) The Consultant shall coordinate and obtain approval/permit(s) where required, including but not limited to: Manitoba Hydro, MTS, and City Departments.

D6.2.2 General Requirements for Drawings

(a) The drawings shall be prepared from the legal plans, certificates of title, as-built records and topographic survey. The City's GeoMedia and Google Earth screen captures may not be used for the creation of drawings.

(b) All profile components of drawings shall be in natural scale.

(c) Where existing systems are being modified, the existing drawings shall be modified or superseded rather than creating a new drawing only showing a limited portion of the new work. New drawing numbers will be required for all drawings containing new work.

(d) The City will provide comments on the draft drawings. Comments shall be reviewed and incorporated into the final drawings.

(e) All drawings shall be submitted in AutoCAD format version 2012 and in 11x17 hard copy format, unless otherwise specified.

(f) The Consultant shall follow WWD construction drawing standards. This standard is available on the "Computer Assisted Drafting (CAD)-Geographic Information System (GIS) Standards" page at https://www.winnipeg.ca/waterandwaste/dept/cad_gis.stm, specifically:

  (i) document named "WWD CAD/GIS STANDARDS (August 4, 2016)" at https://winnipeg.ca/waterandwaste/pdfs/dept/CAD-GIS-Specifications.pdf

D6.2.3 General Requirements for Cost Estimates

(a) Complete cost estimates as listed in D6 Scope of Services.

  (i) The Consultant shall submit all cost estimates using the City investment planning templates located at the web link referenced in D6.1.1; specifically the latest revision of the "Basis of Estimate (BoE)" template.

D6.2.4 General Requirements for Photographs

(a) All photographs submitted to the City as part of the Project shall include captions with the following information:

  (i) Date photograph was taken.

  (ii) Location and orientation where the photograph was taken.

  (iii) A brief description of what is depicted by the photograph.

(b) All photographs submitted to the City as part of the Project shall have the date and time stamped on the photograph.

(c) All photograph files submitted to the City as part of the Project shall be named starting with a date stamp in the format YYYYMMDD.

D6.2.5 General Requirements for Meetings

(a) Schedule and chair Project meetings as listed in D6.3.2 Project Management Meetings.

  (i) The Consultant shall prepare an agenda for all Project meetings with a copy to be sent to the City Project Manager at least two (2) Business Days prior to the meeting.

  (ii) The Consultant shall record minutes in all meetings in which they attend. Minutes to be forwarded to all present within five (5) Business Days of the meeting.

(b) All in-person Project related meetings will be held at the NEWPCC as much as possible for input or feedback from NEWPCC plant staff. Alternative meeting locations shall include WWD's main office located at 1199 Pacific Avenue (Winnipeg, Manitoba), the Consultant's office located in Winnipeg, or any alternative site agreed upon by the City and the Consultant.

D6.2.6 General Requirements for Project Deliverables

(a) Project deliverables include but are not limited to:

  (i) CHAIR documentation;

(ii) Technical specifications;
(iii) Detailed design drawings;
(iv) Tender documents;
(v) Construction Plan;
(vi) Commissioning Plan;
(vii) Pre-tender cost estimate;
(viii) Contract Administration documentation;
(ix) Record Drawings;
(x) Construction Report;
(xi) Asset Data Schedule \ Registry updates;
(xii) Operation and Maintenance Manual updates (as required); and
(xiii) Training sessions and workshops (as required).

(b) The submittal format for Project deliverables is outlined in Appendix X Project Documentation Requirements.

(c) All Project Deliverables are to be delivered with a document lifecycle approach.

(d) All documents related to a particular deliverable (i.e. plan, report, etc.) shall be provided in ".PDF" native file format, shall be in a single electronic file, and shall be in text searchable format.

(e) Unless otherwise indicated, the review period for Project deliverables shall be a minimum of three (3) weeks and correspond to the number of pages and complexity of the document. The Consultant shall indicate these review periods on the Critical Path Method schedule as outlined in B13 Project Schedule (Section F).

(f) All Deliverables shall have incorporated the Consultant's internal quality procedures before being submitted to the City.
(i) All Deliverables shall be reviewed by a representative of the Consultant who is proficient in technical writing prior to being submitted to the City.
(ii) Any Deliverables deemed by the City to be of poor quality shall be rejected and will be required to be revised and resubmitted at no additional cost to the City or additional time to the Project schedule.

(g) The Deliverables shall be submitted in a substantially completed draft format for review prior to submittal as a final document.
(i) Draft versions of written documents shall be submitted in Microsoft Word 2016 (.docx) native format.
(ii) All Deliverables shall be submitted to the Project Manager.

(h) Draft Documents
(i) Draft reports and any drawings shall be submitted to the Project Manager at least ten (10) Business Days prior to the formal design review meetings.
(ii) Ten (10) paper copies, including one (1) unbound shall be submitted of all draft documents. The City review period starts once paper copies have been received by the City.
(iii) The City shall have fifteen (15) Business Days to review all draft documents.
(iv) Submit searchable .PDF copy and native file format of all documents submitted for review.

(i) Final Documents
(i) Submit .PDF copy of final documents so the City can verify all comments from the draft documents have been incorporated.
(ii) The City shall have fifteen (15) Business Days to conduct its final review.
(iii) The Project Manager must give final approval that all comments have been satisfactorily incorporated prior to the Consultant printing paper copies.

(iv) Ten (10) paper copies, including one (1) unbound shall be submitted of all final documents.

(v) Submit searchable .PDF copy and native file format of all final documents.

D6.3 Project Management

D6.3.1 Project Management General

(a) Project Management activities required to carry out the Scope of Services will include but not limited to the following:

(i) Directing and coordinating efforts of the Consultant team to achieve the specific Project goals and objectives and to meet all City requirements;

(ii) Providing advice, engineering services, consultation and oversight with respect to the Scope of Services;

(iii) Informal liaising with the City's Project manager on a weekly basis to provide Project Status; and

(iv) Monthly Progress meetings

(b) Upon award of the Contract, the Consultant shall begin to prepare a **comprehensive Project Execution (Delivery) Plan** detailing the process that will be applied during the provision of the Project Services. Requirements are outlined in Project Management Manual at http://winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#2 and project initiation and planning templates at http://winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#4; specifically the Project Delivery Plan (PDP) - Long Version" template. Requirements of this document form a part of this Scope of Services. The Contract shall override the Project Execution (Delivery) Plan document requirements where indicated. For this assignment, the following requirements shall apply to the Project Execution (Delivery) Plan:

(i) PDP Schedule

- Provide a preliminary level critical path schedule from the start of Detailed Design through to the end of the warranty/Acceptance-Certificate-issuance period.
- The level of detail shall be such that it clearly conveys the significant activities related to the various Project components with their inter-dependencies.
- The breakdown of the work shall be into logical phases to accommodate sewage treatment plant operations.
- The schedule shall be configured suitable for use by Microsoft® Office Project 2016.
- Indicate deliverables and milestones.
- Indicate sequence of construction, process shutdown schedules, including magnitude and duration, and Manitoba Conservation notification requirements, if applicable.
- Identify site constraints and develop installation strategies considering lead time for delivery of equipment, site access, and
- Evaluation of overall impact on plant operations throughout construction.

(ii) PDP Cost Estimates

- Cost estimates shall be to an accuracy level consistent with AACE Class 3 (-20% to +30%) for all recommended refurbishment and replacement work.
- Cost estimates shall be broken down into logical construction phases to accommodate sewage treatment plant operation and maintenance activities.

(iii) PDP Quality Management

- ♦ CHAIR workshops will be required, as per D6.5.2(f) and D6.5.3(g).
- ♦ A HAZOP will not be required for this assignment unless the Consultant proposes material modifications to existing P&IDs.

(iv) PDP Risk Management

- ♦ The Consultant shall provide a list of expected risks and mitigations as part of their Proposal.
- ♦ The Consultant shall facilitate the initial baseline risk workshop during the early stages of the Detailed Design phase, develop a risk register in the form of a Risk Management Plan (RMP), and update same prior to the milestones outlined in D6.4 Risk Management.

(v) The initial Project Execution (Delivery) Plan shall be submitted from the Consultant to the City for approval within four (4) weeks of the award of the Contract.

- ♦ Upon receipt and implementation of the City's review comments, submit the Final Project Execution (Delivery) Plan as outlined in Appendix X Project Documentation Requirements.

(vi) Submissions shall be made to the Project Manager at stages referred to in D6 Scope of Services.

(vii) Documents to be presented or reviewed in a meeting or workshop shall be issued a minimum of five (5) Business Days prior to the presentation.

(viii) For any document, the City requires a minimum of fifteen (15) Business Days for review or approval, unless otherwise noted in the Contract.

D6.3.2 Project Management Meetings

(a) The Consultant shall schedule and chair meetings with the Department's Project Manager, the Program Team, and/or the General Contractor at the following stages:

(i) pre-commencement meeting with the Program Team after award of the Project to review scope of work, introduce the Project team, outline Project expectations, discuss the Consultant's general strategy for completing the Project as outlined in their Project Execution (Delivery) Plan including the need for any additional condition assessment activities;

(ii) workshops and meetings outlined in D6.4 Risk Management (with Program team);

(iii) workshops with the Program Team as outlined in D6.5.2(f) CHAIR-1 Workshop and D6.5.3(g) CHAIR-2 and CHAIR-3 Workshops;

(iv) upon completion of the detailed design (with Program Team);

(v) upon completion of the construction tender documents (with Program Team);

(vi) pre-construction meeting (with Program Team, and the General Contractor for the scope of work associated with the Contract);

(vii) weekly construction progress meetings (with Program Team and the General Contractor for the scope of work associated with the Contract);

(viii) pre-commissioning meetings (with Program Team and the General Contractor for the scope of work associated with the Contract); and

(ix) meetings to confirm and certify Substantial Performance, Total Performance / warranty period commencement, and Final Acceptance / end of warranty period (with Project Manager and General Contractor).

(b) Additional meetings between the Consultant, the Department's Project Manager and/or the Program Team may be required in the event of outstanding issues or disagreements between the Consultant and the City regarding any Project Deliverables.

D6.3.3 Project Management Deliverables

(a) Project Execution (Delivery) Plan

(i) Submit a Project Execution (Delivery) Plan, including a schedule of Deliverables, within four (4) weeks of award.

(ii) Submit updates (as applicable) to the Project Execution (Delivery) Plan

(b) Progress Reports

(i) Submit within two (2) weeks for award the proposed progress reporting format for City review and acceptance. The initial progress report will include development of the performance measurement baseline schedule for each task/activity and specific deliverables. Reporting will be completed in a format consistent with the Consultants work breakdown structure (WBS) and be reconcilable with the monthly accounting and invoicing system. Progress reports will include the following minimum requirements;

- Progress reporting to be submitted to the Project Manager on a monthly basis, a minimum of two Business Days prior to the Monthly Progress Meetings
- Problems/issues update including description of the issue and proposed method of resolution;
- Work planned for next month;
- Progress of work planned last month;
- Estimated percentage complete by task/activity and overall; and
- Progress reports will be coordinated so as to be incorporated as part of the monthly progress meetings.

(c) Monthly meeting agenda, PowerPoint presentation slides (as applicable) and meeting minutes

D6.4 Risk Management

D6.4.1 Risk Management General

(a) The Consultant shall explain in their proposal how they will manage risk throughout the term of the project, and include the development and maintenance of a project risk register. The Consultant shall identify risks and associated mitigations in each of the following phases; design, construction, commissioning, and turnover to WWD operations.

(i) The Consultant shall populate the risk register using City project initiation and planning templates located at the web link referenced in D6.1.1; specifically the latest revision of the “Risk Event Identification Checklist” and the “Risk Management Plan (RMP)” templates.

(ii) The WWD Project Manager will provide the Consultant with additional scoring guides for determining and categorizing each risk severity score.

(b) The Consultant shall facilitate a minimum of two (2) formal risk workshops.

(i) Each workshop will have duration of up to three (3) hours.

(ii) The Consultant shall schedule the Workshop No. 1 near the beginning of the assignment but after their review of all relevant drawings and documents outlined in D5.1 and D5.2.

(iii) The Consultant shall schedule Workshop No. 2 during preparation of the construction tender documents to the City (i.e. shortly after completion of the City’s review of the 60% draft detailed tender package and prior to Consultant’s submission of the 90% draft detailed tender package) to allow any new or revised risks to be incorporated into the documents as required) including prior to finalization of the Project Commissioning Plan.

(iv) At a minimum, all Key Personnel, the Program Team, and other City selected stakeholders shall participate in the risk workshops. The Consultant’s Contract Administration Personnel shall also participate in the second risk workshop.

(c) The Consultant shall integrate all City approved risk mitigations and recommendations into the execution of the Project.

(i) The Consultant shall take ownership of all risks that are designated under the Consultant's responsibility.

(ii) The Consultant shall ensure that all risks designated to be transferred to the contractor are appropriately included in the Detailed Tender Package such that an effective transfer of risk occurs.

(d) The Consultant and the Program Team shall work together to update the risk register / RMP during the various phases of the Project (i.e. regular progress meetings throughout the project engineering, construction, commissioning, and turnover phases).

(i) The Consultant shall be responsible for notifying the Project Manager of any potential changes to the existing risk register / RMP or any new threats and opportunities identified.

(ii) The Consultant shall incorporate changes to the individual risk items into the monthly project progress reports.

(e) Review the risk register / RMP and provide comments on any risks or proposed mitigations which may not be complete or appropriately identified.

(f) Ensure that all risk register / RMP mitigation measures are consistent with the Detailed Design and Specification Development deliverables.

D6.4.2 Risk Management Deliverables

(a) The Consultant shall draft the "Risk Identification Checklist" template prior to the first risk workshop, update same at completion of the first workshop, and update the document again at completion of the second workshop.

(b) The Consultant shall draft the "Risk Management Plan" template during the first workshop, update same at completion of the first workshop, and update the document again during/at completion of the second workshop.

(c) The Consultant shall complete the "Stakeholder Assessment and Communications Plan" template at completion of the first workshop, and update same at completion of the second workshop.

(d) The Consultant shall record and issue meeting minutes for each of the two formal risk workshops. Discussions regarding risks at regular progress meetings throughout the project will also be included in the respective meeting minutes.

D6.5 Detailed Design and Specification Development

D6.5.1 General Requirements

(a) Provide a comprehensive set of Detailed Design documents and tender services to allow the City to engage a contractor to construct the work. The development of the Detailed Design shall be based upon the final Preliminary Design.

(i) For RFP bidding purposes, the Consultant shall assume that refurbishment to the existing RAS piping system will be the recommended option from the Preliminary Design phase to proceed to detailed design; specifically, to encase the exterior of the in-scope RAS piping with an engineered non-metallic fiber-reinforced polymer (RFP) composite wrap with the exception of the following areas:

- ♦ Those pipe sections recommended or suggested for replacement as outlined in D6.1.4(a), and
- ♦ Existing pipe valves, flowmeters, and other appurtenances or instrumentation required for plant process operations and maintenance.

(ii) The Consultant shall clearly demonstrate how each of the different refurbishment or replacement areas in D6.5.1(a)(i) will be managed during the course of construction.

(iii) Any changes to the scope of work will be addressed in accordance with C8 of the General Conditions for Consultant Services.

(b) The Detailed Design shall include all requirements including but not limited to: site development, civil, structural, architectural, process, HVAC, plumbing, mechanical, electrical, automation, temporary facilities and operational consumables as applicable to the final design scope.

(c) Where necessary, conduct field investigations to verify existing conditions and to supplement available information.

(d) Organize meetings with City staff to ensure all required information, issues, and concerns are accounted for.

(e) Identify all permits necessary for construction.

(f) Provide any other information applicable to the design.

(g) Unless otherwise stated, the indicated deliverables and any other deliverables which, in the opinion of the Project Manager are typical of a Detailed Tender Package, shall be prepared by the Consultant. Delegation of deliverables to the construction contractor will not be accepted.

(h) Ensure all applicable WWD and WSTP standards, such as color uniformity to the WWD Paint Colour Standard, are incorporated into the Detailed Design as outlined in D6.2.1(g). Deviations to the WWD and WSTP standards shall only be incorporated into the final design with written approval of the City Project Manager via a WWD\WSTP Standards Deviation Form (Appendix Y).

D6.5.2 Preliminary Detailed Design Tasks

(a) The Consultant shall review existing drawings, reports, correspondence, etc. listed in D5 – Relevant Documents and Drawings.

(b) The Consultant shall attend a pre-commencement meeting with the Program Team after award of the Project to introduce the Project team, review the scope of work, outline Project expectations, discuss the Consultant’s general strategy for completing the Project including any need for additional condition assessment activities, and any other issues or concerns which relate to the Consultant completing their Project Execution (Delivery) Plan.

(c) The Consultant shall conduct a detailed Site investigation to verify existing drawings and documentation reviewed in D5 and to familiarize themselves with the NEWPCC facility and the RAS piping system.

(d) Condition Assessment of Existing RAS Piping System Isolation Valves

(i) The Consultant shall conduct a condition assessment of existing RAS piping system isolation valves and include the following tasks:

- ♦ Validate the need for condition assessment as it relates to scope requirements outlined in D6.1.7 - Acceptance Criteria.
- ♦ Meet with WWD operations and maintenance staff to plan, coordinate, and schedule the valve condition assessment task. Determine City operational requirements and resource availability as well as any additional information required. Develop safe work plans or procedures as required.
- ♦ Only use visual, physically exercising, and other non-invasive testing methods to assess isolation valve sealing effectiveness (i.e. passing valve identification without dismantling or isolation).
- ♦ Include condition assessment of the RAS piping system drains in this work.
- ♦ Finalize plan and schedule for condition assessment task and forward to City Project Manager for review and approval to proceed.
- ♦ Prepare a draft technical memorandum summarizing the RAS piping system isolation value condition assessment. Submit to the City Project Manager for review with the Program Team. The memorandum shall be

suitable for submission to the City and must include, but not be limited to the following sections:

- condition assessment approach;
- map the location, field identifiers, and access requirements for each isolation value in the RAS piping system;
- the current condition of each isolation valve complete with a photograph;
- operating valve from open to closed to back open position for two complete cycles using manual actuator and hydraulic or electric controlled equipment (if available);
- leak sounding at each valve location and recording of findings;
- observations, conclusions, and recommendations related to valve operation and isolation capability

♦ Attend a review meeting with the Program Team to discuss the technical memorandum approximately two (2) weeks after submittal of the draft technical memorandum. The meeting shall be held at the NEWPCC unless agreed otherwise with the City Project Manager. The Consultant shall assume a two (2) hour meeting length.

- At a minimum, the Consultant project manager and design leads shall be present at the review meeting.
- The Consultant shall prepare a maximum thirty (30) minute PowerPoint presentation outlining the contents of the technical memorandum listed in □ to facilitate an open table discussion of the review.

♦ The draft technical memorandum shall be revised to final following incorporation of Program Team comments, as applicable.

(e) Preliminary Project Commissioning Plan

(i) Develop a Preliminary Project Commissioning Plan to provide the concept and preliminary details as to how the Project components can be brought on-line while maintaining operations.

(ii) The plan shall minimize impact to the facility's capability to meet its regulatory obligations and provide detail of any planned impacts.

(iii) The plan shall identify and quantify all key commissioning tasks including training, inspection, quality verification, start-up, testing, verification and handover to operations.

(iv) The plan shall identify roles and responsibilities, high level procedures, quantified anticipated resources, and equipment.

♦ Where the solution involves replacement of sections of the RAS lines, the secondary treatment process will be impacted. The Consultant's Commissioning Plan shall consider impacts on secondary treatment including the risk of shut down and restart of biological processes if the RAS process is interrupted.

♦ **The Consultant shall state their assumptions in their Proposal.**

(v) The level of detail shall be such as to enable the required level of costing of the commissioning efforts.

(vi) Submit the Preliminary Project Commissioning Plan to the City, as outlined in Appendix X Project Documentation Requirements.

(f) **CHAIR-1 Workshop**

(i) The Consultant shall prepare, coordinate, and facilitate a CHAIR-1 Workshop according to the CHAIR procedure outlined in Appendix S.

♦ It is the City's expectation that all CHAIR workshops will be facilitated by personnel intimately involved with the design preparation of the Project.

♦ It is not required to bring in specific independent CHAIR expertise.

(ii) Allow for Workshop duration to be up to three (3) hours.

(iii) Clearly document all CHAIR-1 findings and recommendations and issue draft minutes and any applicable CHAIR templates outlined in the CHAIR procedure.

(iv) Integrate all City approved CHAIR-1 recommendations into the Final CHAIR-1 minutes and applicable registers, forms, templates, and worksheets.

(g) **Risk Workshop No. 1**

(i) The Consultant shall facilitate Risk Workshop No. 1 as outlined in D6.4 Risk Management.

- The Consultant shall reference the initial project Risk Register developed during the preliminary design phase and outlined in D5.1(d) Pipe Condition Assessment and Preliminary Design Report.

(h) The Consultant shall determine the maximum feasible service life extension to the RAS piping system using the external non-metallic composite pipe wrapping method identified in the Pipe Condition Assessment and Preliminary Design Report referenced in D5.1(d). Compare against the Preliminary Design recommendation for a twenty-five (25) year service life extension as well as the schedule for upgrade and expansion projects related to decommissioning of the existing RAS piping system, and make recommendations on the service life extension period as the basis for Detailed Design.

(i) The Consultant shall make recommendations regarding refurbishment with new composite pipe wrap or replacement of certain RAS or WAS pipe sections as referenced in D6.1.4(a).

(j) The Consultant shall make recommendations regarding testing requirements to confirm performance of the new composite pipe wrap system and its terminations to existing pipe wall or flange substrate as referenced in D6.1.4(b)(i).

(k) The Consultant shall make recommendations regarding replacement of RAS piping system isolation valves and DN500 flow meters (i.e. flow tubes and associated transmitters) as referenced in D6.1.4(b).

(l) The Consultant shall make recommendations for construction warranty requirements for the external non-metallic composite pipe wrapping including, but not limited to:

(i) length of warranty period,

(ii) scope,

(iii) failure definitions, associated remedies, and impact on the warranty period, and

(iv) any key terms and conditions

(m) Schedule Review and Update

(i) Provide a preliminary level critical path schedule from Detailed Design to Total Performance of the Work.

- The level of detail shall be such that it clearly conveys the significant activities related to the various Project components with their inter-dependencies;
- The breakdown of the work shall be into logical phases to accommodate sewage treatment plant operations, and
- The schedule shall be configured suitable for use by Microsoft® Project Standard 2016.

(ii) Indicate deliverables and milestones.

(iii) Indicate sequence of construction, process shutdown schedules, including magnitude and duration, and Manitoba Conservation notification requirements, if applicable.

(iv) Indicate commissioning and training requirements.

(v) Identify site constraints and develop installation strategies considering:

- Lead time for delivery of materials and equipment,

- Site access, and
- Evaluation of overall impact on plant operations throughout construction.

(n) Preliminary Detailed Design Tasks Presentation

(i) Meet with the Program Team to formally present the Consultant's observations, conclusions, and recommendations for the D6.5.2 Preliminary Detailed Design Tasks and discuss next steps for moving forward with the D6.5.3 Detailed Design tasks.

(ii) Submit a draft presentation plan indicating the topics to be presented for review by the City prior to completing the presentation plan.

- The Consultant shall allow for a five (5) Business Days review period for the City to provide comments on the plan. This should be accounted for and shown in the proposal.

(iii) Upon receipt and implementation of the City's review comments, prepare a PowerPoint presentation on the Preliminary Detailed Design Tasks.

(iv) Present to the City the Preliminary Detailed Design Tasks Presentation. Allow approximately sixty (60) minutes for the presentation and thirty (30) minutes for questions.

(v) Schedule the Preliminary Detailed Design Tasks Presentation to be occur prior to commencement of the Detailed Design Tasks. The presentation should be based upon the completed Preliminary Design Report and D6.5.2 Preliminary Detailed Design Tasks, but may occur in parallel with the Consultant's internal quality control review process.

D6.5.3 Detailed Design Tasks

(a) Civil / Site

(i) Provide a comprehensive civil / site detailed design package, including but not limited to:

- Site plan drawings.
- Drawings to direct the refurbishment works.

(b) Temporary Construction Requirements

(i) Provide a comprehensive temporary construction requirement detailed design package, including but not limited to:

- Temporary construction work drawings.
- Phasing drawings.
- Temporary construction supports.

(c) Structural

(i) Provide a comprehensive structural detailed design package, including but not limited to:

- Legend and general notes drawing(s).
- Plan drawings.
- Section and detail drawings.
- Concrete reinforcing drawings.
- Detail drawings showing structural steel.

(ii) Provide structural design calculations and notes.

(d) Process (as required)

(i) Provide a comprehensive process detailed design package, consisting of but not limited to:

- Flowmeter installation drawings including plan and section views.
- Piping layout drawings.
- Equipment list.

- ♦ Valve list (if required).

(ii) Perform investigations, analysis and calculations associated with potential temporary flow interruptions to perform the work. Identify constraints regarding flow manipulation. Consider seasonal and weather impacts in the analysis. The analysis shall provide clear guidance that can be given to the contractor regarding potential flow interruption scheduling and duration.

- ♦ Provide a flow interruption analysis document which clearly shows the results of the analysis that can be given to the contractor to allow them to plan their work.

(iii) Design Calculations and Notes

- ♦ Provide flowmeter sizing, velocity, and installation calculations and notes.
- ♦ Provide flow interruption calculations and notes.

(e) Electrical (if required)

(i) General Requirements

- ♦ Typical drawings will not be accepted for any wiring details.

(ii) Provide a comprehensive electrical detailed design package, consisting of, but not limited to:

- ♦ Provide detailed panel schedules for all panelboards. Indicate loads, wire sizes, breaker details, etc.
- ♦ Provide electrical plan layouts of all equipment and components. Typical standard of acceptance for the scale is 1:50 or less.
- ♦ Provide cable tray layout plan and section drawings, as required.
- ♦ Provide interior and exterior panel layouts for all custom electrical panels.
- ♦ Provide a detailed cable schedule of all new electrical cables.

(iii) The City will provide standard electrical testing and pre-commissioning forms for the contractor to complete.

(iv) Provide the following calculations as part of a design notes and calculation package:

- ♦ Load calculations.
- ♦ Short circuit calculations.

(f) Automation (if required)

(i) General Requirements

- ♦ Typical drawings will not be accepted for any wiring details, such as loop drawings or schematics.

(ii) Provide a comprehensive automation detailed design package, consisting of but not limited to:

- ♦ System architecture / block diagrams for the facility and communications to the DCS.
- ♦ Loop diagrams for all instrumentation loops.
- ♦ Instrument location plans. Include all automation equipment on plans, in addition to instrumentation.
- ♦ Instrument datasheets for all new and modified process instrumentation. Review the format of the datasheets with the City for approval prior to creation.
- ♦ Provide a cable schedule of all new automation cables.

(iii) The City will provide standard testing and pre-commissioning forms for the contractor to complete.

(g) CHAIR-2 and CHAIR-3 Workshops

(i) The Consultant shall prepare, coordinate, and facilitate CHAIR-2 and CHAIR-3 Workshops according to the CHAIR procedure outlined in Appendix S.
  - ♦ It is the City's expectation that all CHAIR workshops will be facilitated by personnel intimately involved with the design preparation of the Project.
  - ♦ It is not required to bring in specific independent CHAIR expertise.

(ii) Allow for each Workshop duration to be up to three (3) hours.

(iii) Clearly document all CHAIR-2 and CHAIR-3 findings and recommendations and issue respective draft minutes and any applicable CHAIR templates outlined in the CHAIR procedure.

(iv) Integrate all City approved CHAIR recommendations into the Final respective CHAIR minutes and applicable registers, forms, templates, and worksheets.

(h) Technical Specifications

(i) Provide a comprehensive specification package for all disciplines and the entire scope of work in NMS specification format. Ensure that the following are included:
  - ♦ All submittal requirements.
  - ♦ All quality assurance requirements.
  - ♦ All commissioning requirements. Note that the **Consultant is responsible for leading commissioning**, however it is anticipated that the contractor will perform various tasks to assist with the commissioning efforts.

(i) Tender

(i) Provide a Tender document for the tender package, utilize the appropriate City template from Materials Management, identify and comply with all Materials Management policies and requirements, and consult with the City of Winnipeg's Insurance Branch for review of the insurance requirements.

(j) Construction Plan

(i) Provide a construction plan that details the proposed construction sequence, schedule, and mitigation of site constraints. The plan shall clearly demonstrate how the work will be implemented while maintaining operation of the NEWPCC facility. The plan shall be suitable for both City and contractor use.
  - ♦ The construction schedule for the NEWPCC RAS piping system refurbishment works shall account for known plant operational constraints as well as coordination with the latest revision of the construction schedule for ongoing major upgrading and expansion projects on site. Updated schedules for these projects will be provided prior to commencement of Work in this RFP.
  - ♦ The construction schedule for the NEWPCC RAS piping system refurbishment works shall start and end during one continuous period to avoid or minimize any remobilization and restart over the construction phase. Any deviations to this schedule must be coordinated with the City and have written approval from the City Project Manager.

(k) Project Commissioning Plan

(i) Prepare a Project Commissioning Plan to detail the commissioning processes, roles and responsibilities, commissioning specifications and objectives, procedures, verification and certification requirements and documentation and acceptance criteria for the Project.
  - ♦ The plan shall show detailed planning, lists, and schedules, not merely a high level description of commissioning.
  - ♦ Clearly indicate the tasks required and the party responsible for each task.
    - Where the solution involves replacement of sections of the RAS lines, the secondary treatment process will be impacted. The

Consultant's Commissioning Plan shall consider impacts on secondary treatment including the risk of shut down and restart of biological processes if the RAS process is interrupted.

- **The Consultant shall state their assumptions in their Proposal.**

♦ Include all disciplines and coordination between the disciplines.

♦ Include all pre-commissioning requirements.

♦ Integrate a Project training plan within the Project Commissioning Plan. Identify all operations and maintenance training requirements, responsible party (contractor, Consultant, supplier, etc.) and an outline of the content of each training session. As part of the commissioning process, the Consultant shall provide resources to train City personnel on any areas or gaps that are not addressed by the other planned training providers.

♦ Include commissioning phasing plans to ensure the NEWPCC RAS piping system is able to convey required sewage treatment plant process flows at all times throughout the course of construction.

♦ Include verifications forms with the commissioning plan.

(ii) Ensure integration of contractor commissioning requirements into the Detailed Tender Package.

(iii) The Project Commissioning Plan may be produced in NMS style format.

(l) Detailed Tender Package

(i) The Detailed Tender Package shall include:

♦ Drawings from all disciplines;

♦ Specifications;

♦ Tender document;

♦ Construction Plan;

♦ Commissioning Plan;

♦ Equipment, I/O, and other lists (if required);

♦ Applicable reference drawings of the existing site; and

♦ Any other applicable information required by the contractor.

(ii) Submit package as outlined in Appendix X Project Documentation Requirements.

(iii) The Consultant should allow for a four (4) week review period for the City to provide comments. This should be accounted for and shown in the proposal.

(iv) Upon receipt and implementation of the City's review comments, submit the Final Detailed Tender Package outlined in Appendix X Project Documentation Requirements.

(v) Prepare detailed construction sequencing that addresses site constraints identified in D6.5.2(m)(v).

(vi) Prepare detailed shutdown procedures (if required). Include:

♦ Pre-Shutdown Requirements,

♦ Operational Notifications - Include required notice periods, department contacts, notification details and responsibilities, including the WWD Environmental Standards Branch,

♦ Contractor Requirements - Include scope of work, action required and responsibilities,

♦ Schedule, and

♦ Operational Requirements - Include all process systems affected, action required and responsibility.

(vii) Attend Detailed Design review meetings with the City and incorporate changes arising from these meetings.

- Submit one (1) electronic copy of the **60% draft detailed tender package** for all aspects of the work listed in D6.5.3, including detailed construction Drawings and technical specifications.
  - The Consultant is encouraged to submit for review at an earlier stage for any individual components that may be of interest to the City or where City direction is required. Coordinate with the Project Manager as required.
  - Submit electronic copies of the draft tender document and technical specifications in Microsoft Word format.
  - The electronic copies of the draft Drawings shall be submitted in PDF format.
  - Conduct a meeting to review the City's comments on the 60% draft tender documents.
- The Consultant shall facilitate **Risk Workshop No. 2** as outlined in D6.4 Risk Management.
- Submit one (1) electronic copy of the **90% draft detailed tender package** for all aspects of the work, including all tender package items listed in D6.5.3(l)(i).
  - The electronic copies of the draft tender document, technical specifications, commissioning plan and process control narrative updates shall be submitted in Microsoft Word format.
  - The electronic copies of the draft Drawings shall be submitted in PDF format.
  - Conduct a meeting to review the City's comments on the 90% draft tender package.
  - Incorporate all City comments into the final detailed tender package.

(m) Cost Estimate

(i) Prepare a Class 1 cost estimate following incorporation of City Review comments of the 90% draft detailed tender package submission.

- The Consultant shall prepare an AACE Class 1 cost estimate, based on the latest revision of AACE 97R-18 Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Pipeline Transportation Infrastructure Industries and to a level of -10% to +15 % accuracy.
- The cost estimate shall be accompanied by a basis of estimate memorandum from the Consultant which outlines the estimate assumptions, development of material take-offs, source of cost data, allowances, mark-ups/add-ons, exclusions, exceptions, contingencies and cost risks and opportunities.
- The Class 1 Cost Estimate shall be completed using the latest revision of the City's Basis of Estimate (BoE) template, available on the City Asset Management Program page at The City of Winnipeg, Corporate Finance, Infrastructure Planning Division website: https://winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm#4. Provide inputs and work with City Project Manager to complete BoE template document as per City template.
- The Class 1 Cost Estimate shall be submitted to the City Project Manager at least ten (10) Business Days prior to sending the Tender documents to the City's Materials Management Division for review and posting.

(n) Detailed Design Notes and Calculations Package

(i) Prepare and submit a detailed design notes package including items such as structural, mechanical, and electrical design calculations related to process equipment; instrumentation and process control design calculations; and detailed engineering calculations, drawings and criteria employed in the design(s).
  - Submit package as outlined in Appendix X Project Documentation Requirements
  - Provide Draft Detailed Design Notes and Calculations Package together with the 90% Draft Detailed Tender Package to allow for review in parallel.

(o) Detailed Design Deliverables

(i) Deliverables from the Detailed Design Phase shall include, but not be limited to:
  - Condition Assessment of Existing RAS Piping System Isolation Valves;
  - Preliminary Project Commissioning Plan;
  - CHAIR Workshops;
  - Risk Workshops;
  - Schedule Review and Update;
  - Preliminary Detailed Design Tasks Presentation;
  - Detailed Tender Package;
  - Detailed Design Review Meetings at 60% Draft and 90% Draft;
  - Class 1 Cost Estimate; and
  - Detailed Design Notes and Calculations Package.

D6.6 Procurement Services

(a) After approval by the Project Manager, submit the Detailed Tender Package to Materials Management for public bidding.
  (i) All tender packages shall be prepared and posted in accordance with the City of Winnipeg Materials Management Division requirements.
  (ii) Coordinate review of the package with Materials Management and make changes as requested to the tender package.

(b) Provide appropriate response to bidders and advice to the City during tender call and issue addenda to the contract documents as necessary.

(c) Arrange for and lead bidder’s site visit(s).

(d) Coordinate and lead a pre-award meeting with general construction contractor.

(e) Complete a review, analysis, comparison, tabulation, calculation, and evaluation of the tenders received. Make recommendations for award of Contract.
  (i) If the bids deviate more than 15% from the Class 1 Cost Estimate, provide justification for the difference in pricing in the award recommendation letter.
  (ii) Submit a Letter of Recommendation, copies of the bids, a tender comparison sheet, and a tender tabulation as outlined in Appendix X Project Documentation Requirements.

(f) Following tender close, submit Final Detailed Tender Package including all addenda as outlined in Appendix X Project Documentation Requirements.

D6.7 Contract Administration

D6.7.1 General Requirements

(a) Organize meetings with City staff to ensure all required information, issues, and concerns are accounted for.

(b) Throughout the course of the Project, the Consultant shall use the processes, procedures, forms and templates found on the City’s Infrastructure Planning Office website: https://www.winnipeg.ca/infrastructure/asset-management-program/templates-manuals.stm. Relevant documents include:

(i) pre-construction meeting agenda and meeting minutes;
(ii) proposed change notice (PCN);
(iii) PCN log;
(iv) request for information (RFI);
(v) RFI log;
(vi) field instruction (FI);
(vii) FI log;
(viii) contract change log;
(ix) change work order (CWO);
(x) decision log;
(xi) daily construction report;
(xii) inspection report;
(xiii) meeting minutes;
(xiv) site meeting minutes;
(xv) project status report;
(xvi) Certificate of Substantial Performance;
(xvii) Certificate of Total Performance; and
(xviii) Certificate of Acceptance.

(c) Use the appropriate or recommended City templates throughout the course of the Project, including but not necessarily limited to those listed in D6.7.1(b).

(d) All personnel provided by the Consultant for either non-resident or resident engineering Contract Administration work shall be experienced and qualified to perform the Work.

(e) Original photographic records shall have horizontal resolution and vertical resolution of a minimum three-hundred (300) pixels per inch (ppi) complete with date and time stamps as per D6.2.4. Photos in reports may be reduced in scale. Provide original photos to the City upon request.

(f) The City reserves the right to withhold payment of Consultant fees for additional Contract Administration services which result out of errors or omissions in the design work prepared by the Consultant.

D6.7.2 Contract Administration Services

(a) Non-Resident Engineering Services

(i) Refer to B9.3.2(b) for the City's estimated minimum number of hours for the Consultant to perform the Non-Resident Engineering Services.

(ii) Perform project management functions in accordance with the City's Project Management Manual and City requirements.

(iii) Prior to construction, prepare and submit a written and photographic record of the physical condition of the work area, existing facilities, and structures sufficient to equip the City to provide valid evidence and relevant testimony in settlement of any claim involving the City by any court of law, or by any other party for damages thereto arising from the Project.

(iv) Conduct and chair a Project pre-construction meeting and record and distribute minutes with the contractor and the Program Team, in which the Consultant shall discuss:

- Insurance,
- Communication, and
- Safety, etc.

(v) Make application to public agencies for necessary authorizations and permits, prepare and submit reports and drawings thereto, and appear before the same in support of all applications.

(vi) Provide complete sets of Tender Documents including addenda and drawings as per Appendix X Project Documentation Requirements to the contractor.

(vii) Prepare a detailed Vendor Document Requirements (VDR) list based upon the requirements of the drawings and specifications. The list shall in detail identify all contractor submittal requirements.

- ♦ Manage the VDR list and logs of contractor submittals.
- ♦ Update and forward the VDR list and current logs of submittals to the contractor and Program Team.

(viii) Review and accept contractor submittals (i.e. shop drawings) supplied by the contractor or supplier. Each submittal shall be reviewed by a professional engineer.

(ix) Forward final contractor submittals to the City as per document Appendix X Project Documentation Requirements.

(x) Review and report to the City regarding laboratory, shop and other tests conducted on materials and/or equipment.

(xi) Review and provide recommendations for requests for alternate materials and methods. No alternates shall be approved without written authorization from the City Project Manager.

(xii) Consult and advise the City during the course of construction.

(xiii) Provide the City with a copy of all significant correspondence relating directly or indirectly to the contract. These include correspondence originating from or distributed to, parties external to the Consultant. This shall be provided immediately following receipt or dispatch of same by the Consultant.

(xiv) Keep a continuous record of Project activities including but not limited to daily reports, photographic record of construction work and equipment, Working Days, teleconferences, emails, inspections and observations sufficient to equip the City to provide valid evidence and relevant testimony in settlement of any claim involving the City by any court of law, or by any other party for damages thereto arising from the Project.

(xv) "Monitor and manage the Contractor's schedule.

- ♦ Perform regular reviews of the schedule ensuring all predecessor / successor relationships adequately reflect actual site progress. These reviews shall consider all schedule risk impacts due to all other project aspects including:
  - Impact to the plant operations;
  - Change management;
  - City operational activities;
  - Any other site projects; and
  - Health and safety.
- ♦ Perform regular reviews to evaluate how the Contractor’s notifications of changes to baseline and current schedules, relative to the contract specifications and documents, capture all impacts to all successor activities impacting overall project milestones and completion.

(xvi) Provide adequate and timely direction of field personnel by senior officers of the Consultant.

(xvii) Review acceptability of inspection and test plans from contractors, vendors or manufacturers.

(xviii) Coordinate and prepare proposed change notice (PCN) regarding the contractor scope of work as required. This may include the preparation of specifications and drawings for the PCN.

(xix) Coordinate, prepare, and process City Project Manager approved Change Work Order (CWO) forms regarding the contractor scope of work as required and provide backup material to the Project Manager as requested.

(xx) Review and respond to contractor Requests for Information (RFIs) in a timely manner.

(xxi) Prepare contractor site instructions / clarifications / directives as required.

(xxii) Interpret technical aspects of contract as requested by the City.

(xxiii) Plan, coordinate, manage and lead all shutdown and tie-in protocols, required for construction and commissioning. Prepare detailed shutdown or tie-in protocols that detail out a schedule for the work, delegate responsibilities, and clearly identify all operational impacts and plans to address. Review operational and construction risks and plan risk mitigation measures as appropriate. Act as the interface between the contractor and City during the shutdowns and tie-ins.

- Base any required construction shutdown and tie-in protocols on the procedures developed during the Detailed Design phase.

(b) Resident Engineering Services

(i) Allow for twelve (12) months of significant onsite construction activity.

(ii) Provide full time inspection services when the construction contractor is on-site to ensure that the construction conforms to the design Drawings and specifications.

(iii) Refer to B9.3.3(b) for the City's estimated minimum number of hours for the Consultant to perform the Resident Engineering Services.

(iv) Provide a weekly construction report during the course of construction. The weekly construction report shall include, but not be limited to:

- Date and Time report is issued;
- Period for construction progress being reported;
- Unique report identification or report numbers on each report;
- Brief and clear description of the project summary in terms of the project name, project ID, and project manager name;
- Report on any health or safety issues to ensure the Contractor is complying with the appropriate safety policies and plans;
- Planned vs Actual progress and status in terms of timeline, quality, and budget compared with the baselines created in the project plan;
- Working Days and days lost due to inclement weather during the course of the construction;
- Project Budget Status with details and a summary as to whether the project is over, under, or on budget;
- Project schedule updates along with the baseline schedule to indicate if the project is on schedule or beyond schedule;
- Weekly Look Ahead Schedule to give a two (2) or three (3) week look ahead schedule;
- Milestones Status Summary in the form of those achieved and those coming next; and
- On-Site Photography to provide a photographic comparison of the before and after to observe the progress of construction works. Provide descriptions of each photograph.

(v) Provide qualified personnel with appropriate discipline expertise to perform inspections of the construction, including but not limited to the following:

- Inspect temporary supports, hangers, formwork, reinforcing; and
- Conduct inspection of construction sufficient to ensure that the construction carried out by the contractor is in conformance with the drawings and specifications, provide report thereof.

(vi) Provide a specific construction inspection report for each inspection. The construction inspection reports shall be prepared by, or under the supervision of a professional engineer and contain appropriate detail to ascertain whether the construction meets the requirements of the drawings and specifications. The specific construction inspection reports shall be in addition to the daily construction reports.

(vii) Witness quality control procedures implemented by the contractor, including but not limited to:

- ♦ Ensure material storage, repair system application, health and safety considerations, and environmental considerations are consistent with the applicable and recommended ISO and ASME design standards.
- ♦ Non-destructive examination of the composite repair system including reporting on allowable defects in the composite repair system.
- ♦ Witness hydrostatic and pressure testing of pipes and other specified equipment.

(viii) Provide reference line and elevation control points for the works and check the contractor's adherence.

(ix) Arrange for and carry out of testing of materials utilized by the contractor.

- ♦ Notwithstanding C1.1(b), the cost to the Consultant for the provision of third-party testing, as authorized by the Project Manager, will be reimbursed as an Allowable Disbursement.
- ♦ The Consultant shall ensure that selected third-party services are provided at competitive market rates.
- ♦ Costs shall be substantiated by the provision of suitable documentation.

(x) Maintain current logs of the following and provide to the Project Manager on a weekly basis:

- ♦ A current log of all construction reports.
- ♦ A current log of all specific construction inspections and corresponding reports.
- ♦ A materials testing log.

(xi) Promptly report to the City any significant and unusual circumstances.

(xii) Prepare, update, maintain, and coordinate a deficiency list of all issues identified during inspections by the Consultant or the Program Team. Coordinate remediation of the deficiency list with the contractor.

(xiii) Coordinate and lead regular on-site review meetings with representatives of the contractor and Program Team.

- ♦ The typical frequency of meetings shall be weekly, although meeting frequency may vary based upon the level of construction activity.
- ♦ Prepare and distribute comprehensive meeting minutes within two (2) Business Days. Update the meeting minutes with corrections from other parties.

(xiv) Promptly prepare, certify, and submit progress estimates to the City for payment to the contractor(s) for construction performed in accordance with the drawings and specifications.

- ♦ Act as Payment Certifier and administer all contracts as required under the Builder's Liens Act of Manitoba.

(xv) Coordinate and lead a comprehensive, detailed inspection prior to Substantial Performance, including the contractor and the Program Team. Document and report on all issues identified and coordinate completion of the issues.

(xvi) Make a recommendation to the Project Manager when the contractor has achieved Substantial Performance and upon approval, prepare and issue a Certificate of Substantial Performance.

(xvii) Coordinate and lead a comprehensive, detailed inspection prior to Total Performance, including the contractor and the Program Team. Document and report on all issues identified and coordinate completion of the issues.

(xviii) Provide an appropriate recommendation in written form to the City Project Manager when the contractor has achieved Total Performance and upon approval, prepare and issue a Certificate of Total Performance.

(c) Commissioning Services

(i) General Requirements

- Refer to B9.3.4(b) for the City’s estimated minimum number of hours for the Consultant to perform the Commissioning Services.
- Provide comprehensive leadership to the commissioning of the works. The Consultant has the responsibility to ensure that all commissioning activities are carried out to allow for the delivery of a fully operational facility compliant and complete in every respect.
  - Provide a Commissioning leader appropriately qualified to lead the commissioning work. The Commissioning leader shall be a senior engineer with experience in commissioning Projects.
  - Provide all qualified resources and organization to perform commissioning related activities pertaining to the Consultant’s scope.
- Consult with and advise the City during the course of commissioning.
- Coordinate with City Operations personnel as required. Ensure that City Operations personnel are always aware of the current commissioning status and any upcoming operational requirements or impacts.
- The Consultant is fully responsible for the planning and leadership of the overall commissioning activities. While the contractor and the City may perform specific commissioning tasks, this does not reduce or eliminate the Consultant’s responsibilities. Schedule and coordinate all commissioning works in coordination with the contractor’s schedule.
- Review all commissioning records and ensure that the overall commissioning records demonstrate compliance to the specifications and overall Project design requirements.
  - Ensure all equipment and control system settings are documented
- Monitor commissioning activities, witness and certify the accuracy of the reported results.
- Sign-off on all commissioning and training records.
- Ensure all Commissioning Team members have clear definition of their role and understanding of their responsibilities.
- Coordinate with the contractor to ensure appropriate measures regarding safety, health and environmental aspects are implemented throughout the commissioning activities.
- Review commissioning documentation for performance, reliability, durability of operation, accessibility, maintainability, and operation efficiency under all conditions of operation.
- Prepare agenda, lead and record minutes of the commissioning meetings.
- Manage the commissioning documentation.
- Ensure the commissioning process meets effluent licencing requirements. Anticipate any potential commissioning scenarios that impact licensing compliance and, in conjunction with the Project Manager, liaise with the Wastewater Services Division with respect to commissioning activities.

(ii) Planning

- ♦ The Consultant is fully responsible for the planning of the overall commissioning activities. This includes but is not limited to:
  - Update the Commissioning Plan prepared during the Detailed Design Phase and issue to all relevant parties.
  - Define the commissioning activities.
  - Develop commissioning procedures and protocols to fully commission the facility. Coordinate the review of the documents with the City and contractor, and update as required.

(iii) Pre-Commissioning

- ♦ Pre-Commissioning activities will include the factory acceptance testing, on-site inspection, and testing of equipment incorporated into the Project.
  - Records shall be generated for all pre-commissioning inspections and tests.
- ♦ The Consultant is responsible to specify all pre-commissioning requirements as part of the Detailed Design.
- ♦ The Consultant's responsibilities include but are not limited to:
  - Managing the overall pre-commissioning requirements and ensuring that all required pre-commissioning work is completed. Prepare and manage a master list of pre-commissioning requirements.
  - Witness any required Factory Acceptance Tests (FATs).
  - Witness a selected portion of the pre-commissioning tests (approximately a third).
  - Review all pre-commissioning records, including testing forms.
  - Organization and filing of all pre-commissioning records with the City.
- ♦ The contractor is expected to be responsible for the execution of the majority of the pre-commissioning work, such as pre-start-up testing of equipment.

(iv) Training

- ♦ Coordinate and manage training sessions for City personnel for the operation and maintenance of new facilities and equipment. This includes but not limited to planning and scheduling of training sessions, review of training procedures and training documents prepared by the contractor.
- ♦ The Consultant is responsible for the overall packaging and quality assurance of the training program, although delivery of selected portions may be by the contractor or subcontractor.
- ♦ Coordinate to ensure video records of each unique training session are provided to the City. Ensure acceptable and uniform standard of video quality.
- ♦ In addition to the above, include in the Consultant's scope of work:
  - Up to five (5) iterations of a three (3) hour classroom training session to provide Project overview training to City personnel. Train on overall operation and maintenance requirements. Address detailed training gaps that are not addressed by other training sessions. Provide appropriate hand-outs of the training material.

(v) Electrical Commissioning (as required)

- ♦ Be present on-site during commissioning and witness commissioning activities.
- ♦ Test, verify and document that the electrical system and all associated controls perform as designed. Test all operating scenarios.

(vi) Automation Commissioning (as required)

- ♦ Be present on-site during commissioning and witness commissioning activities.
- ♦ Test, verify and document that the automation system and all associated controls perform as designed. Test all operating scenarios.

(vii) Asset Data Schedule

- ♦ The Consultant shall request from the City Representative (Wastewater Services Division Process Improvement Coordinator) the list of the assets (equipment) that are scheduled for maintenance as defined in the project scope. The City Representative will provide the Consultant with both the Asset List and the Guideline to Document Asset Registry.
- ♦ The Consultant shall provide a comprehensive list of all maintainable assets along with associated data based on the Guideline to Document Asset Registry. The list shall be in a spreadsheet in a format defined by the City for uploading into the City's Oracle Work and Asset Management (OWAM) system. It is expected that this document will be an amalgamation and reformatting of other information prepared and received by the Consultant.
- ♦ The Consultant shall reference the latest revision of the Wastewater Services Division asset registry document outlined in D6.2.1(g)(xi).

(viii) Commissioning Handover Package

- ♦ Compile and handover to the City all commissioning documentation, including but not limited to:
  - Commissioning plans and procedures,
  - Evidence of commissioning verification,
  - Deficiency reports and corrective actions taken,
  - Training material and records, and
  - Other commissioning documents.
- ♦ The compilation of all commissioning documentation shall be delivered in a comprehensive, organized electronic format with all files and directories structured for simple identification and searchability of the contents.

(ix) Operations and Maintenance Manuals

- ♦ Include all hours required to coordinate and correct documentation provided by the contractor.
- ♦ The City Operations team utilizes operations and maintenance manuals as reference documents for the operation and maintenance of the facility. The operations manuals provide detailed documentation of the area process and its components, monitoring and control, operational and safety requirements, equipment data, maintenance requirements, etc.
- ♦ Review, co-ordinate, and manage the submission of Operations Manuals prepared by the contractor.
- ♦ **Part A – Process Area Operating Manual** is to be developed or revised as required by the Consultant. It shall include, but not be limited to the following:
  - Introduction indicating location of the facility and general description;
  - Facility layout diagram;
  - Safety and health hazards including hazard control to mitigate the safety and health hazards;
  - Site services - provide an overview of all site services including any restrictions or constraints that apply. Site services scope will include: electric supply, security, communications, etc.;
  - Process description - provide a description of the process objective and a description of the process operation. Reference will be made

to process flow diagrams, P&IDs, and control narratives where applicable. P&IDs will be included as applicable;
- Design criteria - provide process design criteria for the specific unit process.

♦ **Part B – Operations and Maintenance Manual** will be prepared by the contractor based upon specifications provided by the Consultant. The Consultant is responsible for reviewing and amending the information as appropriate to ensure that the manual is comprehensive to meet the requirements of the City. It shall include, but not be limited to the following:
- Brochures/catalogue excerpts of all components of the work,
- Documentation of all test results,
- Complete set of equipment and assembly drawings,
- Manufacturer operations and maintenance manuals,
- Installation, start-up, instructions for operations and maintenance,
- Equipment settings and other applicable specific requirements,
- Reviewed submittals (including shop drawings) of all equipment,
- Certified factory test results,
- Record drawings for the complete installation, and
- Names, addresses, and telephone numbers of all major sub-contractors and suppliers.

♦ Notwithstanding “Part A – Process Area Operating Manual” and “Part B – Operations and Maintenance Manual” above, given the limited changes for process equipment type and limited automation upgrades envisioned for the Scope of Services for the Contract, and the fact that the process control narrative is not changing for the existing RAS piping system, the Consult shall adhere to the following guidance when creating new Operation and Maintenance Manuals or making revisions to existing Operations Manuals:
- Only the applicable sections of the Operations Manual Specification (Appendix T) shall be applied by the Consultant to new and/or existing Operations Manuals documentation.
- The Consultant shall use existing Process Area Operating Manuals as guidance for making revisions to these documents.
- Based on available literature for any new equipment added to the RAS piping system, the Consultant shall bring forward all maintenance tasks associated with any new equipment and document same in the Operations and Maintenance Manual.

♦ Operations and Maintenance Manuals requirements include:
- All documents shall be text-searchable, and
- Native versions of all documents produced by the Consultant are required.

♦ Schedule the production of the Operations and Maintenance Manuals such that the draft version is issued as part of the commissioning / training activities, prior to Substantial Performance.
- Allow a minimum of twenty-five (25) Business Days for the Program Team review of the manuals.

♦ Submit final copies of the Operations and Maintenance Manuals as per the Project Documentation Requirements in Appendix X.

(d) **Contract Administration Deliverables**

(i) Contract Administration deliverables shall include, but not be limited to:

- ♦ All Contract Administration documentation such as Meeting Minutes, RFIs, PCNs, CWOs, weekly construction reports, submittals, etc.,
- ♦ Asset Data Schedule \ Registry spreadsheet,
- ♦ Commissioning Handover Package, and
- ♦ Operations and Maintenance Manual.

D6.8 Post Construction Services

(a) Refer to B9.3.5(b) for the City's estimated minimum number of hours for the Consultant to perform the Post Construction Services.

(b) Confirm and ensure complete turnover of project documentation (shop Drawings, Record Drawings, O&M manuals, design notes and calculations, etc.) to the City by the contractor and verify that the documents are in conformance with the construction contract.

(c) Record Drawings

(i) Record Drawings shall adhere to the General Requirements for Drawings as stated in D6.2.2.

(ii) Record Drawings shall reflect Site verified as-constructed conditions, including contractor markups, contract change orders, RFI's, and markups from resident inspection of the work. Reliance solely on contractor markups without Site verification of as-constructed conditions is not satisfactory.

(iii) Record Drawings shall be authenticated by the engineer-of-record in accordance with the latest revision of the Engineers and Geoscientists of Manitoba document titled "Authentication of Electronic and Hardcopy Document Guideline." For this RFP, the latest revision referenced was "Approved by Investigation Committee December 19, 2019.

(iv) The Consultant shall prepare and submit draft Record Drawings within one (1) month of Total Performance of the construction contract.

(i) Submit one (1) electronic PDF copy of the draft Record Drawings for City review.

(ii) The draft Record Drawing submission is to consist of a drawing transmittal to the Project Manager, and one (1) complete set of drawings.

(iii) The City review comments and/or the marked-up draft Record Drawings will be returned to the Consultant for any corrections and updates in order to comply with the CAD-GIS Standards listed in D6.2.2(f)(i).

(iv) After all corrections or updates are completed, the Consultant shall return the marked up draft Record Drawings, and submit one (1) final set of size A1 Mylar and one (1) electronic copy of PDF and AutoCAD files (in .DWG file format) of the final Record Drawings.

(v) Once the Record Drawings meet the new CAD-GIS Drawing Standards, the drawings will be accepted.

(vi) Unless the Consultant specifically asks to be notified, WWD Drawing Control Staff will not notify Consultants when Project drawings have been accepted.

(d) Construction Report

(i) The Consultant shall provide a draft Construction Report to the City within two (2) months of Total Performance of the construction contract.

(ii) The Construction Report shall include the following:

(i) A brief summary of the project, including:

- ♦ services accomplished, including the initial and final scope of the Project;
- ♦ issues encountered during the Project and the resolutions achieved; and
- ♦ final or projected final contract cost

(ii) Appendices, including:

- ♦ photographs – typical pre-construction, during construction, and post-construction photographs;

- cost summary;
- tabulation of tenders;
- change orders;
- summary of progress payments;
- final Contract schedule;
- subcontractor list;
- daily or weekly reports;
- progress meeting minutes;
- shop Drawings and other submittals;
- field instructions;
- contractor RFI's complete with responses;
- material test reports;
- commissioning documentation;
- certificates of Substantial Performance and Total Performance for the construction contract; and
- warranty information

(iii) Procedures outlined in D6.2.6 shall apply for the City review period for the draft Construction Report.

(iv) The Consultant shall submit the required number of hard copies and one (1) electronic PDF copy of the Final Construction Report.

(e) Training Sessions and Workshops

(i) Coordinate with the installation contractor and any equipment suppliers to provide on-site training sessions and workshops to provide instruction to City staff on the safe operation of all new equipment including recommended maintenance tasks and schedules.

(ii) The training provided by the contractor shall be in compliance with best practices for operations staff to earn continuing education credits.

(iii) Training materials to be submitted to the City for review and comment prior to the on-site training.

(iv) All training sessions shall be video recorded including both classroom and field-focused training.

(f) Operation and Maintenance Manuals

(i) Coordinate with the construction contractor and any equipment supplier(s) to provide the required number of sets of all Operation & Maintenance manuals to the City for all newly installed equipment and devices.

(g) Warranty

(i) Provide two (2) years warranty services tied to the date of Total Performance for the construction contract. The warranty services shall include but are not limited to the following:

(i) Provision of inspection services, at the request of the City, during the warranty period of the construction contract to advise the City in writing of any deficiencies and the proposed resolution of the deficiencies. Upon approval of the City, provide the contractor appropriate notice to correct the deficiencies;

(ii) Determination if corrective work is part of contractor's warranty;

(iii) Liaison and coordination with the contractor to repair defective work;

(iv) Conduction of the inspection and approval of warranty work;

(v) Issuance of instructions for correction of deficiencies;

(vi) Review of updates to operation and maintenance manuals and resolve deficiencies;

(vii) Respond to requests of the City related to the Project;

(viii) Provision of a detailed inspection of the Project with the Contractor and the City prior to the end of the warranty period and provide to the City in written form associated itemized deficiency list or appropriate recommendation of acceptance of the construction contract work; and

(ix) Coordinate and issue Certificate of Acceptance for the construction contract.

(h) Post Construction Deliverables

(i) Final Record Drawings in both hardcopy (Mylar) and electronic file formats (AutoCAD and PDF files).

(ii) Final Construction Report in both hard copy and electronic file format.

(iii) End of warranty period site inspection, recommendations, and meeting minutes.

(iv) Certificate of Acceptance for construction contract.

D6.9 Additional Work Allowance

D6.9.1 The Additional Work Allowance is to be used for engineering and design services which may be required due to unforeseen conditions arising in preliminary stages of the project.

D6.9.2 When Additional Work Allowance work arises, the Consultant shall prepare a concise scope of work and cost proposal in collaboration with the Project Manager.

D6.9.3 The proposal for use of the Additional Work Allowance shall be submitted to the Project Manager for final approval.

D6.9.4 No Additional Work Allowance work shall start prior written approval from the Project Manager.

D6.10 The funds available for this Contract are $1,500,000.00.

SUBMISSIONS

D7. AUTHORITY TO CARRY ON BUSINESS

D7.1 The Consultant shall be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Consultant does not carry on business in Manitoba, in the jurisdiction where the Consultant does carry on business, throughout the term of the Contract, and shall provide the Project Manager with evidence thereof upon request.

D8. SAFE WORK PLAN

D8.1 The Consultant shall provide the Project Manager with a Safe Work Plan at least five (5) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in C4.1 for the return of the executed Contract.

D8.2 The Safe Work Plan should be prepared and submitted in the format shown in the City's template which is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/safety/default.stm

D9. INSURANCE

D9.1 The Consultant shall procure and maintain, at its own expense and cost, insurance policies with limits no less than those shown below.

D9.2 As a minimum, the Consultant shall, without limiting its obligations or liabilities under any other contract with the City, procure and maintain, at its own expense and cost, the following insurance policies:

(a) Comprehensive or Commercial General Liability Insurance including:
   (i) an inclusive limit of not less than $2,000,000 for each occurrence or accident with a minimum $2,000,000 Products and Completed Operations aggregate and $5,000,000 general aggregate;
   (ii) all sums which the Consultant shall become legally obligated to pay for damages because of bodily injury (including death at any time resulting therefrom) sustained by any person or persons or because of damage to or destruction of property caused by an occurrence or accident arising out of or related to the Services or any operations carried on in connection with this Contract;
   (iii) coverage for Products/Completed Operations, Blanket Contractual, Consultant's Protective, Personal Injury, Contingent Employer's Liability, Broad Form Property Damage, Employees as Additional Insureds, and Non-Owned Automobile Liability;
   (iv) a Cross Liability clause and/or Severability of Interest clause providing that the inclusion of more than one Insured shall not in any way affect the rights of any other Insured hereunder in respect to any claim, demand, suit or judgment made against any other Insured.

(b) if applicable, Automobile Liability Insurance covering all motor vehicles, owned and operated and used or to be used by the Consultant directly or indirectly in the performance of the Service. The limit of liability shall not be less than $2,000,000 inclusive for loss or damage including personal injuries and death resulting from any one accident or occurrence.

(c) Project specific professional errors and omissions liability insurance including:
   (i) an amount not less than $5,000,000 per claim and $5,000,000 in the aggregate.

D9.2.1 The Consultant's professional errors and omissions liability insurance shall remain in force for the duration of the Project and for twenty-four (24) months after Total Performance.

D9.3 The policies required in D9.2(a) shall provide that the City is named as an Additional Insured thereunder and that said policies are primary without any right of contribution from any insurance otherwise maintained by the City.

D9.4 The Consultant shall require any Consultants hired to perform geo technical drilling and sample collecting or closed-circuit television to procure and maintain, at its own expense and cost, comparable insurance to that set forth under D9.2(a) and D9.2(b).

D9.5 The Consultant shall require each of its Subconsultants hired for design, architectural or engineering services as outlined in the Scope of Services to provide comparable insurance to that set forth under D9.2(a) and D9.2(c).

D9.6 The Consultant shall provide the Project Manager with a certificate(s) of insurance in a form satisfactory to the City Solicitor, at least two (2) Business Days prior to the commencement of any Services, but in no event later than the date specified in C4.1 for the return of the executed Contract. Such certificates shall state the exact description of the Services and provide for written notice in accordance with D9.9.

D9.7 The Consultant may take out such additional insurance as it may consider necessary and desirable. All such additional insurance shall be at no expense to the City.

D9.8 All insurance, which the Consultant is required to obtain with respect to this Contract, shall be with insurance companies registered in and licensed to underwrite such insurance in the Province of Manitoba.

D9.9 The Consultant shall not cancel, materially alter, or cause any policy to lapse without providing at least thirty (30) Calendar Days prior written notice to the City.

SCHEDULE OF SERVICES

D10. COMMENCEMENT

D10.1 The Consultant shall not commence any Services until it is in receipt of a notice of award from the City authorizing the commencement of the Services.

D10.2 The Consultant shall not commence any Services until:

(a) the Project Manager has confirmed receipt and approval of:

(i) evidence of authority to carry on business specified in D7;

(ii) evidence of the insurance specified in D9.

(b) the Consultant has attended a meeting with the Project Manager, or the Project Manager has waived the requirement for a meeting.

D10.3 The City intends to award this Contract by December 31, 2020.

D11. COVID-19 SCHEDULE DELAYS

D11.1 The City acknowledges that the schedule for this Contract may be impacted by the COVID-19 pandemic. Commencement and progress of the Services shall be performed by the Consultant with due consideration to the health and safety of workers and the public and directives from health authorities and various levels of government, and in close consultation with the Project Manager.

D11.2 If the Consultant is delayed in the performance of the Services by reason of the COVID-19 pandemic, the Services schedule may be adjusted by a period of time equal to the time lost due to such delay and costs related to such delay will be determined as identified herein.

D11.3 Within seven (7) Calendar Days of the award of Contract, the Consultant shall declare whether COVID-19 will affect the start date. If the Consultant declares that COVID-19 will affect the start date, the Consultant shall provide sufficient evidence that the delay is directly related to COVID-19, including but not limited to evidence related to availability of staff or work by others.

D11.4 For any delay related to COVID-19 and identified after Services have commenced, the Consultant shall within seven (7) Calendar Days of becoming aware of the anticipated delay declare the additional delay and shall provide sufficient evidence as indicated in D11.3. Failure to provide this notice will result in no additional time delays being considered by the City.

D11.5 Any time or cost implications as a result of COVID-19 and in accordance with the above, as confirmed by the Project Manager, shall be documented in accordance with C8.

D11.6 The Consultant will recognize the COVID-19 pandemic as a project risk and plan in accordance with:

(a) The schedule for design services shall minimize activities at the NEWPCC facility and in particular minimize the need for in-person interaction with operations and maintenance staff.

(b) The Consultant shall consider mitigations for schedule risk due to COVID-19 and include them in their plans.

D12. INVOICING

D12.1 Project Management in accordance with D6.3 shall be invoiced on a monthly basis once all deliverables in D6.3.3 applicable for that month have been submitted;

D12.2 Risk Management in accordance with D6.4

(a) 30% of the total Risk Management fee shall be invoiced once all deliverables have been submitted and accepted by the City at the completion of Risk Workshop 1;

(b) 30% of the total Risk Management fee shall be invoiced once all deliverables have been submitted and accepted by the City at the completion of Risk Workshop 2; and

(c) The remaining 40% of the fee shall be invoiced on a monthly basis over the course of the engineering, construction, commissioning, and turnover phases for review of the project risk register at each regular progress meeting including any associated risk response planning.

D12.3 Detailed Design and Specification Development in accordance with D6.5 shall be invoiced when all the deliverables in D6.5.3(o) have been submitted and accepted by the City;

D12.4 Procurement Services in accordance with D6.6 shall be invoiced once all deliverables in D6.6(f) have been submitted;

D12.5 Non-Resident Engineering Services in accordance with D6.7.2(a) shall be invoiced on a monthly basis.

D12.6 Resident Engineering Services in accordance with D6.7.2(b) shall be invoiced on a monthly basis.

D12.7 Commissioning Services in accordance with D6.7.2(c) shall be invoiced on a monthly basis.

D12.8 Post Construction Services in accordance with D6.8 shall be invoiced once deliverables in D6.8(h) have been submitted and accepted by the City.

D13. CRITICAL STAGES

D13.1 The Consultant shall achieve critical stages of the Services for this Contract in accordance with the following requirements:

(a) Completion of all Detailed Design Services including City Project Manager approval of the final detailed tender package and submission of same to the City Materials Management Division by September 10, 2021;

(b) Completion of Procurement Services including submission of Letter of Recommendation to City Project Manager by October 22, 2021;

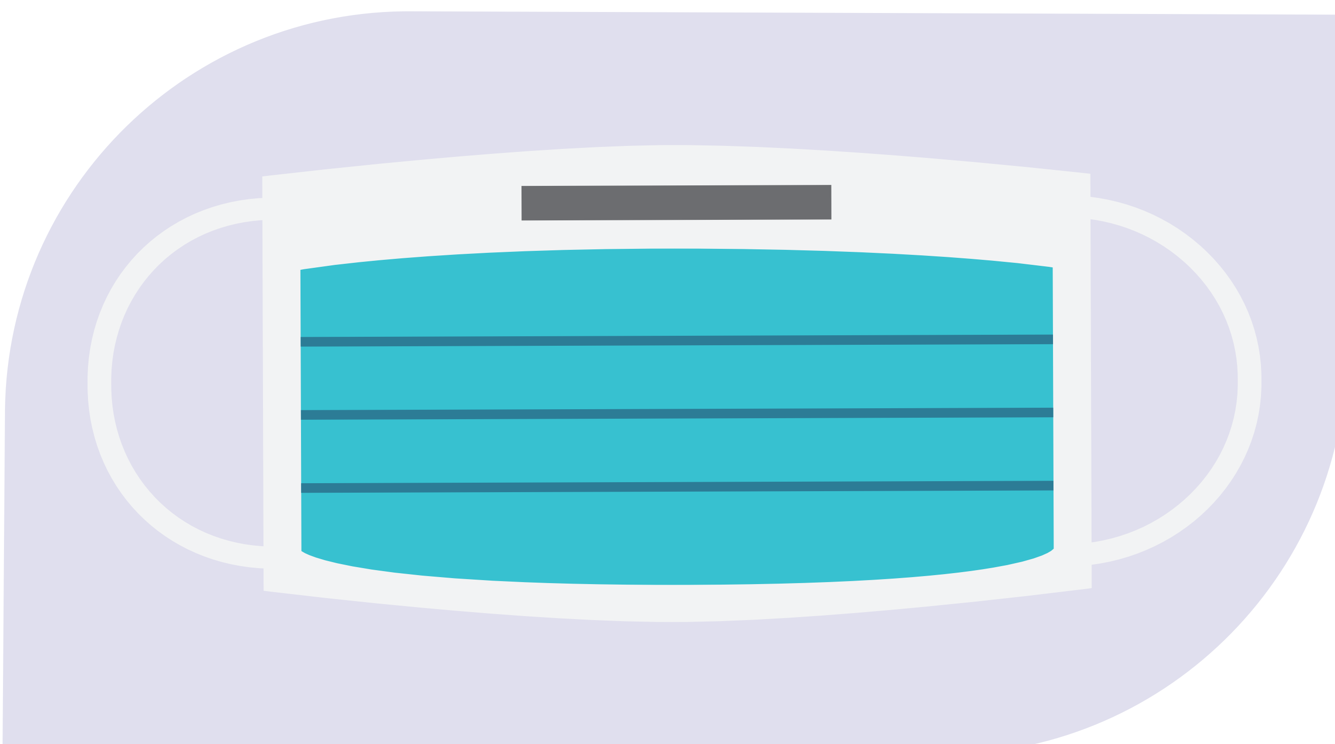
(c) Issue Certificate of Substantial Performance for the construction contract by November 25, 2022; and

(d) Issue Certificate of Total Performance for the construction contract by February 17, 2023.

APPENDIX A – MASKS REQUIRED IN CITY-OPERATED FACILITIES POSTER

Masks are required in this City-operated facility

Le port du masque est obligatoire dans cette installation exploitée par la Ville.



winnipeg.ca

Winnipeg

Masks are required in this City-operated facility

Le port du masque est obligatoire dans cette installation exploitée par la Ville.

winnipeg.ca

Winnipeg

Quand faut-il porter un masque?

Il faut porter un masque qui recouvre la bouche, le nez et le menton en tout temps sauf dans certains cas, dont voici quelques exemples :

- les personnes âgées de moins de cinq ans;
- les personnes qui ne peuvent pas mettre, utiliser ou enlever un masque sans se faire aider;
- les personnes qui ne peuvent pas porter un masque en raison d'un problème ou d'une incapacité mentale ou physique, ou qui font l'objet d'une protection en vertu du Code des droits de la personne du Manitoba;
- les personnes qui mangent ou boivent dans des espaces désignés où l'on peut s'asseoir, ou dans le cadre d'une cérémonie religieuse ou spirituelle;
- les personnes qui pratiquent des activités aquatiques ou qui font de l'exercice;
- les personnes qui donnent des soins ou de l'aide à des personnes handicapées que le port du masque gênerait dans le cadre de leur travail;
- les personnes qui doivent temporairement enlever leur masque pour accomplir leurs tâches ou offrir leurs services (p. ex. pour mettre un respirateur);
- les membres du personnel de la Ville qui travaillent seuls dans des espaces complètement fermés tels qu'un bureau ayant une porte fermée, qui voyagent seuls dans un véhicule ou qui travaillent seuls dans un espace cloisonné situé à au moins deux mètres des autres employés;
- le personnel des services d'urgence, y compris les agents de police, les pompiers et les ambulanciers paramédicaux en service qui doivent déjà suivre des protocoles internes stricts en matière de protection de la santé et de la sécurité propres à leur service.

When are face masks required?

All individuals required to wear a face mask in all indoor City-operated facilities and vehicles with the following exemptions:

- Persons under the age of five
- Persons who are unable to place, use, or remove a mask without assistance
- Persons unable to wear a mask due to a mental or physical concern or limitation, or protected ground under the Manitoba Human Rights Code
- Persons consuming food or drink in designated seating areas or as part of religious or spiritual ceremony
- Persons engaged in water activities or physical exercise
- Persons providing care or assistance to a person with a disability where a mask would hinder that caregiving or assistance
- Persons engaging in tasks or services that require the temporary removal of a mask (e.g. in order to don a respirator)
- City employees who are working alone in fully-enclosed space, such as an office with the door closed or travelling along in a City vehicle, as well as employees working in a cubicle and separated from others by a partition and at least two meters
- Emergency services personnel, including police officers, firefighters and paramedics, while on duty as they already follow stringent additional health and safety internal department protocols

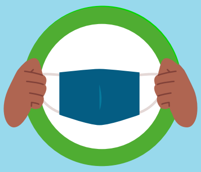
APPENDIX B – HOW TO SAFELY USE A NON-MEDICAL MASK OR FACE COVERING

HOW TO SAFELY USE A NON-MEDICAL MASK OR FACE COVERING

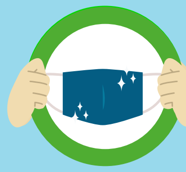
DO'S

DO wear a non-medical mask or face covering to protect others.

DO ensure the mask is made of at least two layers of tightly woven fabric.



DO inspect the mask for tears or holes.

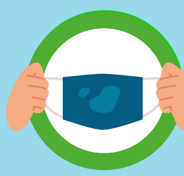


DO ensure the mask or face covering is clean and dry.

DO wash your hands or use alcohol-based hand sanitizer before and after touching the mask or face covering.

DO use the ear loops or ties to put on and remove the mask.

DO ensure your nose and mouth are fully covered.



DO replace and launder your mask whenever it becomes damp or dirty.

DO wash your mask with hot, soapy water and let it dry completely before wearing it again.

DO store reusable masks in a clean paper bag until you wear it again.

DO discard masks that cannot be washed in a plastic-lined garbage bin after use.

DON'TS

DON'T reuse masks that are moist, dirty or damaged.

DON'T wear a loose mask.

DON'T touch the mask while wearing it.

DON'T remove the mask to talk to someone.

DON'T hang the mask from your neck or ears.

DON'T share your mask.

DON'T leave your used mask within the reach of others.

DO YOUR PART.

Wear a non-medical mask or face covering to protect others when you can't maintain a 2-metre distance.

NON-MEDICAL MASKS ARE NOT RECOMMENDED FOR:

- People who suffer from an illness or disabilities that make it difficult to put on or take off a mask
- Those who have difficulty breathing
- Children under the age of 2

DON'T JUDGE OTHERS FOR NOT WEARING A MASK.

Kindness is important as some people may not be able to wear a mask or face covering.

REMEMBER, wearing a non-medical mask or face covering alone will not prevent the spread of COVID-19. You must also wash your hands often, practise physical distancing and stay home if you are sick.

Public Health Agency of Canada
Agence de la santé publique du Canada

Canada

UTILISATION SÛRE D'UN MASQUE NON MÉDICAL OU D'UN COUVRE-VISAGE

À FAIRE

PORTEZ un masque non médical ou un couvre-visage pour protéger les autres.

ASSUREZ-VOUS que le masque est constitué d'au moins deux couches de tissu tissé serré.

INSPECTEZ le masque pour voir s'il y a des déchirures ou des trous.

ASSUREZ-VOUS que le masque ou le couvre-visage est propre et sec.

LAVEZ-VOUS les mains ou utilisez un désinfectant pour les mains à base d'alcool avant de toucher votre masque ou votre couvre visage, et après l'avoir fait.

TOUCHEZ uniquement les attaches qui passent derrière les oreilles ou la tête pour enfiler et retirer le masque.

ASSUREZ-VOUS que votre nez et votre bouche sont entièrement couverts.

REMPLACEZ et lavez votre masque s'il devient humide ou souillé.

LAVEZ votre masque à l'eau chaude savonneuse et laissez-le sécher complètement avant de le porter de nouveau.

ENTREPOSEZ vos masques réutilisables dans un sac en papier propre jusqu'à ce que vous les portiez de nouveau.

JETEZ les masques non lavables dans une poubelle doublée d'un sac de plastique après utilisation.

À ÉVITER

NE RÉUTILISEZ PAS les masques qui sont humides, sales ou endommagés.

NE PORTEZ PAS un masque trop ample.

NE TOUCHEZ PAS le masque lorsque vous le portez.

N'ENLEVEZ PAS votre masque pour parler à quelqu'un.

NE LAISSEZ PAS le masque pendre à votre cou ou à vos oreilles.

NE PRÊTEZ PAS votre masque.

NE LAISSEZ PAS un masque usagé à la portée des autres.

FAITES VOTRE PART

Portez un masque non médical ou un couvre-visage pour protéger les autres lorsque vous ne pouvez pas maintenir une distance de 2 mètres.

LES MASQUES NON MÉDICAUX NE SONT PAS RECOMMANDÉS POUR :

- les personnes atteintes d'une maladie ou d'un handicap qui complique le port ou le retrait d'un masque;
- les personnes qui ont des problèmes respiratoires;
- les enfants de moins de deux ans.

NE JUGEZ PAS CEUX QUI NE PORTENT PAS DE MASQUE.

La gentillesse est de mise, car certaines personnes ne peuvent pas porter de masque ou de couvre-visage.

N'oubliez pas que le seul fait de porter un masque non médical ou un couvre-visage n'empêchera pas la propagation de la COVID-19. Vous devez également vous laver souvent les mains, maintenir une distance physique avec les autres et rester à la maison si vous êtes malade.

2 m

APPENDIX C – CITY OF WINNIPEG COVID-19 SCREENING QUESTIONNAIRE

Winnipeg

COVID-19 Daily Self-Screening Questionnaire

These are questions that employees should ask themselves prior to starting to their work day:

Any employee who is experiencing ANY of the symptoms below should NOT enter the workplace until they are symptom free for a full 24 hour period. https://sharedhealthmb.ca/covid19/screening-tool/ Manitobans are reminded that if they are showing symptoms of COVID-19 and meet testing criteria, they can call Health Links–Info Santé at 204-788-8200 or (toll-free) at 1-888-315-9257 for more information.

Do you have any of the below symptoms?		
Feeling of fever or chills?	Yes	No
New onset of cough or increase in amount of coughing?	Yes	No
Sore throat?	Yes	No
Shortness of Breath?	Yes	No
New onset symptom: runny nose/ congestion (not related to allergies)?	Yes	No
Headache or unusual headache?	Yes	No
Sore muscles not related to overexertion or exercise?	Yes	No
New onset symptom: diarrhea?	Yes	No
New onset symptom: loss of taste and/or smell?	Yes	No
Have you had close contact (within 2 metres) with a confirmed case of COVID-19?	Yes	No
Have you been told by Public Health to be in self-isolation?	Yes	No
In the last 14 days have you returned from international travel, or from Ontario (east of Terrace Bay), Quebec or the Atlantic provinces? Travel restrictions are subject to change; up-to-date information is available at: https://www.gov.mb.ca/covid19/soe.html	Yes	No

IF ALL ANSWERS ARE NO

- Clean your hands again and enter the work location

IF ANY ANSWERS ARE YES

- **DO NOT ENTER FURTHER INTO THE WORK LOCATION**
- Contact your workplace supervisor
- Contact Occupational Health: 204-986-5218
- Call Health Links–Info Santé at 204-788-8200 or (toll-free) at 1-888-315-9257
- Return home maintaining social distancing

APPENDIX D – SAMPLE NON-DISCLOSURE AGREEMENT

APPENDIX D – SAMPLE NON-DISCLOSURE AGREEMENT

NON-DISCLOSURE AGREEMENT

To register, please complete and return this Non-Disclosure Agreement by email

TO: Brian Station, P. Eng.
Project Manager
bstation@winnipeg.ca

REFERENCE: Request for Proposal No. 384-2020 for Professional Consulting Services for North End Sewage Treatment Plant Return Activated Sludge Piping System Refurbishment Detailed Design and Contract Administration (the "RFP")

In consideration of receiving Confidential Information from the City of Winnipeg and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, ____________________________(insert name of legal name of counterparty) (the "Confidant") agrees as follows:

1. Definitions: In this Agreement the following terms shall have the following meanings:
a) "Agreement" means this agreement.
b) "Confidant" means the Person named as such above.
c) "Confidential Information" means any and all information, regardless of form, format or medium (including without limitation visual or oral information), of, related to, concerning, or resulting from, the City, the RFP and/or the Permitted Use, which comes into the possession or knowledge of the Confidant, including, without limitation, the RFP, documents, business information, know how, data, trade secrets, processes, designs, communications, materials, drawings, diagrams, computer programs, concepts, and any and all copies, reproductions, modifications, and derivative works.
d) "Effective Date" is the day and date last below written.
e) "City" means The City of Winnipeg.
f) "Permitted Use" means private evaluation by the Confidant solely for the purpose of preparing a submission(s) to City in response to the RFP, and for no other purpose whatsoever.
g) "Person" shall be broadly interpreted to include, without limitation, any corporation, partnership, other entity, or individual.
h) "RFP" has the meaning given above.
i) "Third Party" means any Person other than City or Confidant.

2. Access/Use of Confidential Information: Subject to the terms and conditions of this Agreement, Confidant may use the Confidential Information only for the Permitted Use and for no other purpose whatsoever. Confidant acknowledges and agrees that City reserves the full independent right to modify the scope and content of Confidential Information available for access and/or use hereunder at any time and without prior notice.

3. **Restrictions**: Confidant agrees that:
a) Confidential Information shall be kept in the strictest confidence without limitation of time, and shall not be disclosed to any Third Party;
b) Confidant shall restrict access to Confidential Information only to its employees with a need to know to carry out the Permitted Use, and prior to disclosing same, each such employee shall be made aware of the terms and conditions of this Agreement; and
c) Confidant shall cause all of its applicable employees to observe the terms of this Agreement, and shall be responsible for any breach of the terms of this Agreement by it or any such employee.

4. **Return of Confidential Information**: The Confidant shall immediately on notice at any time from City return to City, or destroy, any and all Confidential Information in accordance with City's direction.

5. **Continuing Obligations and Remedies**: The obligations of Confidant under this Agreement shall not terminate but shall continue without limitation of time. Confidant acknowledges and agrees that a breach of any term or condition of this Agreement shall cause irreparable harm to City which cannot be adequately compensated for in damages, and accordingly Confidant agrees that City shall be entitled, in addition to any other remedies available to it, to interlocutory and permanent injunction relief to restrain any anticipated, present or continuing breach of this Agreement.

6. **No License Granted**: Confidant acknowledges and agrees that all rights in and to Confidential Information are and shall remain the sole property of City, and Confidant agrees that it shall not contest or challenge any of City's rights in or to any Confidential Information. Nothing in this Agreement obligates, or shall be deemed to obligate, City to provide, disclose, or deliver any Confidential Information.

7. **Enurement**: This Agreement shall be binding and shall enure to the benefit of the parties hereto, and their respective legal representatives, successors and permitted assigns.

8. **Governing Law and Interpretation**: This Agreement shall be subject to, interpreted, performed and enforced in accordance with the laws of Manitoba and the applicable laws of Canada without regard to Manitoba or Federal Canadian law governing conflicts of law, even if one or more of the parties to this Agreement is resident of or domiciled in any other province or country. Section headings in this Agreement are for the convenience of the parties only, and shall not affect the interpretation of this Agreement.

9. **Severability**: If any provision in this Agreement is illegal, invalid or unenforceable at law, it shall be deemed to be severed from this Agreement and the remaining provisions shall continue in full force and effect. The parties agree that they shall endeavor to replace any such severed provision with a new provision which achieves substantially the same practical effect and which is valid and enforceable.

10. **No Waiver**: No waiver of any provision of this Agreement, or a breach thereof, shall be effective unless it is in writing and signed by the party waiving the provision or the breach thereof. No waiver of a breach of this Agreement, whether express or implied, shall constitute a waiver of a subsequent breach thereof.

11. **Amendments**: No amendment or change or modification of this Agreement shall be valid unless it is in writing and signed by both parties.

12. **Assignment**: Confidant shall not assign this Agreement without first having obtained the prior written consent of City. No assignment of this Agreement shall operate so as to relieve Confidant from any obligation of this Agreement.

13. **No Authority**: This Agreement shall not create, nor shall it be deemed to create, the relationship of employer and employee, principal and agent, partnership, or joint venture, between City and Confidant. Confidant has no authority whatsoever to make any representation in respect of, enter any commitment on behalf of, or incur any liability for or on behalf of, City, or to bind or purport to bind City to any Third Party in any way whatsoever.

14. **Further Acts and Assurances**: Each of the parties shall, from time to time, do all acts and things and execute from time to time all such further documents and assurances as may be necessary to carry out and give effect to the terms and conditions of this Agreement.

15. **Opportunity to Negotiate**: Both parties have had the opportunity to negotiate, review and comment upon this Agreement, and obtain independent legal advice with respect to the content, meaning, and legal effect of this Agreement.

18. **Fax Execution**: This Agreement may be executed in any number of counterparts, including counterparts signed by fax, each of which shall be deemed an original and all of which together shall constitute one in the same instrument. A photocopied and/or fax copy of this Agreement bearing the signature of each party, in a single document or counterparts thereof as provided herein, shall be deemed an original execution version of this Agreement.

IN WITNESS WHEREOF, an authorized representative of the Confidant has executed and delivered this Agreement, as of the _____ (day) day of __________ (month), 2020 (the "Effective Date").

Authorized Signature ______________________________________

Print Name: ______________________________________

Title: ______________________________________

Confidant Contact:

Company Name: ______________________________________

Contact Name: ______________________________________

Title: ______________________________________

Telephone: _______________________ Fax: ________________

Email: _______________________

APPENDIX E – DEFINITION OF PROFESSIONAL CONSULTANT SERVICES

APPENDIX E –DEFINITION OF PROFESSIONAL CONSULTANT SERVICES

DEFINITION OF PROFESSIONAL CONSULTANT SERVICES (CONSULTING ENGINEERING SERVICES)

1. INTRODUCTION

1.1 It is the intent of the City of Winnipeg, in defining Professional Consultant Services (Consulting Engineering Services), to clarify the role required of consulting Engineers; to more fully identify the services to be rendered by consulting Engineers to the City and to other parties on behalf of the City; and to provide a more clearly determined basis of obligation in respect thereof by consulting Engineers to the City and to third parties in the provision of such services.

1.2 The services shall be performed in the City of Winnipeg, unless otherwise authorized by the City, under direct supervision of a professional Engineer. All drawings, reports, recommendations and other documents, originating therefrom involving the practice of professional engineering, shall bear the stamp or seal and signature of a qualified Engineer as required by the Engineering and Geoscientific Professions Act of the Province of Manitoba and By-laws of the Association of Professional Engineers and Geoscientists of the Province of Manitoba. Other reports and documents not involving the "practice of professional engineering", such as letters of information, minutes of meetings, construction progress reports, may be originated and signed by other responsible personnel engaged by the consulting Engineer and accepted by the City. Progress estimates, completion certificates and other reports related to the technical aspects of a Project, must be endorsed by the Engineer in a manner acceptable to the City.

2. ADVISORY SERVICES

2.1 Advisory services are normally not associated with or followed by preliminary design and/or design services, and include, but are not limited to:

(a) Expert Testimony;
(b) Appraisals;
(c) Valuations;
(d) Rate structure and tariff studies;
(e) Management services other than construction management;
(f) Feasibility studies;
(g) Planning studies;
(h) Surveying and mapping;
(i) Soil mechanics and foundation engineering;
(j) Inspection, testing, research, studies, or reports concerning the collection, analysis, evaluation; and
(k) Interpretation of data and information leading to conclusions and recommendations based upon specialized engineering experience and knowledge.

3. PRELIMINARY DESIGN

3.1 Preliminary design services are normally a prelude to the detailed design of a Project and include, but are not limited to:

(a) Preliminary engineering studies;

(b) Engineering investigation;

(c) Surface and subsurface site explorations, measurements, investigations, and surveys;

(d) Operations studies including drainage studies, traffic studies, etc.;

(e) Functional planning;

(f) Physical, economical (capital and operating) and environmental studies including evaluation, comparison, and recommendation regarding alternative preliminary designs;

(g) Preparation and submission of a report and appropriate drawings to the City, fully documenting data gathered, explaining adequately the assessment made, stating with clarity the resulting conclusions, and containing all recommendations which are relevant to this stage of Project implementation;

(h) Special applications to public agencies for necessary authorizations, preparation and submission of reports and drawings thereto and appearance before same in support of the application.

4. DETAILED DESIGN

4.1 Detailed design services normally involve preparation of detailed designs, tender specifications and drawings, and analysis of bids and recommendations for contract award, and include, but are not limited to:

(a) Addressing alternative methods of accommodating; relocating; avoiding, and/or avoiding injury to Utilities and railways; proposing alternative methods of solution, reviewing same with the appropriate Regulatory approval agencies and stakeholders;

(b) Application to public agencies for necessary authorizations, preparation and submission of reports and drawings thereto, and appearance before same in support of the application;

(c) Preparation and submission of detailed engineering calculations, drawings, and criteria employed in the design(s), securing review of and an acceptance by the City;

(d) Preparation of detailed engineering drawings, specifications and tender documents consistent with the standards and guidelines of the City, securing review of acceptance by the City;

(e) Preparation and provision to the City in written form, a fully detailed formal construction contract estimate;

(f) Provision of appropriate response to bidders and advice to the City during the bid period and, subject to acceptance by the City, issuing addenda to the tender documents;

(g) Submission of a review, analysis, comparison, tabulation, calculation, and evaluation of the bids received, to the City;

(h) Preparation of a report including revised contract estimate, identifying and explaining variations from the earlier formal estimate, and containing recommendation regarding contract award identifying the reasons therefore.

5. CONTRACT ADMINISTRATION SERVICES

5.1 Contract administration services are associated with the construction of a Project and include the office and field services required to ensure the conduct of the Project in accordance with the intent of the City and in conformance with the particulars of the drawings and specifications; and include but are not limited to:

NON-RESIDENT SERVICES

(a) Consultation with and advice to the City during the course of construction;

(b) Review and acceptance of shop drawings supplied by the contractor or supplier to ensure that the drawings are in conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(c) Review and report to the City upon laboratory, shop and other tests conducted upon materials and/or equipment placed or installed by the contractor to ensure to the City conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(d) Acceptance of alternate materials and methods, subject to prior acceptance by the City, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(e) Provision to the City of a complete current report on the Project status on a monthly basis;

(f) Provision to the City a current update of revised contract-end cost estimate on a monthly basis, or more frequently if found necessary, with explanation and justification of any significant variation from the preceding contract-end cost estimate;

(g) Definition and justification of and estimate of cost for additions to or deletions from the contract for authorization by the City;

(h) Furnishing the City with a copy of all significant correspondence relating directly or indirectly to the Project, originating from or distributed to, parties external to the consulting Engineer, immediately following receipt or dispatch of same by the consulting Engineer;

(i) Provision of adequate and timely direction of field personnel by senior officers of the Consultant;

(j) Establishment prior to construction and submission to the City of written and photographic records of, and assessment of the physical condition of adjacent buildings, facilities, and structures sufficient to equip the consulting Engineer to provide valid evidence and relevant testimony in settlement of any claim involving the City by any court of law, or by any other party for damages thereto arising from the Project;

(k) Arranging and attending pre-construction meetings and on-site or off-site review meetings, which meetings shall include representatives of the contractor and the City;

(l) The preparation and submission of:

    (i) a detailed design notes package including items such as structural geotechnical, hydraulic and heating, air-conditioning and ventilation design calculations; mechanical and electrical design calculations related to process equipment and building services; process design calculations; and instrumentation and process control design calculations;

    (ii) approved related shop drawings and equipment process manuals all within one (1) month of completion of each separate installation contract required to complete the Works.

RESIDENT SERVICES

(a) Provision of qualified resident personnel acceptable to the City present at the Project site to carry out the services as specified immediately below, without relieving the contractor of his contractual and other legal obligations in respect thereof:
   (i) inspection of all pipe prior to installation;
   (ii) inspection and acceptance of excavation for, and full time inspection at the time of bedding placement, pipe laying and backfilling in respect of installation of watermains, LDSs, and wastewater sewers;
   (iii) inspection of installation of all connections to watermains, sewers, manholes, valves, hydrants or house services, and excavation and/or exposing of all underground services, structures, or facilities;
   (iv) "full time inspection" and/or testing of watermains and sewers;
   (v) inspection of all excavations to determine soil adequacy prior to installation of base and subbase courses for sidewalks, public back lanes, and street pavements.

   It is to be understood that "full time inspection" will require assignment of a qualified Person to each specific location when the referenced work is being undertaken by the contractor.

(b) Without relieving the contractor of his contractual and other legal obligations in respect thereof, conduct detailed inspection of construction sufficient to ensure that the construction carried out by the contractor is in conformance with the drawings and specifications;

(c) Co-ordination and staging of all other works on the Project site including traffic signal installations, hydro, telephone, and gas utility work, railway work forces and City or developer work;

(d) In conjunction with the City, provision of notice to adjacent residents and businesses of those stages of construction of the Project that will interrupt public services or access thereto, sufficiently in advance of same to permit preparation therefore;

(e) Enforcement of contractor conformance with the City of Winnipeg Manual of Temporary Traffic Control in Work Areas on City Streets and with reasonable standards of safety for motorists and pedestrians, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(f) Provision of reference line and elevation to the contractor and checking upon the contractor's adherence thereto, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(g) Responsible, sensitive, and prompt reaction to the reasonable requests and complaints of citizens regarding the conduct of the Project, acting in the interest of the City;

(h) Arranging for and carrying out of testing of materials utilized by the contractor to ensure conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(i) Preparation, certification, and prompt submission of progress estimates to the City for payment to the contractor for construction performed in accordance with the drawings and specifications;

(j) Arrange, attend and prepare and distribute records of and minutes for, regularly held on-site or offsite Project review meetings including representatives of the contractor and the City;

(k) Promptly reporting to the City upon any significant and unusual circumstances;

(l) Promptly arranging for and taking part in a detailed final inspection of the Project with the contractor and the City prior to commencement of the period of contractor maintenance guarantee specified in the contract for the Project and providing to the

City in written form an appropriate recommendation of acceptance of the constructed or partially constructed Project;

(m) Act as Payment Certifier and administer all contracts as required under the Builder's Liens Act of Manitoba;

(n) Prepare a Certificate of Substantial Performance;

(o) Preparation and submission to the City of "as-constructed" drawings for the Project within 1 month of Project completion;

(p) Prepare a Certificate of Total Performance;

(q) Provision of inspection services during the maintenance guarantee period of the contract;

(r) Undertake a detailed inspection of the Project with the contractor and the City prior to the end of the period of contractor maintenance guarantee specified in the contract for the Project;

(s) Keep a continuous record of working days and days lost due to inclement weather during the course of contract works;

(t) Prepare a Certificate of Acceptance.

6. ADDITIONAL SERVICES

6.1 Additional services are in addition to those specified in other Types of Services and may or may not be associated with a construction Project, but are not in place of or in substitution for those services elsewhere specified in the Definition of Standard Consulting Engineering Services in respect of other Types or Categories of Services.

(a) Revision of completed, or substantially completed, drawings and/or specifications that were in conformance with the original intent of the City or had been accepted by the City;

(b) Preparation of operating manuals and/or training of operating personnel;

(c) Startup and/or operation of operating plants;

(d) Procurement of materials and equipment for the City;

(e) Preparation for and appearance in litigation on behalf of the City;

(f) Preparation of environmental studies and reports and presentation thereof in public hearings.

APPENDIX F – WSTP ARCHITECTURAL DESIGN GUIDELINE - R01

The City of Winnipeg

Winnipeg Sewage Treatment Program

Architectural Design Guideline

Document Code:

Revision: 01

Approved By:	Duane Griffin, Branch Head - Wastewater Planning & Project Delivery	Nov 27, 2018 Date

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REVISION REGISTER				
Rev.	**Description**	**Date**	**By**	**Approved**
00	Issued for Use	2015-08-18	C. Reimer	D. Griffin
01	Minor Changes	2018-11-22	C. Reimer	D. Griffin

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Table of Contents

1 INTRODUCTION

This document identifies the standard architectural design requirements that are applicable to any 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 to convey general design guidance and expectations regarding architectural 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 architectural designers to fully develop the architectural details with general conformance to the concepts presented herein. This standard shall not be construed as comprehensive architectural / engineering design requirements or negate the requirement for professional architectural / engineering involvement. Any design must be executed under the responsibility and seal of the respective architect / 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 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, 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

AASHTO	American Association of State Highway and Transportation Officials
AHJ	Authority Having Jurisdiction
CMU	Concrete Masonry Unit
FRP	Fibreglass Reinforced Plastic
NBC	National Building Code
NFC	National Fire Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
STC	Sound Transmission Class
UL	Underwriters Laboratory, Inc.
ULC	Underwriters' Laboratories of Canada
WSTP	Winnipeg Sewage Treatment Program

1.5 Definitions

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 PLCs and control panels, but not typically occupied by personnel for operations functions.
Codes	As defined in Section 2.1.
Contractor	The entity responsible for constructing the design. In a design-build procurement methodology, this is the design-builder.
Control Room	A room containing PCS operator workstations and other operator systems for monitoring and controlling the facility.
Electrical Room	A room this is primarily designated to contain electrical equipment, including switchgear, MCCs and panelboards.
Engineer of Record	The professional engineer ultimately responsible for the design.
Hazardous Location	An area where flammable liquids, gases, vapors or combustible dusts may exist in sufficient quantities to produce an explosion or fire.
Non-Process Area	Any area or location either within or outside of a building that is not a Process Area.
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.

2 GENERAL

2.1 Design Codes and Standards

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

- Manitoba Building Code (National Building Code of Canada with Manitoba Amendments)
- Manitoba Energy Code (National Energy Code with Manitoba Amendments)
- National Fire Code of Canada (NFC)

2.2 Referenced Standards

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

- National Fire Protection Association (NFPA) standards, including:
  - NFPA 101 Life Safety Code
  - NFPA 820 Fire Protection in Wastewater Treatment and Collection Facilities

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 City Of Winnipeg Accessibility Design Standards

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).

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3 BUILDING CODE REQUIREMENTS

3.1 Building Code Classification

All facilities will be designed in accordance with applicable codes for life safety, fire protection, and occupational health and safety.

It is expected that existing buildings were designed in compliance with the codes and standards applicable at that time. Renovations within existing building and upgrades limited to the equipment replacement should not typically affect building Use Group and Occupant Load classification as defined in the National Building Code of Canada (NBC). The type of the alteration and repairs within existing buildings must be reviewed with the Authorities Having Jurisdiction (AHJ) to define which areas might need further upgrades to meet current codes and standards. Ensure that buildings renovations and upgrades are carried out with the indicated design intent to maintain the degree of safety within all existing areas.

Where new structures need to be attached to existing buildings, firewall separation may need to be provided. Ensure that the proposed design approach will satisfy the requirements of applicable building code in terms of fire safety and protection for both new and adjacent existing structures.

3.2 Accessibility Requirements

The City Of Winnipeg Accessibility Design Standards requires application in all City public and employee spaces, but as per the standard shall not be applied to wastewater/sewage treatment Process Areas.

The application of the City Of Winnipeg Accessibility Design Standards within wastewater/sewage treatment plants shall include, but not be limited to:

- Administration Areas;
- Employee spaces such as lunch rooms and locker rooms;
- Control rooms and suites that are routinely occupied. This includes the main control room and a secondary control room (if applicable), but does not typically include area control rooms;
- Other Non-Process Areas routinely occupied by personnel.

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4 BUILDING COMPONENTS

4.1 Exterior Treatment and Materials

1. Design structure exteriors to be practical and functional with emphasis on durability and minimum maintenance requirements.
2. Ensure exteriors are complementary to existing structures on the site.
3. Consider the use of local construction materials and techniques where practical and cost effective.

4.2 Exterior Walls

1. Design exterior walls using cavity wall construction with Concrete Masonry Unit (CMU) or concrete backup wall faced with air barrier, insulation, air space, and wall facing of either:
   - Face brick
   - Architectural Concrete Masonry Unit (ACMU)
   - Stone
   - Metal siding
2. Select the facing material based on the appearance of adjacent buildings, material cost and durability.
3. Design insulation to meet the greater of the following:
   3.1 The requirements and recommendations of the National Energy Code; or
   3.2 A minimum R value of 20
4. Wall insulation requirements do not necessarily apply to tank walls.

4.3 Roofs

1. Ensure that the design arrangements of roofs, canopies, fascia, parapets, overhangs, or other roof elements will be in harmony with the massing and materials of the structures, and to control runoff and direct drainage away from equipment, doorways, sidewalks, ramps, or other occupied areas.
2. For flat roofs, provide with a with Modified Bitumen Roofing assembly. Ensure slopes to drains are provided with tapered insulation. Design overflow roof drains or scuppers to satisfy building code requirements.
3. For sloped roofs, design using an insulated metal roofing assembly.
4. Design roof assemblies to achieve a minimum R value of 40 and meet the requirements of the National Energy Code, whichever is greater.
5. Where required for equipment removal and replacement, provide removable skylights.
6. Consider the use of insulated aluminum or FRP dome covers over circular process tanks as an alternate to a conventional building roof and make a recommendation based upon the best lifecycle cost for the City.

7. Provide access to all roof levels via maintenance access hatches or exterior caged ladders.
8. Ensure travelled pathways on the roof are protected by concrete pavers.

4.4 Exterior Doors, Windows, and Louvers

1. General Requirements
   1.1 Design sills, thresholds, flashing, and trim to prevent water penetration to the interior of the building.
   1.2 Provide corrosion-resistant hardware, accessories, fasteners, and operating mechanisms.
2. Exterior doors
   2.1 Use extruded aluminum sections with factory-applied protective coatings.
   2.2 Ensure locksets and keying arrangements match the existing keying systems with a minimum of 6 pins
3. Windows
   3.1 Use extruded aluminum sections with factory-applied protective coatings.
   3.2 Provide glazing with tinted, insulated glass. Use tinted, insulated tempered glass for exterior doors, sidelights and transoms.
4. Equipment and vehicle doors
   4.1 Provide motorized operation for doors frequently utilized by personnel (weekly or more frequent).
   4.2 Provide manual backup for emergency hand operation of motorized doors.
5. Louvres
   5.1 Provide extruded aluminum sections with factory-applied protective coatings.
   5.2 Provide storm-proof louvre assemblies complete with bird screens, filters, dampers, blank-off panels, acoustical treatment, or other required features. Design louvres to prevent infiltration of rain and provide positive drainage to the exterior.
6. Provide signage at each door with the building name and door number, in accordance with the WWD Identification Standard.
7. Provide door monitoring and access control in accordance with the WSTP Automation Design Guide.

4.5 Open Grating Platforms, Railings, Ladders and Guardrails

1. Provide permanent access ladders and working platforms as required for operation and maintenance of equipment, instrumentation, and other systems. Permanent installations are required where:
   1.1 Operations or maintenance access is required at a typical frequency of once a month or greater; or
   1.2 The hazard / risk of performing the work is not within City safe work standards.
2. Select the material for interior and exterior open grating stairs, platforms, railings, and guardrails based on the specific local conditions and exposure to corrosive materials.
3. See Table 4-1 for a general guideline of materials.

Table 4-1 : Open Grating Platforms, Railings, and Guardrails Materials

Location	Material	Notes
Exterior	Aluminum	
Interior with no / minimal chlorine content	Aluminum	
Areas with corrosive chemicals such as chlorine	FRP (Fibreglass Reinforced Plastic)	Ensure anti-slip surface finish is provided.

4. Ensure adequate fall restraint provisions for the servicing of any roof top equipment such as condensing units and around tanks or locations where there is a significant drop in elevation.

4.6 Interior Treatment and Materials

1. Design structure interiors to be practical and functional with emphasis on durability with minimum maintenance requirements.
2. Consider using local construction materials and techniques where practical.
3. Design interior components and finishes with minimum flammability and smoke developed characteristics.

4.6.2 Interior Walls

1. Design interior walls within process areas of concrete or concrete masonry units (CMU). Where sound isolation is required, design with a minimum STC of 50.
2. Design interior walls within administrative/personnel areas of metal stud framing with sound attenuation blankets and applied gypsum board as finish materials with a minimum STC of 50.
3. Where required for fire separations, design walls in accordance with recognized tested ULC assemblies.

4.6.3 Floors

1. Select floor and base materials based on a minimum maintenance requirements and durability.
2. Provide a hard surface flooring material in process areas. Provide bases of suitable material and height to protect wall finishes.
3. Locker rooms, washrooms and shower areas: Ceramic tile as floor and base finish in washroom areas.
4. Design floors, ramps, and steps with non-slip finishes. Provide abrasive nosing inserts.
5. Access ramps shall be designed to have a maximum slope of ≤5% to ensure safe access for mobile maintenance equipment.
6. Provide anti-slip finish in areas where the floors may be slippery, such as polymer preparation rooms.
7. Provide floor slopes to drains in areas where process cleanup and hosedown may be required.

4.6.4 Ceilings

1. Ceilings will be designed to be integrated with the building services and lighting systems. Where required, provide ceiling materials and finishes that enhance the acoustic properties of the spaces.
2. Ensure that exposed structural elements in process areas are coated with the appropriate protection system.
3. Provide suspended acoustical tile ceilings in administrative areas.

4.6.5 Interior Doors, Frames, Sidelights, Transoms, and Windows:

1. Design interior doors, frames, sidelights, transoms, and windows of appropriate materials to meet fire-ratings (as applicable) and corrosion resistance of the environment. General standards of acceptance are as follows:
   - 1.1 Use painted steel components within general interior applications and fire-rated assemblies.
   - 1.2 Use corrosion resistant components in applications where additional corrosion resistance is required.
     - 1.2.1 Consider the use of aluminum components in spaces with moderate H_2S gases, but no chlorine content.
2. Provide glazing in the upper half of all interior doors except for bathrooms, janitor closets and private offices.
3. Provide clear tempered glazing for all interiors where glazing is not required to be labelled as a fire separation.
4. Provide corrosion-resistant hardware, accessories, fasteners, and operating mechanisms.
5. Provide room identification, consistent with the WWD Identification Standard, on all interior doors.
6. Provide door monitoring and access control in accordance with the WSTP Automation Design Guide.

4.6.6 Roof Access, Hatches and Floor Doors

1. Specify roof access hatches and floor doors as manufactured items.
   - 1.1 This does not eliminate the requirement of the engineer to fully detail out the configuration, dimensions, opening mechanism and other relevant details.
2. Unless in an area with chlorine content, design single or double leaf units to utilize aluminum components.
3. Provide for locking.
4. Design units subject to vehicle traffic for AASHTO H-20 loading, as a minimum. Higher ratings shall be provided based on the vehicles utilized.
5. Ensure that the units can be safely operated by personnel without the use of special equipment, such as a portable crane. Access hatched shall be hinged and manual lifting weight shall be limited to 23kg (50lb).

4.6.7 Painting and Protective Coatings

1. Where practical, the design should include factory finishes of interior items.
2. Provide field-applied finishes and protective coatings to all other building elements that are not supplied with factory-applied protective coatings.
3. Ensure coatings provide long-term service use with minimum maintenance requirements.

4.6.8 Chemical Resistant Coating Systems

1. In secondary containment areas, design chemical resistant coating systems to provide a minimum of 48-hour immersion protection against spills or leaks of stored chemicals.
2. Concrete coating systems shall include primer, fibreglass mat, saturant, and two trowel-applied coats of vinyl ester resin with silica filler.
3. Provide anti-slip finish on all horizontal surfaces with chemical resistant coating systems.

4.7 Noise Control

1. Perform noise calculations as indicated in Section 5.4.1. Coordinate with other disciplines as required.
2. Design appropriate acoustical treatment for areas subject to elevated noise levels.
3. Design the following spaces with indicated maximum ambient noise levels:

3.1	Administration & Office Spaces	50 dBA
3.2	Main Control Room	50 dBA
3.3	Control Rooms (Other than main)	55 dBA
3.4	Electrical Rooms	60 dBA
3.5	Server Rooms	70 dBA

4. Design all installations to meet the noise exposure limits as defined by the Manitoba Workplace Safety and Health Regulation (217/2006). An excerpt is included below for reference:

Hearing protection

12.3 If a worker is or is likely to be exposed to noise in a workplace that exceeds 80 dBA Lex but does not exceed 85 dBA Lex, the employer must

(a) inform a worker about the hazards of the level of noise; and

(b) on the request of the worker, provide him or her with

(i) a hearing protector that complies with CAN/CSA Standard-Z94.2-02, Hearing Protection Devices X Performance, Selection, Care, and Use, and

(ii) information about the selection, use and care of the hearing protector.

Control measures if exposure exceeds 85 dBA Lex

12.4(1) When a noise exposure assessment conducted under this Part indicates a worker is exposed to noise in the workplace that is more than 85 dBA Lex, and if reasonably practicable, an employer must implement sound control *measures that reduce the noise to which the worker is exposed to 85 dBA Lex or less.*

12.4(2) When it is not reasonably practicable to implement sound control measures, or the sound control measures implemented by an employer do not reduce the worker's noise exposure to 85 dBA Lex or less, an employer must

(a) inform the worker about the hazards of the level of noise;

(b) provide the worker with

(i) a hearing protector that

(A) complies with CAN/CSA Z94.2-02, Hearing Protection Devices X Performance, Selection, Care, and Use, and

(B) reduces the worker's noise exposure to 85 dBA Lex or less, and

(ii) information about the selection, use and care of the hearing protector; and

(c) at the employer's expense, provide the worker with the following audiometric tests:

(i) an initial baseline test as soon as is reasonably practicable but not later than 70 days after the worker is initially exposed to that noise level,

(ii) a further test at least once every year after the initial baseline test.

5. The acceptable noise level depends on the time of the exposure and the noise source. Absolute maximum noise exposure limits are indicated in Table 4-2; however these limits do not necessarily indicate minimum design requirements.

Table 4-2 : Noise Exposure Level Limits

Noise Level dbA	Maximum Permitted Daily Duration (Hours) (1)
85	8
88	4
91	2
94	1
97	0.5
100	0.25

Notes:

1. Table 4-2 is based upon Canadian Center for Occupational Health and Safety requirements. The table is provided for reference and does not necessarily indicate minimum design requirements.

6. The following shall be utilized as guidance regarding application of Manitoba Workplace Safety and Health Regulation clause 12.4(2), which provides an exemption regarding practicality of sound control measures.

6.1 The requirements of Table 4-3 are considered to be minimum requirements where acoustical treatment, noise reduction and/or reduction of worker exposure are required.

6.2 Where the calculated noise exposure for any space is above 85 dB after any proposed mitigation, provide complete documentation indicating the design rationale and demonstrating impracticability of further noise reduction.

6.2.1 Include operating assumptions.

6.2.2 Include applicable information from manufacturers.

6.2.3 Include calculations.

6.3 Design installations with high noise levels such that operational and maintenance activities in the space are minimized. For example, additional automation, locating control panels outside the room and providing a window to view the equipment from outside the room may reduce noise exposure.

6.4 Cost factors may be utilized as an argument regarding practicality only where approved by the City.

Table 4-3 : Acoustical Treatment Minimum Requirements

Typical Operational Use (1)	**Maximum Noise Level dbA**	**Noise Level Without Treatment dbA**	**Acoustical Treatment / Noise Reduction Required**	**Hearing Protection PPE Requirements**
Occupancy >= 2h / day	85	<= 85	No	N/A
		> 85	Yes	
Occupancy: 1 – 1.9h / day	88	<= 88	No	Mandatory (2)
		> 88	Yes	
Occupancy: 0.5 – 0.9h / day	91	<= 91	No	Mandatory (2)
		> 91	Yes	
Occupancy: 0.26- 0.5 / day	94	<= 94	No	Mandatory (2)
		> 94	Yes	
Occupancy: 0.01- 0.25 / day	97	<= 97	No	Mandatory (2)
		> 97	Yes	
Unoccupied spaces	115	> 115	Yes	Mandatory (2)

Notes:

1. *Operational Use is based upon typical daily operations, not including infrequent maintenance or special operating scenarios.*
2. *As per the Manitoba Workplace Safety and Health Regulation, hearing protection PPE is required for all spaces with a noise level above 85 dBA.*

3. Hearing protection is not readily available for noise levels above 115 dB, and thus shall be considered an upset maximum limit for noise exposure for any space, regardless of occupancy.

7. Where practical, select / specify / design equipment such that noise is reduced at the source.
   7.1 Utilize acoustical equipment covers where appropriate / required.
8. Design acoustical wall and ceiling panels to reduce ambient noise levels in rooms requiring acoustical treatment, in accordance with Table 4-3:
   8.1 The type and location of the acoustical panels shall be incorporated into the design drawings. This may require that an acoustical sub-consultant be utilized during the design phase.
   8.2 Coordinate the location of the panels with the equipment, piping and ducting, cabling, lighting etc.
   8.3 Ensure that the acoustical panels do not impede operation or maintenance activities.
9. For very high noise areas, consider whether access to the space should be provided with a vestibule to buffer the noise.
10. Spaces with noise levels above 85 dBA shall not be pathways through the plant required to access or egress from a space. For example, it shall not be required to pass through a noisy compressor room to reach a quieter mechanical room to change a filter.
11. For spaces with noise levels above 85 dBA the designer shall:
    11.1 Provide and document administrative controls to minimize worker exposure to the high noise levels.
    11.2 Minimize the instrumentation and other maintainable equipment within the noisy space. For example, control panels shall be located outside the noisy area. Coordinate with other disciplines as required.

5 ARCHITECTURAL DESIGN TEAM RESPONSIBILITIES

5.1 General

1. Responsibility for deliverables

    1.1 All drawings and other deliverables related to a design are the responsibility of the design architect / engineer.

2. Ensure all architectural deliverables are sealed by a qualified professional architect / 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.

    - Update existing building floor plans.
    - The update of architectural detail drawings for existing works is not expected to be 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 architectural deliverables shall be updated to "as-built" status at the end of the project. The "as-built" documents shall incorporate contractor mark-ups and all relevant information from 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 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 architectural / design team.

    7.2 Areas where an external 3rd party consultant may be utilized, with permission from the City, are:

    - Fire protection systems.
    - Acoustic systems

    7.3 The design team shall be responsible for monitoring the activities and progress of each 3rd party consultant.

    7.4 It is the responsibility of the design architect/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 architect / 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.

5.2 Drawings

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

5.2.1 General Requirements

1. Provide scale bar on all scaled drawings to allow for measurement takeoff and avoid any potential confusion regarding scale, regardless of the format or size reproduction of the document.
2. Show a north arrow on all plan drawings.

5.2.2 Legend

Provide a legend drawing showing the symbols and abbreviations utilized. Ensure that the legend is consistent with the City's practices.

5.2.3 Building Code Matrix

1. Provide a building code matrix for all new and modified buildings.

5.2.4 Life Safety Plan

1. Provide a life safety plan showing all occupied areas of the facility along with egress paths and distances to the nearest exit.

5.2.5 Floor Plans

1. Provide detailed floor plans for all building elevations.
2. Ensure all rooms are identified in a manner consistent with the Identification Standard.

    2.1 Ensure that the proposed room numbering coexists with the existing room numbering at the facility.

5.2.6 Elevation Drawings

1. Provide detailed building elevation drawings for all building exterior faces.
2. Ensure all exterior materials are clearly identified.

5.2.7 Stair Plan and Sections

1. Provide a comprehensive set of building stair plans and section drawings.
2. Ensure all materials of construction and dimensions are clearly identified.

5.2.8 Building Section and Detail Drawings

1. Provide a comprehensive set of building section and detail drawings to fully describe the construction of the building.
2. Ensure all materials of construction and dimensions are clearly identified.

5.2.9 Schedule Drawings

1. Provide a room finish schedule.
2. Provide a louvre schedule.
3. Provide a door schedule complete with hardware data and room identification requirements.
4. Provide a hatch schedule.

5.2.10 Window Elevation Drawings

1. Provide window elevation drawings for all large multi-panel windows.

5.2.11 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 architectural elements 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 building configuration.
    - 3.2 3D detail drawings of all areas with significant interdisciplinary coordination requirements.

5.3 Fire Safety Plan

1. Prepare drawings to be updated or included in the facility Fire Safety Plan, in accordance with the Guidelines for Preparation of Fire Safety Plans and Required Maintenance Procedures for all buildings coming under the Manitoba Fire Code, as adopted by the Fire Prevention By-Law 150/2004. The drawings required are as follows:

   1.1 Site plan showing at minimum: gas shut-off, electrical shut-off, fire hydrant, and muster/meeting points. Provision of this plan is required where the project work modifies the site plan in any way.

   1.2 Fire plan drawings for each level of each building showing at minimum emergency exits, fire alarm pull stations, fire extinguishers, fire alarm control panels, fire dept. access, electrical shut-off, gas shut-off, self-contained breathing apparatus, primary exit routes, emergency generator location. Provision of these drawings is required for any building where the project work modifies the fire safety plan in any way.

2. Incorporation of the drawings provided and packaging of the complete fire safety plan will be by the City.

5.4 Calculations

5.4.1 Noise Calculations

Coordinate with other disciplines and provide noise calculations, based upon design equipment and materials, for all rooms and spaces with noise levels above 80 dBA. Coordinate with other disciplines as required. The calculations are to be performed and presented to the City during the detailed design stage, prior to construction.

APPENDIX G – WSTP BUILDING MECHANICAL DESIGN GUIDELINE - R01

Winnipeg

The City of Winnipeg

Winnipeg Sewage Treatment Program

Building Mechanical Design Guideline

Document Code:

Revision: 01

Approved By:	Duane Griffin Duane Griffin, Branch Head - Wastewater Planning & Project Delivery	May 23, 2018 Date

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REVISION REGISTER				
Rev.	**Description**	**Date**	**By**	**Approved**
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Table of Contents

1 INTRODUCTION

This document identifies the standard building mechanical design requirements that are applicable to any work within the City of Winnipeg 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 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 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, 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

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
CSA	Canadian Standards Association
CO	Carbon Monoxide
DX	Direct Expansion
FRP	Fiber Reinforced Plastic
H_2S	Hydrogen Sulphide
HVAC	Heating Ventilation and Cooling
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
PCS	Process Control System
PLC	Programmable Logic Controller
RH	Relative Humidity
PCS	Process Control System
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
TLV-TWA	Threshold Limit Value - Time Weighted Average
TWA	Time Weighted Average
UL	Underwriters Laboratory, Inc.
VFD	Variable Frequency Drive
WSTP	Winnipeg Sewage Treatment Program

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 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 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-bid procurement methodology, this is typically the consultant. In a design-build procurement methodology, this is the design-builder.
Electrical Room	A room this is primarily designated to contain electrical equipment, including switchgear, MCCs and panelboards.
Engineer of Record	The professional engineer ultimately responsible for the design.
Hazardous Location	An area where flammable liquids, gases, vapors 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 a daily basis 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 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 2011 with Manitoba amendments
- 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 B149.1-10 Natural Gas and Propane Installation Code
- ANSI Z358.1-2009, Standard for Emergency Eyewash and Shower Equipment
- CSA B64.4-11 Reduced Pressure Principle (RP) Backflow Preventers
- CSA B64.5-11 Double 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
- 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 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.
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 in Pa (Pascals).

2.4 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.

2.5 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

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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 AHU's, fans, pumps, expansion units, ducting, refrigerant and drain piping, thermal and vapor 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 HVAC design that provides appropriate comfort for personnel and equipment protection.
5. Provide a 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 Area or auxiliary area and service areas, ventilation shall follow ASHRAE 62.1 for minimum outdoor air and exhaust.
8. For areas with no established standards (NFPA 820, ASHARE and NFC), design the ventilation in terms of air changes to follow good engineering practice in Manitoba. Consider heating cost implications when determining proposed ventilation rates.
9. 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:

Table 3-1: Outdoor Temperature Design Criteria

Winter:	-35°C DB (Dry Bulb)
Summer:	30°C DB (Dry Bulb)
	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	-	35°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 +/-1°C of the temperature setpoint, except that the average temperature of frequently occupied spaces shall be maintained with +/-0.5°C of the temperature. 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 average 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 takes into account 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 Table 3-1, 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 or greater) 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 Redundancy is required where a single point of failure would potentially create a hazardous situation.
   - 1.4 Provide redundancy 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 heat recovery systems, in accordance with Section 3.4.3.
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.
   - 2.5 Provide automation for boiler water treatment systems to limit operational involvement.

3. Gas fired air-handlers are preferred in areas of the facility where the use of hydronic heating is not practical.

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 40 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 design to avoid 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 in accordance with this Section 3.4.3.

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 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. 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 unit or air handling unit 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:
      1.1.1 They 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 taken into account 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 implications of AC units operating a 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 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 spaces 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 a stack to exhaust to atmosphere.

4.6 Equip each boiler unit with a condensate neutralization tank.

3.4.6 Natural Gas Heating

1. Direct-fired air handlers may only be utilized where:
    1.1 Serving Process Areas;
    1.2 Permissible by Codes;
    1.3 Do not serve or are located in an environment where there is a potential for an explosive atmosphere; and
    1.4 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. Do not size HVAC equipment beyond good engineering practice for design safety factors, most notably where there will be an ongoing increase in operating costs due to oversizing.
2. Coordinate with the architectural discipline to minimize building ventilation leakage rates through both material and component selection and construction methods.
3. Provide variable speed drives as appropriate to provide energy savings, where:
    3.1 Required for functional reasons; or
    3.2 The simple payback period of the additional capital cost (excluding engineering) is ten (10) years or less.
4. Under no condition shall any airflow or space be simultaneously, or near simultaneously, be 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 prevent 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 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 down 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 air handling unit filters.
8. Provide sufficient clearances to replace air handling unit 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 than 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 Section 3.8.4 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 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.

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.*

17. 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.
18. Provide all required facilities, to provide for safe maintenance access. 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.
19. Where HVAC components, including but not limited to dampers, are installed in locations where there is potential for corrosion (H_2S, chemical, etc.), ensure that the design and materials selected prevent corrosion.
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.

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

Note(s):

1. Minimum Efficiency Reporting Value (MERV) for filters as per ASHRAE Standard 52.2.

2. Provide bird screens for rooftop air handling unit intake louvers.
3. Where possible, select filters to minimize types of filters and reduce inventory stock requirements.
4. Provide filter instrumentation and PCS monitoring in accordance with the Automation Design Guide.
5. 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.
   - 5.1 Provide additional filter stages as required to address the atmosphere present.
   - 5.2 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. Ensure provision of removable insect screens for any air intake dampers and supply fans and also on the vent ducts/pipes for process as required.
3. Provide AMCA Type A or Type B spark resistant fans in all fans serving electrically classified spaces.

3.7.4 Equipment Design Requirements

1. Outdoor equipment shall not require the use of tools for regular inspections as 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.

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.
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.

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.

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:
   1.1 Section 3.8.3.
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 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, provide gasketted doors with self-closers to segregate spaces with different levels of electrical classification. In addition to the door, the following shall apply:

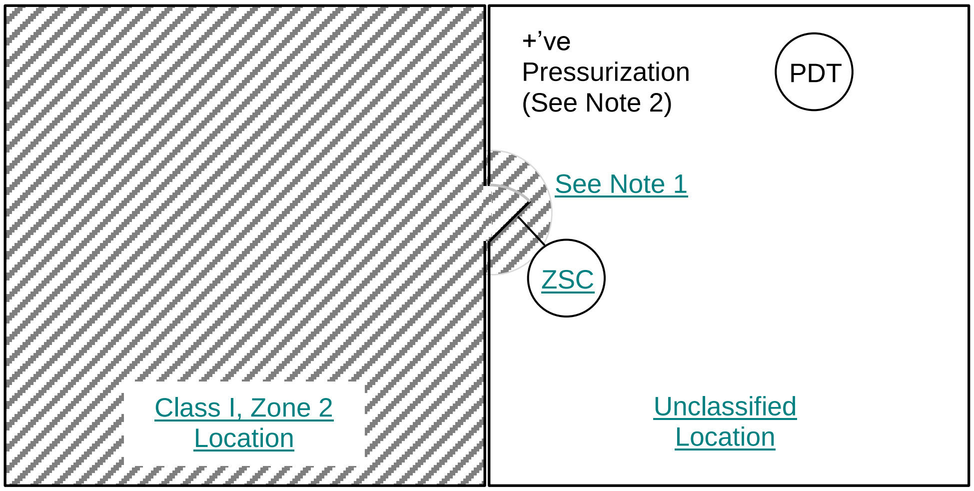
   6.1 Provide positive space pressurization for the unclassified location and negative pressurization for the classified location.

   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.”

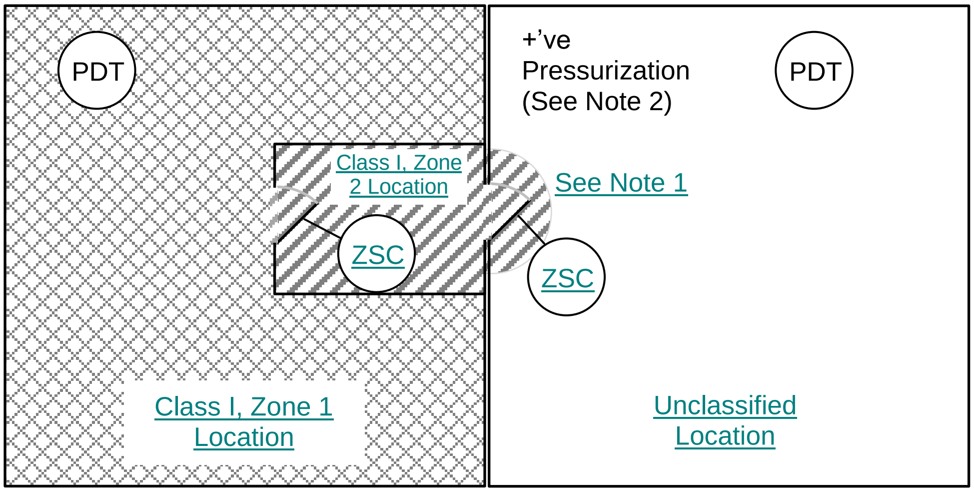
Figure 3-1 : Requirements for Doorway between Class I, Zone 2 and Unclassified Location



Notes:

1. *Each door shall be gasketted, 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



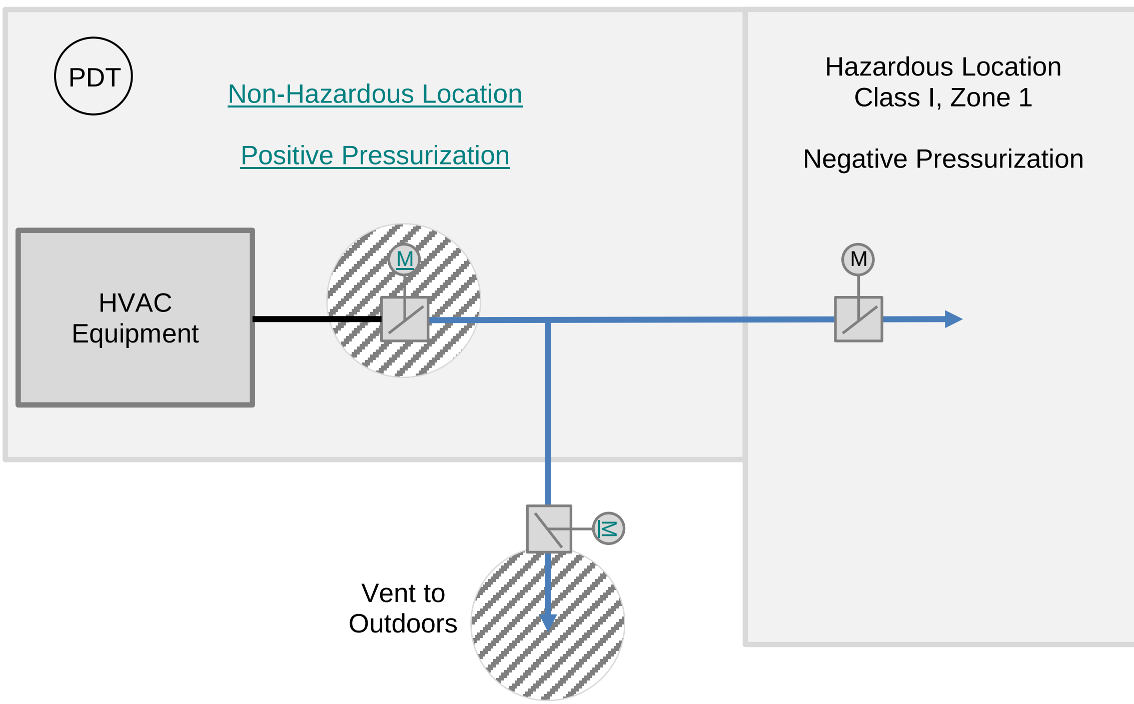
Notes:

1. *Each door shall be gasketted, 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.
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

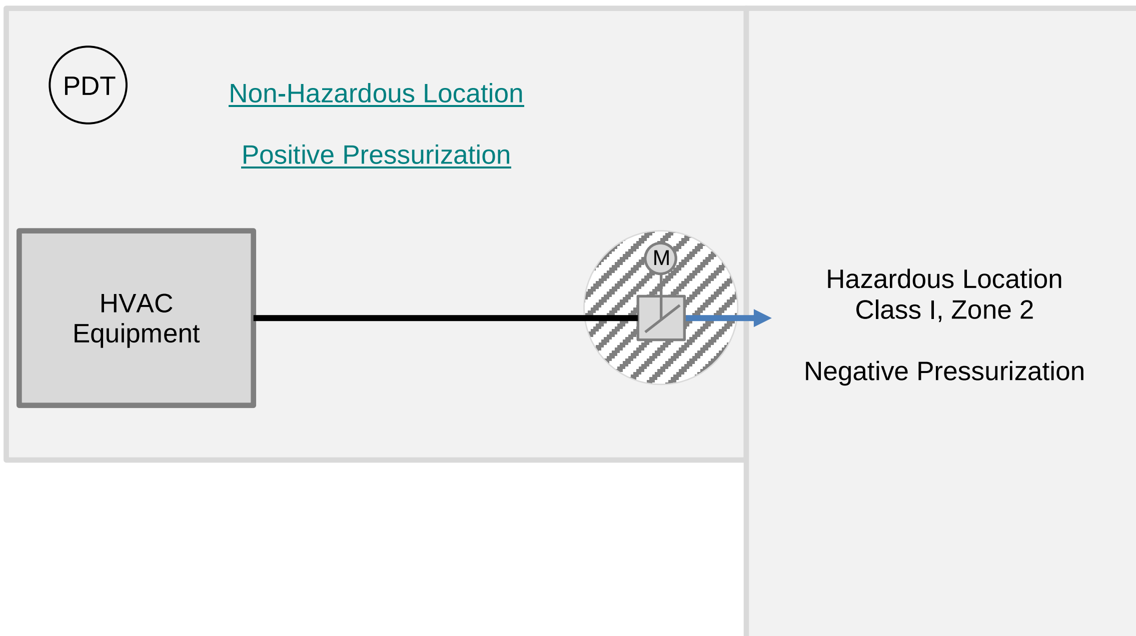


Notes:

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

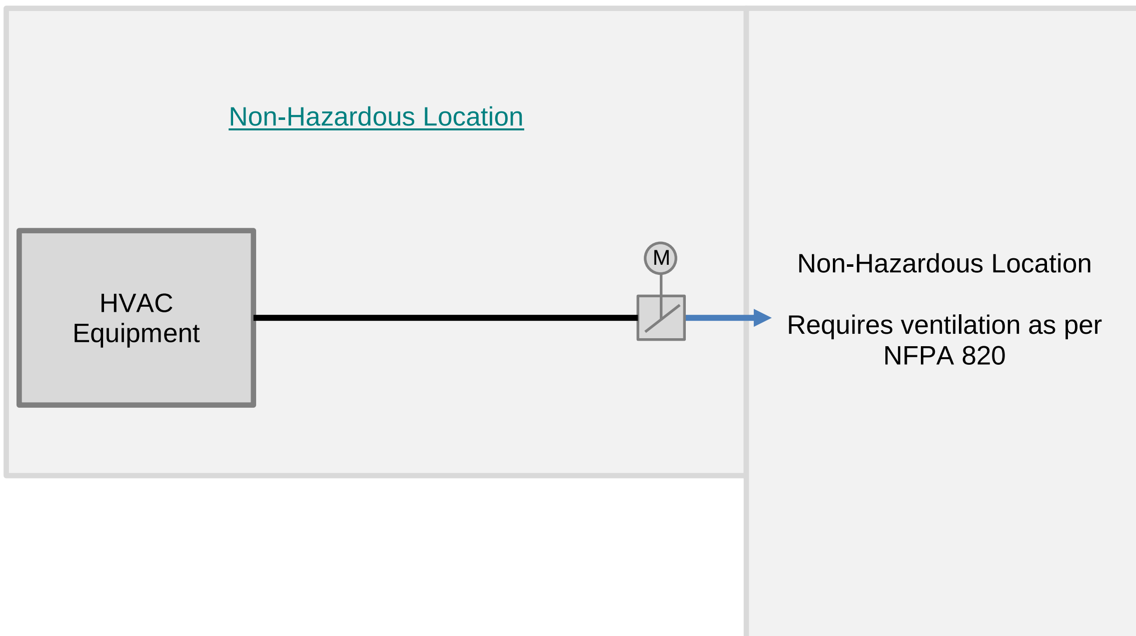


Notes:

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.*
4. *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.*

5. 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 VFD control to meet ventilation requirements as per National Fire Code and ASHRAE standards.

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4 PLUMBING SYSTEMS

4.1 General Requirements

1. Comply with the National Plumbing Code of Canada with Manitoba Code 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 room’s plumbing fixtures and combination 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 in accordance with Section 4.2.3.
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.

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.
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. 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, 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. Cause 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.

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
2. Provide piping material in accordance with 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 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
CS31	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. 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. 40
		200 - 400 mm		Sched. 30
		≥ 450 mm		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
PD01	HDPE	≥ 25 mm	ASTM D3350	SDR 11

Pipe Specification Code	Material	Size	Characteristics [1]	Minimum Schedule / Thickness [2]
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		Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441.	Schedule 80
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 TDW NPT	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 / Roof 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

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.*

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.

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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 certified by a registered Fire Protection Engineer.
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.

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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.

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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; and

   1.3 Lubricants.

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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 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, 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 A1 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 an A1 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 an A1 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 an A1 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 an A1 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 an A1 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 an A1 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 an A1 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 an A1 size format.

8.2.11 3D Model

1. A 3D model is required in the event 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; or
   1.3 Any new substructure or superstructure with a building footprint exceeding 10 m².
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, 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.

APPENDIX H – WSTP CIVIL DESIGN GUIDELINE - R01

The City of Winnipeg

Winnipeg Sewage Treatment Program

Civil Design Guideline

Document Code:

Revision: 001

Approved By:	D. Griffin Duane Griffin, Branch Head-WW Planning & Project Delivery	April 17, 2019 Date

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REVISION REGISTER					
Rev.	**Description**	**Date**	**By**	**Checked**	**Approved**
00	Issued as Final	2017-06-06	various	C. Reimer	D. Griffin
001	Revised Site Drainage Design Criteria	2018-10-18	C. Reimer	D.S. Allen	D. Griffin

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Table of Contents

1 INTRODUCTION

This document identifies the standard design requirements that are applicable to any civil 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 to convey general design guidance and expectations regarding civil infrastructure systems. This document does address specifics related to design type, selection, and configuration; however the indicated requirements are presented without knowledge of the specific site civil infrastructure implementation. It is not within the scope of this document to provide detailed design direction, and it will be the responsibility of the respective civil designers to fully develop the civil 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 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 and sites are expected to comply with this standard.
- All major upgrades to a building or site 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 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 on-site conditions, 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

AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standard Institute
ASTM	American Society for Testing Materials
AWWA	American Water Works Association
CSA	Canadian Standards Association
NBC	National Building Code
TAC	Transportation Association of Canada
WSTP	Winnipeg Sewage Treatment Program

2 GENERAL

2.1 Design Codes and Standards

The requirements of the latest issue of the following codes, standards and regulations shall apply to civil design:

- National Building Code of Canada with Manitoba Amendments (NBC);
- Geometric Design for Canadian Roads, Transportation Association of Canada (TAC);
- AASHTO Guide for Design of Pavement Structures;
- Manual of Uniform Traffic Control Devices for Canada (MUTCDC);
- Water Supply for Public Fire Protection, Fire Underwriters Survey;
- Canadian Standards Association (CSA);
- American National Standard Institute (ANSI);
- American Water Works Association (AWWA);
- National Fire Protection Association (NFPA);
- Transport Canada's Grade Crossing Standards (TC-E10); and
- Pipe and Wire Crossing CPR Right of Way Approval Guide.

2.2 Other City Standards

While not exclusive, ensure that the following City Standards are adhered to:

- Water Demand Estimation and Design Guidelines;
- Wastewater Flow Estimation and Servicing Guidelines;
- Storm Water Management Criteria;
- City of Winnipeg Transportation Standards Manual;
- 2010 City of Winnipeg Accessibility Design Standard;
- City of Winnipeg Standard Construction Specifications;
- City of Winnipeg Listings of Approved Products ;
- Water and Waste Department Identification Standard;
- Drainage Criteria Manual for the City of Winnipeg;
- Culvert and Drainage Inlet/Outlet Safety Guidelines;
- City of Winnipeg Water and Waste Department WWD CAD/GIS Standards (August 2016); and
- Manual for the production of Construction Drawings for the City of Winnipeg, Works and Operations Division (November 1984).

2.3 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; and
2. All elevations are to be in meters, in the format EL. ###.### (example EL. 273.520).

2.4 Site Co-ordinates

All site co-ordinates shall be provided in Universal Transverse Mercator (UTM) Zone 14 North mapping projection. North American Datum 1983 (NAD 83) co-ordinates using Province of Manitoba 1990 realization, consistent with City of Winnipeg co-ordinates

Vertical datum shall be as per metres above sea level (MSL) (example EL.273.500), and co-ordinated with on-site monumentation.

Co-ordinates shall be site calibrated to on-site monumentation, where provided. Site specific Combined Scale Factor shall be provided.

3 GENERAL SITE DEVELOPMENT REQUIREMENTS

3.1 Overall Site Layout

1. Provide an overall site layout design considering all civil and building works, as well as requirements of other disciplines.
   1.1 Include all inter-building electrical and control services.
   1.2 Include all inter-building mechanical services.
2. Coordinate site layout requirements to include both current and future site development requirements.
3. Coordinate the site arrangement to minimize fill and/or excavation costs while maintaining efficiency of project construction, operation, and maintenance.
4. Ensure oil and chemical storage areas are designed to contain spills.

3.2 Flood Protection

1. Unless otherwise indicated by the City, design flood protection systems to protect all facilities as follows:
   1.1 The NEWPCC shall be designed based on 700-year flood protection level of 229.83 m.
   1.2 The SEWPCC shall be designed based on 1997 FPL + 0.61m flood protection level (1997 water level + 0.61m + 0.61m) of 232.56 m.
   1.3 The WEWPCC shall be designed based on 700-year flood protection level of 234.1 m.

Note: The process hydraulic requirements with respect to flood levels may be different.

3.3 Buried Services

1. Ensure that all buried infrastructure is accurately updated in the City's GIS based upon the completed installation.
2. All non-conductive underground piping shall be provided with durable electrical trace wires such that they can be easily traced in the future.

3.4 Sanitary Sewers

1. Design sanitary sewers and drains for the entire facility.
2. Ensure that sanitary sewers are drained into or upstream of the headworks facility.

3.5 Fencing

1. Design a permanent perimeter fence around the entire facility.
2. Except where architectural fencing is required to be architectural, permanent perimeter fencing shall be chain link fencing, in accordance with CW 3550-R3.
   - 2.1 Fencing shall have a height of 3 m (10 feet) plus top guard.
   - 2.2 Fencing shall have a top guard consisting of 300mm tall outrigger at 45 degree angle, facing outward with 3 strands of 13.5 gauge barbed wire.
3. Gates:
   - 3.1 Provide gates on all access roads.
   - 3.2 Gates must provide an opening to the full width of the access road.
   - 3.3 Gates must be able to be secured (locked) in either an open or closed position.
   - 3.4 Gates which are expected to be open and closed more than twenty times per week shall be electric actuated. Include controls including pushbuttons, RFID, or wireless controls as appropriate for the application.
4. Design temporary fencing for construction areas.

3.6 Railway Crossing

1. Proposed utility crossings under Canadian Pacific Railway's (CPR) track and parallelisms within CPR's right of way will require a formal application submission complete with 11x17 drawing containing all information as outlined in CPR's "*Pipe and Wire Crossing CPR Right of Way Approval Guide*".
2. Proposed utility crossings under Canadian National Railway's (CNR) track and parallelisms within CNR's right of way will require a formal application submission as outlined in CNR's "A Guide to the Pipe and Wire Process".
3. Proposed road crossings over Canadian Pacific / National Railway's track will be subject to a crossing safety review by CPR as per the most recent version of Transport Canada's Grade Crossing Standards.

3.7 Landscaping

1. Design landscaping for all new and modified areas of the facility.
2. Provide low maintenance landscaping. Where shrubs are provided, they shall be drought-resistant.
3. Include aesthetic landscaping in publically accessible areas of the facility (i.e. next to Administration Building).
4. Removal of trees and shrubs shall be according to the City of Winnipeg Standard Construction Specifications CW 3010 "Clearing and Grubbing".

3.8 Spill Contaminant

1. Design must include grading of pavement to provide containment in the in areas where chemical is being delivered in a liquid state. Appropriate valves must also be included on the land drainage system to isolate land drainage piping during chemical delivery.
2. Provide containment around chemical storage tanks, sized as per codes, or 110% of the largest tank, whichever is greater.
3. Provide containment around chemical delivery areas, sized as per codes, or 110% of the largest delivery vehicle, whichever is greater.

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4 WATER MAIN DESIGN CRITERIA

4.1 General Requirements

1. These requirements apply to potable water mains from the municipal water supply.
2. Provide new water mains to service new structures (where service is required). Ensure water service to modified structures is suitable for the required service in those structures.
3. Provide location and size of water meters external to building as required.
4. Water mains shall be designed according to the City of Winnipeg "Water Demand and Design Guidelines"
5. Geo-coordinates for all hydrant and valve locations shall be submitted as part of the As-Built / Record Drawings.
6. The water distribution system should be designed to provide full redundancy for critical buildings and facilities.
7. Where possible, provide ring or loop water distribution to ensure continuity of service in the event of a break or maintenance.

4.2 Hydraulic Design

4.2.1 Non-Residential Water Demand

1. Where actual water demand is unknown, use 22,500 L/ha/day for light industrial development and 33,600 L/ha/day for wet industrial development.
2. For design purposes, where specific land uses are known, water demand can be derived from literature values i.e. AWWA Water Distribution System Handbook; references must be included with design assumptions.

4.2.2 Fire Flow Analysis

1. The required minimum required fire flow will be either as determined based NFPA 1142.
2. The fire flow shall be provided at minimum residual pressure of 140 kPa (20 psi) during maximum day demand.

4.2.3 Hydraulic Model Analysis

1. Contact the City of Winnipeg Water and Waste department for pressure and flow curves at requested feed points to facilitate hydraulic modeling analysis.
2. Utilize the following factors for analysis:
    - Hazen-Williams C-value = 120 for water main diameter <= 200mm;
    - Hazen-Williams C-value = 130 for water main diameter > 200mm;
    - Minimum water main pressure during peak hour demand = 207 kPa; and
    - Minimum feeder main pressure during peak hour demand = 310 kPa.

4.3 Design and Installation Requirements

4.3.1 Depth of Cover

1. Minimum ground cover for water mains shall be 2.5 m.
2. Where it is not possible to achieve 2.5 m of cover, water main and water service shall be insulated according to the City of Winnipeg standard detail SD-018 “Watermain and Water Service Insulation”.

4.3.2 Pipe Structural Design

1. All water main piping shall be designed for the following pressures:
   - 1.1 minimum working pressure 700 KPa;
   - 1.2 minimum transient allowance of 40%; and
   - 1.3 minimum test pressure of 1,000 KPa, or as approved by City for systems over 600 mm in diameter.
2. All piping shall be designed for:
   - 2.1 Earth dead loads and surcharge loads;
   - 2.2 Live Loads minimum CSA CL-625 Design Vehicle;
   - 2.3 Construction loads should be considered where appropriate; and
   - 2.4 Combination pressure, live and dead loads as required by the appropriate AWWA and or/CSA Standard.
3. Pipes shall be selected according to CSA, ANSI, ASTM or AWWA standards for the relevant materials.

4.3.3 Fire Hydrants

1. Hydrants shall be AWWA Standard C502 Dry-Barrel Fire Hydrants.
2. Linear spacing of hydrants along streets shall not be greater than 90 m. The maximum spacing of hydrants shall be such that a circle of protection is not more than a 75 m radius.
3. Hydrants shall be installed at water mains dead ends.

4.3.4 Valves

1. Maximum distance between valves shall be 150 m.
2. Minimum two valves shall be installed at each water main tee.
3. Minimum three valves shall be installed at each water main crossing.

4.3.5 Water Services

1. Minimum size of fire service shall be 150 mm.
2. Sizes of domestic water service pipes shall be determined based on the fixture or appliance numbers. And minimum size of domestic water service is 25 mm.
3. Valves for fire and fire-domestic services shall be installed 1 m from the City water main.

4.3.6 Materials

1. Materials for pipes, joints and fittings shall be in accordance with "Approved Products for Underground Use within the City of Winnipeg" where specified.
2. Bedding and backfill materials shall be according to the City of Winnipeg Standard Construction Specification CW 2030 "Excavation Bedding and Backfill" as a minimum, or as required by structural pipe design.

4.3.7 Separation Distances between Water and Sewer Mains

1. Parallel Installation:
   1.1 Minimum horizontal distance between water main pipe and any gravity sewer pipe shall be 3.0 m.
2. Crossings:
   2.1 Minimum vertical distance between the outside of water main pipe and outside of any gravity sewer pipe shall be 450 mm.

4.3.8 Connections to Buildings

1. Piping connections to buildings and rigid structures shall be designed to prevent shear and settlement using appropriate means including but not limited to:
   1.1 flexible ball joints,
   1.2 grade beams, and
   1.3 non-shrink foundation materials.

4.3.9 Dissimilar Materials and Corrosion Protection

1. All dissimilar metallic components shall be provided with non-metallic electrical isolation components.
2. Galvanic anodes shall be provided where required by City construction specifications.
3. Corrosion systems shall be designed for soil electrical resistivity of 150 ohm-cm.

4.3.10 Thrust Restraint

1. Thrust Restraint for mains less than 600 mm in diameter shall be as per City of Winnipeg Specification CW 2110.
2. Thrust Restraint for mains greater than 600 mm in diameter shall be designed for appropriate thrust forces and allowable soil bearing pressures as recommended by a Geotechnical Engineer.
3. Where suitable soils for reaction blocking are not available or have potential to be disturbed, provide thrust restraint by means of joint restraint devices. Provide design criteria and minimum restraint lengths on construction drawings. Permanent metallic restraint devices shall be protected from corrosion.

4.3.11 Installation of Water Mains

1. The following items shall be specified in accordance with the City of Winnipeg Standard Construction Specifications:
   - bedding and backfill,
   - pressure/leak testing, and
   - disinfection.

4.3.12 Abandonment of Existing Water Mains

1. Abandonment of existing water mains shall be according to the COW Specification CW 2110 “Water mains” within the limits shown on the drawings.
2. Sections of abandoned water mains within excavation limits (including existing water mains and previously abandoned water mains) shall be removed.
3. The ends of remaining water main sections shall be plugged and abandoned according to CW 2110.

5 WASTEWATER SEWER MAIN DESIGN CRITERIA

5.1 General Requirements

1. These requirements apply to collection, interceptor, forcemain and transmission wastewater mains.
2. Provide new sewer mains to service new structures (where service is required). Ensure sewer service to modified structures is suitable for the required service in those structures.
3. Collection wastewater mains shall be designed according to the City of Winnipeg “Wastewater flow estimation and servicing guidelines”.
4. Geo-coordinates for all manhole, junction and connection locations shall be submitted as part of the as-built/record drawings.

5.2 Hydraulic Design

1. Gravity wastewater mains shall be designed to attain minimum flushing velocity of 0.6 m/s under full flow conditions using a roughness co-efficient (n) of 0.013.
2. Wastewater design flow rate shall include peak domestic inflows, extraneous inflow and infiltration, processing wastewater flows, and wash down flows.

5.3 Design and Installation Requirements

5.3.1 Depth of Cover

1. The minimum invert depth at the high end of a wastewater pipe shall be 2.6 m below finished street centre line grade.

5.3.2 Major Yard Pipe Structural Design

1. Flexible pipe design shall consider prism load for earth load.
2. Rigid pipe design shall consider construction constraints, adjacent and parallel pipelines and structures. Where trench widths cannot be assured, consider use of embankment loading, as described in ASCE 15 Standard Practice for Direct Design of Buried Precast Pipe Using Standard Installation (SIDD) Type 3 installation and minimum vertical arching factor of 1.40.
3. For reinforced concrete pipe in deep fills, consider use of Direct Design as per latest version of ASCE 15 Standard Practice for Direct Design of Buried Precast Pipe Using Standard Installation (SIDD).
4. Minimum excavation widths to ensure proper embedment compaction and safety shall be selected.
5. As a minimum live loads shall be based on CSA CL625 design vehicle. Construction loads shall also be considered where appropriate, including potential crane staging, earth moving and other temporary and transient loads that may be present.
6. Forcemains shall consider cyclical pressure loading as per appropriate AWWA standard.
7. Pipes shall be selected according to CSA, ANSI, ASTM or AWWA standards for the relevant materials.

8. All force main and pressure piping shall be designed for the following pressures:
   8.1 Maximum working pressure as required by force main design;
   8.2 Minimum transient allowance of 40% of maximum working pressure; and
   8.3 Minimum test pressure of 1.25 times the maximum design operating pressure or as approved by City.

5.3.3 Dissimilar Materials and Corrosion Protection

1. Gravity wastewater sewer pipe material selection and design shall consider:
   1.1 Hydrogen sulfide gas corrosion;
      1.1.1 When utilizing concrete pipe in area with high hydrogen sulfide level, evaluate the use of HDPE or PVC liner and provide recommendation accordingly; and
   1.2 CSA S1 soil sulphate exposure.
2. Forcemain pipe material selection and design shall consider:
   2.1 All dissimilar metallic components shall be provided with non-metallic electrical isolation components;
   2.2 Galvanic anodes shall be provided where required by City construction specifications; and
   2.3 Corrosion systems for metallic mains and components shall be designed for soil electrical resistivity of 150 ohm-cm.

5.3.4 Manholes

1. For collection systems, manholes shall be spaced a maximum of 120 m apart.
2. For interceptor sewers, manholes shall be spaced a maximum of 200 m, or as otherwise approved.

5.3.5 Valves - Forcemain

1. Maximum distance between valves shall consider operational and maintenance requirements. Mains with multiple flow paths should consider isolation for operation and maintenance.

5.3.6 Connections to Buildings - Forcemain

1. Forcemain piping connections to buildings and rigid structures shall be designed to prevent shear and settlement using appropriate means including but not limited to;
   1.1 Flexible ball joints,
   1.2 Grade beams, and
   1.3 Non-shrink foundation materials.

5.3.7 Thrust Restraint – Forcemains

1. Thrust Restraint for mains less than 600 mm in diameter shall be as per City of Winnipeg Specification CW 2110.
2. Thrust Restraint for mains greater than 600 mm in diameter shall be designed for appropriate thrust forces and allowable soil bearing pressures as recommended by a Geotechnical Engineer.
3. Where suitable soils for reaction blocking are not available or have potential to be disturbed, provide thrust restraint by means of joint restraint devices. Provide design criteria and minimum restraint lengths on construction drawings. Permanent metallic restraint devices shall be protected from corrosion.

5.3.8 Wastewater Sewer Size

1. Minimum size of service shall be 150 mm.
2. Minimum size of collection main shall be 250 mm.
3. Sizes of wastewater service pipelines shall be determined based on the fixture or appliance number.

5.3.9 Materials

1. Materials for pipes, joints and fittings shall be in accordance with “Approved Products for Underground Use within the City of Winnipeg” where available.
2. Bedding and backfill materials shall be according to the City of Winnipeg Standard Construction Specification CW 2030 “Excavation Bedding and Backfill” as a minimum, or as required by structural pipe design.

5.3.10 Installation of Wastewater Mains

1. The following items shall be specified in accordance with the City of Winnipeg Standard Construction Specifications:
    - bedding and backfill, and
    - pressure/leak testing.

5.3.11 Deflection Testing of Flexible Sewers

1. Deflection testing of flexible sewers shall be completed in accordance to CW 2130.
2. Further to CW 2130, deflection testing of flexible gravity sewers, testing shall not occur until a minimum of 30 days of completion of backfilling.

5.3.12 Abandonment of Existing Waste Water Mains

1. Abandonment of existing water mains shall be according to the COW Specification CW 2130 “Gravity Sewers” within the limits shown on the drawings.

5.3.13 CCTV Inspection

1. Perform video inspection of sewers in accordance with CW 2145.

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6 ROAD DESIGN CRITERIA

6.1 General Requirements

1. Provide a comprehensive design for all roads and parking lots required for the facility.
2. Include in the design:
   2.1 all permanent roadways and parking lots; and
   2.2 all temporary construction access roads, laydown areas and contractor parking lots.
3. Horizontal and vertical alignments for roads shall be designed according to the more stringent Guideline of either the TAC or City of Winnipeg standards. Design speed shall be 40 km/h for construction access road. Horizontal alignment for temporary construction roads shall be developed.
4. All roadway geometry shall meet the most stringent of TAC, City of Winnipeg Transportation Standards Manual or City of Winnipeg Standard Construction Specifications Surface Works Standard Details.
5. Perform simulations to evaluate truck movements around the facility to verify roadway geometry.
   5.1 Standard of acceptance is AutoTURN simulation.
6. Avoid mixing vehicle and pedestrian traffic.
7. Provide a traffic management plan for construction and operation, as per Section 8.3.1.

6.2 General Road Design

6.2.1 Road Type and Design Life

1. Selection of road type shall be as per Table 6-1~~Table 6-1~~.

Table 6-1 : Sewage Treatment Plant Road Type Selection

Location	Road Type	Pavement Material	Design Speed	Min. Pavement Width	Design Vehicle
Main Plant Entrance to Administration Building	Primary	Concrete	40 km/h	7.5 m	WB-20
Connection to municipal roads	Primary	Concrete	40 km/h	7.5 m	WB-20
Interior plant roads	Primary	Concrete	40 km/h	7.5 m	WB-20
Interior plant roads	Secondary	Concrete or Asphalt	30 km/h	7.5 m	HSU
Approaches to Buildings	Secondary	Concrete or Asphalt	30 km/h	7.5 m	HSU
Other	Gravel	Gravel	30 km/h	6.0 m	HSU
Construction Roads	Gravel	Gravel	30 km/h	6.0 m	As required

2. Posted speeds for roadways are intended to be 10 km/h less than design speed.

3. Primary roads shall be designed and constructed as concrete pavement with a minimum 30-year design life.

4. Secondary roads shall be designed and constructed as asphalt or concrete pavement with a minimum 20-year design life.

5. There shall be two classifications of roadway type, Urban and Rural. Each shall be designed as follows:

   5.1 All urban roadways shall be designed and constructed with a Mountable Curb (COW detail SD-201 for concrete pavement) or Mountable Curb and Gutter (for asphalt pavement). The exception shall be at all containment areas where Barrier Curb shall be constructed. All administration buildings and public areas requiring handicap access shall have ramp curb constructed. Drainage shall be accommodated along gutters and shall be collected in drainage inlets with either catch pits or catch basins. Boulevards shall be graded flush to the top of the curb along the roadway edges.

   5.2 All rural roadways shall be constructed with an embankment 0.9 m above surrounding existing ground, side slopes to a ditch, ditch width and ditch back slope. Ditch widths and depths shall be designed to accommodate the specified storm events.

6.2.2 Pavement Structure

1. Concrete or asphalt pavement surface thickness (concrete or asphalt) and pavement structure shall be determined according to the AASHTO Guide for Design of Pavement Structures based on the traffic movement data obtained from the City of Winnipeg.

2. Minimum pavement structure requirements for Primary Roads:

   2.1 200 mm reinforced Portland cement concrete pavement;

   2.2 75 mm of compacted base course material;

   2.3 375 mm of 50 mm compacted crushed sub-base material;

   2.4 Non-woven geotextile; and

   2.5 Geo-grid as required at weak subgrade locations.

3. Minimum pavement structure requirements for Secondary Roads (Asphalt)

   3.1 100 Asphaltic concrete pavement Type 1A;

   3.2 75 mm of compacted base course material;

   3.3 400 mm of 50 mm compacted crushed subbase material;

   3.4 Non-woven geotextile; and

   3.5 Geo-grid at weak subgrade locations.

4. Minimum pavement structure requirements for Secondary Roads (Concrete)

   4.1 150 mm reinforced Portland cement concrete pavement;

   4.2 75 mm compacted base course material;

   4.3 375 mm of 50 mm compacted crushed sub-base material;

   4.4 Non-woven geotextile; and

   4.5 Geo-grid as required at weak subgrade locations.

5. Minimum pavement structure requirements for Gravel Roads
   5.1 100 mm compacted base course material;
   5.2 300 mm of 50 mm compacted crushed sub-base material;
   5.3 Non-woven geotextile; and
   5.4 Geo-grid as required at weak subgrade locations.
6. All Portland Cement Concrete pavements shall be constructed with a longitudinal centreline joint and transverse joints as per the COW Standard Construction Specifications. All joints shall have either tie bars (tied joint) or dowels (moving joint) as per COW Standard Construction Specifications for the thickness of pavement in question.
7. All manholes or catch basins within pavement limits shall have isolations constructed, as per the COW Standard Construction Specifications.
8. At an urban site all roadways will be constructed using the Urban Classification with the exception of gravel roadways.
9. At rural sites all roadways will be constructed using both the Urban and Rural Classifications as directed by the City of Winnipeg.
10. Where asphalt or gravel pavement is permitted, provide concrete pavement where handicap parking is provided or where fully loaded transport vehicles are parked for extended periods.
11. Where gravel payment is permitted, consider the use of dust control systems where dust from road traffic may impact operations or adjacent private properties.

6.2.3 General Roadway Grading Requirements

1. All urban roadways will have a minimum longitudinal gutter gradient of 0.50% with a maximum grade differential at low or high points of 1.50%. Low or high points with a longitudinal grade differential of greater than 1.50% shall have a vertical curve incorporated into the design. The vertical curve K value will be in accordance with the design speed for the road and TAC guidelines.
2. Minimum longitudinal gutter gradient around radii or on Cul-de-Sacs shall be 0.75%.
3. All urban roadways shall have a minimum transverse crossfall of 2.0%.
4. All rural roadways shall be constructed with a 2.0% crossfall for paved roadways and 4.0% for gravel surface roadways.
5. All rural roadways shall have a minimum 0.25 m shoulder rounding allowance, minimum 4:1 side slopes, and 3:1 back slopes.
6. Minimum longitudinal grades for ditches shall be 1.0% or in extreme cases of very long ditches 0.75%.

6.2.4 Roadway Signage Requirements

1. All roadway signage shall be designed in accordance with the Manual of Uniform Traffic Control Devices for Canada (MUTCDC).
2. All roadway signage installation locations shall be designed in accordance with the MUTCDC.
3. Stop/Yield signs shall be provided on the secondary road at intersections with Primary Roads and on the Gravel roads at intersections with Secondary Roads.
4. Speed limit signs shall be provided on all Primary Roads and shall be considered to be 10 km/h less than the applicable design speed.
5. All pavement striping for Primary Roads shall be installed in accordance with MUTCDC.

6.2.5 Roadway Clearance Requirements

1. Lateral clearance requirements from edge of roadway to physical obstructions including but not limited to; poles, trees and buildings, shall be in accordance with the Clear Zone requirements from TAC for the applicable design speed of each type of roadway.

6.2.6 Sidewalks

1. Design sidewalks for all pathways between buildings routinely utilized by Operations personnel.
2. All sidewalks shall be concrete.
3. Concrete sidewalks shall be minimum 1.5 m wide with 100 mm thick slab according to the COW detail SD-228A. Thickness of sub-base course shall be 150 mm.

6.2.7 Parking Lots

1. Parking lot pavement type:
   - 1.1 Administration and Workshop areas (all sizes): concrete.
   - 1.2 Parking lots for greater than ten vehicles: asphalt or concrete.
2. Layout:
   - 2.1 Minimum parking stall width: 2.8 m
   - 2.2 Minimum parking stall length/depth: 6.1 m
   - 2.3 Minimum parking aisle width: 7.0 m
3. Parking lot shall include number of barrier free parking stalls according to the City of Winnipeg Accessibility Design Standard. This is expected to only be applicable for the Administration Buildings and public areas of the wastewater treatment plants.
4. Minimum requirements for concrete parking lot pavement:
   - 4.1 Non-woven geotextile with geo-grid at weak subgrade locations;
   - 4.2 Sub-base course: 350 mm of 50 mm crushed sub-base material;
   - 4.3 Base course: 75 mm of base course material; and
   - 4.4 Pavement surface: 150 mm Reinforced Portland cement Concrete Pavement.

5. 5.6. Minimum requirements for asphalt parking lot pavement:

   5.1 Non-woven geotextile with geo-grid at weak subgrade locations;

   5.2 Sub-base Course: 375 mm of 50mm crushed sub-base material;

   5.3 Base Course: 100 mm of base course material; and

   5.4 Pavement Surface: 100 mm of asphalt Type 1A.

6. All parking lots shall have yellow parking stall pavement markings and handicap parking stalls shall have markings in accordance with City of Winnipeg codes and by-laws.
7. All concrete parking lot pavements shall have joints constructed as per City of Winnipeg Standard Construction Specifications.
8. All manholes/catch basins in concrete parking lots shall have isolations constructed in accordance with City of Winnipeg Standard Construction Specifications.

6.2.8 Road Removals/Restorations

1. Removal of concrete pavement and concrete curbs shall be performed according to the City of Winnipeg Standard Construction Specifications CW 3110 “Sub-Grade, Sub-Base and Base Course Construction” and CW 3230 “Full-Depth Patching of Existing Pavement Slabs and Joints”.
2. Removal of gravel roads shall be performed according to the City of Winnipeg Standard Construction Specifications CW 3110 “Sub-Grade, Sub-Base and Base Course Construction”.

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7 SITE DRAINAGE CRITERIA

7.1 General Requirements

1. Provide a comprehensive site drainage design.

   1.1 The general site grading will establish a working surface for operating and construction areas, provide positive drainage from buildings and structures, and provide adequate soil coverage for underground utilities.

2. On-site drainage will be accomplished through gravity flow whenever possible. The surface drainage system will consist of gentle, uniform slopes.

3. Land drainage system should include two separate systems: Minor System and Major System. The minor system usually conveys runoff from more frequent rainstorms up to the design storm limit. The major system conveys runoff from high intensity but less frequent rainstorms that are in excess of what the minor system can handle.

   3.1 The minor system consists of the gravity pipeline network, plus gutters and inlets which provide a conveyance system to rapidly carry away storm runoff from road surface for the City of Winnipeg's 5-Year MacLaren rainfall events.

   3.2 The site must be able to store the 25-Year Maclaren rainfall event with criteria not less than that applicable for commercial properties in the City of Winnipeg.

   3.3 The major system conveys runoffs from for the City of Winnipeg's 25-Year MacLaren rainfall event which exceed the capacity of the minor system. The major drainage system consists of mainly storage facilities, temporary overland ponding areas, open ditch, swales, and culverts.

   3.4 Retentions / detentions facilities shall be designed to accommodate runoff from the City of Winnipeg 100-Year design rainfall event.

4. The NEWPCC, the SEWPCC and the WEWPCC shall meet the urban area drainage design criteria.. The designs shall still include minor and major system considerations.

   4.1 Should the SEWPCC or WEWPCC be approved by the City for rural area drainage design, a ditch system can be utilized in place of a pipe network for the minor rainstorm event.

5. The site will be graded away from structures with an appropriate slope for drainage. Minimum standard of acceptance is 2% uniform slope.

6. Design temporary facilities for site and excavation drainage during construction.

7. A detailed hydrograph method such as the SWMM modeling must be used for final design of pipe networks, open channels, and storage facilities that incorporate regional retention/detention facilities.

7.2 Design Criteria

1. Peak runoff rate calculation shall use Rational Method for development area smaller than 100 ha, and use Hydrograph Method (SWMM hydraulic modeling) for development area larger than 100 ha.

2. The Rational Method is used to estimate the peak runoff to be conveyed in the piped or open ditch system. Runoff coefficients used in the Rational Method for various land uses are listed in Table 7-1~~Table 7-1~~.

Table 7-1 : Runoff Coefficient "C" Values

Surface Type	C Value
Roof	0.9
Concrete / Asphalt pavement	0.9
Gravel Pavement	0.85
Lawn	0.25

3. Rainfall intensity values shall be calculated based on the intensity – duration formula below:

   $i = a / (t_c + b)^c$

   where: i = rainfall intensity in mm/hr

   t_c = time of concentration in minutes. Initial time to concentration (t_c) is equal to 10 minutes for paved development and 15-20 minutes for natural reserve land.

4. City of Winnipeg design rainfall (IDF) coefficients are listed in Table 7-2.

Table 7-2 : IDF Coefficients

Design Rainfall	a	b	c
5 Year	1199	8	0.828
10 Year	1529	9	0.842
25 Year	1842	9	0.842
50 Year	2081.5	9	0.842
100 Year	2318	8	0.856

5. For modifications to existing sites that have existing drainage infrastructure, review the existing drainage pipes and ditches and provide the capacity to meet the calculated runoff requirements, as stated above. Should the review determine that the existing infrastructure is based on design criteria with a lower calculated runoff rate and this was not noted within the project scope of work, provide appropriate drainage (or storage) solutions for the new infrastructure, and review the existing deficiencies with the City. That is, the civil designers are required to upgrade existing infrastructure as needed to meet the requirements of the current project, but correction of existing design criteria deficiencies shall be reviewed with the City unless noted in the project scope of work.

7.3 Site Design

1. Site design criteria must be controlled in accordance with the Sewer By-law.
2. Runoff rates to be restricted to the 5-year MacLaren City of Winnipeg design storm using a “c” value coefficient. The “c” value coefficient will be supplied by the Water and Waste Department and must be obtained in advance (Contact 204-986-3484).
3. The pre-development and post-development peak discharge rates for 5-year and 25-year MacLaren City of Winnipeg design rainfalls should be used to estimate the required on-site storage.

4. Maximum depth and extent of ponding shall not exceed 0.3 m of depth on paved surfaces for the 25-year MacLaren City's design rainfall.

7.4 Ditches

1. New ditches will be built and existing ditches shall be regarded or filled according to the City of Winnipeg Standard Construction Specifications CW 3170 "Earthwork and Grading" and CW 3110 "Sub-Grade, Sub-Base and Base Course Construction".
2. Ditches shall be designed with a maximum side slope of 4 to 1, minimum bottom width of 1.0 m and minimum longitudinal slope of 0.1%.
3. Ditch sides and bottom surfaces shall be covered with erosion control blanket to promote establishment of vegetation.

7.5 Culverts

1. Culvert and drainage inlet/outlet structures shall be designed based on the City of Winnipeg's Culvert and Drainage Inlet/Outlet Safety Guidelines.
2. New culverts will be built and existing culverts shall be removed according to the City of Winnipeg Standard Construction Specifications CW 3610 "Installation of Culverts".
3. Culvert sizing shall be determined based on the peak flow calculated with the Rational Method and using time of concentration of 15 minutes using coefficient "C" values provided in Table 7-1~~Table 7-1~~.
4. Minimum culvert size shall be 450 mm.
5. Corrugated metal pipe culvert size shall be calculated using Manning roughness coefficient (n) of 0.024.

7.6 Land Drainage Sewer

1. LDS installation shall be accordance with the City of Winnipeg Standard Construction Specifications CW 2130.
2. Land drainage sewer (LDS) pipe size shall be based on the City of Winnipeg 5-year MacLaren design rainfall event.
3. LDS pipes shall be designed with capacity to control the maximum surcharge level at the upper reach of the development's LDS is 0.30 m below gutter elevation.
4. LDS pipes shall be designed with a minimum full flowing velocity of 0.9 m/s using a Manning roughness co-efficient (n) of 0.013.
5. The minimum LDS size shall be 300 mm; minimum catch basin lead size shall be 250 mm.
6. The minimum invert depth at the high end of LDS system shall, where practicable, be 1.52 m below finished street centre line grade.

7.7 Manholes and Catch Basins

1. Manholes and Catch Basins installation shall be accordance with the City of Winnipeg Standard Construction Specifications CW 2130.

2. Manholes for land drainage sewers shall be installed at the junction of LDS, except at catch basin connections, at changes of alignment or grade except in curved LDS, at the upper end of each line and at all street intersections, with a maximum desirable spacing between any two manholes of 107 m, and in no case more than 120 m in cases of LDS pipe 1,350 mm diameter or larger, the manhole spacing may be varied upon approval.

3. For all manholes and catch basins the minimum barrel diameter shall be 910 mm. the minimum bottom section diameter shall be 1,200 mm.

7.8 Retention and Detention Storage

1. All retention and detention facilities shall meet the City of Winnipeg Criteria for Stormwater Management.
   - 1.1 Flood level or high water level (HWL): 100-year design rainfall.
   - 1.2 Maximum design water level rise in 25-year design rainfall is 1.8m for industrial or open space.
   - 1.3 Freeboard elevation from 100-year rainfall is 0.6 m.
   - 1.4 Minimum depth is 2.5 m.

2. Stormwater retention basin shoreline revetment shall accordance with City of Winnipeg Standard Construction Specifications CW 2165 and detail drawing SD-026.

7.9 Oil and Sediment Interceptors

1. Oil and sediment separators shall be provided in accordance with the City of Winnipeg Sewer By-law.

2. Oil and sediment interceptor should be installed underground and integrated into the land drainage sewer system in parking lots and loading areas to capture particulates and hydrocarbons from small, highly impervious surfaces.

8 CIVIL 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 civil designer / engineer.
2. Ensure all civil design deliverables are sealed by a qualified professional civil engineer registered in the Province of 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.
   - Update existing site plans.
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 Detailed drawings and specifications (hard copy and electronic format) at the 33%, 66% and 90% working drawings stages, or other design review milestones approved by the City.
   5.3 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 design deliverables shall be updated to "as-built" status at the end of the project. The "Record Drawing" 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 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 civil 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 civil designer / 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.

8.2 Drawings

Provide a comprehensive set of drawings to detail the civil construction requirements. The drawings indicated in this section are minimum requirements for new construction, unless otherwise approved by the City. All drawings shall meet or exceed City of Winnipeg Water and Waste Department WWD CAD/GIS Standards (August 2016) and the Manual for the production of Construction Drawings for the City of Winnipeg, Works and Operations Division (November 1984).

8.2.1 General Requirements

1. All civil drawings are to be produced on a standard A1 size drawing.
2. All civil 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. Provide a legend drawing showing the symbols and abbreviations utilized. Ensure that the legend is consistent with the City's practices and other disciplines.

8.2.3 General Notes Drawing

1. Provide a general notes drawing.
2. Content

   2.1 Include general construction notes.

   2.2 Provide key design criteria

8.2.4 Existing Site Plan

1. Provide a detailed site plan of the existing facility, prior to construction.
2. Contents shall include:

   2.1 All existing surface topography and spot elevations

   2.2 All existing underground plant

   2.3 All existing legal boundaries

   2.4 Label all existing buildings/facilities

   2.5 All existing underground utilities

3. Format:
   - 3.1 Scale:
     - 3.1.1 Maximum: 1:500

8.2.5 Site Plan

1. Provide an overall site plan showing all buildings and major services.
2. Contents shall be in accordance with City of Winnipeg Building and Site Design Summary, Section II required for permitting (http://www.winnipeg.ca/ppd).
3. Contents shall include:
   - 3.1 All proposed buildings, roadways and sidewalks;
   - 3.2 All proposed surface features including but not limited to landscaping, lighting, poles;
   - 3.3 All proposed access points to existing roadways;
   - 3.4 North Arrow, civic address, street names, and legal description;
   - 3.5 Property lines, lot lines and all adjacent public right-of-way, lot dimensions;
   - 3.6 Total lot area;
   - 3.7 Construction access route(s);
   - 3.8 Indicate site-surfacing material and show all curbs, wheel stops, parking fences and lighting;
   - 3.9 Dimensions of all projections;
   - 3.10 Proposed on-site lighting and signage;
   - 3.11 Existing and proposed approaches, aisles/driveways, vehicle parking areas, loading, storage, etc. including dimensions, location and surface type;
   - 3.12 Accessary structures (e.g. booths, fences, parking lots, planters, retaining walls, curbing, lamp standards, free standing signs, awning, etc.) with dimensions and offsets/setbacks from property lines;
   - 3.13 Indicate total number of parking spaces;
   - 3.14 Indicate total number of loading spaces;
   - 3.15 Indicate all landscaping areas and identify material (grass, trees, shrubs, ornamental paving, etc.);
   - 3.16 Storage compounds with the surfacing indicated and the type and height of fencing around the compound;
   - 3.17 Proposed surface alternations and enhancements or improvements in the public right-of-way including all landscaping, ditch modifications, and proposed hard surfacing; and
   - 3.18 Areas of the public right-of-way that will encumbered, occupied or obstructed as a result of the proposed construction, including the installation of any hoarding, fencing, covered walkways, piles or shoring, or any portion of a construction crane that occupies or projects into the right-of-way.
4. Format:
   - 4.1 Scale:
     - 4.1.1 Maximum: 1:500

8.2.6 Site Servicing Plan

1. Provide detailed plans showing all piping in the yard.
2. Contents shall be in accordance with City of Winnipeg Building and Site Design Summary, Section II required for permitting (http://www.winnipeg.ca/ppd).
3. Contents shall include:
   - 3.1 Show sizes and locations of sewer (wastewater and/or land drainage) and water (domestic, fire or combined fire/domestic) service connections, fire hydrants, and Siamese connections, including percent slope and connection details to the common mains. Wastewater and land drainage connections shall be separate connections to the common sewer mains;
   - 3.2 Indicate size and location of all existing services not planned for re-use which are then to be abandoned in accordance with the City of Winnipeg Standard Construction Specifications;
   - 3.3 Indicate size, location, and material type of common sewer and water mains and other underground utilities in the street or easements;
   - 3.4 Indicate the size, location, and configuration of storm water control devices including overflow locations;
   - 3.5 Indicate 25-year ponding limit on the drawings; and
   - 3.6 The size, location, and configuration of drainage safety features must be constructed in accordance with City of Winnipeg Culvert and Drainage Inlet/Outlet Safety Guidelines.

8.2.7 Lot Grading Plan

1. Provide detailed yard grading plan including all slopes and elevations.
2. Contents shall be in accordance with City of Winnipeg Building and Site Design Summary, (Section II B. Lot Grade Plan) required for permitting (http://www.winnipeg.ca/ppd).
3. Contents shall include:
   - 3.1 Indicate civic address and legal description of the property;
   - 3.2 Indicate project location with reference to adjoining streets or dimensions to street corners at mid-block locations;
   - 3.3 Show building locations and distance to other buildings, property lines, driveways, etc.;
   - 3.4 Show existing and proposed geodetic lot grade elevations in metric both on the site and on adjacent property, public right-of-way, easements, including all property corners, along all lot lines, swales and other drainage features, plus entrances to buildings and proposed finished floor elevations;
   - 3.5 Mark drainage patterns indicated by flow arrows and slopes for all swales and other areas within the property;
   - 3.6 Indicate dimensions and locations of all paved or impervious areas such as parking lots, lanes, driveways, sidewalks, curbs and gutters, roof, etc.; and
   - 3.7 Indicate catch basin locations with rim and invert elevations including location of land drainage sewer connections.
4. Format:
   - 4.1 Scale:
     - 4.1.1 Maximum: 1:500

8.2.8 Plan and Profile Drawings

1. Provide a comprehensive set of drawings to detail the plan and profile of all buried services and surface grades and roadwork.
2. Format:
   2.1 Scale:
      2.1.1 Maximum plan view: 1:250
      2.1.2 Maximum profile view: 1:10

8.3 Other Documents

8.3.1 Traffic Management Plan

1. Provide a traffic management plan for all facility upgrades where traffic is affected. The traffic management plan shall be developed to maintain the safe and efficient passage of vehicular and pedestrian traffic on existing roadways and sidewalks within and adjacent to the site.
2. Ensure that safe and efficient emergency vehicle access is maintained to the site at all times.
3. Construction and operations traffic shall be considered during the roadway and parking design and the overall approach shall consolidate construction traffic to minimize impacts to existing plant operation. This includes employee traffic and parking, surrounding environments and deliveries and pickups required for normal plant operations.
4. Comply with requirements of Acts, Regulations and By-Laws in force for regulation of traffic or use of roadways upon or over which it is necessary to carry out work or haul materials or equipment. All traffic controls to be in accordance with the latest edition of the City of Winnipeg Manual of Temporary Traffic Control on City Streets (herein after called The Manual).
5. Do not close any lanes of City streets or control areas outside the wastewater treatment facility without approval of the City of Winnipeg Public Works Department.
6. When construction activities disrupt the normal flow of public traffic, provide and maintain flag persons, traffic signals, barricades and flares, lights and lanterns as required to direct the flow of equipment used in performance of the Work and to protect public traffic in accordance with “The Manual”.
7. Where applicable ensure that all traffic disruptions and plans are updated to the City of Winnipeg Waze traffic information program managed by the City of Winnipeg’s Transportation Management Centre (TMC).
8. If it is necessary to haul materials over roads that are not designated as truck routes, the Contractor shall be responsible for obtaining written acceptance from the AHJ and/or the City of Winnipeg Public Works Department for use of proposed haul routes within their respective jurisdictions.
9. If a new access road is required for construction purposes, the Contractor shall obtain necessary permits and approvals in consultation with the City of Winnipeg Public Works Department or appropriate Government Authority having jurisdiction.
10. Plan for pedestrian and vehicular traffic control to be compatible with construction operations employed in each construction area. If existing parking facilities will be disrupted by the work; provide temporary parking facilities so as not to obstruct the construction zone and the flow of the vehicular and pedestrian traffic.

11. Incorporate construction sequencing and operations within the traffic management plan.
12. Include procedures for pedestrian and vehicular traffic routing and protection in immediate construction area and surrounding area during working and nonworking hours.
13. When deemed necessary due to construction activities, provide well graded detours or temporary roads to facilitate passage of traffic around restricted area. Provide and maintain signs and lights and maintain roadway. Reduce the length of detours to the degree possible.
14. Provide and maintain reasonable road access and egress to all facilities in vicinity of the Work unless other reasonable means of road access exist.
15. Contractor parking will be permitted on-site provided it does not disrupt existing site operations, employee traffic or parking, and the performance of the Work.
16. Provide and maintain dust control in the construction areas and along any approved traffic diversion route or temporary parking area.
17. Keep the travelled way free of mud and debris. Materials spilled on, or dropped along, or across any roadway, both within and outside the contract limits, shall be removed immediately.
18. Do not proceed with construction of any portion of the work until relevant plans for traffic control measures have been presented and the implementation of those measures have been reviewed and approved.

8.4 Design Calculations

1. Provide detailed design calculations in accordance with the relevant codes and authorized local and national bodies taking into account the most unfavorable conditions. Design calculations shall be submitted with the design drawings as part of the review cycle to allow for parallel review. At minimum, the following calculations shall be submitted to the City for review.
2. Submit draft design calculations to the City when the design calculation is performed, such that the calculation can be referenced during the review stage.
3. Provide final calculations, updated to include any modifications during design and construction, as part of the final as-built/record package.

8.5 Civil Servicing Report

1. Provide civil servicing report including design briefs, outline specifications, calculations, design criteria and associated figures and appendix for water distribution system, wastewater collection system and land drainage study.

APPENDIX I – WSTP PROCESS MECHANICAL DESIGN GUIDELINE - RPB

The City of Winnipeg

Winnipeg Sewage Treatment Program

Process Mechanical Design Guideline

Document Code:

Revision: PB

Approved By:		
	Duane Griffin, Branch Head - Wastewater Planning & Project Delivery	Date

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REVISION REGISTER					
Rev.	**Description**	**Date**	**By**	**Checked**	**Approved**
PA	Issued for Internal Review	2015-06-03	C. Reimer		
PB	Issued for Inclusion in RFPs	2015-06-18	C. Reimer		

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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Table of Contents

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.

APPENDIX J – WSTP STRUCTURAL DESIGN GUIDELINE - R02

Winnipeg

The City of Winnipeg

Winnipeg Sewage Treatment Program

Structural Design Guideline

Document Code:

Revision: 002

Approved By:	D. Griffin	Nov 27, 2018
	Duane Griffin, Branch Head - Wastewater Planning & Project Delivery	Date

REVISION REGISTER				
Rev.	**Description**	**Date**	**By**	**Approved**
00	Issued as Final	2017-03-30	C. Reimer	D. Griffin
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Table of Contents

1 INTRODUCTION

This document identifies the standard design requirements that are applicable to any structural 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 to convey general design guidance and expectations regarding structural design. 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 structural designers to fully develop the structural details with general conformance to the concepts presented herein. This standard shall not be construed as comprehensive structural engineering design requirements or negate the requirement for professional engineer's 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 a deviation from this design guideline could be considered. 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, fully complete a *WSTP Standards Deviation Form* and submit to the WSTP Project Manager for approval. Do not proceed with the proposed deviation unless approval is received from the WSTP Project Manager.

1.4 Acronyms and Abbreviations

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ASTM	American Society of Testing and Materials
CAC	Cement Association of Canada
CISC	Canadian Institute of Steel Construction
CSA	Canadian Standards Association
NACE	NACE International
NBC	National Building Code
QC/QA	Quality Control / Quality Assurance
SSPC	The Society for Protective Coatings
WSTP	Winnipeg Sewage Treatment Program

1.5 Definitions

Contractor	The entity responsible for constructing the design. In a design-build procurement methodology, this is the design-builder.
Design Team	The entity responsible for providing the detailed design of a project. In a design-bid-bid procurement methodology, this is typically the consultant. In a design-build procurement methodology, this is the design-builder.
Structural Engineer of Record	The professional engineer ultimately responsible for the structural design, in accordance with Section 2.5.

2 GENERAL

2.1 Design Codes and Standards

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

- National Building Code of Canada (NBC) with Manitoba Amendments
- CSA A23.3, Design of Concrete Structures
- ACI 350M, Code Requirements for Environmental Engineering Concrete Structures
- CSA S16, Limit States Design of Steel Structures
- CSA S136, North American Specification for the Design of Cold-Formed Steel Structural Members
- CSA S157, Strength Design in Aluminum
- CSA S304.1, Design of Masonry Structures
- Concrete design shall be in accordance with CSA A23.3, except for facilities or portions of facilities that are considered hydraulic structures. Design hydraulic structures in accordance with ACI 350M.
- Design steel structures in accordance with CSA S16.
- Masonry shall be designed in accordance with CSA S304.1.

Note: This design guideline is based upon the current version of the above documents in effect at the time of preparation. All designs shall comply with the latest version of the codes and standards. Where this document conflicts with the latest codes and standards, advise the City along with a recommendation for resolution.

2.2 References

The following list of references shall be used in the design:

- CAC Concrete Design Handbook, latest edition (currently Third Edition)
- CISC Handbook of Steel Construction, latest edition (currently Tenth Edition)
- NRC-CNRC User’s Guide – NBC 2010 Structural Commentaries
- ACI 350.1M Specification for Tightness Testing on Environmental Engineering Concrete Containments Structures and Commentary
- ACI 350.4R Design Considerations for Environmental Engineering Structures
- ACI 350.5M Specification for Environmental Concrete Structures
- ACI 515.2 Guide to Selecting Protective Treatments for Concrete.
- NACE 6 / SSPC-SP 13 Surface Preparation of Concrete
- NACE Standard Practice SP0188 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
- NACE Standard Practice SP0288 Inspection of Lining Application in Steel and Concrete Equipment

- NACE Standard Practice SP0892 Coatings and Linings Over Concrete For Chemical Immersion and Containment Service
- PCA Circular Concrete Tanks without Prestressing
- PCA Rectangular Concrete Tanks, Revised Fifth Edition, By Javeed A. Munshi
- PCI Design Handbook Precast and Prestressed Concrete, 7th edition, MNL-120-10
- AISC Design Guide 27, Structural Stainless Steel
- Aluminum Association AA ADM 1-05 Aluminum Design Manual
- Canadian Foundation Engineering Manual, 4th edition, Canadian Geotechnical Society, 2006
- SSPC The Society for Protective Coatings

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

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 structural dimensions are to be in millimeters.
2. All elevations are to be in meters, in the format EL. ###.### (example EL. 273.520).
3. All loads are to be expressed in kPa, N, or kN.
   - Crane or hoist loads may be expressed in kg.

2.5 Engineer of Record

2.5.1 Responsibilities

1. The Structural Engineer of Record will have responsibility for the structural design of all structural elements and connections to the structures, whether existing or new.
2. All speciality structural engineers or supporting registered professionals for the design of components, and connections shall be under the direction of and coordinate with the Structural Engineer of Record. All designs by the specialty structural engineers or supporting registered professionals shall be signed and sealed and sealed by the specialty structural engineers or supporting registered professionals, as applicable; and the Structural Engineer of Record.
3. The Structural Engineer of Record shall ensure and certify that loadings and reactions of all equipment are identified and addressed in the design. This includes:
   3.1 Anchorage, deflection, natural frequency of the structure, vibration and thermal expansion and seismic (as applicable).

3 DESIGN LOADS

3.1 General

1. Classify all structures and facilities as post-disaster buildings except those not directly associated the wastewater treatment process or in any way critical to the wastewater treatment process. For example, an electrical building providing power to the wastewater treatment process would be a post-disaster building, while a storage shed for non-critical parts would not be required to be a post-disaster building.
2. Use climatic data for the City of Winnipeg.
3. Numerous loads indicated in this section are indicated with minimum values. Ensure that the actual design values used are appropriate and current, but not less than the minimum values.

3.2 Dead Loads

Reference shall be made to CISC Handbook of Steel Construction, Part 7. The following typical values from the CISC Handbook for mass of materials are to be considered as minimum requirements:

Table 3-1 : Dead Loads

Description	**Minimum Value (See Note 1)**
Roof Dead Loads	
4-ply asphalt and gravel:	0.32 kPa
Insulation:	0.21 kPa (assuming 300 mm thick)
Tiled ceiling:	0.20 kPa
Floor Dead Loads	
Additional concrete due to floor slope	1.5 kPa (assume 50 mm thick)
Wall Dead Loads	
300 mm CMU:	2.9 kPa
200 mm CMU:	2.1 kPa
100 mm Brick:	1.9 kPa

Notes:

1. *Confirm that actual dead loads with appropriate safety margins are utilized.*

3.3 Collateral Loads

Collateral loads are dead load allowances for suspended utilities such as small piping, ducts, lights, conduit, cable trays, and sprinklers. Minimum values are listed below.

Table 3-2 : Collateral Load Values

Description	**Minimum Value (See Note 1)**
Roof Collateral Load:	1.0 kPa
Floor Collateral Load:	1.0 kPa

Notes:

1. *Confirm that actual dead loads with appropriate safety margins are utilized.*

3.4 Live Loads

Table 3-3 : Live Load Values

Description	**Minimum Value (See Note 1)**
Roof Live Load (not including snow):	1 kPa
Electrical Rooms:	12 kPa (see Note 2)
Grating, Checkered Plate and Hatch Covers:	Same as surrounding floor area or 5 kPa, whichever is greater
Mechanical Rooms:	10 kPa (see Note 2)
Process Areas (slabs, beams, and girders):	15 kPa (see Note 2)
Process Areas (columns and foundations):	10 kPa (see Note 2)
Office and Laboratory Areas:	4.8 kPa
Stairs, Landings, Platforms, and Corridors:	4.8 kPa
Storage Areas:	Actual maximum stored weight or 10 kPa, whichever is greater
Unrestricted Vehicular Areas:	HS 20-44
Forklift Wheel Loading	See Note 4

Notes:

1. *Confirm that actual live loads with appropriate safety margins are utilized.*
2. *Design the structure to support actual equipment and tank loads in addition the minimum uniform load indicated. Where this minimum uniform load is not possible (i.e., in existing spaces), the maximum allowable load shall be noted on drawings.*
3. *See Impact Loads and Other Machinery Loads for other equipment related live loads.*

4. *Design forklift wheel loading utilizing 120% of the loading associated with the rated full load of the largest specified or currently utilized forklifts allocated for the area. The additional 20% is utilized to account for potential future changes in forklift requirements or sizing.*

3.5 Seismic Loads

Per Manitoba amendments to the NBC, specifically pertaining to Section 4.1.8.1, the value of $S_a(0.2) = 0$. Therefore, the seismic loads may be ignored, unless newer codes prevail.

3.6 Wind Loads

The minimum values for wind parameters utilized shall be as per Table 3-4~~Table 3-4~~.

Table 3-4 : Hourly Wind Pressure Loads

Description	Minimum Design Value
Hourly Wind Pressures:	
1/10	0.35 kPa
1/50	0.45 kPa
Exposure Factor	Calculate for open terrain

3.7 Snow Loads

The following are the snow parameters for the City of Winnipeg to allow for calculation of the snow load as per the NBC.

Table 3-5 : Snow Loads

Description	Minimum Design Value
S_s:	1.9 kPa
S_r:	0.2 kPa

3.8 Rain Loads

Consider rain loads associated with blockage of the primary roof drainage system where applicable or due to ponding. Utilize the following rain parameters for the City of Winnipeg as a minimum:

- One Day Rain Fall: 108 mm

3.9 Ice Loads

Design items such as exterior exposed wires and cables, piping, ductwork, support structures, process covers, etc. for ice loads where applicable.

Ice parameters as follows:

- Minimum Design Ice Thickness: 10 mm or as required by CSA S37 or other applicable codes

3.10 Impact Loads

Confirm equipment loading, including any impact loads due to equipment, with data sheets requested from the manufacturers.

Table 3-6 : Impact Loads

Description	Minimum Design Value
Light machinery (shaft or motor driven):	Increase load by 20 percent minimum or manufacturer's recommendation for impact, whichever is greater.
Reciprocating machinery or power-driven unit:	Increase loads by 50 percent minimum or manufacturer's recommendations for impact, whichever is greater.
Torsional and thrust force:	Obtain maximum torsional and thrust forces from vertical turbines from equipment manufacturer. Identify any other torsional and thrust forces.
Vertical impact due to lifting devices:	The maximum wheel loads of the crane shall be increased by the following percentages: • Cab operated, or radio-operated cranes (powered): 25 percent • Pendant or hand-operated cranes: 10 percent
Lateral force due to cranes:	The lateral force applied perpendicular to the crane runway beams shall be calculated as 20 percent of the sum of the rated capacity of crane and the weight of the hoist and trolley.
Longitudinal force due to cranes:	The longitudinal force on crane runway beams shall be calculated as 10 percent of the maximum wheel loads of the crane.

3.11 Thermal Loads

1. Consider thermal loads for facilities with structural members that will be permanently exposed or partially exposed to exterior condition.
2. Design temperature range for the City of Winnipeg is shown in Table 3-7~~Table 3-7~~.

Table 3-7 : Thermal Loads

Description	Design Value
Temperature Range	-35 °C to +30 °C

3. Thermal loading shall also consider the effects of direct heating from the sun, or process heating that may occur because of process heat exposure. Thermal loading shall also be considered as a differential loading situation

3.12 Liquid Loads

1. Define groundwater and flood levels in the geotechnical report. Consider wall loads and uplift pressures due to groundwater levels. Weight of the structure shall be used to counteract uplift.
   1.1 Any design where non-structural weight (i.e. tank fill) is used to counteract buoyancy or uplift forces is not acceptable, unless specific approval is provided by the City.
2. The factor of safety for buoyancy shall be 1.1 against 100-year flood levels. The factor of safety for buoyancy shall be 1.25 against typical high groundwater levels.
   2.1 Where the weight of the structure is insufficient, such as for empty tanks, provide a weeping tile system to an appropriate drain.
3. Tanks shall be designed for maximum liquid levels at overflow. Where there is no overflow, tanks shall be designed for maximum liquid level at top of the walls.
   3.1 Overflows shall be static and not rely on gate position or actuation. Consider cases where downstream situations may prevent the overflow from acting as intended.

3.13 Earth Loads

1. Define lateral design loads due to earth pressure and other geotechnical design. Basement and below grade tank walls shall be designed using the At-Rest earth pressure (Ko).
2. Surcharge loads, as recommended by the geotechnical report, are to be applied to the design of buried walls.

3.14 Test Loads

1. Ensure complete test loads are incorporated into the design and commissioning specifications, including the following:
   1.1 Ensure all liquid-containing tanks are tested for water-tightness.
      a) Adjacent tanks shall be tested independently.
   1.2 Ensure all gas-containing structures are tested for gas leakage.
   1.3 Concrete liquid holding structures will be tested to requirements of ACI 350M.1.
   1.4 Ensure testing of liquid containing structures is to the full hydraulic capacity, including overtopping.
2. Tanks and channels shall be designed for hydrostatic testing prior to backfilling.
3. Determine test loads for foundation support elements from geotechnical recommendations.
4. Design structure taking into consideration test loads for equipment and piping.

3.15 Blast Loads

1. Include blast loads as part of the design where appropriate.
2. Assess blast or overpressure loads based on a process risk assessment, following accepted best practices.
3. Ensure continuously occupied spaces are outside blast or deflagration areas.

3.16 Insurance Load Requirements

1. There are no known insurance load requirements that exceed loads listed above.

3.17 Load Combinations

1. Building Structures:
    - Limit states design - NBC, Division B, Part 4
2. Hydraulic Structures:
    - ACI 350M Chapter 9 using the environmental factor (Sd) from Section 9.2.6.
    - Overflow liquid level with no backfill (water-tightness test condition), as per Section 3.12.
    - Empty basin with backfill in place.

3.18 Deflection Criteria

1. The deflection criteria indicated in Table 3-8~~Table 3-8~~ apply to all structural elements.
2. Ensure concrete structures meet the most stringent of deflection requirements of CSA A23.3 ACI 350M and Table 3-8~~Table 3-8~~.

Table 3-8 : Deflection Criteria

Description	Load Type	Design Value (Maximum)
Roof Members	Dead + Live	L/240
	Live Only	L/360
	Snow Only	L/360
Floor Members	Dead + Live	L/240
	Live Only	L/360
Steel Floor Plates and Grating	Live	L/360
Crane Suspension Systems		
Monorail Crane	Dead + Live	L/800
Bridge Crane	Dead + Live	L/1000
Beams and Lintels Supporting Masonry		
Vertical Support	Dead + Live	Lesser of L/720 or 8 mm
Structural Members bracing out-of-plane loads	Dead + Live	L/360
Concrete Tanks and Channels differential settlement	Dead + Live + Liquid	L/400
Exterior Walls and Interior Partitions	Live, Snow, or Wind	L/240
Beams supporting vibrating equipment	Dead + Live	L/800

3.19 Vibration Design Criteria

1. Consult equipment manufacturers for vibration-related information such as frequencies, unbalanced loads, use of vibration isolators or dampeners, and support requirements.
2. Mount all rotating equipment that produces vibrations of sufficient magnitude on suitable foundations or support systems to control the energy transfer to the structure.
3. Design the concrete support and surrounding structure such that the natural frequency shall be less than 0.5 times or more than 1.5 times the normal operating frequency of the equipment. Special consideration shall be given to variable frequency equipment.
4. Where vibration is significant, anchorage to concrete foundations shall be by cast-in-place embedded anchors, not post-installed anchors
5. The following references provide a guide and example for design of foundations and supporting structures for vibrating equipment:
   - *Canadian Foundation Engineering Manual*, Chapter 14, Canadian Geotechnical Society 2006
   - *Soil Mechanics*, Chapter 15, T. William Lambe and Robert V. Whitman
   - *Foundation Engineering Handbook*, Chapter 24, Hans F. Winterkorn and Hsai-Yang Fang
   - *Foundation Analysis and Design.* Chapter 20, Joseph E. Bowles.

- *Standard Handbook for Civil Engineers,* Section 6, Fredrick S Merritt
- *Department of Defense Handbook Soil Dynamics and Special Design Aspects,* MIL-HDBK-1007/3.
- *Design Considerations for Environmental Engineering Concrete Structure*, ACI350.4R-05 Section 4.5.4-Foundations at grade.
- *Foundations for Dynamic Equipment,* ACI 351.3R-04
- *Principles of Soil Dynamics, Chapter 5, Braja M. Das and Zhe Luo*

3.20 Structural System Requirements

1. The requirements indicated in this section are minimum requirements for typical wastewater application and are subject to the material meeting the required design life specified for the specific service conditions. Some environments may require different material selection and the designer is responsible for selecting the appropriate material for the environment and application, but in no case shall the selected material have lower performance, including durability, maintenance and corrosion considerations, than the indicated material. Where the indicated materials will not meet this requirement, provide alternate materials that will meet this requirement without degrading any other requirement.

2. Handrail / Guardrails

   2.1 Provide aluminum handrails / guardrails, except as follows:

      a) Utilize fibreglass in areas with chemical exposure; and

      b) Galvanized steel may be utilized in non-process areas with no exposure to corrosive liquids or gasses.

3. Grating / Floor Plates

   3.1 Provide aluminum grating / floor plates, except as follows:

      a) Utilize fibreglass in areas with chemical exposure;

      b) Galvanized steel may be utilized in non-process areas with no exposure to corrosive liquids or gasses; and

      c) Utilize heavy-duty galvanized steel grating in areas with traffic loading while ensuring that corrosive liquids and gasses do not corrode the grating.

4. Structural Elements

   4.1 Dry building with no corrosive elements

      a) Provide concrete, galvanized steel; or coated/painted steel.

   4.2 Exterior stairs / platforms (not in highly corrosive environments)

      a) Aluminum (preferred); or

      b) Galvanized steel, minimum thickness of 6mm.

   4.3 Walkways and structure over influent and other channels and process equipment until and including the primary clarifiers

      a) Aluminum;

      b) Stainless steel; or

      c) FRP (where the above alternatives are not suitable).

   4.4 Bolts and anchor bolts in wastewater or exposure to splashing

      a) Stainless steel (AISI Type 316)

   4.5 Provide pipe racks constructed out of galvanized steel.

4.6 Tank covers where the tank has a potential for H_2S:

a) Construct covers out of fibreglass / plastic. Plastic coated steel may be utilized for support of covers.

4.7 Walkways and structure over secondary clarifiers and associated channels:

a) Coated carbon steel; or Stainless steel.

5. Process Equipment

5.1 Construct structural elements of secondary clarifiers utilizing:

a) Coated carbon steel; or

b) Stainless steel.

5.2 Construct structural elements in areas subject to H_2S utilizing:

a) 316 Stainless steel;

b) Fibreglass; or

c) Plastic.

6. Process Tanks

6.1 Wastewater process tanks shall be constructed out of concrete to meet the required service life.

Table 3-9 : Structural System Requirements

Description	**Requirement**
Concrete	To CSA A23.1 with mix designs in accordance with specifications. Concrete shall have minimum compressive strength as required based on CSA Exposure Class and ACI 350 requirements Concrete Exposure Class based on CSA requirements for wastewater A-1, A-2, and A-3 and sulfate exposure S-1, S-2, S-3.
Concrete Masonry	CSA A165
Reinforcing Steel (unless otherwise noted)	CAN/CSA G30.18, Grade 400(R)
Structural Steel (unless otherwise noted)	CAN/CSA G40.21, Grade 350W
Anchor Bolts	ASTM A 307 or ASTM F1554
Structural Bolted Connections	ASTM A 325
Stainless Steel	Exposed to wastewater, salts, or chemicals: AISI Type 316/316L Other exposure: AISI Type 304/304L
Aluminum	Alloy 6061-T6 or 6351-T6

Notes:

1. Ensure that all materials utilized are compatible with the specific environment within the building or process area, including consideration for all chemicals utilized, to achieve the required design life of the facility.

3.21 Erosion Prevention

1. Falling or rapidly moving water through channels or conduits can cause erosion of concrete surfaces. The maximum allowable hydraulic velocity to prevent erosion of concrete shall be assessed by the design engineer and shall not exceed:
   1.1 9.14 m/s for continuous flows (one or more events per day). Note that water falling 4.25 m will reach a velocity of 9.14 m/s
   1.2 15.24 m/s for Intermittent flow (three to four events per month). Note that water falling 9.14 m will reach a velocity of 15.24 m/s
2. Utilize stilling basins as required to prevent erosion.
3. When exposed to cavitation and high flow rates, the embedded reinforcing bar or element closest to the concrete surface should be placed parallel to the direction of flow.
4. Consider the use of armor protection to prevent erosion. Stainless steel plates or micro-silica concrete (70 MPa to 85 MPa) with sound aggregates should be considered.

3.22 Concrete Coatings & Liners

1. Protect against chemical deterioration or corrosion in accordance with requirements and recommendations of ACI 350M Chapter 4-Durability Requirements and ACI 515.2R Guide to Selecting Protective Treatments for Concrete.
2. Evaluate the chemical and physical properties of the liquids, gases and other environmental parameters to which the structure will be exposed and determine if coating or liner systems will be required for the structure to achieve the desired service life.
3. Design concrete surfaces requiring protective coatings or liners assuming severe environmental exposure.
4. Identify coating and liner products that are compatible with service condition, the substrate, and any materials used to clean, repair and patch concrete surfaces prior to the installation of coatings or liners, through consultation with the coating or liner manufacturers.
5. Specify for any concrete surfaces requiring protective coatings or liners are to be prepared in accordance with NACE 6 / SSPC-SP 13 Surface Preparation of Concrete. Provide for QC/QA inspection and testing of the concrete surfaces as required by the standard, including any owner specified or requested conditions noted therein.
6. Specify protective coatings and linings for concrete surfaces are to be installed in accordance with NACE SP0892 and NACE SP0288. Provide for the QC/QA inspection and testing of the coating and liner installations as required by the standards, including any owner specified or requested conditions noted therein, and discontinuity testing in accordance with NACE SP0188.

3.23 Structural Steel Coatings

1. Design and select structural steel coatings to meet the design life of the structure in the given application and environment.

4 DESIGN REQUIREMENTS

4.1 Concrete Design

4.1.1 Requirements

1. Provide cast-in-place concrete design in accordance with the following:
   1.1 Design all concrete building elements in accordance with CSA A23.1, CSA A23.2 and CSA A23.3;
   1.2 Design all process tanks and liquid holding structures and structures with spaces to be dry flood-proofed to be watertight in accordance with ACI 350M, ACI 350.4R, and AWWA D110;
   1.3 Provide concrete formwork, constituents, proportions, and maximum water-cement ratios in accordance with CSA 23.1;
   1.4 Provide reinforcing steel for structural concrete in accordance with CAN/CSA-G30.18 Billet-Steel Bars for Concrete Reinforcement, A National Standard of Canada and RSIC "Reinforcing Steel Manual of Standard Practice";
   1.5 Provide concrete cover of reinforcing steel to meet service life but not less than requirements of CSA 23.1, CSA 23.3, AWWA D110, and ACI 350M, whichever is more stringent for the exposure; and
   1.6 Provide concrete mix designs to resist deterioration from applicable elements including, but not limited to hydrogen sulfide and wastewater, to provide the required service life and provide certification verifying that the concrete mix designs will provide the service life for the exposure conditions, design and construction.
      a) Where the concrete cannot meet the service life requirements, provide appropriate coating or lining to meet the service life requirements.

4.1.2 Liquid Holding / Waterproof Structures

1. Ensure crack control is assessed and controlled. Ensure that the design accounts for shrinkage of the concrete, differential settlement, operating and "under construction" thermal regimes, concrete mix design, strain relief restraints, stresses, and construction.
2. All liquid holding structures must pass leakage test with no visible leakage through walls or floor slabs within a 24-hour static condition at ambient air conditions. Where floor slabs are not accessible to assess leakage, test duration should be extended to assess seepage from drains or from well points adjacent to the structure.
3. All leaks shall be sealed and repaired.

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5 MAINTENANCE AND SAFETY

5.1 Maintenance

1. Provide appropriate lifting devices to allow for maintenance and removal of equipment. Coordinate with other disciplines as required.
2. All permanent lifting devices shall be designed and detailed on the design drawings.
3. Design responsibility shall not be deferred to the Contractor except when using a design-build procurement model.
4. All structural components will be designed for a minimum service life of 80 years, unless otherwise indicated.

5.2 Safety

1. Provide systems to accommodate safe access to all areas of the facility, including tanks, conduits, and channels. Minimum requirements include, but are not limited to the following:
   - 1.1 Where physically practical, provide embedded safety davit bases to accommodate a portable safety davit to allow for safe personnel access to tanks, conduits, and channels.
   - 1.2 Surface mount davits may be utilized where embedded davit bases are not acceptable.
   - 1.3 Provide permanent ladders where portable ladders are not effective or where personnel access is frequent (> once per month).

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6 STRUCTURAL DESIGN TEAM RESPONSIBILITIES

6.1 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 (consultant) shall not pass responsibility for items indicated in this section to the Contractor.
2. Ensure all structural design deliverables are sealed by a qualified professional structural 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 updating. Update existing drawings as required to ensure that the City has a comprehensive set of as-built drawings.
5. Design reviews:
   - 5.1 Arrange internal reviews of all design documents (including drawings) by a structural engineer qualified and experienced in design of equivalent structures 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 drawings:
   - 6.1 Update all structural design deliverables 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 in the Contract, as-built drawings are not required to be sealed.
7. External, 3rd Party Consultants:
   - 7.1 Expertise and assistance may be required, from external 3rd party specialized consultants, outside of the primary structural design team.
   - 7.2 The design team shall be responsible for monitoring the activities and progress of each 3rd party consultant.
   - 7.3 The design engineer is responsible for ensuring 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 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.

6.2 Drawings

Provide a comprehensive set of drawings to detail the structural construction requirements. The drawings indicated in this section are minimum requirements for new construction.

6.2.1 General Requirements

1. All structural drawings are to be produced on a standard A1 size drawing.
2. All structural 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.

6.2.2 Legend

1. Provide a legend drawing showing the symbols and abbreviations utilized. Ensure that the legend is consistent with the City's Water and Waste Dept. practices and other disciplines working in the project.

6.2.3 General Notes Drawing

1. Requirements
   1.1 Provide a general notes drawing for each type of structure.
2. Content
   2.1 General construction notes;
   2.2 Building design criteria including key design loads;
   2.3 Foundation design criteria;
   2.4 Concrete requirements;
   2.5 Concrete reinforcing requirements;
   2.6 Masonry requirements as applicable; and
   2.7 Structural steel and metal fabrication requirements.
3. Format
   3.1 Prepare drawings to communicate the design requirements in a clear, concise and unambiguous manner. Ensure that drawings are not unnecessarily congested or complicated.

6.2.4 Pile Layout Plans

1. Requirements
   1.1 Provide pile layout drawings for all designs where piling is employed.
2. Content
   2.1 The position of piles relative to grid lines;
   2.2 A reference identifier (number) for each pile shown on the drawing, corresponding to the pile schedule as per Section 6.2.5;
   2.3 Grid lines and grid line dimensions;
   2.4 Estimated pile lengths and capacities, or a source for this information; and
   2.5 The approximate location of existing services and foundations, or any other relevant site information made known to the Design Team, that may conflict with the proposed piles; however, service locates are still the responsibility of the Contractor.
3. Format:
   3.1 Scale:
      a) Recommended: 1:100
      b) Maximum: 1:150

6.2.5 Pile Schedule and Details

1. Requirement
   1.1 Provide pile schedule and detail drawings where piling are utilized.
2. Content
   2.1 Pile schedule including:
      a) Pile identifier (number);
      b) Member size;
      c) Safe working load of pile;
      d) Imposed moment;
      e) Imposed horizontal force;
      f) Finished pile cut-off elevation (geodetic); and
      g) Angle of rake.
   2.2 The layout, sections and details of all foundation works showing:
      a) Types of piles or foundation and specification of material to be used;
      b) Location of piles or foundation;
      c) Pile or foundation founding depth or pile minimum embedment into competent stratum for each pile or foundation;
      d) Unit shaft friction, pile base resistance or foundation bearing pressure;
      e) Pile positional tolerances;
      f) Allowable foundation capacity before and after accounting for negative skin friction where applicable, allowable tension, and lateral load;
      g) Details of pile reinforcements, pile joints, connection with pilecaps are considered minimum requirements for shop drawings; and

h) Number, type of pile or foundation tests, structural integrity tests and location of preliminary test pile or ultimate load tests and site investigation for the tests.

6.2.6 Foundation Drawings

1. Requirement
   - 1.1 Provide detailed foundation drawings comprehensive of all new and modified areas.
2. Content
   - 2.1 Layout of foundations;
   - 2.2 Grid lines and grid line dimensions, as well as overall dimensions and structurally derived dimensions;
   - 2.3 The types, sizes, locations and details of foundations for columns, walls, piers, equipment, and any other structural load bearing components;
   - 2.4 The position of each foundation relative to the grid lines. Provide the width, length and depth and the elevation level of the foundation component;
   - 2.5 Indicate a distinguishing letter for each foundation that will serve as a cross-reference for foundation details detailed elsewhere. Note the maximum allowable safe ground bearing pressure, the blinding thickness (plain, non-reinforced concrete) and concrete classification type on the drawing;
   - 2.6 The anticipated bearing elevations for foundations;
   - 2.7 Any drainage or dewatering system or requirements;
   - 2.8 The foundation system installation sequence, if the sequence is required by the structural design;
   - 2.9 Sub-grade preparation for slabs-on-grade, as well as the thickness, reinforcing and elevation of the slabs-on-grade;
   - 2.10 Estimated pile lengths and capacities, or a source for this information;
   - 2.11 Frost-safe soil cover or equivalent insulation requirements for shallow foundations;
   - 2.12 The approximate location of existing services and foundations, or any other relevant site information made known to the Design Team, that may conflict with the proposed foundations, however, service locates are still the responsibility of the Contractor; and
   - 2.13 Allowable SLS and ULS soil or rock bearing capacity, pile capacities and lateral earth pressures for retaining structures with reference to pertinent geotechnical reports.
3. Format:
   - 3.1 Scale:
     - a) Recommended: 1:50 to 1:100
     - b) Maximum: 1:150

6.2.7 Structural Plan Drawings

1. Requirement
   1.1 Provide detailed structural plan drawings comprehensive of all new and modified areas.
2. Content
   2.1 Provide sufficient details and notes to indicate the loads and the structural system to resist those loads and sufficient information to allow the design to be independently checked.
   2.2 Provide locations, sizes, reinforcement and details of structural elements at appropriate scales, to enable the fabrication, installation, and connection of the elements in a reasonable sequence by a reasonably competent contractor who is familiar with the techniques of construction for the specified materials.
   2.3 Provide drawings for concrete structures consisting of dimensional data necessary for the setting out and construction of the concrete formwork, i.e.
      a) Setting out of the concrete structure on site;
      b) Plans, sections and elevations where appropriate showing layout, dimensions and levels of all concrete members within the structure; and
      c) Locate key chases, pockets, fixings and items affecting the concrete work
   2.4 Reinforcement drawings that describe and locate the reinforcement in relation to the outline of the concrete work and to relevant holes and fixings. Generally, circular holes up to 150 mm diameter and rectangular holes up to 150x150 mm in slabs or walls need not be indicated on the reinforcement drawings. All other holes should be indicated on the reinforcement drawing and should be trimmed, where necessary, by suitable reinforcing bars.
   2.5 Separate drawings or plans for top and bottom layers of reinforcement that should be used only for fabrication and in exceptional cases, e.g. voided decks and box girders with four layers of reinforcement.
   2.6 Provide north arrow.
   2.7 Provide scale bar.
3. Format:
   3.1 Scale:
      a) Recommended: 1:50
      b) Maximum: 1:100

6.2.8 Structural Section Drawings

1. Requirement
   1.1 Provide detailed structural section and detail drawings comprehensive of all new and modified areas to completely define the required work.
2. Content
   2.1 Elevations, sections, and details are to be at an appropriate scale to portray the relationship of structural elements to each other and their interconnection(s). Sections and details are to be in sufficient number to show all non-typical conditions, their locations and extent.
   2.2 For concrete, show conceptual reinforcing steel design.
   2.3 Use typical details where appropriate, however, care should be taken to determine that details noted as “typical” are applicable to the condition being portrayed and that their locations and extent are explicit.
   2.4 Include on the structural drawing set, graphically or by notes:
      a) Grid line dimensions and structurally derived dimensions
      b) Expansion, construction and control joint locations and details
      c) The lateral load resisting system
   2.5 Cross-sections provide a general impression of the entire vertical structure. Show all major dimensions and levels. Complicated profiles etc. may remain undimensioned; these are shown by local section prepared with the main plan layouts. The elevation of background walls and columns are often included to increase impression.
   2.6 Show elevation of the key components.
3. Format:
   3.1 Scale:
      a) Recommended: 1:20
      b) Maximum: 1:50

6.2.9 Concrete Reinforcing Drawings

1. Requirement

   1.1 Provide structural detail drawings to fully portray the required structural work and in sufficient detail in order for the Contractor's Reinforcing Steel Detailer to prepare detail reinforcing steel fabrication Shop Drawings.

   1.2 Standard details may be utilized to represent structural features, elements, hooks and laps used on a repetitive basis. Details used in this way must be carefully worked out, depicted in sufficient detail in order to provide the Contractor's Reinforcing Steel Detailer the Designer's intent and totally applicable to each location where they are to be specified. Standard details may apply to concrete profiles or reinforcement arrangements, and shall be drawn to a large scale.

2. Content

   2.1 Elevations, sections, and details are to be at an appropriate scale to portray the relationship of the reinforcing steel, reinforcing steel orientation, hooks and laps to each other and their interconnection(s). Sections and details are to be in sufficient number to show all non-typical conditions, their locations and extent.

   2.2 Use typical details where appropriate, however, care should be taken to determine that details noted as "typical" are applicable to the condition being portrayed and that their locations and extent are explicit.

   2.3 Include on the structural drawing set, graphically or by notes:

      a) Reinforcing steel size, spacing and define top upper layer, top lower layer, bottom upper layer, and bottom lower layer.

      b) Define the concrete cover for the concrete components in the General Notes.

      c) Define the reinforcing steel grade for the concrete components in the General Notes.

      d) Define the reinforcing steel minimum lap development lengths and hook lengths for the concrete components in the General Notes.

   2.4 Cross-sections provide a general impression of the entire vertical structure. Show all major reinforcing steel design intents in order for the Contractor's Reinforcing Steel Detailer to prepare detail reinforcing steel fabrication shop drawings.

   2.5 Show elevation of the key components.

3. Format:

   3.1 Plan Scale:

      a) Recommended: 1:50 to 1:100

      b) Maximum: 1:150

   3.2 Detail Scale:

      a) Recommended: 1:20

      b) Maximum: 1:50

6.2.10 Structural Detail Drawings

1. Requirement

    1.1 Provide structural detail drawings to fully portray the required structural work.

    1.2 Standard details may be utilized to represent structural features and elements used on a repetitive basis. Details used in this way must be carefully worked out, fully detailed and totally applicable to each location where they are to be specified. Standard details may apply to concrete profiles or reinforcement arrangements, and shall be drawn to a large scale.

2. Content

    2.1 Elevations, sections, and details are to be at an appropriate scale to portray the relationship of structural elements to each other and their interconnection(s). Sections and details are to be in sufficient number to show all non-typical conditions, their locations and extent.

    2.2 Use typical details where appropriate, however, care should be taken to determine that details noted as "typical" are applicable to the condition being portrayed and that their locations and extent are explicit.

    2.3 Include on the structural drawing set, graphically or by notes:

    a) Grid line dimensions and structurally derived dimensions

    b) Expansion, construction and control joint locations and details

    c) The lateral load resisting system

    2.4 Cross-sections provide a general impression of the entire vertical structure. Show all major dimensions and levels. Complicated profiles etc. may remain undimensioned; these are shown by local section prepared with the main plan layouts. The elevation of background walls and columns are often included to increase impression.

    2.5 Show elevation of the key components.

3. Format:

    3.1 Scale:

    a) Recommended: 1:20

    b) Maximum: 1:50

6.2.11 Miscellaneous Component Detail Drawings

1. Requirement

    1.1 Detail drawings shall include, but not be limited to:

    a) Access hatch configuration, including dimensions, direction of swing and handle location, sill configuration, and materials

    b) Concrete embeds such as studded anchor plates and angles to support masonry veneers, beams, slabs and girders. Provide top of studded anchor plate elevations for all locations.

    c) Monorail hoists, bridge cranes, large diameter piping supports, structural steel stair cases in stairwells, etc.

    d) Guardrail, ladder, and gate details including dimensions and detailed layout

2. Content

   2.1 Check that:

   a) The information agrees with the general arrangement and other associated drawings and reinforcing steel schedules, with particular reference to dimensions, termination of reinforcement, construction details, and notes.

   b) The details shown can, in practice, be constructed.

   c) Where standard drawings are used they should be checked to ensure they represent the actual structure correctly, and when alterations are made check to ensure that the original design intentions are valid.

6.2.12 3D Model

1. When 3D design is required by the Contract, or proposed by the Design Team, this section shall be complied with in its entirety. 3D models and associated drawings are required for all projects that meet one or more of the following criterion:

   1.1 Any work exceeding $5M in construction costs; and

   1.2 Any substructure or superstructure with a building footprint exceeding 10 m^2.

2. The 3D model shall include key structural elements (other than concrete reinforcing) 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 structural configuration.

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.

6.2.13 Drawing Checking

1. Prior to submitting drawings, ensure that the following checklist is confirmed. The below checklist is not to be construed as comprehensive.

   a) Is general presentation and orientation correct?
   b) Are titles, scales, drawing numbers correct?
   c) Are revision letters correct and their location shown?
   d) Are sufficient sections and details given?
   e) Are general notes complete and convey requirements clearly and concisely?
   f) Is spelling correct?
   g) Have all standards and codes of practice been complied with?
   h) Are layout dimensions correct?
   i) Do running dimensions agree with overall dimensions?
   j) Can the materials specified be obtained?
   k) Do numbers, sizes and reinforcement agree with the relevant calculations and other drawings?
   l) Has cross-referencing to other drawings been provided?
   m) Are chamfers, fillets and drips and similar features shown?
   n) Are all projections reinforced?
   o) Is concrete cover specified and correct?

p) Are splices and laps in correct position?
q) Do splices suit construction joints?
r) Is the right water bar being used?
s) Is there congestion of reinforcement?
t) Are cranks required where bars cross?
u) Is spacing and orientation of reinforcement correct both on plan and section?
v) Is reinforcement required for anti-crack or fire resistance?
w) Do hooks foul other reinforcement?
x) Where required are the spacers and chairs shown/specified?

6.3 Structural Design Calculations

1. Provide detailed design calculations in accordance with the relevant codes and authorized local and national bodies taking into account the most unfavorable condition of dead load, live load, wind load, construction load etc. for all structures. Design calculations shall be submitted with the design drawings as part of the review cycle to allow for parallel review. At minimum, the following calculations shall be submitted to the City for review:
   1.1 Design criteria:
      a) Table of content for the calculations
      b) Building codes used with edition dates
      c) Discussion and description of design basis including all assumptions
      d) Listing of live loads, water levels, earth loadings, snow loading, and wind loads, and other special loadings
      e) Structural material materials and strengths
      f) Geotechnical report information and design criteria
      g) Deflection limits of the structural elements and systems
   1.2 Sketch of the overall structure and elements with applied loadings
   1.3 Analysis and design calculations for all structural elements for applied loading
      a) Roof structures
      b) Walls
      c) Floors structures
      d) Columns
      e) Foundations
   1.4 Special studies and analysis (example, but not limited to dynamic, vibration, crack control, thermal, etc.)
   1.5 All calculation sheets will be signed by the Structural Engineer of Record and design check engineer.
2. Submit draft design calculations to the City when the design calculation is performed, such that the calculation can be referenced during the review stage.
3. Provide final calculations, updated to include any modifications during design and construction, as part of the final as-built package.
4. Where applicable, provide listing of all structural components to be designed by the Contractor. The final responsibility of all structural design is the responsibility of the Structural Engineer of Record.

APPENDIX K – WSTP WASTEWATER TREATMENT FACILITIES AUTOMATION DESIGN GUIDE - R01

Winnipeg

The City of Winnipeg

Water & Waste Department

Wastewater Treatment Facilities Automation Design Guide

Document Code:

Revision: 01

Approved By:	Duane Griffin Duane Griffin, Branch Head – WW Planning & Projects	July 5, 2019 Date

REVISION REGISTER					
Rev.	**Description**	**Date**	**By**	**Checked**	**Approved**
00	Issued for City Use	2015-08-19	B. Cleven	T. Church	T. Church
01	Revisions Accepted	2019-06-19	D. S. Allen	M. Mulligan	D. Griffin

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TABLE OF CONTENTS

1 INTRODUCTION

This Wastewater Department Automation Design Guide is intended to serve as a reference for consistent design of new automation systems for City of Winnipeg owned wastewater facilities. This document provides guidance to department personnel, as well as external consultants, in the design of automation systems for the Winnipeg Sewage Treatment Program (WSTP), and also indicates the expectations and responsibilities of the designers.

1.1 Scope of the Guide

These design requirements will apply to the following facilities:

1. North End Water Pollution Control Centre (NEWPCC),
2. South End Water Pollution Control Centre (SEWPCC),
3. West End Water Pollution Control Centre (WEWPCC).

These design requirements will also be applied to the collection system where relevant and useful.

1.2 Application

The scope and intent of this document is to convey general design guidance regarding automation systems at wastewater facilities. This document addresses specifics related to equipment type, selection, and configuration; however the guidance is presented without knowledge of the specific process implementation. It is not within the scope of this document to provide detailed design direction, and it will be the responsibility of the respective system designers to fully develop the automation design details with general conformance, as appropriate, for the concepts presented herein. This guide 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 respective engineer in each instance, and must be performed in conformance with all applicable codes and standards, as well as good engineering practice, with due consideration for other relevant issues such as equipment warranties, statutory certifications, and the like.

Where significant deviations from this guide are deemed to be appropriate by the design engineer, these shall be subject to further review and acceptance by all stake holders.

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

All new designs, not related to an existing facility, are expected to be subject to the utilization of this guideline.

All major upgrades to a facility, or a larger facility's process area, are expected to be subject to the utilization of this guideline, however in some cases compromise with the configuration of the existing facility design may be required.

All minor upgrades should use this guide as far as practical for new equipment, however in some cases compromise with the configuration of the existing facility design and installation which will be retained after an upgrade will be required.

This document shall be reviewed and updated as required on an annual basis by the City of Winnipeg Water and Waste department to ensure that the document remains relevant and accurate.

Where a requirement is indicated with the word “should”, the designer may deviate from the indicated requirement provided that:

the rationale for deviation is reasonable and logical from a design perspective;

the chosen design solution provides a solution that equivalently meets the intent; and

The City is in no way disadvantaged by the alternate design solution.

The model numbers provided within this document are indicative of preferred equipment with features required by the City (at the time of writing). In addition the City is/would be likely to carry stock spares parts of and/or replacement units of the indicated models. The indicated model number should be utilized where these models are still current, actively marketed and fully meet the project requirements without any disadvantage to the City. Where a newer/replacement model is available that satisfies the minimum requirements, and has additional features that would benefit the City, the newer models shall be utilized in place of current models, as required to meet the project requirements,

1.3 Acronyms and Abbreviations

A	Amperes
ACIC	Armoured Control and Instrumentation Cable
BPCS	Basic Process Control System
CIC	Control and Instrumentation Cable (Non-Armoured)
CPT	Control Power Transformer
CPU	Central Processing Unit
CSA	Canadian Standards Association
CV	Control Variable (PID Control)
d	Flame-proof
DCS	Distributed Control System
DIO	Distributed I/O
DMZ	Demilitarized Zone
DP	Decentralized Periphery (PROFIBUS DP protocol)
DRS	Dual Ring Switch (Ethernet Switch)
EDDL	Electronic Device Description Language - IEC 61804
EMT	Electrical Metallic Tubing
FAT	Factory Acceptance Test
GSD	General Station Description (description of the PROFIBUS DP/PA or PROFINET device)

JB	Junction Box
HMI	Human Machine Interface
HOA	Hand - Off - Auto (switch)
HOR	Hand - Off - Remote (switch)
HP, hp	Horsepower
HSBY	Hot Standby
HVAC	Heating Ventilation and Cooling
I/O	Input / Output
ia	Intrinsic Safety Level, Zone 0
ib	Intrinsic Safety Level, Zone 1
ic	Intrinsic Safety Level, Zone 2
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IS	Intrinsically Safe
IT	Information Technology
LHMI	Local HMI (dedicated to a specific piece of equipment)
LOR	Local - Off - Remote (switch)
MCC	Motor Control Centre
MOA	Manual - Off - Auto (switch)
MRP	Media Redundancy Protocol
MTBF	Mean Time Between Failure
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
PA	Process Automation (PROFIBUS PA protocol)
PB	Pull Box
PCS	Process Control System
PCU	Process Control Unit
PCV	Process Control View (DCS HMI software)
PDF	Portable Document Format
PE	Potential Earth
PID	Proportional Integral Derivative
PLC	Programmable Logic Controller
PRM	Profibus Remote Master (by Schneider Electric)
PV	Process Variable (PID Control)
RFI	Request for Information

RIO	Remote I/O
RRF	Risk Reduction Factor
RSTP	Rapid Spanning Tree Protocol
RTU	Remote Terminal Unit
SAT	Site Acceptance Test
SCCR	Short Circuit Current Rating
SIS	Safety Instrumented System
SIF	Safety Instrumented Function
SIFT	System Integrated Functional Test
SIL	Safety Integrity Level
SIT	Site Integrated Test
SP	Setpoint
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
TWA	Time Weighted Average TC Tray Cable
TU	Termination Unit
UPS	Uninterruptible Power Supply
V	Volts
VCSEL	Vertical Cavity Surface Emitting Laser
WAN	Wide Area Network
WSTP	Winnipeg Sewage Treatment Program
VFD	Variable Frequency Drive
VM	Virtual Machine

1.4 Definitions

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 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 2.1.3

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 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-bid procurement methodology, this is typically the consultant. In a design-build procurement methodology, this is the design-builder.
Electrical Room	A room this is primarily designated to contain electrical equipment, including switchgear, MCCs and panelboards.
Engineer of Record	The professional engineer ultimately responsible for the design registered in the Province of Manitoba.
Hazardous Location	An area where flammable liquids, gases, vapors or combustible dusts may exist in sufficient quantities to produce an explosion or fire.
Non-Process Area	Any area or location either within or outside of a building that is not a Process Area.
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.

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2 GENERAL

2.1 References

2.1.1 General

Where this document, codes, standards, and other referenced documents differ in content, the most stringent shall generally apply.

2.1.2 City of Winnipeg Standards

The following City of Winnipeg standards shall be used where applicable:

1. Water and Waste Department Identification Standard, document number 510276-0000-40ER-0002.
2. Wastewater Treatment Electrical Design Guide, document number 510276-0000-40ER-0002.
3. Tag name Identification Standard, document number 612620-0014-40ER-0001.
4. HMI Layout and Animation Plan, document number 612620-0015-40ER-0001.
5. Historical Data Retention Standard, document number 612620-0016-40ER-0001.

2.1.3 Codes and Standards

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ATEX	Atmospheres Explosives
CSA	Canadian Standards Association
CEC	Canadian Electrical Code (modified by Winnipeg Electrical Bylaw)
IEEE	Institute of Electrical and Electronic Engineers
IEC	International Electro-technical Commission
ISA	International Society of Automation
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers Association
PI	PROFIBUS International
ULC	Underwriters Laboratories of Canada
WSHA	the Workplace Safety and Health Act (Manitoba)

2.1.4 Local Codes and Bylaws

The latest editions of the following local codes and bylaws, together with any bulletins or addenda thereto, shall be referenced when performing automation designs for the City of Winnipeg.

1. Canadian Electrical Code
2. Winnipeg Electrical Bylaw

2.2 Units of Measure

All drawings and documentation, including design calculations, and field instruments shall use the International System of Units (SI units). Imperial units on drawings and documentation will be provided in parenthesis after the metric unit, where requested or appropriate.

3 PROCESS CONTROL SYSTEM

3.1 General

The Process Control System (PCS) at the wastewater treatment facilities provides monitoring and control of the wastewater treatment process and ancillary systems.

The original process control system installed at each wastewater treatment facility was based on an ABB/Bailey Infi90 Distributed Control System (DCS). The City has initiated a program to replace the DCS with a Process Control System (PCS) based upon distributed Programmable Logic Controllers (PLCs) along with a new HMI and historian system.

The City underwent a standardization process to standardize on the make and model of new control system equipment including PLCs, HMI software, historian software, information server software, process instruments, gas detection systems, motor control equipment, and valve actuators. All new designs utilizing such components shall make use of the City's standardized components to ensure consistency in the operation and maintenance of the treatment facilities.

The following sections provide guidance on the design and implementation of new process control systems at the wastewater treatment facilities utilizing the City's standardized components.

3.2 Existing DCS

The original ABB/Bailey Infi90 DCS installations are composed of one or more Process Control Units (PCUs) in each major process area, and an HMI system utilizing ABB/Bailey Process Control View (PCV) and S+ software.

A PCU consists of one or more rack type industrial cabinets containing the DCS programmable controller, I/O modules, communication modules, power supply, and field wiring Termination Units (TUs). The processor and I/O modules are typically located in the front-half of the main cabinet, and the TUs are located in the rear-half of the same cabinet. Additional TUs may be located in adjacent cabinets as required.

A TU provides the physical connection points for discrete and analog I/O field wiring, and often contains DIP switches, relays, and other components for customizing the operation of the TU for the associated I/O module and/or field device. One TU is typically provided for each I/O module, and are individually connected together using pre-fabricated cord sets.

The City typically uses 120 Vac discrete input modules and 24 Vdc discrete output modules. Note that the TUs for the discrete output modules contain interposing relays to transition the 24 Vdc signal coming from the discrete output modules to 120 Vac signals for the field devices.

While the DCS has served the City well, the functionality and maintainability of an older system is limited and therefore the City has initiated a program to replace the DCS with distributed PLCs.

As the existing DCS is in the process of being replaced, the Automation Design Guide does not provide details regarding DCS component upgrades, nor the means of integrating new process equipment into the DCS. However, Section 3.10.1 provides details on the replacement of a DCS PCU with a new PLC-based system.

3.3 Architecture Overview

A high-level overview of the upgraded process control system architecture is provided in Figure 3-1, which shall be used as the basis for design of all new PLC-based process control system installations.

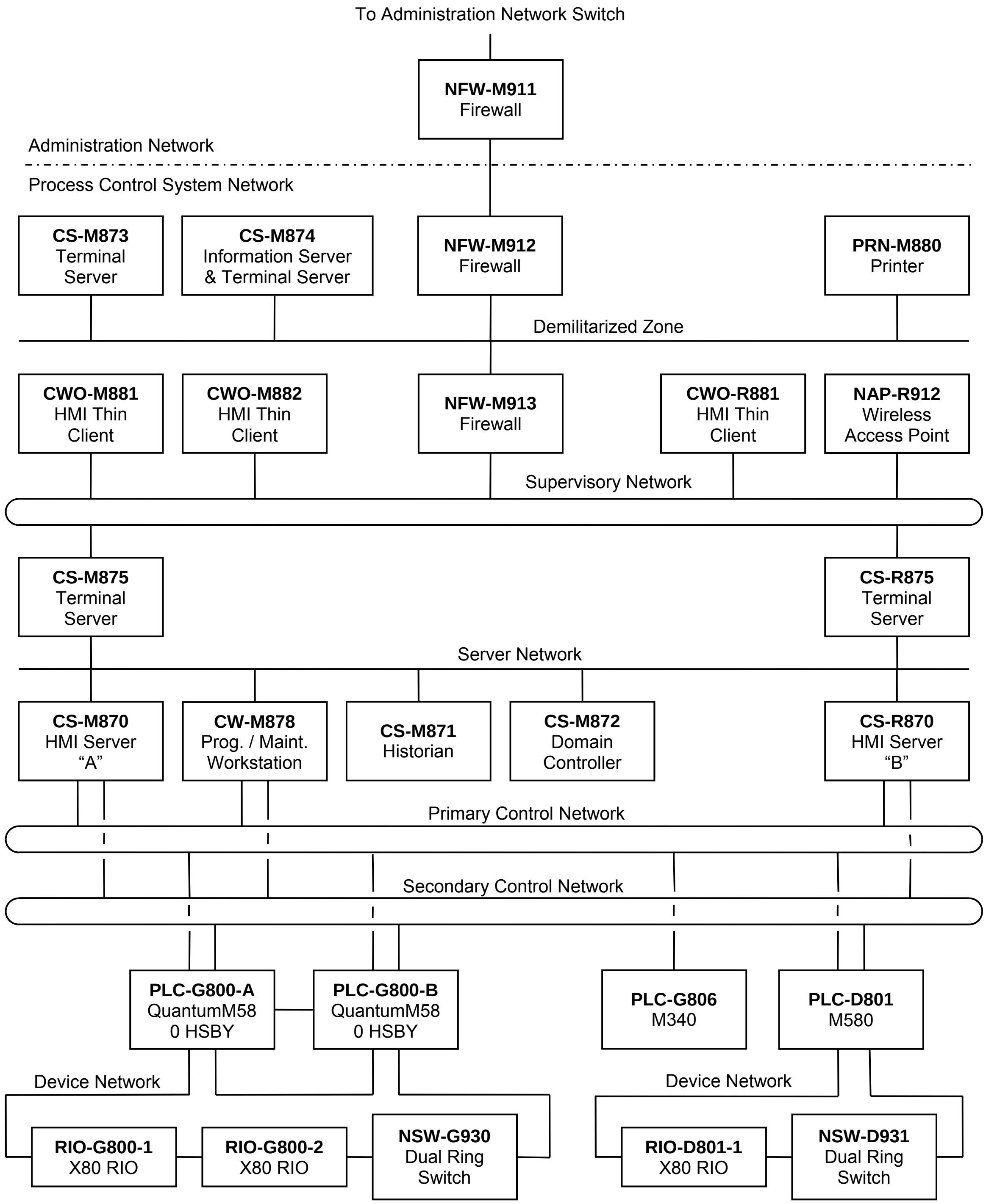

Figure 3-1: Facility PLC-based Process Control System Architecture

Notes regarding Figure 3-1:

1. *The figure is not comprehensive in that it does not show typical quantities of programmable controllers, remote I/O racks, HMI clients, etc., that would be installed at a wastewater treatment facility.*
2. *All network switches and patch panels are not shown.*
3. *Field equipment such as instruments, motor starters, VFDs, etc., are not shown.*
4. *Refer to Section 3.4.35 for additional details on the device networks for connecting field equipment.*

Implementation details for the communication network, HMI system, programmable logic controllers, and field devices are provided in the following sections.

3.4 Communication Networks

3.4.1 General

The standard communication network implementation at the wastewater treatment facilities consists of three primary networks, as follows:

1. **Process Control System Network** – a multi-tier network for communication between process control system equipment including programmable controllers, HMI servers, HMI clients, historian servers, and field devices. The network is composed of a mix of Ethernet and fieldbus technologies.
2. **Administration Network** – an Ethernet network for communication between administration systems including office and laboratory computers, printers, computer servers, and the corporate WAN.
3. **Security Network** – an Ethernet network for security systems equipment including video surveillance cameras and recorders.

Only the Process Control System Network is shown in Figure 3-1, with the exception that firewall NFW-M911 is also shown, which is part of the Administration Network. Note that the Administration Network and Security Network typically fall under the responsibility of the City's Information Technology (IT) group and therefore standard topologies for these networks are not provided.

3.4.2 Facility-Wide Fibre Backbone Ring Network

Provide a facility-wide fibre backbone ring that will act as the backbone for the new Process Control System Network. Provide a minimum of a 24-strand fibre cable between major process areas. Eight of the strands in the fibre cable would be dedicated to the Process Control System Network, two strands for the Administration Network, and another two strands for Security Network. The remaining strands in the cable will be spare.

The fibre backbone ring shall span the entire facility and pass through all process areas and buildings, Install fibre patch panels and networking panels with spacing to ensure that:

Copper network wiring is not required between buildings;

Copper networking lengths are limited to 75% of their maximum design lengths;

At least one fibre-networking panel is located in each building for connection to the fibre ring.

Care must be taken with the network design to not exceed the limiting distance between controllers

Networking equipment associated with the Administration and Security Networks is the responsibility of the City's IT group, and will be physically separated at all levels from the Process Control System Network (other than sharing a common fibre cable).

The City's IT group will assign IP addresses for all levels of the network and subnetworks. Should a subnetwork be utilized by a device on a proprietary basis, City IT will also assign the associated IP address (example Schneider PLC – RIO).

3.4.3 Process Control System Network

The Process Control System Network is segregated into multiple tiers for the sake of performance and security as follows:

1. **Demilitarized Zone (DMZ)** – a sub-network between the Administration Network and the Process Control Network for locating devices that are accessed from both of these networks. The demilitarized zone typically contains the Information Server, a read-only terminal server, and a printer.
2. **Supervisory Network** – a facility-wide fibre/copper Ethernet, for communication between HMI terminal servers, HMI thin clients, and portable HMI clients.
3. **Server Network** – a fibre/copper Ethernet sub-network for communication between HMI servers, HMI terminal servers, historian server(s), and domain controller(s).
4. **Control Network** – a facility-wide redundant fibre/copper Ethernet sub-network for communication between HMI servers and programmable controllers, and for controller-to-controller communication.
5. **Device Networks** – multiple independent copper sub-networks within each process area for communication between the programmable controllers, remote I/O, and field devices. The network is implemented using a combination of Ethernet/IP, Modbus/TCP, and PROFIBUS.

Each of these network tiers are further described in the following sections.

1. Demilitarized Zone (DMZ)

The Demilitarized Zone (DMZ) is a sub-network that contains computer servers and other networked equipment that will be accessed from both the Administration Network and the Process Control System Network. The DMZ would typically contain an Information Server, a terminal server for read-only access to the HMI system, and a printer.

Firewalls are used on either side of the DMZ to control access in and out of the DMZ. Two firewalls shall be installed between the Administration Network and the DMZ, and shall be different brands to reduce the likelihood that an attack can penetrate both firewalls. The firewall nearest the Administration network (NFW-M911 in Figure 3-1) shall be installed and maintained by the City's I.T. group, and the downstream firewall (NFW-M912 in Figure 3-1) nearest the DMZ shall be owned and maintained by City Wastewater Services. Between the DMZ and the Process Control System Network, a single firewall shall be installed (NFW-M913 in Figure 3-1), which is to be owned and maintained by City Wastewater Services.

The DMZ network shall be located in the Administration Building of a wastewater treatment facility, and does not typically extend to other plant areas. For this reason, the DMZ is implemented using CAT6 cabling in a star topology. Devices in the DMZ operate at a minimum of 100 Mbps or 1 Gbps network speed as required.

Install a dedicated DMZ network switch for connection of the devices in the DMZ, such as computer servers and a printer.

2. Supervisory Network

The Supervisory Network is a facility-wide sub-network used for communication between the HMI thin clients and HMI terminal servers.

Implement the Supervisory Network using a combination of fibre and CAT6 Ethernet cabling in a ring/star topology. Use fibre cabling in a ring topology between major process areas and fibre or CAT6 cabling in a ring topology to feed minor process areas from adjacent major process areas. Connect HMI thin clients and HMI terminal servers to the network using CAT6 cabling in a star topology.

Install a dedicated network switch for the Supervisory Network inside a networking panel in each major process area. The network switch shall be equipped with both fibre and copper ports for connection to the supervisory fibre ring and copper-connected devices.

The main ring shall operate at 1 Gbps network speed. The HMI terminal servers shall operate at a minimum 1 Gbps, and the HMI clients that are connected via CAT6 cabling shall operate at a minimum of 100 Mbps.

3. Server Network

The Server Network is an Ethernet sub-network used for communication between computer servers including the HMI servers, HMI terminal servers, historian server, and domain controller. Programming/maintenance workstations are also connected to the Server Network to facilitate server administration.

Redundant computer servers (e.g. the HMI Terminal Servers and HMI Servers) are to be located in two separate areas of the facility; therefore a fibre cable is used to connect the two areas where the computers are located.

The fibre cable for the Server Network would typically be a separate fibre cable from that of the main fibre ring, but two strands in the main fibre ring may be used for the Server Network if it is practical to do so (i.e. if the routing is similar).

Provide dedicated network switches at each end of the server network for connection of the servers and programming/maintenance workstations.

The server network and the computer servers shall operate at a minimum of 1 Gbps network speed.

4. Control Network

The control network is a redundant facility-wide Ethernet sub-network for communication between the HMI servers and programmable logic controllers, and for controller-to-controller communication. The network is to be implemented using a combination of CAT6 and fibre media in a redundant (parallel) ring and star topology. Fibre cabling in a redundant ring topology is used between major process areas, and CAT6 cabling in a redundant ring topology is used to feed minor process areas from adjacent major process areas. Connect the HMI servers and programmable logic controllers to the network using CAT6 cabling in a star topology.

As the Control Network is implemented in a redundant fashion, the two control networks are identified as “Primary” and “Secondary”. The Primary Control Network shall be a separate subnet and act independently of one-another. This is to mitigate the effect of broadcast storms or similar events that can take down an Ethernet network.

The Primary network is for critical process equipment and all other network connected equipment such as HVAC, electrical distribution, etc. The Secondary network is reserved for critical equipment only. For example, a PLC used for process control will be connected to both the Primary and Secondary network, whereas a PLC used for HVAC control is typically only connected to the Primary network.

Provide dedicated network switches in major process areas for each control network. The network switches shall be equipped with both fibre and copper ports for connection to the facility fibre ring and the copper-connected devices. Control network switches shall be located in networking panels.

Programming/maintenance workstations are also connected to the Control Network for programming and maintenance of the PLCs. These workstations will require two network adapters for connection to the Primary and Secondary Control Networks, in addition to the network adapter for the server network.

The control network rings shall operate at 1 Gbps network speed. The HMI servers and engineering workstations shall operate at a minimum of 1 Gbps, and the PLCs shall operate at a minimum of 100 Mbps.

5. Device Networks

Install one or more independent device networks in each process area to allow for data exchange between programmable controllers and field equipment.

Device networks are implemented using a combination of Ethernet and fieldbus technologies including Ethernet/IP, Modbus/TCP, and PROFIBUS DP/PA. The network provides high-speed connectivity to field devices such as remote I/O racks, VFDs, and MCCs, and PROFIBUS devices such as instruments and valve actuators.

Ethernet-based field devices shall be connected using a ring topology to the greatest extent practicable. All field devices in an Ethernet ring must support the Rapid Spanning Tree Protocol (RSTP). Ethernet-based field devices that do not support the ring topology can be connected to an in-rack Ethernet module or to a network switch in the main ring using a star or daisy-chain topology, rather than a ring topology.

Remote I/O racks on the network are considered RIO devices, and all other Ethernet devices such as MCC intelligent overloads, VFDs, and soft-starters are considered DIO (Distributed I/O) devices. RIO devices and DIO devices cannot reside within the same Ethernet ring. DIO devices must be connected in a “DIO sub-ring” or in a “DIO cloud” off the main ring, or placed in an independent network from the RIO devices (e.g. by connecting the DIO devices directly to a DIO Ethernet module that is not interlinked with an RIO Ethernet module). A DIO cloud is a collection of DIO devices connected using a star or daisy-chain topology rather than a ring topology. Schneider Electric manufactures specific “Dual Ring Switches” (DRSs) to facilitate dual ring network architectures and for connection of DIO devices to the RIO ring. Part numbers for Dual Ring Switches are provided in Table 3-1-2.

Note that a maximum of 31 RIO drops plus 64 DIO devices are supported in a single network (as of the time of writing).

Ethernet networks should be designed such that no more than ten (10) Ethernet devices are connected to a single point of failure (e.g. a network switch). This can be achieved by providing additional PLC networking modules, network switches, or connecting the devices in a ring topology to eliminate the single point of failure.

Where equipment redundancy (e.g. Duty/Duty or Duty/Assist) is provided in the field, the associated networked devices (e.g. motor controllers) should be connected to separate network switches to prevent both pieces of equipment from being taken out of service upon a single network device failure.

Minimize the number of Ethernet network switches in process networks by connecting Ethernet cabling directly to field devices where practicable. Network switches are a point of failure, therefore network switches shall only be installed within device networks if absolutely required (e.g. to support a DIO sub-ring or DIO cloud).

A PROFIBUS network may be added to a device network if communication to PROFIBUS devices is required. It is recommended to use PROFIBUS instruments as opposed to hard-wired 4-20 mA instruments due to the reduced cabling and availability of additional diagnostics information. A PROFIBUS network is created by connecting a Schneider Electric PROFIBUS Remote Master (PRM) module to an in-rack Ethernet module or a dual-ring switch in the device network. The PROFIBUS network provided by PRM module is a PROFIBUS DP network, therefore a DP/PA coupler is also required for connection of PROFIBUS PA devices.

PROFIBUS DP networks shall be designed for operation at 1.5 Mbps and operated at 500 kbps. PROFIBUS PA networks shall be designed for and operated at 31.25 kbps.

Each PROFIBUS DP and PA segment shall have at least one point of connection for a programming device or bus analyzer. For Profibus DP segments, this is typically provided by a 9-pin D-shell connector that has a PG socket. For Profibus PA segments, a set of feed-though terminals with parallel points of connection may be provided.

Ensure that all PROFIBUS installations facilitate removal of the field devices from the network without adversely affecting the process. If equipment is daisy-chained on the network, removal of one device from the mid-point of the network may cause all downstream devices, or the entire network segment, to stop working. Some equipment, such as Rotork valve actuators, have provisions for isolating the equipment from the network without affecting the network. Where such provisions are not provided by the equipment vendor and disconnection of a particular device from the network will negatively affect the process, and then external provisions are typically required. One method is to provide multi-channel repeaters or segment protectors and segregate the devices to independent network segments. Another method is to provide external terminations on the network. These methods may be used independently, or in conjunction, as required.

If multi-channel repeaters or segment protectors are used then it is best to group devices that are associated with one control loop on a common segment. That way, it won't matter if removal of a device takes down the network segment since failure of the device would have prevented the control loop from operating in the first place. Where equipment redundancy is provided in the field, group all devices associated with the duty equipment on one segment and all instruments associated with the standby equipment on another segment.

If a field device (e.g. instrument or valve actuator) is providing the end-of-line termination, removal of the device will generally take down the network, since the termination will be lost. For this reason, it is often required to install external end-of-line terminations, even if the field devices are capable of terminating the network. As previously indicated, PROFIBUS DP networks require an active termination, so if an external terminator is used it will typically require 24 Vdc power to it. For PROFIBUS PA networks, the terminating capacitor and resistor could be installed in a small enclosure at the end of the network.

PROFIBUS repeaters often incorporate automatic termination at the "beginning" of the network, so only a terminator and the "end" of the network is required if they are used.

When designing PROFIBUS networks, follow all design and implementation rules indicated by PROFIBUS International with respect to network speed, cable lengths, installation of equipotential bonding conductors, cable routing, and terminations.

Use of insulation displacement connectors on PROFIBUS networks should generally be avoided as their use in practice has shown that they are not reusable. After disconnecting an insulation displacement connector from the cabling they typically cannot be properly reconnected due to malformation of the contacts within connector.

PROFIBUS field devices (instruments, valve actuators, etc.) shall be assigned an address in the range of 2 to 125. Address 0 is reserved for the Class 2 master (configuration and diagnostics tool), and address 1 is reserved for the Class 1 master (the Schneider Electric PRM module). Address 126 is the default address used for new devices on the network, so it should not be assigned to a device, otherwise an address conflict may arise when adding a new device to the network. Address 127 is the broadcast address, so this address shall not be assigned to any device.

For connection of HART devices, Schneider Electric produces in-rack HART modules that are available for the X80 platform. Where HART modules are used, they must be installed in an appropriate slot within a BME Ethernet backplane. HART modules must be used in conjunction with an M580 processor, as opposed to an M340 processor. If HART modules are installed in a remote rack, then the BME XBP and BME CRA drop adapters must be used.

If wireless instruments are required, install an appropriate gateway on the associated device network to facilitate communication with the instruments. Wireless instruments shall not be connected to the Control Networks. Refer to Section 16.3.3 for additional information on use and selection of wireless instruments.

3.4.4 Network Routing

Network routing between the control networks and the device networks should be provided so that the programming/maintenance workstations are able to connect to devices in the device networks.

Routing functionality can be provided by the Ethernet Control Network Head Adapter, catalog number BMENOC0321. Install one Control Network Head Adapter module in each HSBY rack where it is required to route down to an associated device network. Note that static routes will need to be configured on the programming/maintenance workstations, which is described in the Schneider Electric documentation.

For M340 based systems, routing between the control network and the device network would be provided via an external router. The decision to include a router to provide connectivity to an M340 device network should be based on the quantity and type of devices in the device network. For example, if the only Ethernet device in an M340 device network is a variable frequency drive, which doesn't often require maintenance, then the router may be omitted.

Where routing capability is not provided to a particular device network, this would require maintenance personnel would bring a laptop into the field and connect to devices or the device network directly, and should only be utilized for special cases where limited, infrequently maintained devices are on the network.

One or more Layer 3 network switches shall be installed with the Process Control System Network to provide routing between the Supervisory Network, Server Network, and Control Networks.

3.4.5 Network Equipment and Cabling

Table 3-1-2 provides standard catalog numbers for typical Schneider Electric network hardware used in the Process Control System Network.

Table 3-1-2: Standardized Networking Components

Purpose	Port Specifications	Model Number
Dual Ring Switch in Device Network	8 x 100Base-TX	TCSESM083F23F1
PROFIBUS Remote Master	2 x 100Base-TX	TCSEGPA23F14F

Use laser-optimized 50/125 µm, multimode, OM3 cable for all new fibre installations. All fibre network switches shall use VCSEL transmitters.

Cabling associated with ring networks shall be routed such that no two points of the ring are adjacent to each-another within the same duct or cable-tray.

Where CAT6 cable is routed near sources of electromagnetic noise, such as in MCCs, VFD cabinets, or near power cabling, use shielded CAT6 cable and ground the shield at one end. Shielded RJ45 connectors that are plugged into appropriately grounded RJ45 ports may be used for grounding the cable shield.

CAT6 cable located within equipment containing 600V shall have an insulation rating of 600V.

CAT6 cabling entering or leaving a networking panel shall be terminated on patch panels. Do not connect fibre or CAT6 field cables directly to the network switches within network panels; only patch cables are permitted to be connected to network switches in networking panels. It is generally preferred to connect CAT6 cabling directly to equipment in the field, where patch panels are not provided.

For CAT6 cabling operated at 100/1000 Mbps network speed, the maximum allowable length is 100 meters. However, to allow for cabling between patch panels and network switches, and between network jacks and end devices, permanent cabling shall be limited to 75% of the maximum allowable design length. This allows for the installation of patch cables and incorporates some level of contingency.

3.4.6 Wireless Networking

Wi-Fi (IEEE 802.11) wireless networking should be provided for access to the HMI system from mobile devices such as laptops, smart-phones, and tablets. Wi-Fi access points should be provided throughout wastewater treatment facilities in electrical and control rooms and in the field where useful. Access points should be mounted on the ceiling for better coverage if possible. Provide a wireless controller/switch combination to accommodate the number of access points being installed.

Wi-Fi access points shall be connected to the facility Administration Network, and be fully managed by the City's Information Technology (IT) group.

Access to the HMI system for wireless devices is provided by a read-only HMI terminal server that is located in the DMZ Network.

3.5 HMI, Historian, and Information Server Systems

3.5.1 General

When a wastewater treatment facility is upgraded with a PLC based control system, provide new HMI, historian, and information server systems based on the City's standardized components, which consists of a Schneider Electric Vijeo Citect/CitectScada HMI, Citect Historian, and Ampla Information Server. The following sections apply to new HMI system installations at wastewater treatment facilities.

3.5.2 HMI Servers

Each HMI server consists of multiple individual software services that operate on a common hardware server. Such services include the I/O server, alarms server, trends server, and report server. The primary purpose of the HMI servers is to communicate with the PLCs to obtain tag data and make the data available to HMI clients.

Provide redundant HMI servers at each facility and locate the servers in separate process areas. The primary HMI server shall be located in the main process control system server room (typically within the Administration Building), and the secondary HMI server shall be located inside an automation room or server room in a different major process area. The purpose of locating the HMI servers in different areas is to prevent both servers from being damaged in the event of a fire or similar catastrophic event that is localized to the process control system server room. The HMI servers shall be installed in non-floodable areas that don't have any pipes with liquids above the area.

Install Schneider Electric Vijeo Citect server software and the facility HMI application on each HMI server.

Implement hardware virtualization on the HMI server computers with VMWare ESXi. Refer to Section 3.8 for additional information on server virtualization.

Each HMI server shall be connected via Ethernet to the Primary and Secondary Control Networks, as well as the server network, as shown in Figure 3-1. Each HMI server therefore requires three Ethernet adapters.

3.5.3 HMI Clients

Vijeo Citect HMI clients will use thin client technology based on Microsoft Remote Desktop Protocol (RDP), also known as Terminal Services. Use of thin client technology allows for rapid replacement of HMI clients in the event of failure, and reduces the maintenance requirements of HMI client computers.

Connect the HMI clients to the Supervisory Network for communication with the HMI terminal servers. HMI clients communicate with the HMI terminal servers only, and do not directly communicate with the HMI servers.

Configure Vijeo Citect HMI thin clients to automatically open a remote desktop (terminal services) session with the HMI terminal server upon boot-up.

Use of hardware virtualization on HMI clients is not required since they will not have a user-installed operating system and application software.

3.5.4 HMI Terminal Servers

A minimum of three (3) HMI terminal server instances will typically be provided at a wastewater treatment facility for hosting the facility HMI runtime software. As the HMI clients use thin client technology, they will connect to the HMI servers for access to the HMI system. Note that Terminal Services is also known as Remote Desktop Protocol (RDP).

Two (2) of the HMI terminal server instances are installed on dedicated terminal server computers, which connect between the Supervisory Network and the Server Network (reference 3.5.2 for additional network connection information). These terminal servers will be used as the main terminal servers for the facility HMI system and will operate in a redundant manner. The HMI runtime software on these HMI terminal servers shall be configured read/write, thereby giving operations personnel the ability to view equipment status and control the process via the HMI. Each HMI terminal server computer shall be located in a separate area of the facility, typically in the same locations as the HMI servers.

An additional two (2) HMI terminal server instances (subject to provision of an information server) shall be provided in the DMZ network for access to the HMI from the office computers on the Administration Network, from mobile devices such as smart-phones and tablets, and from other facilities (e.g. viewing SEWPCC from NEWPCC). The terminal server instance is installed on a dedicated terminal server computer in the DMZ, and will be considered the primary DMZ HMI terminal server. A second terminal server instance is installed on the same computer hosting the Ampla Information Server software, and will be considered the secondary DMZ HMI terminal server. The HMI runtime software on these DMZ HMI terminal servers shall be configured read-only to prevent unauthorized control of the HMI system.

Install the Vijeo Citect HMI runtime client software on all four (4) (subject to provision of an information server) computers hosting the HMI terminal server instances. The Vijeo Citect HMI server software is not required on these computers.

Create a user-login script that automatically opens the Vijeo Citect HMI runtime client upon logging into the terminal services session.

Implement hardware virtualization on the HMI terminal server computers using VMWare ESXi. Refer to Section 3.8 for additional information on server virtualization.

3.5.5 Historian Server

Provide a single historian server at the facility. Only one historian server is required as the HMI servers are able to buffer data in the event that the historian server is out of service.

Install the latest version of Schneider Electric Citect Historian (minimum 5000 point) license part number CT211014 Historian software on the historian server.

Separate server hardware shall be provided for the historian server. Do not use the HMI server hardware, domain controller hardware, or HMI terminal server hardware for hosting the historian server instance.

Locate the historian server in the main process control system server room (typically within the Administration Building at the facility).

Implement hardware virtualization on the historian server computer with VMWare ESXi. Refer to Section 3.8 for additional information on server virtualization.

The period of data retention on the historian system shall be consistent with the Historical Data Retention Standard, document 612620-0016-40ER-0001. Ensure the hard drives are sized to meet the data retention requirements.

3.5.6 Information Server

An information server using the Schneider Electric Ampla software may be provided at each facility for collection and reporting of process and equipment statistics, but this is not a mandatory requirement.

If an information server is provided, install it on a computer in the De-militarized Zone (DMZ) network so that computers on the Process Control System Network and Administration Network are able to access the information server. The information server computer should physically be located within the process control system server room within the Administration Building of a facility.

If an Information Server is provided, utilize hardware virtualization on the server's computer with VMWare ESXi. Refer to Section 3.8 for additional information on server virtualization.

The configuration and implementation of the information server software, including configuration of reports and key performance indicators, etc., will typically be performed by the City.

3.6 Modification of HMI Systems

All HMI system configurations and HMI applications shall be fully accessible and editable by the City of Winnipeg. HMI hardware or software applications that are password protected and as a result made inaccessible for modification by the City for any reason, will not be accepted under any circumstance. This applies to HMIs used for any application, including process and HVAC applications.

3.7 Domain Controller

Provide a domain controller at each facility for security authentication (user login, permissions, etc.). Use domain based security on all computers associated with the process control system, which includes the HMI servers, HMI terminal servers, historian, HMI clients, programming/maintenance workstations, and laptops as applicable.

The domain controller server instance may be located on one of the HMI terminal server computers since the resource utilization by the domain controller is low. A second domain controller may be installed on the second HMI terminal server computer for domain server redundancy.

If a stand-alone domain controller is provided, locate the computer in the main process control system server room (typically within the Administration Building at the facility).

3.8 Server Virtualization

Computers hosting process control system server software should use virtual machine (VM) technology to facilitate rapid recovery following a hardware or software failure. Use of server virtualization is not mandatory, but is recommended. Note that omission of server virtualization must be reviewed and approved by the City before it is omitted.

VMWare ESXi is the preferred server virtualization software since Schneider Electric has verified compatibility of their HMI software with VMWare ESXi.

VMWare ESXi is a Type 1 hypervisor, also known as a bare metal hypervisor, which means the server virtualization software is installed directly on a bare computer, not within an operating system such as Microsoft Windows. The server virtualization software then mimics the existence of virtual hardware, which an instance of Microsoft Windows is installed upon. Since the hardware seen by the operating system (Microsoft Windows) is virtual hardware, it is possible to replace the physical computer with a new computer and reinstate the software without having to repair the operating system installation or update the drivers. The benefit of using a Type 1 hypervisor as opposed to a Type 2 hypervisor is that it is not required to install an operating system prior to installing the server virtualization software.

Snapshots of the VM’s disk file will be taken by the City at periodic intervals and will be used to restore a server after a hardware or software failure.

It is not expected that any individual computer will be running more than one VM instance – the computers will have a single operating system.

3.9 Programming/Maintenance Workstations

Provide programming/maintenance workstations to facilitate remote programming and management of process control system equipment including the PLCs, HMI servers, historian, motor control equipment, and field instruments. A typical facility would require a minimum two (2) programming/ maintenance workstations.

Install the following relevant software applications on the programming/maintenance workstations, including:

1. Schneider Electric Vijeo Citect HMI development software,
2. Schneider Electric Vijeo Designer touchscreen HMI software,
3. Schneider Electric Unity Pro XL PLC programming software,
4. Schneider Electric Citect Historian (minimum 5000 point) Historian client,

5. Schneider Electric SoMove motor control equipment configuration software, and
6. MDT AutoSave change management software.

Prior to securing any software confirm with City Automation Group to ensure licenses have not been purchased already.

Locate one of the programming/maintenance workstations in the Administration Building. A second workstation should generally be located in the same room as the secondary HMI server and secondary HMI terminal server.

Connect the programming/maintenance workstations to both control networks and the server network. As such, each programming/maintenance workstation requires three network adapters.

3.10 Programmable Logic Controllers

The City has standardized on the use of Schneider Electric Modicon PLCs for all new PLC installations at the wastewater treatment facilities. All processors shall be of the M580 series unless otherwise approved by the City. The exact model and configuration of the PLC is dependent on its application, but will generally fall into one of the four following categories:

1. **PLC to Replace an Existing DCS PCU** – a high-end redundant PLC system installed within an existing DCS cabinet or in an adjacent cabinet that is used for control of existing equipment via the existing field wiring.
2. **PLC for New Process Equipment or Independent Critical Equipment** – a high-end redundant PLC system that is used for control of new wastewater treatment process equipment or for control of independent critical equipment.
3. **PLC for a Minor Process Train or Auxiliary Equipment** – a mid-grade, non-redundant PLC for control of non-critical equipment.
4. **Packaged PLC from Equipment Vendor** – a mid-grade, non-redundant PLC supplied with packaged equipment having non-customizable control.

Each of these applications are described further in the following sections.

3.10.1 PLC to Replace an Existing DCS PCU

New PLC installations that replace existing DCS PCUs shall use Schneider Electric Modicon M580 controllers in a hot-standby (HSBY) configuration with X80 series Remote I/O (RIO).

The M580 HSBY configuration requires that each processor be installed in an independent chassis. Each HSBY rack (chassis and modules) must be identical, and must only contain a power supply module, processor module, and communication modules. I/O modules are located in separate RIO racks.

Table 3-5-6 and Table 3-9 in Section 3.11 list the standard part numbers for the M580 HSBY racks and X80 remote I/O racks.

RIO racks are connected to the main racks via a fault-tolerant Ethernet RIO ring network. Distributed I/O (DIO) devices such as intelligent MCCs, VFDs, and soft-starters connect to a Schneider Electric Dual-Ring Switch (DRS) off the main RIO ring. DIO devices can be connected in a ring topology (if the devices support ring networks), or a star topology.

A sample architecture diagram of a hot-standby system with remote I/O, VFDs, and smart overloads is shown in Figure 3-2 in Section 3.12.

It is recommended to re-use the existing Termination Units (TUs) in the DCS cabinets to facilitate the reuse of the existing field wiring. This will significantly reduce downtime and costs associated with the new PLC installation. The TUs can be connected to the new PLC system using custom cordsets that are available from Schneider Electric Winnipeg Inc.

If mounting the new PLC hardware in an existing DCS cabinet, the installation may be expedited by pre-mounting and pre-wiring all the new components onto one or more back-panels that can be installed into the DCS cabinet as an assembly.

In some instances it may be more expedient to install the new PLC hardware in separate independent control cabinets. This will allow parallel operation of the PLC and DCS during the integration process. The new I/O would likely be part of a separate control panel installation if insufficient room exists in the existing DCS termination cabinets.

Prior to decommissioning any DCS PCU, coordinate with the City to have them back-up the DCS run-time application.

Do not damage the DCS PCU and other components in the removal process as they will be turned over to City personnel.

Minimize interruptions to the process and coordinate activities with plant Operations. Each outage must be scheduled and approved by the City prior to commencement of the work.

The existing DCS implementation uses 120 Vac discrete input modules and 24 Vdc discrete output modules. The signals from the discrete output modules drive interposing relays on the termination units to change the 24 Vdc signals from the output modules to voltage free contacts. In general, these contacts are field powered by 120 Vac. For the new PLC system, use 120 Vac discrete input modules and 24 Vdc discrete output modules to ensure compatibility with the existing TUs and field devices. For new I/O that was not previously connected to the DCS, use 24 Vdc input and 24 Vdc output modules. New I/O will require the installation of new terminals for termination of the field and I/O module wiring, along with the appropriate Schneider Electric preformed cordset (e.g. BMX FCW 303 for the BMX DDI 3202 K input module).

3.10.2 PLCs for New Wastewater Treatment Process Equipment or Independent Critical Equipment

New PLC systems for control and monitoring of new wastewater treatment process equipment or independent critical equipment shall use Schneider Electric Modicon M580 controllers in a hot-standby (HSBY) configuration with X80 series Remote I/O (RIO).

The M580 HSBY configuration requires that each processor be installed in an independent chassis. Each rack (chassis and modules) must be identical, and must only contain a power supply module, processor module, and communication modules. I/O modules are located in separate RIO racks.

Table 3-5-6 and Table 3-9 in Section 3.11 list the standard part numbers for the redundant M580 racks and X80 remote I/O racks.

RIO racks are connected to the main racks via a fault-tolerant Ethernet RIO ring network. Distributed I/O (DIO) devices such as intelligent MCCs, VFDs, and soft-starters connect to a Schneider Electric Dual-Ring Switch (DRS) off the main RIO ring. DIO devices can be connected in a ring topology (if the devices support ring networks), or a star topology.

A sample architecture diagram of a hot-standby system with remote I/O, VFDs, and smart overloads is shown in Figure 3-2 in Section 3.12.

New control panels associated with wastewater treatment process equipment should be located in dedicated control/automation rooms, or electrical rooms. The control panels should be located at an elevation such that they are not subject to potential flooding. Additionally, the control panels should not be located below grade or below any piping that may be subject to leaks of any kind.

The 24 Vdc power supplies associated with each control panel should be located in a separate “Power Supply Panel”.

Network switches and gateways should be located in dedicated “Networking Panels” rather than inside the control panel, but there are exceptions and in some cases installation of a network switch in a control panel may be appropriate. Networking panels should be provided in each major process area for housing the fibre switches.

3.10.3 PLCs for a Minor Process Train or Auxiliary Equipment

PLC systems for minor process trains or auxiliary equipment are not required to use redundant processors because the criticality of the equipment is low, unless failure of the minor system will in turn directly prevent another critical system from running. For non-redundant applications, use a mid-grade PLC processor, such as the Modicon M340 or from the Modicon series. I/O modules are typically located in the same chassis as the processor, but may be in a remote I/O rack if required.

For applications where the I/O modules are in installed in the local rack or an extension rack, an M340 processor is sufficient. If remote I/O is required, use the M580 processor since the M340 does not support remote I/O. Note that modules with a part number beginning in “BME”, such as the HART analog I/O modules require the M580 processor and the “BME” Ethernet backplane.

Where remote I/O (RIO) racks are required, connect them to the main rack using a fault tolerant Ethernet RIO ring network. DIO devices, such as MCCs and VFDs, may be connected to a Dual Ring Switch (DRS) as a DIO sub-ring or DIO cloud, to the service port of the processor as a DIO cloud, or to an Ethernet module as a DIO cloud.

Instruments may be connected to the PLC via hard-wired cabling, but use of PROFIBUS is encouraged. Hard-wired instruments are typical for most HVAC applications, as PROFIBUS instruments are typically higher cost.

Table 3-7-8 in Section 3.11 lists the standard Schneider Electric part numbers associated with a mid-grade PLC system. The part numbers for X80 remote I/O racks, if required, are listed in Table 3-9 in Section 3.11.

Sample architecture diagrams of mid-grade PLC systems are shown in Figure 3-3 and Figure 3-4 in Section 3.12. Figure 3-3 illustrates a single PLC rack that is connected to the Primary Control Network, which uses local I/O. Figure 3-4 illustrates a slightly more critical application, which makes use of an M580 processor that connects to both the Primary and Secondary Control Networks, and uses remote I/O.

3.10.4 Packaged PLC from Equipment Vendor

Where packaged PLC systems are permitted in accordance with Section 6.0 of this Design Guide the following shall apply:

Packaged PLC systems from equipment vendors may come in a variety of implementations with various brands of hardware if not specified. If possible, specify the packaged system should be based on a Schneider Electric Modicon M340 or M580 PLC, which will allow for straightforward integration with the plant process control system.

If the vendor is unable to provide a Schneider Electric Modicon PLC, ensure that their PLC system incorporates a Modbus/TCP interface so that the City’s Process Control System (PCS) can communicate with it. If a third-party product is required for the Modbus/TCP interface, the preference is to use an in-rack solution as opposed to an out-of-rack (e.g. DIN rail mounted) solution.

Regarding the program within the Vendor supplied Packaged Equipment the preferred approach is to have the vendor program the PLC, based on the City’s standard function block classes and consistent with the PCS programming for the entire site. If the vendor is unable or unwilling to program the PLC based on the City’s standards, then the Vendor shall provide a detailed control narrative with a detailed functional requirements and communications specifications. These would be issued to the systems integrator for programming the PLC. Failing this, the vendor should, at minimum provide a control narrative, such that the design engineer is able to develop the functional requirements specification, which would be issued to the systems integrator or the City for programming.

Due to warranty issues, some vendors may not approve that another party program the PLC supplied by the vendor. If the vendor requires that they program the PLC, have the vendor supply a PLC interface map so that the process control system PLCs and HMI system can interface with the vendor PLC. Refer to Section 24.3.4 for further information on Interface Maps. Request that the vendor supply a copy of the PLC program to the City and that the program not be locked or password protected. Software applications that are password protected and as a result made inaccessible for modification by the City for any reason, will not be accepted under any circumstance.

It is desired that all integration and configuration software and hardware tools and documentation are provided to the City for packaged equipment with intelligent controls, with password access to the levels and registers used by manufacturer service technicians.

3.11 Standardized PLC Hardware

This section provides standard Schneider Electric part numbers for PLC system hardware, including processors, I/O modules, backplanes, power supply modules, and ancillary components.

Additional products, beyond those listed below, may be used in the design if required.

Schneider Electric also has “harsh environment” versions of many of their products, which may be used in corrosive or damp locations. Harsh environment versions have a catalog number ending in “H” or “C”.

Standard part numbers for M580 hot-standby racks are listed in Table 3-5-6. Standard part numbers for mid-grade PLC racks are listed in Table 3-7-8. Standard part numbers for X80 remote I/O racks are listed in Table 3-3-4.

Table 3-5-6: M580 Hot-Standby Racks

Description	Catalog Number	Notes
Chassis, Ethernet Backplane	BMEXBP••00	
Power Supply Module, 24 Vdc	BMX CPS 3020	
Power Supply Module, 120 Vac	BMX CPS 3500	
Processor	BME H58 ••••	See Note 1 below
Ethernet Communication Module	BME NOC 0311	
Ethernet Control Network Head Adaptor	BME NOC 0321	Integrated router
Empty Slot Filler	BMX XEM 010	

Notes:

1. *A BME H58 6040 would typically be used for DCS replacement.*

Table 3-7-8: Mid-Grade PLC Racks

Description	Catalog Number	Notes
Chassis	BMX XBP ••00	X-Bus Backplane
	BME XBP ••00	X-Bus + Ethernet Backplane
Power Supply, 24 Vdc	BMX CPS 2010	
	BMX CPS 3020	
Power Supply, 120 Vac	BMX CPS 2000	
	BMX CPS 3500	
Processor	BMX P34 2020	M340 series. Compatible with BMX backplanes only.
	BME P58 ••••	M580 series. Compatible with BMX or BME backplanes.
Ethernet Communication Module	BMX NOC 0401	Use with M340 processor (Minimum model # BMXP342030)
	BMX NOC 0402	Use with M580 processor
	BME NOC 0311	Requires BME Backplane and M580 processor
Discrete Input Module, 32 channel, 24 Vdc	BMX DDI 3202 K	
Discrete Output Module, 32 channel, 24 Vdc	BMX DDO 3202 K	
Discrete Output Module, 16 channel, Relay	BMX DRA 1605	
Analog Input Module, 8 channel, Non-Isolated	BMX AMI 0800	
Analog Input Module, 8 channel, Isolated	BMX AMI 0810	
HART Analog Input Module, 8 channel, Isolated	BME AHI 0812	Requires BME Backplane
Analog Output Module, 4 channel, Isolated	BMX AMO 0410	
Analog Output Module, 8 channel, Non-Isolated	BMX AMO 0802	
HART Analog Output Module, 4 channel, Isolated	BME AHO 0412	Requires BME Backplane
Empty Slot Filler	BMX XEM 010	As required
Rack Extension Kit	BMX XBE 2005	As required

Notes:

1. *Part numbers starting with “BMX” can be installed into “BME” backplanes.*

2. *On some BME backplanes, only specific slot numbers on the backplane support "BME" modules. Refer to Schneider Electric documentation.*

Table 3-9 : X80 Remote I/O Racks

Description	Catalog Number	Notes
Chassis	BMX XBP ••00	X-Bus Backplane
	BME XBP ••00	X-Bus + Ethernet Backplane
Power Supply Module, 24 Vdc	BMX CPS 2010	
Power Supply Module, 120 Vac	BMX CPS 2000	
X80 Ethernet Drop Adapter	BMX CRA 312 10	Use with BMX I/O modules only
	BME CRA 312 10	Use with BME or BMX I/O modules
Discrete Input Module, 16 channel, 120 Vac	BMX DAI 1604	Use for existing I/O
Discrete Input Module, 32 channel, 24 Vdc	BMX DDI 3202 K	Use for new I/O
Discrete Output Module, 16 channel, 24 Vdc	BMX DDO 1602	
Analog Input Module, 8 channel, Non-Isolated	BMX AMI 0800	
Analog Input Module, 8 channel, Isolated	BMX AMI 0810	
HART Analog Input Module, 8 channel, Isolated	BME AHI 0812	Requires BME Backplane
Analog Output Module, 4 channel, Isolated	BMX AMO 0410	
Analog Output Module, 8 channel, Non-Isolated	BMX AMO 0802	
HART Analog Output Module, 4 channel, Isolated	BME AHO 0412	Requires BME Backplane
Empty Slot Filler	BMX XEM 010	As required
Rack Extension Kit	BMX XBE 2005	As required

Notes:

1. *Part numbers starting with "BMX" can be installed into "BME" backplanes.*
2. *On some "BME" backplanes, only specific slot numbers on the backplane support "BME" modules. Refer to Schneider Electric documentation.*

3.12 Standard Architectures

Standard architectures are shown in the following figures to illustrate the method for connecting process control system equipment using the City's preferred methods.

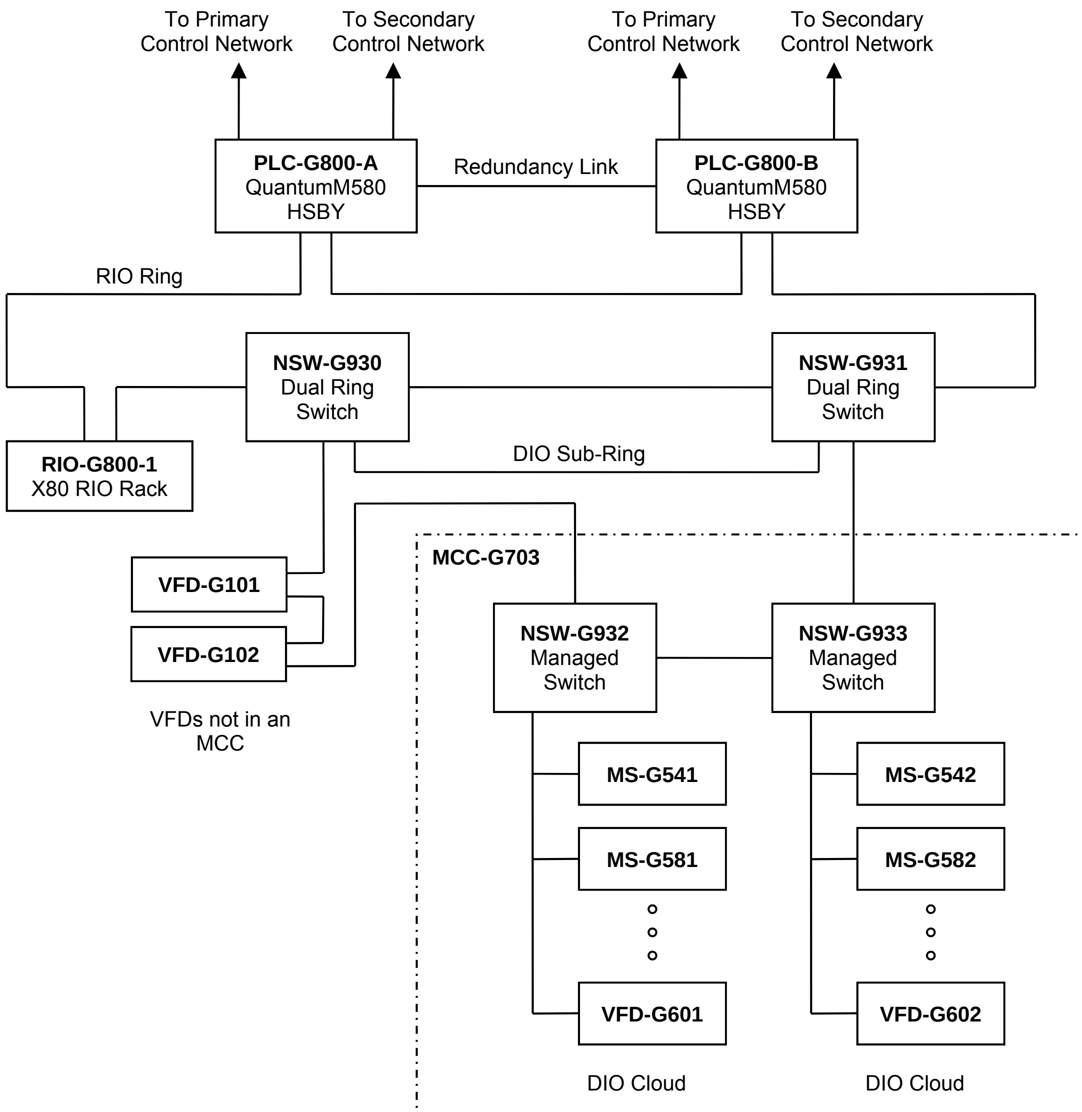

Figure 3-2: M580 Hot-Standby Architecture

Notes:

1. *All I/O modules are located in separate remote I/O (RIO) racks.*
2. *Where process equipment redundancy is provided, the associated motor controllers should be connected to separate network switches to improve availability. In this figure, the starters in the MCC are divided to separate switches, but could also be placed in separate MCCs.*
3. *The DIO sub-ring for the VFDs and MCC is shown connected to two dual ring switches to improve reliability.*

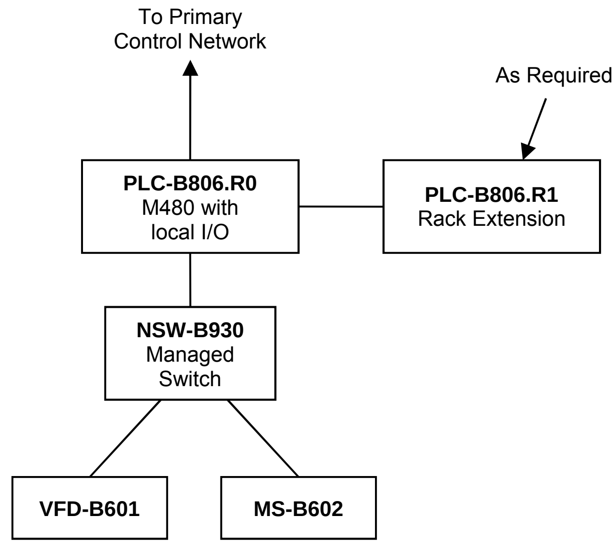

Figure 3-3: Mid-grade PLC System Architecture with M340 Processor

Notes:

1. *Non-redundant PLCs typically connect to one control network via the processor service port or an in-rack Ethernet module. An additional in-rack Ethernet module may be installed if connection to the Secondary Control Network is required.*
2. *Rack extensions may be added to the main rack for additional I/O if required. The M340 processor does not support Remote I/O (RIO) racks.*
3. *Instruments are typically hardwired to in-rack I/O modules.*
4. *Distributed I/O (DIO) devices such as MCCs and VFDs are connected to the service port of the processor or to an Ethernet module. If the field devices support Rapid Spanning Tree Protocol (RSTP) then they may be connected in a ring topology to a BMXNOC0401 in-rack Ethernet module.*

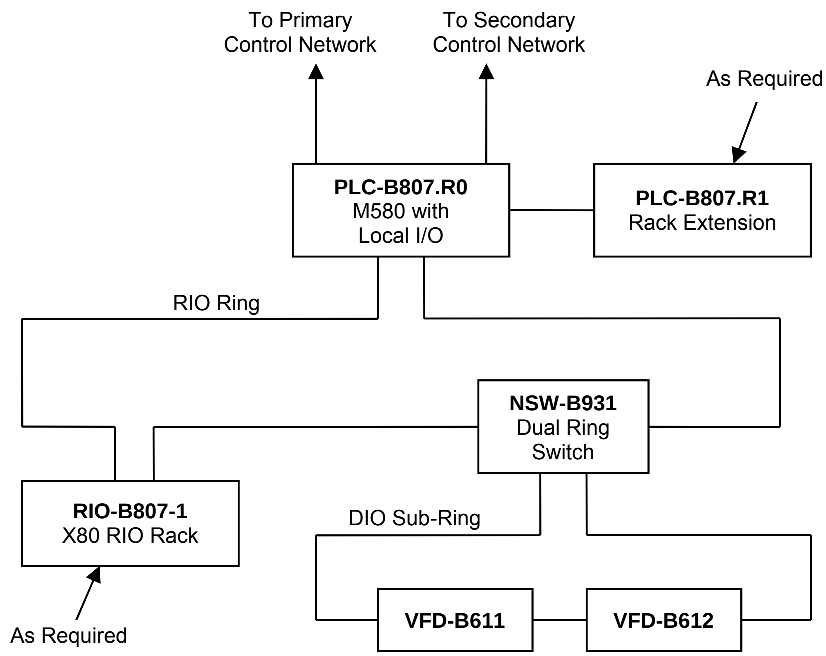

Figure 3-4: Mid-grade PLC System Architecture with M580 Processor

Notes:

1. *Non-redundant PLCs connect to one or both control networks via the processor service port and/or in-rack Ethernet modules.*
2. *The M580 processor may use in-rack I/O or Remote I/O (RIO).*
3. *Instruments are typically hardwired to in-rack I/O modules.*
4. *Distributed I/O (DIO) devices such as MCCs and VFDs are connected in a DIO sub-ring (preferred) or as a DIO cloud. DIO devices connected as a DIO cloud may connect to a dual ring switch (DRS), to the service port of the processor, or to an Ethernet module.*

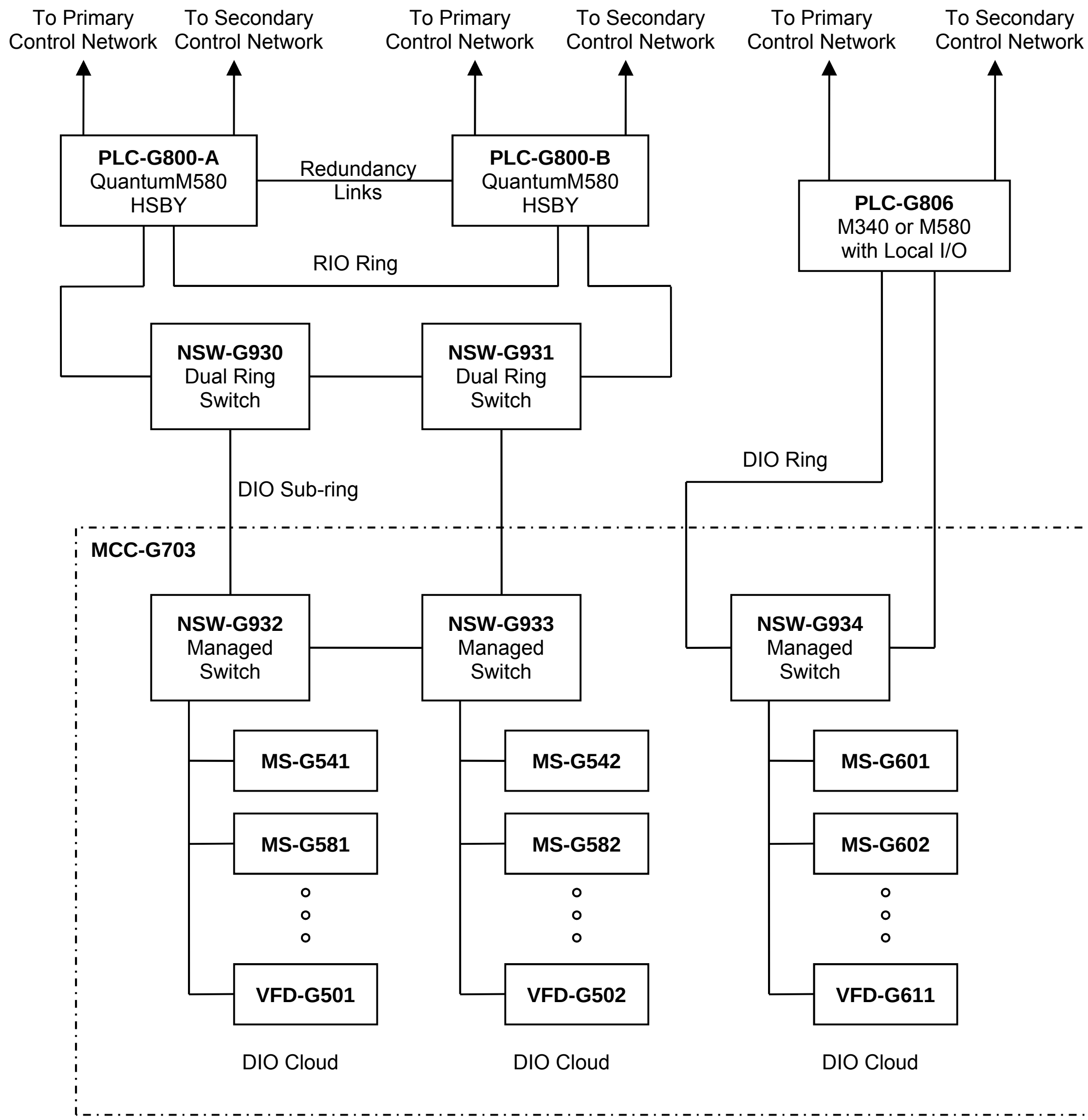

Figure 3-5: Multiple PLCs controlling a single MCC

Notes:

1. *Multiple PLCs cannot connect to the same RIO ring. As such, if an MCC must be controlled by separate PLCs, separate networks must be provided to the MCC.*
2. *An X80 remote I/O rack could be connected in the RIO ring associated with the M580 HSBY pair, but this is not shown.*
3. *PLC-G806 is connected to network switch NSW-G934 in the MCC using a ring topology. This requires the use of an in-rack Ethernet module such as the BMXNOC0401. Alternatively, a single (non-ring) connection to NSW-G934 can be implemented, but it will not have the same fault-tolerance as a ring topology.*

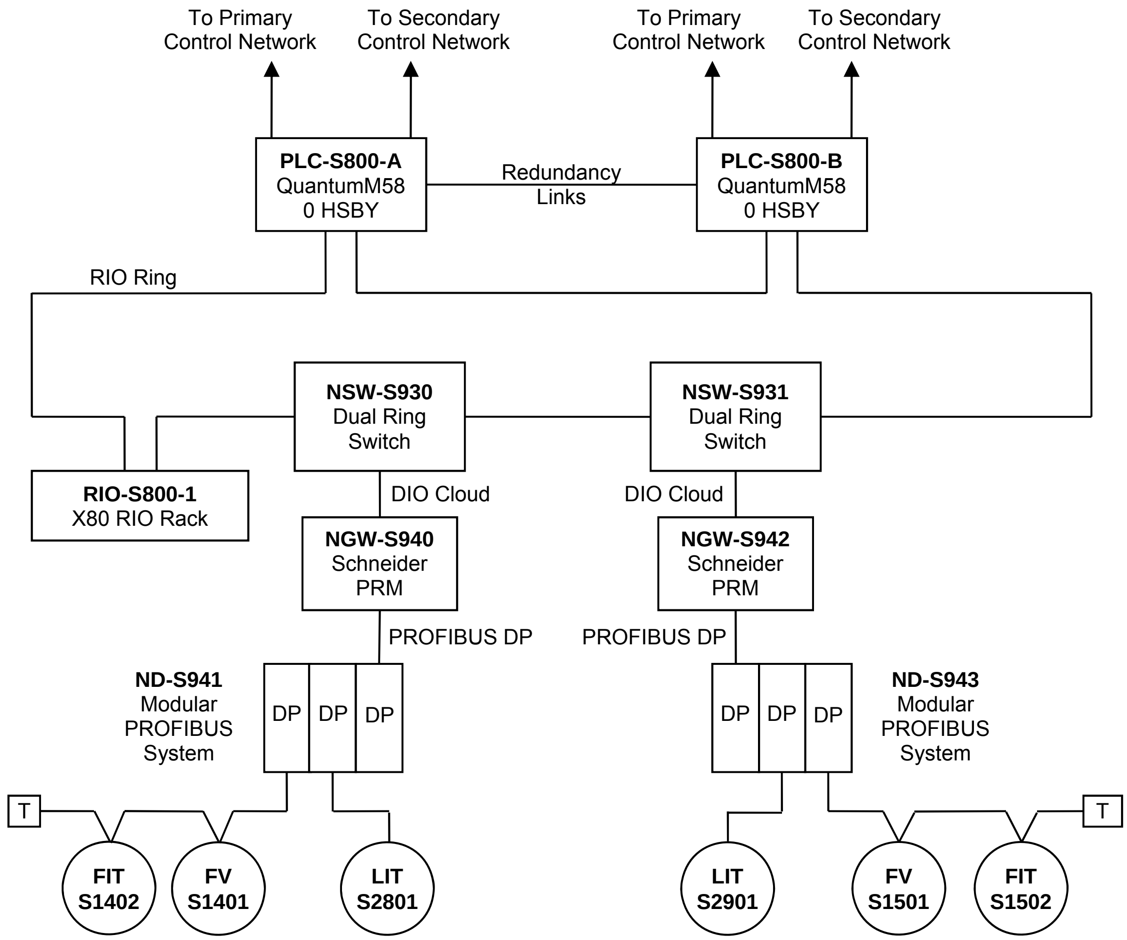

Figure 3-6: Connection of PROFIBUS DP Devices

Notes:

1. *The Schneider PRM (Profibus Remote Master) module provides conversion between Modbus/TCP and PROFIBUS DP, and is connected as a DIO cloud to the PLC system.*
2. *The Schneider PRM may connect directly to the PLC, or to a dual ring switch. In the case of redundant M580 PLCs, the PRM would be connected to a dual ring switch.*
3. *A modular PROFIBUS system is shown for connection of PROFIBUS devices. This facilitates replacement of PROFIBUS DP devices without affecting the entire PROFIBUS DP network.*
4. *External terminations are shown at the ends of the PROFIBUS DP segments with more than one instrument, to facilitate replacement of the last device without affecting the segment. Note that if all the instruments on one segment are in the same loop then external terminations may not be required.*
5. *Group together devices of one process loop on a common PROFIBUS DP segment. FV-S1401 and FIT-S1402 are in the same process loop and therefore share the same PROFIBUS DP segment.*
6. *Where process equipment and/or instrumentation redundancy is provided, it is encouraged to connect the redundant devices to separate PRM modules, as shown.*

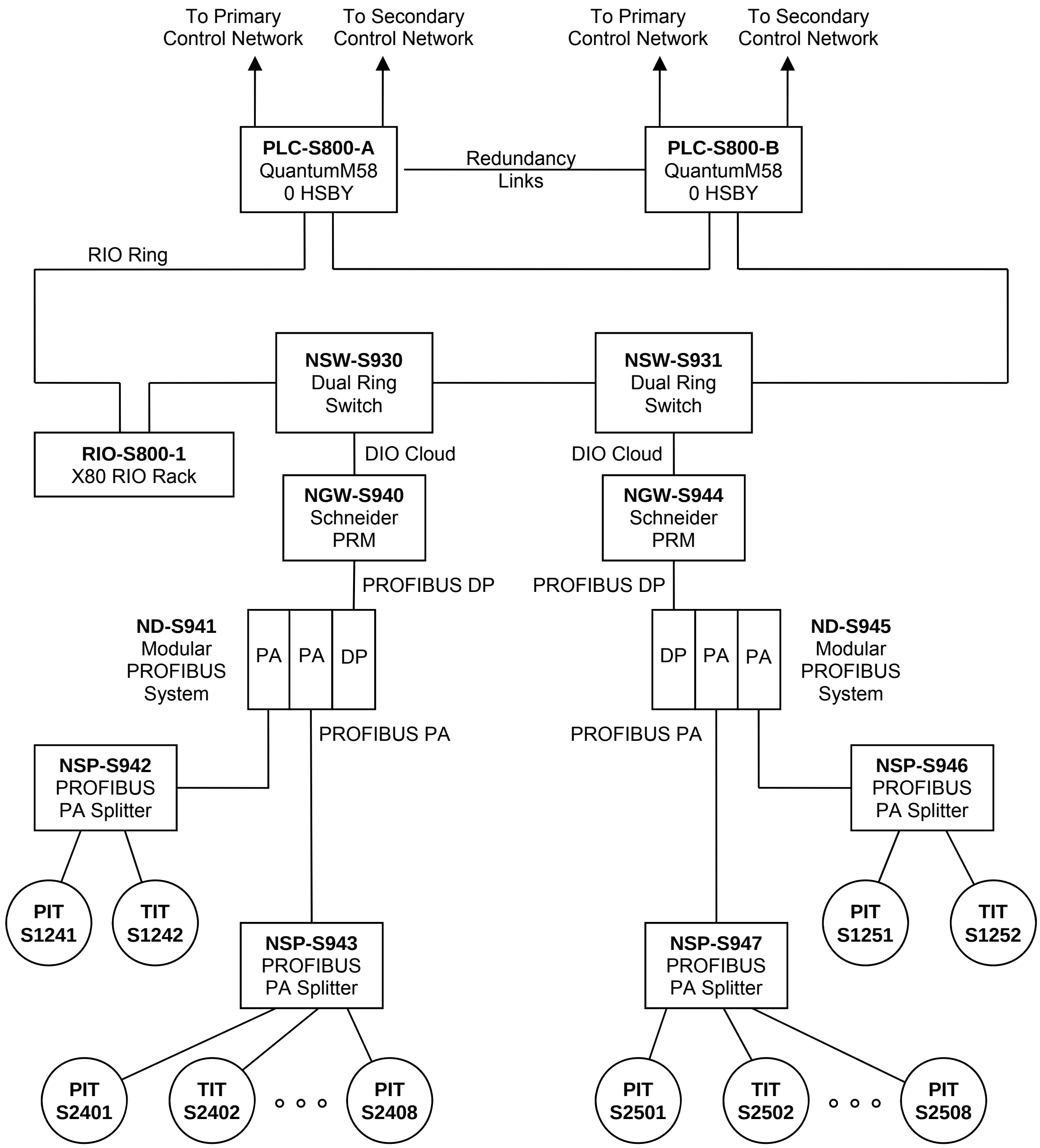

Figure 3-7: Connection of PROFIBUS PA Devices

Notes:

1. *PROFIBUS PA splitters (or "segment protectors") are used in the field to provide spur connections for PROFIBUS PA devices, rather than connecting the devices in a daisy-chain fashion. This allows for easy replacement of individual devices, and prevents an electrical short on one spur from affecting other spurs.*
2. *Provide multiple splitters (or "segment protectors") in the field as required to minimize spur lengths.*

3.13 PLC Programs

3.13.1 Program Language

The Schneider Electric Modicon PLCs support all five languages defined by IEC 61131-3. However, the specific language used for an application must be selected as per Table 3-10-11. Note that more than one programming language may be used within a single PLC program.

Table 3-10-11: Permitted PLC Programming Languages

Language	Permitted	Notes
Function Block Diagram	Yes	Preferred for most general applications.
Ladder Diagram (Ladder Logic)	Yes	Permitted for specific logic applications with minimal analog control.
Instruction List	Generally Not	May be considered for a very specific subroutine requiring high performance.
Structured Text	Yes	Appropriate for certain math and logic applications.
Sequential Function Chart	Generally Not	May be considered for complex sequencing applications when difficult to implement in a different language.

3.13.2 PLC Configurations and Program Logic

1. All PLC configurations and program logic shall be fully accessible and editable by the City of Winnipeg. PLC systems that are password protected, and as a result made inaccessible for modification by the City for any reason, will not be accepted under any circumstance... This applies to PLC systems used in any application, including process and HVAC applications.
2. A standard library of function block classes are in development for the wastewater treatment program, and it is expected that new PLC programs be implemented with these function block classes. Where an existing function block class does not provide the required functionality, develop a new function block class and add it to the library for re-use.
3. Programs are to be implemented using an object-oriented approach, utilizing user-defined data types and encapsulation where possible.
4. Programs are to be implemented using positive logic, meaning that discrete variables are to be named based on the function they perform in the 1 State (True State).
5. Use state machine logic for state-based and sequencing applications.
6. Refer to the City of Winnipeg Tag-name Identification Standard, document code 612620-0014-40ER-0001, for standards regarding naming of tags and function block classes.

3.13.3 Program Structure

1. Segregate programs into multiple tasks and routines to improve readability and maintenance of the program.
2. The name (identifier) of all tasks and routines shall contain the identifiers of the equipment they are associated with. Exceptions to this rule include system tasks that cannot be

renamed, and routines that are not directly associated with equipment such as input/output mapping routines. When using periodic tasks, the priority number and scan rate of the task shall be included in the name of the task.

3. The name for each X80 RIO adapter in the configuration shall include the physical rack identifier and the assigned drop number per the rotary switches on the front of the module.
4. The name for each X80 I/O module in the configuration shall include the rack identifier and slot number in which the module is installed.

3.13.4 Program Documentation

1. Provide complete documentation within PLC programs to aid in full understanding of the logic. Note that the level of documentation expected is greater than what an experienced programmer would need, since the programs may be viewed and maintained by personnel who may not have substantial programming experience, or may not be fully familiar with "class based" function block programming.
2. Where documentation is provided for specific logic, avoid creating documentation that simply repeats the logic. Documentation should describe the functionality of the logic. For example, avoid saying "the A bit turns off the B bit after 10 seconds". Instead, say "the discharge pressure sensor turns off the motor after it indicates low pressure for 10 seconds".
3. All routines shall contain a documentation header containing the authoring company name, the date the routine was created, the current revision number of the routine, date of the latest revision, and the document number of the associated Functional Requirements Specification if applicable.

3.13.5 Variable Data Types

1. For each variable tag, use a data type that results in the least amount of memory usage while still providing the required number of significant figures.
2. For all digital (On/Off or True/False) variables, use the BOOL or EBOOL data types.
3. For analog integer variables in the range of -32768 to +32767, use the INT data type (16 bits).
4. For analog integer variables in the range of -2147483648 to +2147483647 and that exceed the range of the INT data type, use the DINT data type (32 bits).
5. Use of UINT or UDINT is to be avoided to ensure that the data is not misconstrued as being signed data by an ancillary system (e.g. Microsoft Excel).
6. For non-integer analog data, use the REAL data type. Do not use the INT or DINT data types with an implied decimal for storing non-integer data.

3.14 Control Modes

Process equipment may be controlled from a number of sources including the PLC system, panel instruments, and manual pilot devices. Operator controls shall be provided on the HMI system and/or in the field for selection of the active control source.

The following equipment operating modes have been defined:

1. PLC Only – The equipment is always controlled by the PLC, although may be switched between *Manual* and *Auto* modes via the HMI. Manual controls are provided on the HMI.

2. Local/Off/Remote – A Local/Off/Remote switch is provided at the equipment or at the motor controller (e.g. MCC, or VFD). When in *Local* mode, the equipment is controlled via the local pilot devices. When in *Remote* mode, the equipment is controlled from the PLC system.
3. Hand/Off/Remote – A Hand/Off/Remote switch is provided at the equipment or at the motor controller. When in *Hand* mode, the equipment runs continuously. When in *Remote* mode, the equipment is controlled from the PLC system.
4. Hand/Off/Auto – A Hand/Off/Auto switch is provided, with the *Auto* mode providing automatic equipment control via a controller other than the PLC system.

Using the "Auto" designation for PLC system control is not recommended as this designation can conflict with the HMI Auto/Manual modes that may be provided on the HMI/PLC system.

Where Local/Off/Remote or Hand/Off/Remote switches are provided, connect one of the "Remote" position contacts to a PLC input and program the PLC such that its outputs associated with the equipment are only enabled when in *Remote* mode.

Refer to Section 11 for further details on local controls.

3.15 Cyber Security

Security controls and safeguards shall be provided with all new PLC system and network installations to prevent internal and external threats from affecting plant assets through system vulnerabilities.

Security controls and safeguards are divided into the several categories including:

1. Corrective – Controls that minimize the effect of an attack and the degree of resulting damage.
2. Detective – Controls that determine if an attack has occurred, or is in the process of occurring, and initiate corrective controls.
3. Deterrent – Controls that reduce the ease in which an external threat can affect assets.
4. Preventative – Controls that prevent external threats from affecting assets.

Controls and safeguards shall be provided to protect against the various types of attacks which include:

1. Passive – Monitoring, capture, and analysis of communication, and decrypting weakly encrypted data.
2. Active – Attempts to circumvent or break encryption, modify information, and introduce malicious code.
3. Close-In – Attaining close proximity to system components to learn about the implementation and modify, gather, or deny access to information.
4. Spoof – Modification of the source address of packets the attacker is sending so that they appear to be originating from someone or something else.
5. Buffer Overflow – Sending more data to a system than is expected, causing complete failure or unexpected operation of the system.
6. Hijack – Taking over a session between two systems and disconnecting one of the systems from communication.

Network firewalls, gateways, and encryption shall be used at appropriate points within the networks to inspect and control network traffic as a means to mitigate attacks. Firewalls shall use techniques such as packet filtering, stateful inspection, deep-packet inspection, and rate limiting.

Firewalls used in the process control system network shall be purpose-built for process control systems, and shall be able to perform packet inspection on common industrial Ethernet protocols such as Ethernet/IP and Modbus/TCP. For example, the following mechanisms shall be provided for Modbus/TCP enforcement:

1. User-definable lists of allowed Modbus unit IDs, commands, registers, and coils.
2. Protocol "sanity check" blocks any traffic not conforming to the Modbus standard.
3. Automatic blocking and reporting of traffic that does not match the rules.

Firewalls shall also incorporate a logging mechanism to allow for routine inspection of event messages to determine if attacks have been attempted, have occurred, or are in progress. In addition to internal logging, the device shall be capable of logging to an external (syslog) monitoring system.

Encryption shall be used for all wireless communication and any inter-plant communication that uses the Internet. Wireless (Wi-Fi) networks shall not use Wired Equivalent Privacy (WEP) as it is easily breakable even when configured correctly. Wi-Fi networks shall use WPA or WPA2 encryption. At minimum, Virtual Private Networking (VPN) shall be used for inter-plant communication or anywhere the Internet is required for transmission of data associated with the process control system.

All Ethernet network switches shall be managed switches and have all unused ports disabled. Network switches shall be password protected.

All process control system devices that incorporate password protection shall be configured with a password other than the default password. The same password should not be used on multiple devices.

Field devices that incorporate physical DIP switches or jumpers to prevent write access to the device and do not require frequent configuration changes should be set read-only to prevent unauthorized or accidental change.

Demilitarized zones with upstream and downstream firewalls should be used for access to such systems as an Information Server and a read-only HMI terminal server. These systems shall still incorporate authentication mechanisms and credentials to prevent access by unauthorized users. Systems in demilitarized zones shall be configured read-only.

Restrict physical access to process control system equipment, including programmable controllers, network switches, and field devices. This may be achieved via a lock on the enclosure containing the devices, or placing the devices in a locked room.

Disable unused services on computer servers to improve security and performance.

Configure user and group security appropriately; do not grant unnecessary privileges.

Avoid use of personal or commercial grade hardware and software components (e.g. virus scanning and firewall software) that may be incompatible with process control system components. For example, some firewall software may block network packets that are required for redundant HMI server synchronization and may prevent failover of the HMI server. Be aware of such issues, and properly configure and test all components.

Computers associated with the process control system shall not be directly connected to the Administration or Security networks. Similarly, computers on the Administration or Security networks shall not be directly connected to the Process Control System Network. Where connections between networks are required, they shall occur through firewalls.

Components providing system security shall be implemented in a manner that failure of the component acts to disable system functionality rather than disable system security.

Use the following standards and guidelines when implementing system security:

1. NIST Special Publication 800-82, Guide to Industrial Control Systems (ICS) Security,

2. ISA/-62443 (formerly ANSI/ISA-99.00.01): Security for Industrial Automation and Control Systems,
3. North American Electric Reliability Corporation (NERC), Critical Infrastructure Protection (CIP) Cybersecurity Standards,
4. NIST Special Publication 800-53, Recommended Security Controls for Federal Information Systems,
5. Department of Homeland Security, Catalog of Control Systems Security: Recommendations for Standards Developers,
6. AMI-SEC Task Force, AMI System Security Requirements,
7. DOD Instruction 8500.2, Information Assurance (IA) Implementation.

4 I/O REQUIREMENTS

UNDER DEVELOPMENT

Discrete inputs shall be fused as follows:

- At minimum one fuse shall be provided per I/O module. In no event shall a fuse power I/O across more than one module; and
- As minimum one fuse shall be provided per instrument / device / equipment. In no event shall a single I/O fuse be permitted to service multiple instruments / devices / equipment.

Individual fusing of each I/O point is an acceptable means to achieve the above, but is not mandatory.

Discrete inputs shall be fused as follows:

Individually fused per I/O output.

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5 IDENTIFICATION

All equipment, including but not limited to automation panels, networking panels, junction boxes, instruments, and cables, shall be given an identifier that conforms to the City of Winnipeg Water and Waste Identification Standard. All equipment shall be identified on the drawings and in the field with the same identifier.

Provide identification of equipment, components, and cabling as per the City of Winnipeg Sewage Treatment Program Standard Specifications, Section 26 05 01, Common Work Results – Electrical.

6 PACKAGED EQUIPMENT SYSTEMS

6.1 Introduction

It is common for some complex systems to be packaged, such that the equipment vendor integrates the automation system tightly together with the equipment, to provide a comprehensive equipment package.

Packaged systems are sometimes supplied with electrical and automation control panels, such that the delivered system only requires service connections to operate. However, in other scenarios the electrical and automation components are specified and supplied independently from the package supplier so that the owner has more control over the configuration and type of electrical and automation components supplied. The City had completed an initiative to standardize on numerous electrical and automation components, and the package vendors may potentially have issues with compliance to these standards.

Specific wastewater treatment equipment will include packaged solutions from vendors that will include a pre-designed equipment arrangement that may be based on a proprietary design. An example of this is the potential use of high-speed turbo blowers for a BNR system, where the vendor would supply the blower complete with the VFD and integrated controls as part of a packaged unit for each blower. These packaged solutions will include equipment that has been preconfigured to achieve the performance metrics that would be established as part of the vendor’s contract obligations. Alteration of these proprietary systems could therefore impact system performance and it is likely that vendors would refuse to provide the requested performance guarantees under these circumstances. It is recognized that equipment components that form part of an overall complex system incorporating significant vendor proprietary knowledge and specialized equipment integration would be difficult to modify without impacting the vendor’s ability to meet its stated performance guarantees.

On the other hand, there are instances where part or all of a pre-packaged system includes non-complex and non-proprietary equipment configurations; where the electrical and automation controls can easily be delivered via alternate delivery approaches without significant impact upon vendor performance guarantees.

6.1.1 Scenario 1 - Comprehensive Vendor Supply

Under this scenario, all package systems, including non-complex systems, are supplied with the manufacturer’s standard electrical and automation components and typically integrated into a vendor control panel. The specification would still require compliance with some of the City standards, including identification, voltage levels, etc.

Advantages:

The control system components would be tested and proven by the equipment supplier to properly operate the equipment.

- Single point of responsibility.
- May provide the lowest capital cost, provided the level of PCS integration is minimal.

Disadvantages:

- Additional spare parts must be maintained in the spare parts inventory if the manufacturer and model of supplied components are not the same as the City’s standard components.

- Additional training may be required for the City to support the electrical and automation components supplied by the package vendor.
- Service will likely require bringing in the vendor's service personnel, who may not be local and thus potentially at significant expense and operational risk.
- The manufacturer and models of the electrical and automation components may not be natively compatible with the City's future control system products. As a result, integration of the two systems may require additional components, such as protocol converters, which require configuration and are additional points of failure.
- The user interface to City personnel would likely not be consistent with the City's standards.
- As the components utilized may be proprietary, the longevity of service and support cannot be guaranteed.
- Some package vendors may desire or even insist on the ability to remote access the system for support or warranties. While this is not necessarily impossible, this would require significant coordination and City IS&T approval as well as segregation of the automation network domain to provide the appropriate security protection.

6.1.2 Scenario 2 – Comprehensive Vendor Supply - City Hardware and Software Standards

Under this scenario, the package vendor for non-complex systems supplies an integrated system with applicable electrical and control components, integrated into a vendor control panel. However, the hardware component manufacturer (and potentially models) would be specified in detail in the tender documents and the City standards given to the vendor to ensure that the package system supplied complies with the City's standards. In addition, City software standards would be provided to the vendor to ensure that the software produced is compliant with the City's requirements. It is assumed that the specification would require City ownership of the final software delivery.

Advantages:

- The control system hardware components would match the City's standard components; therefore no compatibility issues would arise.
- Single point of responsibility.
- Less training, as the City would be familiar with the components.

Disadvantages:

- The manufacturer of the packaged system may be unfamiliar with the specified control components and may make errors or omissions during the implementation.
- The cost of the packaged system would increase due to potential unfamiliarity with the specified products and requirement arising from additional design efforts to implement the specified solution. In some cases, the vendor may not be able to meet the requirements.
- The level of electrical and automation shop drawing reviews required would be significantly higher due to the fact that the design may be new for the manufacturer and they are likely unfamiliar with the specified products.
- As a library of the City software standards does not currently exist, it would be difficult to provide consistency in programming between the package suppliers and the Systems Integrator.

- Where a PLC is supplied by the package vendor, the programming style would likely differ significantly from the rest of the plant, which would be programmed by the Systems Integrator.
- The manufacturer's software programmer may need to spend a significant amount of time on site debugging software, which could increase the commissioning duration.
- The user interface to City personnel would still likely have a different "look and feel" compared to the user interface provided by the Systems Integrator.
- Some package vendors may desire or even insist on the ability to remote access the system for support or warranties. While this is not necessarily impossible, this would require significant coordination and IS&T approval as well as segregation of the automation network domain to provide the appropriate security protection.

6.1.3 Scenario 3 –Vendor Hardware Supply - City Hardware Standards

Under this scenario, the package vendor for non-complex systems supplies an integrated system with applicable electrical and control components, integrated into a vendor control panel. Once again, the hardware component manufacturer (and potentially models) would be specified in detail in the tender documents and the City standards given to the vendor to ensure that the package system supplied complies with the City's standards. However, the programming of the controls would be omitted from the vendor's scope of work. The vendor would be responsible for providing a control narrative for the operation of the package system, which would be utilized by the main Systems Integrator for the overall project to do the programming.

Advantages:

- The control system components would match the City's standard components; therefore no compatibility issues would arise.
- Less training, as the City would be familiar with the components.
- Single point of responsibility.
- Would provide a high level of consistency from a user interface "look and feel" perspective.
- The implementation details, including program methodology and the HMI animation standards, would closely match the City's standards, thereby reducing confusion for operations and maintenance personnel.

Disadvantages:

- The manufacturer of the packaged system may be unfamiliar with the specified control components and may make errors or omissions during the implementation.
- The cost of the packaged system would increase due to potential unfamiliarity with the specified products and requirement arising from additional design efforts to implement the specified solution.
- The level of electrical and automation shop drawing reviews required would be significantly higher due to the fact that the design is likely new for the manufacturer and they are likely unfamiliar with the specified products.

6.1.4 Scenario 4 – Custom Designed Approach

Under this scenario, non-complex packaged systems are supplied without the associated electrical and automation components. These would be designed in advance based upon the expected equipment supply package. The package vendor would be asked to review the electrical and control design, to ensure that it is compatible with their equipment. Note that under this scenario, standardized instruments would be supplied by the package vendor if they are installed by the package vendor on a tightly integrated skid, but would be supplied by the installation contractor if they are installed in the field. Various checks and balances would need to be set in place to ensure that the overall system operates appropriately.

Advantages:

- The control system components would match the City's standard components; therefore no compatibility issues would arise.
- Fewer spare parts.
- Less training, as the City would be familiar with the components.
- Would provide a high level of consistency from a user interface "look and feel" perspective.
- The implementation details, including program methodology and the HMI animation standards, would closely match the City's standards, thereby reducing confusion for operations and maintenance personnel.
- All electrical and automation drawings would be standard City drawings, under the City's full ownership.

Disadvantages:

- More design drawings would be required to detail the installation of the electrical and automation components. Additional coordination work to ensure that the electrical and control system meets the requirements of the package system.
- In some cases, the manufacturer of the packaged system may try to absolve themselves of any responsibility for warranty-related issues, since they did not supply or configure the control system. This is only expected to be likely for systems with a higher level of complexity or proprietary knowledge. (This can possibly be addressed via appropriate warranty specifications)
- Some scope changes may be required for the systems integrator, based upon changes in the vendor's supply compared to that expected. However, this is dependent upon the contracting strategy.

6.2 Understanding of the City's Priorities

It is understood that the City places a very high value on the long-term operation and maintenance implications of equipment that is incorporated into the SEWPCC facility. It is also understood that the City has had some previous experience with package control systems, where the maintenance has been more difficult than with custom designed solutions.

In addition, the City underwent a formal E&IC Standardisation process, which included approvals by various City departments, including IST and Corporate Support Services. The use of components different than that standardized could potentially cause issues. In certain cases, the E&I standardized vendors could file an objection with the City in the event that they feel the terms or intent of the standardization RFP are violated.

6.3 Package System Requirements

As a general rule, it is required that all electrical and control systems shall be implemented as per Scenario 4, except where the system is complex or proprietary. The decision as to whether a package system is complex or proprietary must be made on a case-by-case basis. Refer to the table below for the packaging strategy for various systems in the SEWPCC scope of supply.

Table 6-1 : Acceptable Package Automation Systems

Description	Catalog Number	Notes
Chassis	BMX XBP ••00	X-Bus Backplane
	BME XBP ••00	X-Bus + Ethernet Backplane

Package System	Package Format	Notes
High-Speed Turbo-blowers	Scenario 1	The complexities of the package system require complete vendor control of the deliverable.
Conventional Blowers (>200 hp)	Scenario 1 / 2	It is desired that the electrical starter is fully compliant with the E&IC standardization. The automation is expected to be by the vendor. Scenario 2 is preferred, but Scenario 1 may be accepted upon discussion with and approval of the City.
UV System	Scenario 1	The complexities of the package system require complete vendor control of the deliverable. However, the scope of control shall be limited to the vendor supply.
Centrifuge (rotating above 100 RPM)	Scenario 1	The complexities of the package system require complete vendor control of the deliverable. However, the scope of control shall be limited to the vendor supply.

Package System	Package Format	Notes
Polymer Mixing System	Scenario 2/4	Electrical: The 120VAC motor controls may be proprietary; however the 600V motor controls should meet the City standards via Alternative 2 or 4. Automation: Either Scenario 2 or 4 is acceptable.
High-Rate Clarifier	Scenario 4	This was previously decided to be custom
Biofilter / Odour Control Systems	Scenario 4	The system is not deemed to be complex or have proprietary controls. The burner controls (if any) would be proprietary and implemented under Scenario 1. The space is not expected to be conducive for significant electrical / controls installations. By selecting Scenario 4 for the electrical, it will allow the starters to be contained in an intelligent MCC.
Perforated Plate Screens	Scenario 4	May have vendor provide a marshalling panel.
Secondary Clarifier Mechanisms	Scenario 4	The vendor may provide instrumentation such as torque switches.
Chemical Feed Pump Skids	Scenario 4	The control of the pump is simple, and does not require significant vendor involvement. It also allows the electrical to be integrated into a MCC. Instrumentation may be supplied by vendor, provided it meets City standards (i.e. flowmeter).
Boilers	Scenario 1	
HVAC Air Handler – Natural Gas fired	Scenario 1/4	The NG Burner management system and directly associated systems will be proprietary (Scenario 1), however all systems not part of the burner management control shall be by PLC. For example, a pre-heat coil control valve shall be controlled by the PLC.

7 LAYOUT / LOCATION REQUIREMENTS UNDER DEVELOPMENT

7.1 Control Panels

7.1.1 PLC Panels

PLC control panels associated with wastewater treatment process equipment should be located in dedicated automation or electrical rooms. PLC panels (containing PLC processors) are never acceptable within hazardous locations or dirty / corrosive locations.

Table 7-1: PLC Locations

Application	Hazardous Location	Dirty / Corrosive	Automation / Electrical Room

Network switches and gateways should be located in dedicated “Networking Panels” rather than inside the control panel, but there are exceptions and in some cases installation of a network switch (e.g. Connexium switch) in a control panel may be appropriate subject to the City’s approval. Networking panels should be provided in each major process area for housing the fibre switches.

7.1.2 Remote I/O Panels

Remote I/O panels should generally be located close to the devices that the I/O wiring connects to, which may be in the field. However, remote I/O panels shall be avoided in Class I, Zone 1 hazardous locations.

7.1.3 Power

The 24 Vdc power supplies associated with each control panel should be located in a separate “Power Supply Panel”.

8 ENVIRONMENTAL REQUIREMENTS

8.1 Ingress Protection

All instruments and enclosures shall have ingress protection against liquids, gasses, and dust for the environmental conditions in which they are used. So far as feasible, control panels should not be located outdoors.

Table 8-1-2 lists the minimum ingress protection for various environmental conditions.

Table 8-1-2: Minimum Ingress Protection for Instruments and Enclosures

Environment	NEMA
Clean indoor air conditioned area (control, electrical room)	1
Indoor non-corrosive area subjected to dripping	12
Indoor non-corrosive area subjected to wash-down	4
Outdoor non-corrosive area	4
Indoor corrosive area	4X
Outdoor corrosive area	4X

Control panels shall be located at an elevation such that they are not subject to flooding. Additionally, the control panels shall not be located below any piping that may be subject to leaks of any kind.

8.2 Temperature and Humidity Ratings

All automation equipment and instruments located outdoors shall have a minimum operating temperature range of -40°C to 40°C. Equipment exposed to direct sunlight shall be suitable for operation at up to 60 °C.

Where instrumentation and panels are exposed to direct sunlight, a suitable stainless steel sunshade or cooler shall be provided. Pneumatic instruments (actuators), gauges, switches, etc., generally do not require a sunshade.

All equipment and instruments shall be suitable for high humidity (95% non-condensing) conditions unless installed in a climate controlled room.

8.3 Cold Environment Requirements

Instrumentation subjected to freezing conditions colder than their minimum operating temperature shall be enclosed within a heated enclosure. Soft covers are not acceptable.

Impulse lines subject to process liquid freezing shall be heat traced and covered.

9 WIRING, CABLING, AND CONDUIT

9.1 Standard Colours

9.1.1 Control Wiring – Wire Colour

Wires shall be colour coded as per Table 9-1-2.

Table 9-1-2: Wire Colour Codes

Conductor Purpose	Colour
Power – 120/240 Vac Supply	Black
Power – 120/240 Vac Neutral	White
Power – 24 Vdc Supply (+)	Blue
Power – 24 Vdc Common (–, or 0 Vdc)	Brown
Discrete Control – ac	Red
Discrete Control – dc	Blue
Intrinsically Safe (IS)	IS (light) Blue
Protective Earth (PE)	Green
Signal Ground / Instrumentation Earth (IE)	Green/Yellow

9.1.2 Network Cable – Jacket Colour

Network cables shall be colour coded as per Table 9-3-4.

Table 9-3-4: Network Cable Jacket Colour Codes

Cable Purpose	Colour
Ethernet, CAT5e or CAT6	Blue
PROFIBUS DP	Purple
PROFIBUS PA, Non-Intrinsically Safe	Black
PROFIBUS PA, Intrinsically Safe	Light Blue
Modbus/RTU (serial)	Grey

9.1.3 Profibus Cable – Conductor Colour

Use the colour scheme indicated in Table 9-5-6 for all Profibus cable connections.

Table 9-5-6: Profibus Cable Conductor Colours

Profibus DP	Profibus PA	Colour
Line A (RxD/TxD-N)	PA-	Green
Line B (RxD/TxD-P)	PA+	Red

9.1.4 Conduit Colour Coding

Apply colour coded bands to all conduits at points where they enter walls, ceilings, or floors, and at 5 meter intervals. Colour coding shall be as per Table 9-7-8.

Table 9-7-8: Conduit Colour Codes

System	Prime Band	Aux. Band
Power, 120/208/240 Vac	Black	
UPS Power, 120/208/240 Vac	Black	Green
Control Wiring, 120 Vac	Black	Orange
Fire Alarm	Red	
Low Voltage Communication/General	Blue	
Low Voltage Control Wiring, < 50 V	Blue	Orange
Intrinsically Safe	Blue	White

Use a 38 mm wide prime band and a 19 mm wide auxiliary band.

9.2 Cable Types and Ratings

Multi-conductor automation cables are to be of the CIC (Control and Instrumentation Cable) or ACIC (Armoured Control and Instrumentation Cable) type, meeting CSA C22.2 No. 239-09.

Where single-conductor wiring is used, use of RW90 in conduit is acceptable.

The voltage rating of automation cables shall meet or exceed the highest voltage present in the control panel or equipment in which the cable is used.

Refer to the City's Sewage Treatment Program standard equipment specifications for further details on cable specifications.

9.2.1 Cable Requirements

Control and Instrumentation cables:

- CIC or ACIC, XLPE RW90, 600/300V, with 100% insulation.
- 600V cable is to be utilized for any cable termination in an enclosure containing voltages above 300V.
- Phase/polarity numbering marking/colour codes – Standard numbering and colour coding.
- Jacket – Black PVC jacket rated FT-4 and low acid gas emitting. The jacket will be UV, moisture and oil resistant.

Ethernet Cables

CAT 6 Cable

- UNDER DEVELOPMENT

Fibre Optic Cables:

Outdoor Fibre Optic Cable

Fibre Requirements:

- Single-mode
  - Fiber Category: OS2
  - Maximum Attenuation:0.4 / 0.3 dB/km
  - Chemical Resistance: RoHS
  - Approvals: CSA FT-4-ST1
  - Manufacturer and Model:
    - Corning 036EUL-T3601D2M or approved equal

- Multi-mode
  - Fiber Category: OS3
  - Maximum Attenuation:0.4 / 0.3 dB/km
  - Chemical Resistance: RoHS
  - Approvals: CSA FT-4-ST1
  - Manufacturer and Model:
    - Corning 036EUL-T3601D2M or approved equal

Indoor Fibre Optic Cable

In accordance with requirements of EIT/EIA 568, section 12.5

Manufacturer:

- Corning 040402R5Z200xxM (where xx is length in metres) or approved equal

9.3 Use of Conduits vs. Cables

In general, the decision to use conduits or cables should be based on the specific details of the application. In general, cables in cable tray is preferred for new installations; however there are cases were the use of conduits is appropriate. It is acceptable for a facility to have a mixture of conduits and cables.

Conduits should be considered in the following applications:

1. Where the existing installation is conduit based.
2. Fire alarm systems.
3. Where aesthetics are a concern.
4. Where there is potential for physical abuse or damage.
5. Where the specific cables required do not have an FT4 rating.

9.4 Conduit Materials and Sizes

Use rigid conduit, except where flexible conduits are required for maintenance of equipment or in areas where the equipment is subject to vibrations during operation (compressors, motors, etc.), to reduce the effect on connections. EMT may be used within office areas if there are no environmental issues.

Rigid galvanized steel conduit is not acceptable for use within wastewater facilities. See Table 9-9-10.

Conduit boxes to be aluminum with cast covers. Use spring door covers for areas with circulating dust and contamination.

Table 9-9-10 : Facility Conduit Application

Application	Type
In poured concrete walls and floors	PVC
Underground	PVC
General Use	Rigid Aluminum
Locations with presence of agents that cause corrosion of aluminum	PVC
Exterior	Rigid Aluminum
Hazardous Locations	Rigid Aluminum
Office and similar locations, without environmental contamination.	EMT

9.5 Junction Boxes

Junction boxes with terminals shall be used for automation cable connections. Joints or splices to automation wires within junction boxes without the use of terminals are not acceptable.

Junction boxes shall have an area to one side of the terminal strip reserved for the homerun cable(s). If there are two terminal strips the area between the two strips shall be reserved for the homerun cable(s).

Sufficient space for the homerun cable gland(s) must be allowed for in junction boxes. Holes for the homerun cable glands are to be punched on site unless they are explosion proof boxes.

All cables and conduits should enter the bottom of the junction box. Cables should not enter the top of the enclosure in order to avoid the issue of liquid ingress.

All junction boxes installed outside shall be supplied with an air breather/drain approved for the area classification.

Physical separation of cabling within junction boxes shall be provided for each type or category of signal, as follows:

1. Low level analog milliVolt signal cables (TC, strain-gauge),
2. 12 to 24 VDC discrete signals and high level analog DC signals (4-20 mA, 0-5 V, etc.),
3. 120/240 VAC discrete signals,
4. Intrinsically Safe (IS) signals.

9.6 Cable Trays

1. A side rail height of 152 mm (6”) is preferred. Use 102 mm (4”) side rail height where vertical space is limited.

2. Size cable tray to meet current and future cable requirements. Minimum tray width is 152 mm (6”).
3. Tray to be CSA, cUL listed.
4. The rungs of the ladder shall typically be at 229 mm (9”) spacing.
5. Cable tray load ratings shall be sufficient for the cables installed and any additional loads such as snow, ice and wind, where applicable.
6. Allow for spare cables in cable tray loading calculations.
   a. Minimum load rating for indoor tray: CSA Class C1
   b. Minimum load rating for outdoor tray: CSA Class D
7. Use tray covers for mechanical protection in dusty areas, outdoors, and for trays passing under walkways or where there is a risk of falling debris.
8. Use aluminum cable tray in wastewater treatment facilities.
   a. Consider the use of fibreglass cable tray in corrosive locations. Fibreglass tray shall not be exposed to sunlight unless confirmed by the manufacturer that it is sunlight/UV resistant.

9.7 Shield Termination and Grounding

1. Instrument cable overall shields and individual shields are to be grounded at one end only to avoid ground loops.
   1.1 For non-intrinsically safe wiring, where an incoming shielded cable and an outgoing shielded cable connect at a set of terminals and one of the cable shields is grounded elsewhere, use insulated feed-through terminals to connect the shields of the incoming and outgoing cables.
2. Instrument overall and individual cable shields should typically be grounded at the control panel or I/O marshalling cabinet.
   2.1 RTDs embedded in windings of medium and high voltage (> 1 kV) motors shall be bonded to ground in a junction box to avoid fault currents from propagating into control panels or I/O marshalling cabinets.
3. Except for grounded thermocouples, all of the shield drain wires shall be cut and taped in the field near the instrument.
4. Exposed parts of the drain wires should be inside insertion jackets. Drain wires for different loops should not touch each other within the junction boxes, I/O or marshalling cabinets.
5. PROFIBUS cable shields should be grounded at both ends to improve noise rejection, unless ground loop currents prevent proper operation of the communication cables, in which case the cables may be grounded at one end only. Provide an insulated, 12 AWG, equipotential bonding conductor along with all PROFIBUS cabling to minimize currents in the cable shields.
6. If intrinsic safety is required, the intrinsic safety ground system shall have a dedicated ground conductor that is isolated from the safety ground, except for at the final connection to the building electrode ground, to prevent ground fault currents from entering the intrinsically safe system.

9.8 Signal Noise Prevention

1. Analog signals such as 4-20 mA, RTD, thermocouple, pulses, and milli-Volts shall use individually shielded twisted pairs or triads.
2. Where practicable, 24 Vdc discrete signals such as relay contacts, process switches, solenoids, and limit switches should use twisted pairs or triads with overall shield but individual shielding is not required.
3. Analog and discrete signals shall not share the same multi-pair/triad cable.
4. Each signal shall have its own return wire extending from the source to the destination to protect against common impedance coupling.
5. It may be useful to ground spare wiring in marshalling cabinets and junction boxes to minimize potential noise pickup.
6. Where signal noise is an issue, use of isolated analog PLC I/O modules may be considered.
7. Signal isolators may be installed to prevent ground loops, prevent passage of noise between cables via the common reference, or split a signal for multiple pieces of equipment. Signal isolators shall not to be used on communications cabling.

10 HMI SYSTEMS

10.1 Locations UNDER DEVELOPMENT

Field Operator Stations

Indoor?

Reference NEWPCC Guidelines

10.2 Typical Information and Control Points on HMI Systems

The following information shall be provided on HMI systems for display of automation equipment status and facilitate control. The following is not comprehensive in nature, but represents the minimum requirements.

1. HMI system equipment:
    a. Primary and secondary HMI server operational status,
    b. Indication of which HMI server is acting as primary, secondary,
    c. Manual controls for switching between primary and secondary HMI servers,
    d. HMI server resource utilization,
    e. Historian server status,
    f. Historian server resource utilization,
    g. HMI client license usage.
2. Programmable Logic Controller (PLC) equipment:
    a. PLC operating mode (Run / Remote / Program),
    b. PLC fault status,
    c. For redundant PLCs:
        - Indication of which controller is primary, secondary,
        - Manual controls shall be provided to facilitate switching between the primary and secondary controllers for users with appropriate privileges,
    d. Resource utilization,
3. Networking equipment:
    a. Network switch status,
    b. Firewall status and alarms,
    c. Communication gateway (PROFIBUS / Modbus / etc.) status,
    d. Network Time Protocol server status,
4. Plant process:
    a. Equipment mode (e.g. Hand, Off, Remote, etc.),
    b. Equipment operating status (e.g. Not Ready, Running, Faulted, etc.),
    c. Equipment manual controls,

d. Duty assignments for redundant equipment,
e. Instrument readings in engineering units,
f. Process control setpoints and modes,
g. PID controller PV, SP, CV (read-only on HMI systems),
h. Equipment and plant operating limits to allow operators to react before an alarm is generated,
i. Adjustable alarm setpoints,
j. Plant statistics (daily/monthly flow totals, etc.)

5. General:
   a. Alarm management system,
   b. Screen navigation buttons,
   c. Date and time,
   d. Currently logged-in user,
   e. Links to help system / plant operating manuals, if available, and
   f. Mathematical constants page.

10.3 HMI Standards and Reference Material

Use the following City of Winnipeg documents in the development of HMI system applications:

1. Tag name Identification Standard, document code 612620-0014-40ER-0001,
2. HMI Layout and Animation Plan, document code 612620-0015-40ER-0001,
3. Historical Data Retention Standard, document code 612620-0016-40ER-0001.

The following guidelines may be referenced as required:

1. ASM Consortium Guidelines, Effective Operator Display Design,
2. ASM Consortium Guidelines, Effective Alarm Management Principles.

11 LOCAL USER INTERFACE

11.1 General

The local user interface for equipment may be composed of physical pilot devices, a touchscreen HMI terminal, or a combination of the two. Where both pilot devices and a touchscreen HMI are used, the pilot devices shall be associated with essential and/or safety functions only.

Pilot devices, including push buttons, selector switches, and pilot lights are to be of the heavy-duty, dust and oil-tight type, rated for the area in which they are used.

11.2 Pilot Device Colours

Where pilot devices are use, the color convention shall be as follows:

Table 11-1-2: Standard Pilot Device Colours

Purpose	Pilot Device Colour
Running Status Light	Green
Stopped Status Light (not normally provided)	Blue
Position Open Status Light	Green
Position Closed Status Light	Blue
Alarm Status Light – Major or Safety	Red
Warning or Minor Alarm Status Light	Amber
Ready Status Light	Blue
Operating Mode Light – Normal Mode	Blue
Operating Mode Light – Alternate Mode	Amber
Start Pushbutton	Green or Black
Stop Pushbutton	Red or Black
Test Pushbutton	Black
Reset Pushbutton	Black
E-Stop Pushbutton	Red (Note 3)
Overload Reset Pushbutton	Blue with White “R”
Selector Switch	Black with White Insert

Notes:

1. *The pilot light colours used are selected from an operations perspective.*
2. *Use of white or clear lens pilot lights is not permitted as it is difficult to discern whether they are illuminated in brightly lit areas.*
3. *Emergency stop pushbuttons to be push-pull maintained operators with red mushroom cap.*

11.3 Touchscreen HMIs

Touchscreen HMIs can provide more functionality than pilot devices but come at a higher installed cost due to the labour involved with software configuration and testing. Use a touchscreen HMI rather than pilot devices if the equipment requires more than approximately eight pilot devices to facilitate local control, or requires operator input or indication of analog values.

HMI (software) Auto/Manual modes may be provided on the HMI/PLC system to facilitate manual control of equipment via the PLC.

11.4 Typical Manual Controls

Manual controls in the form of physical pilot devices may be provided for equipment to facilitate maintenance activities or for control of the equipment during PLC system failure. Manual controls should be located adjacent to the equipment but may be located elsewhere on a control panel or on a Motor Control Centre (MCC) if mounting adjacent to the equipment is not practicable.

Refer to the standard control modes defined in Section 3.14. Where manual controls are provided for equipment, selector switches are typically provided in the field for selecting between the available control modes.

The City has standardized on the following control mode switch configurations:

1. Local/Off/Remote (L/O/R) selector switch with local pilot devices for manual control, and local pilot lights to indicate status.
2. Hand/Off/Remote (H/O/R) selector switch with pilot lights to indicate status. No additional manual controls are typically provided.
3. Hand/Off/Auto (H/O/A) selector switch with pilot lights to indicate status. No additional manual controls are typically provided.

Remote mode implies equipment control is from the PLC system, and *Auto* mode implies equipment control is from some automatic controller, other than the PLC system. When equipment is in *Hand* mode, the equipment is run continuously.

Lock-Off-Stop (LOS) pushbuttons are generally prohibited as they do not provide the required level of electrical isolation for maintenance activities. Use a local disconnect switch if electrical isolation is required.

Emergency stop pushbuttons (e-stops) shall be provided for equipment that presents a safety hazard to personnel (e.g. unguarded rotating machinery). Design the emergency stop circuit such that the equipment requires a fresh start command to restart upon releasing the e-stop pushbutton.

Typical manual control requirements are indicated in Section 7.8 of the Electrical Design Guide, document 510276-0000-47ER-0001, the following for single speed and VFD controlled motor driven equipment.

12 CONTROL PANELS

12.1 Heating, Ventilation, and Cooling

Control panels shall be provided with heating, ventilation, and/or cooling as required to ensure the internal temperature and humidity are maintained at acceptable levels for the components within.

Perform a heat-load analysis for all control panels containing heat-generating components. Determine if the thermal dissipation via the enclosure walls is sufficient or if additional cooling is required. If additional cooling is required, consider installing filtered louvers at opposite corners of the control panel to provide cooling through natural convection. If natural convection is insufficient, install a filtered fan unit to provide forced air flow through the panel.

Where fans are provided on control panels, ensure that the fans positively pressurize the cabinet to prevent ingress of contaminants through small openings.

Panels installed in cold or outdoor locations may require an internal heater and thermostat to maintain the temperature above the minimum required for the internal components.

A cabinet dryer or heater may be required for control panels installed in humid locations to prevent build-up of moisture within the panel, and to prevent corrosion of internal components.

Provide the mandatory ventilation clearances around heat-generating components as specified by the component manufacturer. Indicate mandatory component clearances on the panel layout drawings.

12.2 Spare Space

Control panels are to be provided with a minimum 20% spare space to facilitate installation of additional terminals, relays, and other components in the future. Spare space shall be logically distributed throughout the panel rather than concentrated to one area, and dimensioned on the control panel layout drawing.

The mandatory ventilation clearances around equipment shall not be considered as spare space.

For chassis based PLCs, a minimum of 20% spare space shall be provided within the chassis for the future addition of modules. Alternatively, space could be provided within the control panel for the addition of another PLC chassis in the future.

12.3 Wireways

Provide narrow-slot, ventilated wireways complete with snap-on covers within all control panels to contain both the internal panel wiring and incoming/outgoing field wiring.

Size wireways such that they are not more than 40% full once the wiring is installed.

Provide a minimum of 50 mm spacing between wireways and adjacent devices such as terminals and relays. This is to facilitate clear viewing of the wire identification marking, and for insertion and removal of the wiring to the device.

Provide a minimum of 19 mm separation between ventilated wireways containing intrinsically safe wiring and ventilated wireways containing non-intrinsically safe wiring.

Use grey wireways for normal (non-intrinsically safe) wiring and light blue wireways for intrinsically safe wiring.

Wiring run to the door of the control panel shall be appropriately grouped, tied together at short intervals with nylon cable ties, and secured to the door using adhesive backed cable tie mounts in a manner that minimizes stress on the wires.

Categorize and group conductors based on their application. Provide separate wireways for conductors of each category in order to minimize electromagnetic interference. Categories 3 and 4 may be combined if space is limited. Wiring categories are provided in Table 12-1-2.

Table 12-1-2: Wiring Categories

Category	Description	Examples
1	AC Power and Control	• AC power for power supplies • 120 Vac control wiring • 24 Vac control wiring to HVAC devices
2	DC Power and Control	• DC power • DC control wiring
3	Analog Signals	• Analog I/O
4	Communications	• Communication cables

12.4 Cable Entry

The location of cable entry into the panel should be determined prior to designing the layout of the control panel as component layout can affect the routing of field cabling.

Recommended point of cable entry for control panels is at the bottom of the enclosure. Top entry of cables is only permitted in dry locations.

12.5 Power Supply Voltage

PLC control panels in control/automation rooms should be powered by 24 Vdc from an external power supply panel adjacent to the control panel. However, for a DCS replacement where the PLC is installed within an existing DCS cabinet, the 24 Vdc power supplies may be located in a DCS cabinet.

Small control panels and remote I/O panels in the field may be powered by 120 Vac.

12.6 Control Voltage

Use 24 Vdc signalling for discrete I/O rather than 120 Vac where possible in order to reduce shock and arc flash hazards.

12.7 Grounding and Bonding

Control panels with I/O, 24 Vdc power supplies, or shielded network cabling shall be provided with both a non-isolated electrical (safety) ground bar and an isolated instrumentation ground bar. The non-isolated electrical (safety) ground bar shall be used for bonding components such as the enclosure wall, enclosure door, back-panel, PLC chassis, and 120 Vac powered equipment to the building electrical (safety) ground. The isolated instrumentation ground bar shall be used for bonding instrumentation cable shields, the DC supply common, shielded network cabling, and other sensitive components to the building instrumentation ground.

Locate the isolated and non-isolated ground bars at logical and convenient locations within the control panel to minimize the length of bonding conductors. Generally, the ground bars are to be located at the point of cable entry into the panel.

Provide a lamacoid or label adjacent to the isolated instrumentation ground bar reading “Isolated Ground”.

Ensure that any paint or other such insulating materials are scraped off of components at the point where bonding conductors attach. Use star washers at the mating surface to ensure a proper bonding connection.

Where a control panel is powered from a 120 Vac source, the bonding connection associated with the 120 Vac supply shall be connected to the electrical (safety) ground bar within the control panel (either directly or via a feed-through terminal).

Instrumentation cable overall and individual shield drain wires shall connect to insulated feed-through terminals on the terminal block DIN rail. These feed-through terminals shall then be connected together via insulated jumpers (either on the side or down the centre of the terminals), and the first or last terminal be bonded to the isolated instrumentation ground bar. In this way, the instrumentation cable shields are not connected directly to the electrical (safety) ground. Provide insulation on bare drain wires as required to prevent accidental bonding to electrical (safety) ground. For smaller panels, drain wires may be directly connected to the isolated ground bar rather than through feed through terminals, but the drain wire must be insulated to prevent contact with the electrical (safety) ground.

All bonding conductors shall be connected in a star, and not be daisy chained. Bonding conductors shall be insulated, stranded copper, 14 AWG or larger. Use green insulation on bonding conductors associated with the electrical (safety) ground, and green/yellow insulation on bonding conductors associated with the instrumentation ground.

Existing buildings may not be equipped with both an electrical (safety) ground and instrumentation ground. In this situation, the isolated instrumentation ground bar within the control panel should be connected to the building star ground, or as close to the building electrode ground as possible. If these options are not feasible, a single bonding link would be provided between the non-isolated electrical (safety) ground bar and the isolated instrumentation ground bar within the control panel, in order to bond the isolated instrumentation ground bar to ground. If at a later time the building is provided with an instrumentation ground, remove the bonding link in the panel and bond the panel’s isolated instrumentation ground bar to the instrumentation ground.

Refer to Section 22 for further information on grounding.

12.8 Terminals

Terminals are to be provided for termination of field wiring and internal panel wiring.

All terminals are to be of the screw connection type.

Where possible, use plug-in bridges rather than wire jumpers to connect terminals together within a terminal block.

12.9 Terminals for Hardwired I/O Terminations

The terminals listed in Table 12-3-4 are the preferred terminals for termination of hardwired I/O signals and for connection to PLC I/O modules.

Table 12-3-4: Hardwired I/O Terminations

Application	Function	Terminal Type
Analog Input/Output, 2-wire Transmitters	24 Vdc Loop Power	Fused Terminal
	4-20 mA Signal	Disconnect Terminal
	24 Vdc Common	Feed-Through Terminal
	Shield Drain	Feed-Through Terminal *(Note 1)*
Analog Input/Output, 4-wire Transmitters	4-20 mA Signal	Disconnect Terminal
	4-20 mA Common	Feed-Through Terminal
	Shield Drain	Feed-Through Terminal *(Note 1)*
Discrete Input	24 Vdc / 120 Vac Supply to Field	Double-Level Fused Terminal
	Discrete Input Signal	
Discrete Output	Discrete Output Signal	Double-Level Fused Terminal
	24 Vdc Common / Neutral	

Notes:

1. *Feed-through terminals are used for terminating analog shields in the case where the associated DIN rail is bonded to the enclosure's electrical (safety) ground. If an isolated DIN rail is provided, which is only connected to the isolated instrumentation ground bus in the enclosure, potential earth terminals may be used instead of feed-through terminals.*

It is recommended to use Schneider Electric cord sets to connect high-density discrete I/O modules to the field terminals. These cord sets are available with flying leads for termination to standard screw-connection terminals.

The use of Schneider Electric TeleFast blocks is not typically recommended and use of them requires special approval from the City.

12.10 Lighting

Interior lighting should be provided for all floor-standing automation control panels, and all wall-mount automation control panels 762mm (30") wide by 914mm (36") tall or larger.

Control panels that contain 120 Vac I/O may contain a 120 Vac powered interior light fixture. Use a 24 Vdc LED lighting strip for control panels operating at 24 Vdc.

Provide a door-actuated switch for control of the control panel interior light.

12.11 Shelves

Provide an externally-mounted shelf on automation control panels that contain a programmable logic controller. The shelf is to provide support for a laptop computer used for local PLC programming and maintenance.

12.12 Laptop Receptacle

A GFCI protected 120 Vac receptacle may be provided with control panels that contain a PLC and 120 Vac power or control wiring. Clearly label the receptacle “For Laptop Use Only” and indicate the upstream fuse or circuit breaker rating on the label. Receptacles for laptop use should typically be fused at 5 Amps. The receptacle should be located on the enclosure door, but may be located inside the panel.

Control panels that operate at 24 Vdc (with no 120 Vac present in the panel) should not contain a laptop receptacle. Instead, a receptacle should be installed outside of and adjacent to the control panel.

12.13 Ethernet Port

Provide a door-mounted Ethernet port on automation control panels that contain a programmable logic controller. The port may be used by maintenance personnel for connection to the programmable logic controller. Connect the Ethernet port to the service port on the PLC processor or in-rack Ethernet networking module.

In some instances City staff may connect with a USB connection. Confirm approach with City Automation group prior to design and installation.

13 MOTOR CONTROL

13.1 Standard Equipment

The City of Winnipeg has standardized on the use of Schneider Electric motor control centres (MCCs), variable frequency drives (VFDs), and soft-starters for motor control applications operating at 600V and below. Where such motor control equipment is required, specification of the equipment from the chosen manufacturer is mandatory for all new installations.

13.2 Control and Monitoring

13.2.1 General

Control and monitoring of MCCs, VFDs, and soft starters may be implemented in multiple ways, as follows:

1. **Hardwired control and monitoring** – all control signals are hardwired to the controlling device (e.g. the PLC system or a field instrument) and monitoring signals are hardwired to the PLC system. This method typically has highest reliability but also has highest installation costs due to the requirement for installing and terminating significant amounts of field cabling.
2. **Hardwired control, network monitoring** – all control signals are hardwired to the controlling device and all monitoring signals are obtained through a network connection. This method has acceptable reliability and often lower installed cost than a fully hardwired system, but control may be affected by a network failure. This method has the advantage that significant monitoring information can be obtained from network-connected motor controllers. Note that inclusion of network-based monitoring will increase the cost of the components.
3. **Network control and monitoring** – all control and monitoring signals are conveyed through a network connection. This method has acceptable reliability if the network is properly implemented, and typically has the lowest installed cost due to the elimination of all hardwired automation cabling. The increased component cost is offset by the elimination of the hardwired cabling. Significant monitoring information can be obtained from the motor controller.

The City of Winnipeg has standardized on the use of network control and monitoring for most motor control applications utilizing MCCs, VFDs, and soft starters. The primary reasons are the reduced installed costs due to the lack of hardwired cabling, and the increased diagnostics information available from network-connected motor controllers.

Hardwired control may be used for simple applications where there is little financial or operational benefit from using network control and monitoring, or where equipment configuration or system requirements may govern. Cases where hardwired methods would be used may include VFDs used for an HVAC application, a motor starter that is not controlled by the PLC system, packaged system applications, or other configurations identified by the designer.

Hardwired control and monitoring would typically be used for very critical applications, but should generally be limited to critical applications having insufficient process equipment redundancy to mitigate against network failures.

13.2.2 Low Voltage Motor Control Centres

The City's standard MCC for use in wastewater treatment facilities is the Schneider Electric Model 6 intelligent MCC with TeSys T motor management relays. The TeSys T motor management relays may be ordered with various communication interfaces, logic input voltage ratings, and with an optional extension module, as discussed in the following.

Use the Ethernet TCP/IP communications interface on all TeSys T motor management relays. The Ethernet TCP/IP interface allows for control and monitoring of the motor controller by the PLC system utilizing the Modbus/TCP protocol. Note that the Ethernet TCP/IP interface also incorporates a device webpage on HTTP port 80.

For the logic inputs on the TeSys T, the City typically uses the 100-240 Vac option, with the power source for the inputs being the control power transformer in the MCC unit compartment. The logic inputs are commonly used for control interlocking with motor disconnect switches and process instruments in the field.

The extension module has a part number beginning with “LTM E” and incorporates 3-phase voltage monitoring. It allows for undervoltage and overvoltage functions to be incorporated into the protection scheme, and allows for computation of power factor, power, and energy usage. Provide the extension module for all motors larger than 74.6 kW (100 HP) since the additional monitoring and diagnostics information may be useful for future maintenance activities. It is not required to provide the extension module for motors less than 74.6 kW (100 HP), but may be provided if desired.

Motor soft starters are typically installed in MCCs, unless the size and/or cooling requirements are prohibitive. Where soft starters are used in an MCC, they are installed in the unit compartment with a TeSys T motor management relay to provide network control and monitoring.

Typical control and monitoring points for intelligent MCCs with the TeSys T motor protection relay are listed in Table 13-1-2.

Table 13-1-2: Low Voltage, Intelligent MCC Starter – Typical Control and Monitoring Points

Motor Size	Typical Control Points	Typical Monitoring Points
All motors	• Run command • Reset command	• Local/Remote, Hand/Off/Remote, or Manual/Off/Remote switch • Ready • Running • Fault • Average motor current • Accumulated run time • Out of service (e.g. a communication failure)
≥ 37.3 kW (50 HP)		• 3-phase motor currents
≥ 74.6 kW (100 HP)		• 3-phase motor voltages • Power factor • Power • Energy

Notes:

1. *Refer to the Electrical Design Guide, document 510276-0000-47ER-0001, for typical motor protection requirements, which should be monitored by the process control system.*

Where hardwired control is used with non-intelligent MCCs, provide the control and monitoring points indicated in Table 13-3-4.

Table 13-3-4: Low Voltage, Hardwired MCC Starter – Typical Control and Monitoring Points

Motor Size	Typical Control Points	Typical Monitoring Points
All motors	• Run command	• Local/Remote, Hand/Off/Remote, or Manual/Off/Remote switch • Ready • Running • Overload tripped
≥ 37.3 kW (50 HP)		• Motor current (single phase) • Accumulated run time • Starts per hour
≥ 187 kW (250 hp)		• 3-phase motor current

Notes:

1. *Refer to the Electrical Design Guide, document 510276-0000-47ER-0001, for typical motor protection requirements, which should be monitored by the process control system.*

13.2.3 Low Voltage Variable Frequency Drives

The City has standardized on Schneider Electric Altivar 61 variable frequency drives for low voltage applications in the sewage treatment program.

Smaller VFDs should be located within MCCs, however, installation of VFDs within vendor supplied equipment is also permitted provided that the equipment is not on the roof (heating issue) and not in a location with any potential for corrosive gases. Larger VFDs with significant space or cooling requirements shall be located outside of MCCs.

The Altivar 61 VFD is available with one or two Ethernet communications interfaces and supports star and ring network topologies. Where the VFD is installed in an MCC, use a single Ethernet connection to the VFD to facilitate easy removal of the MCC bucket without disturbing other networked devices. However, if the VFD is installed in a separate cabinet (not in an MCC), connect the VFD using a ring topology for better network fault tolerance.

Where a VFD is used with critical process equipment but equipment redundancy is not provided, it is recommended to provide a bypass starter in parallel with the VFD to allow for motor starting in the event of VFD failure. If a bypass starter is provided, it is recommended to also provide an isolation contactor upstream and downstream of the VFD to fully isolate the VFD from the circuit when starting from the bypass starter.

Typical network control and monitoring points for networked and hardwired low voltage VFDs are provided in Table 13-5-6 and Table 13-7-8, respectively.

Table 13-5-6: Low Voltage, Networked VFDs – Typical Control and Monitoring Points

Motor Size	Typical Control Points	Typical Monitoring Points
All motors	• Run command • Speed command • Reset command	• Local/Remote, Hand/Off/Remote, or Manual/Off/Remote switch • Ready • Running • Motor speed • Motor current (3-phase average) • Accumulated run time • Last protection fault • Starts per hour • Out of service (e.g. a communication failure)

Notes:

1. *Refer to the Electrical Design Guide, document 510276-0000-47ER-0001, for typical motor protection requirements, which should be monitored by the process control system.*

Table 13-7-8: Low Voltage, Hardwired VFDs – Typical Control and Monitoring Points

Motor size	Typical Control Points	Typical Monitoring Points
All motors	• Run command • Speed command	• Local/Remote, Hand/Off/Remote, or Manual/Off/Remote switch • Ready • Running • Motor speed • Motor current (3-phase average) • Accumulated run time • VFD faulted • Starts per hour

Notes:

1. *Refer to the Electrical Design Guide, document 510276-0000-47ER-0001, for typical motor protection requirements, which should be monitored by the process control system.*

13.2.4 Medium Voltage Motors

The City does not currently have an official standard for medium voltage motor controllers.

The typical control and monitoring points applicable to medium voltage motors are indicated in Table 13-9-10.

Table 13-9-10: Medium Voltage Motors – Typical Control and Monitoring Points

Motor size	Typical Control Points	Typical Monitoring Points
All motors	• Run command • Speed command (VFD applications only)	• Local/Remote, Hand/Off/Remote, or Manual/Off/Remote switch • Ready • Running • Motor speed (VFD applications only) • 3-phase motor current • Accumulated run time • Starts per Hour

Notes:

1. *Refer to the Electrical Design Guide, document 510276-0000-47ER-0001, for typical motor protection requirements, which should be monitored by the process control system.*

13.2.5 Automatic Restart

Motor driven equipment that is controlled from the process control system shall be configured to restart after a delay following control system failure or a power failure event. Starting many motors at once can cause significant loading of the electrical distribution system and may cause unintentional tripping of circuit breakers.

The City's standardized PLC function blocks incorporate a timer to delay automatic restarting of motors. This functionality, along with the equipment restart delay, shall be specified in the project's functional requirements specification.

14 VALVE CONTROL

14.1 General

Use electric actuators, as opposed to pneumatic actuators, where practicable for applications requiring power actuation of valves.

The type of electric actuator used is dependent on the type of valve. For small open/close valves that do not require position feedback, a solenoid actuator may be used. For applications requiring position feedback, electric motor-operated actuators should be used.

The City has standardized on the use of Rotork quarter-turn and multi-turn electric valve actuators with an on-off torque requirement above approximately 250 Nm and modulating torques above approximately 150 Nm. Where actuators are required for these applications, specification of the valve actuators from the chosen manufacturer is mandatory for all new installations. For applications other than these, no standard currently exists.

Refer to Rotork Inc. documentation for actuator specifications and selection criteria. The valve actuator standardization was established through City of Winnipeg RFP 331-2014 and was awarded to:

Company: Rotork Inc.
Address: #6, 820 – 28th Street North East, Calgary, AB, T2A 6K1

14.2 Control and Monitoring

For solenoid operated valves, use hard-wired control from the PLC system in the form of a discrete output. Use an external interposing relay to energize the solenoid valve, rather than energizing the solenoid directly from the PLC output. Monitoring of valve position is typically not provided for solenoid operated valves.

Small electric actuators used for process or HVAC control are typically hardwired and controlled via discrete 120 Vac or analog 4-20 mA signals. Provide feedback to the control system as required.

HVAC damper actuators are typically hardwired, and position feedback to the controlling device is usually required for interlocking and/or alarming.

Electric actuators from Rotork Inc. may be ordered with a PROFIBUS communications interface. The decision to include a PROFIBUS interface on Rotork electric actuators is primarily based on the cost and application of the actuator. For small applications or applications where accuracy is not of great importance, it may be more cost effective and simpler to use hardwired control and monitoring. For larger valves, or where accuracy is of concern, use PROFIBUS communication.

The typical control and monitoring points for various valve actuator applications are provided in Table 14-1-2.

Table 14-1-2: Typical Valve Control and Monitoring Points

Valve and Actuator Characteristics	**Typical Control Points**	**Typical Monitoring Points**
Open/Close Valve, Solenoid Actuated, Hardwired	• Open Command	N/A
Small valves (≤ 102 mm), Open/Close, Electric Actuator, Hardwired	• Open and Close Command	• Open and Closed Limit (as required)
Small valves (≤ 102 mm), Modulating, Electric Actuator, Hardwired	• Position Command (4-20 mA)	• Position Feedback (4-20 mA)
Medium/Large (> 102 mm) Open/Close, Electric Actuator, Hardwired	• Open Command • Close Command	• Remote Selected • Open Limit • Closed Limit • Fault
Medium/Large (> 102 mm) Modulating, Electric Actuator, Hardwired	• Position Command (4-20 mA) • Stop/Maintain Command	• Remote Selected • Position Feedback (4-20 mA) • Open Limit (optional) • Closed Limit (optional) • Fault
Open/Close Valve, Electric Actuator, PROFIBUS Communication *(See Note 1)*	• Open command • Close command	• Actuator Moving • Closed Limit • Open Limit • Running Closed • Running Open • Remote Selected • Local Stop Selected • Local Selected • Thermostat Tripped • Monitor Relay • Valve Obstructed • Valve Jammed • Valve Moving by Hand • Moving Inhibited • Position Control Enabled • Watchdog Recovery • Battery Low • Control Contention

Valve and Actuator Characteristics	Typical Control Points	Typical Monitoring Points
Modulating Valve, Electric Actuator, PROFIBUS Communication *(See Note 1)*	• Position command	• Valve Position • Actuator Torque • Actuator Moving • Closed Limit • Open Limit • Running Closed • Running Open • Remote Selected • Local Stop Selected • Local Selected • Thermostat Tripped • Monitor Relay • Valve Obstructed • Valve Jammed • Valve Moving by Hand • Moving Inhibited • Position Control Enabled • Watchdog Recovery • Battery Low • Control Contention
On/Off Valve, Pneumatic Control	• Open Command • Close Command	• Closed Limit • Open Limit
Modulating Valve, Pneumatic Control	• Position Command	• Valve Position

Note:

1. *Not all of the monitoring points from PROFIBUS-connected valves are required to be displayed on the HMI system. Several of these monitoring points will be used in the control strategy only, or used in combination for indicating higher level alarms on the HMI.*

15 SPECIFIC APPLICATION REQUIREMENTS

15.1 Building Mechanical Systems

1. 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.
2. All Building Mechanical control and monitoring shall be by PLC, consistent with the WSTP Automation Design Guide. No exceptions shall be permitted except for the following:
   - 2.1 Natural gas fired air handlers may utilize proprietary packaged controls for the natural gas burner and associated devices. However, the proprietary packaged controls shall not monitor or control any equipment or instrumentation outside of the air handler unit. Any liquid coils in the air handler shall be controlled by the PLC.
   - 2.2 Boilers and chillers may utilize packaged controls that do not fully comply with the WSTP Automation Design Guide. Ensure integration into the plant PCS is consistent with the Automation Design Guide and meets operational requirements.
   - 2.3 Small out-buildings with a ventilation rate of 100 L/s or less may utilize non-PLC based controls, provided the control is very basic. For example, a single unit heater may be controlled by a wall-mounted thermostat.
3. In situations where package HVAC controls are permitted in accordance with the above, the following requirements apply:
   - 3.1 Associated drawings shall clearly identify the wired devices and their locations.
   - 3.2 All interlocks shall be clearly documented for maintenance personnel.
   - 3.3 When an interlock is not met, there shall be a clear indication of the specific interlock not being met to maintenance personnel.
   - 3.4 As-built drawings shall be provided.
   - 3.5 Setpoint control of boilers, chillers, and air handling units shall be from the plant PCS via a coordinated interface.
   - 3.6 Alarms shall be provided from the package unit to the PCS.
4. Where possible and practical, utilize separate PLCs, dedicated to Building Mechanical systems rather than connecting to process-based PLCs. Note that all PLCs are part of a common PCS.

16 INSTRUMENTATION

16.1 General Requirements

1. The instrumentation identified as requirements in this document shall not be construed as limiting the instrumentation requirements for a complete system that meets all requirements.

2. Unless specifically identified, all instrumentation shall be connected to the PCS with appropriate integration into control strategies and alarming.

16.2 Typical Practices

16.2.1 Fail-Safe Implementation

Where hardwired methods are used for connection of switches used for alarming purposes, the switches shall be wired in a fail-safe implementation, meaning that the switch is closed during normal operation and opens upon an alarm condition.

Failure of any instrument shall cause the system to react in a way that will not cause damage to equipment, injury to personnel, or leave operation of equipment in an unsafe condition.

16.2.2 Routing of Signal Cabling

Where remote transmitters are used, careful consideration is required in the routing of the signal cabling between the sensor and transmitter, especially near high sources of noise such as VFD cabling. Use of dedicated conduits for such cabling is recommended.

16.2.3 Instrument Redundancy

Where failure or inaccuracy of a single instrument has unacceptable consequences, instrument redundancy may be required. Instrument redundancy can be provided by either an identical instrument or an alternative (less expensive) instrument technology that provides an acceptable response.

Where instrument redundancy is provided for analog instruments (e.g. pressure transmitters), the process control system would typically operate on an average of the readings from the instruments. Selections should be provided on the HMI system to select which instrument(s) are actively used. For example, if two instruments are provided, the HMI would allow for selection of the first instrument, the second instrument, or an average of both instruments, for use by the control system.

While instrument redundancy may be provided using two instruments, it may be difficult to determine which of the two signals is correct if they do not match. For this reason, consider implementing triple redundancy for critical applications and implement a voting scheme in the PLC. Under this scenario, the PLC would compare the readings from all three instruments and if one signal did not match the other two then it would be ignored, and an alarm would be generated on the HMI system.

If an instrument in a redundant application fails, the process control system shall immediately ignore that instrument (i.e. not use it in the calculation of the average), and generate an alarm on the HMI system.

16.2.4 Installation and Removal

Instruments shall not be mounted on equipment or piping subject to vibration.

Field instruments (unless in-line) shall be mounted on a 51 mm (2") hot dipped galvanized or aluminum pipe support (as appropriate for the location), or wall mounted. The instrument stands shall have a height of 1,500 mm to allow an easy access for process observation or maintenance. Where mounted on a catwalk/platform the preferred location shall be on the outside of the hand railing.

Removal of process instruments must be possible without stopping the process. This is achieved by installing appropriate isolation and/or bypass systems such as thermowells, valve manifolds, or software overrides.

16.2.5 Instrument Displays

Readings on instrument displays shall be in SI (metric) units and the units of measure shown shall match that specified in the project functional requirements specification.

16.2.6 Instrument Manifolds

All pressure instruments for process applications shall be supplied with block-and-bleed valves or three-way manifolds.

Differential pressure instruments for process applications shall be supplied with a five-way manifold.

16.2.7 Gas Detection Equipment

Fixed gas detection equipment shall be provided with a means for calibrating and testing the equipment at an accessible location. Some sensors need to be mounted on the ceiling or other readily inaccessible location, and as such will be difficult to access. Sensors shall be provided with means to attach 6 mm (1/4") I.D. stainless steel tubing, and the tubing shall be routed down to a location that is readily accessible to personnel and near the transmitter display.

Gas detection transmitters shall be provided with a local display and configured to indicate the gas concentration in units of % LEL.

A gas detection alarm shall be indicated with both a visual and audible alarm, where the visual alarm consists of a flashing red light.

16.2.8 Hazardous Location Door Entry Stations

Provide a door entry station at each door to a hazardous location where entry into the area is only permitted based on certain operating criteria. Examples include areas where the ventilation system is used to maintain a lower area classification, or a dual-rate ventilation system that must run at the high rate when the area is occupied by personnel.

The door entry station shall be equipped with coloured lights to indicate whether entry is permitted based on the information available to the control system. Provide a green light to indicate there are no known hazards (e.g. the ventilation system is running and no gas alarm is present, etc.), and that entry is therefore permitted. Provide a red "Do Not Enter" light to indicate that entry is not permitted due to ventilation system failure, the presence of a gas alarm, or other hazardous condition.

For dual-rate ventilation systems that operate at the high rate when occupied, provide a selector switch (or utilize the light switch) to allow personnel to switch to the high rate operation prior to entry. While the system is ramping up to the high ventilation rate, flash the red "Do Not Enter" light to indicate that this switch has been turned on but the system has not yet reached the high ventilation rate. Once the system has reached the high ventilation rate and no other hazards are known to exist then turn the red flashing light off and turn the green light on to signal that entry is permitted.

Note that in addition to door entry stations, an audible alarm should also be provided inside the area to alert personnel of a ventilation system failure.

16.3 Selection Criteria

16.3.1 Standardized Manufacturers

The City has standardized on Siemens electromagnetic flowmeters, ultrasonic level transmitters, RTD-based temperature transmitters, and pressure transmitters. This standardization was established under City of Winnipeg RFP 449-2014 and was awarded to:

Company: Trans-West Inc.
Address: 126 Bannister Rd., Winnipeg, MB, R2R 0S3

For gas detection equipment, the City has standardized on Mine Safety Appliance Company (MSA) equipment under City of Winnipeg RFP 123-2014, which was awarded to:

Company: MSA.
Address: 12134 – 154 Street NW, Edmonton, AB T5V 1J2

Refer to the City of Winnipeg Sewage Treatment Program standard specifications for additional details. Specification of instruments from the chosen manufacturer is mandatory for all new installations.

16.3.2 Instrument Accuracy

The accuracy of all instruments shall be better than the application requirements.

Instrument scales/ranges should be selected such that the normal operating point will be at approximately 50% of the full scale/range for pressure, temperature and density, and at 75% for flow rate and level. The design engineer should take a common-sense approach on systems that have large variability to ensure that instruments are operating at accurate points along their curve.

16.3.3 Transmitter Output

The preferred method to connect process instrument transmitters to the process control system is via a PROFIBUS network. PROFIBUS instruments have the advantage that they can be configured remotely, they can transmit one or more process variables to the process control system using a digital communication link, and can provide additional diagnostics information. Note, however, that PROFIBUS instruments typically are more expensive than traditional 4-20 mA based instruments.

New analytical instruments, electromagnetic flowmeters, level transmitters, temperature transmitters, and pressure transmitters used for process applications should utilize a PROFIBUS output wherever possible. Some analytical instruments may be unavailable with a PROFIBUS output, in which case a Modbus/TCP output should be utilized instead. Replacement of existing 4-20 mA based transmitters with PROFIBUS transmitters is not generally required during wastewater treatment plant upgrades, but this may be performed where desired. For non-process applications, such as an HVAC system, use of 4-20 mA output is generally preferred due to simplicity and cost.

Transmitters for process applications without a PROFIBUS output should incorporate a 4-20 mA output with HART protocol. Switches on process systems will typically be hardwired I/O. However, PROFIBUS should be considered if maintenance diagnostic information would be of value. Instruments used for HVAC applications shall be connected via hardwired methods, to minimize the cost of the instruments.

Use of DeviceNet, CANopen, or ControlNet instruments for new installations is not approved under any circumstance. Use of AS-i should be reviewed with the City prior to implementation.

Wireless instruments should generally not be used for process-related applications, but if they are required then select instruments that communicate using industry standard WirelessHART or ANSI/ISA 100.11a technology. Note that the wireless versions of Siemens instruments use WirelessHART. Install and connect an appropriate wireless gateway (or multiple gateways) to the associated Device Network for communication with the instruments. Wireless instruments should only be used where hard wiring is cost-prohibitive or infeasible, and only be used for non-critical monitoring applications. If use of wireless instruments is required for critical monitoring and control, employ redundant instruments and ensure that contingencies are in place to prevent process down-time resulting from wireless system failure. All wireless instrumentation applications shall be reviewed with and approved by the City prior to implementation.

16.3.4 Switches vs. Transmitters

The selection of discrete instruments compared with transmitters (either networked or not) should be considered in all cases. The primary advantages of switches over transmitters are simplicity and cost. Transmitters have the advantage that they can be part of an analog control scheme, such as PID control, and in the case of most PROFIBUS instruments, can be configured with internal alarm setpoints for use by the process control system. General application guidelines are provided in Table 16-1-2.

Table 16-1-2: Guidelines for Selection of Switches vs. Transmitters

Application	Instrument	Notes
Critical and safety applications	Consider Transmitter	Careful review is required. Codes may apply.
HVAC low temperature (Freeze-stat)	Switch	Simple, cost effective solution requiring hard-wired interlock.
Wet Well Level	Transmitter	Redundancy should be provided for control
Wet Well Low/High Level	Switch	Backup to level transmitter.
Room High Temperature	Transmitter	Can be used in control strategy as well.
Pump Low Flow Detection	Switch	Partial testing with pump on/off cycling provided.
	Transmitter	Where there is use as part of process measurement.
Ventilation Low Airflow Detection	Switch	On/off fans. Partial testing with fan on/off cycling provided.
	Transmitter	Variable speed fans
Instrument Air Low Pressure	Transmitter	Continuous indication of operation.

16.3.5 Instrument Power Supply

Instruments requiring external power should be powered from 24 Vdc unless it is not an option for a specific instrument, in which case 120 Vac would typically be used. For HVAC applications, 24 Vac is acceptable.

16.3.6 Materials

Materials for the wetted parts of all off-line instruments and instrument process connections shall be, as a minimum, 316 SS or per the corresponding piping specification and suitable for the handled process fluid.

Materials not in contact with the process fluid shall be suitable for the environment in which instruments are installed. In general, epoxy coated aluminum enclosures shall be used. For ingress protection requirements see Section 8.1. All instrumentation accessories and mounting hardware shall be stainless steel.

16.3.7 Flow Measurement Instruments

Electromagnetic flowmeters shall be used for measurement of the flow rate of liquids; however consideration should be given to alternate technologies where requirements dictate.

Table 16-3-4 lists acceptable electromagnetic flowmeter liner materials for various types of media.

Table 16-3-4: Acceptable Electromagnetic Flowmeter Liner Materials

Media	Acceptable Liner Materials
Liquid Polymer	PFA, PTFE (Teflon), Ceramic
Water with up to 20 mg/l of organic solids, Chloraminated	PFA, PTFE (Teflon), Ceramic, EPDM, ETFE, Rubber – Ebonite.
Primary Clarifier Scum	PFA, PTFE (Teflon), Ceramic
Activated Sludge	PFA, PTFE (Teflon), Polyurethane, Neoprene.
Raw Sewage	PFA, PTFE (Teflon), Polyurethane, Neoprene.

Provide grounding rings for all electromagnetic flowmeter installations in accordance with the flowmeter manufacturer's recommendations for the specific application.

For all flow meter installations, ensure that the required upstream and downstream pipe diameters are met.

16.3.8 Level Measurement Instruments

Where practicable, use ultrasonic level instruments for measurement of liquid level in process-related tanks and wet wells. Use of radar technology is to be avoided unless prior approval is obtained from the City.

Where ultrasonic level instruments are used for critical applications, provide discrete level switches (e.g. float switches) as a backup to the ultrasonic level instrument.

Use float switches for level control of small sump pits. The standard of acceptance is Flygt ENM-10 float switches for latched relay control and PIL-1 – PIL-15D for single float switch with hysteresis.

16.3.9 Pressure Measurement Instruments

The Siemens pressure transmitters may be used for measurement of gauge pressure, differential pressure, volumetric flow, liquid level, or liquid volume level.

16.3.10 Temperature Measurement Instruments

Field mounted RTDs are to connect to field mounted transmitters and be connected to the process control system via PROFIBUS or hardwired (4-20 mA) cabling. Use of PLC in-rack RTD input modules with direct connection to field mounted RTDs is not approved.

Use of thermocouples for temperature measurement in the wastewater treatment process is to be avoided; RTDs are to be used instead of thermocouples for process applications. Note that thermocouples may be required for non-process, high temperature applications. Use of thermocouples should be reviewed and approved by the City before being incorporated into a design.

All in-line sensors used for process and liquid temperature measurement instruments shall use thermowells. HVAC temperature measurement instruments in clean air typically do not require thermowells.

16.4 Application Requirements

16.4.1 HVAC – Air Systems

Provide instrumentation for HVAC filtration in accordance with Table 16-5. Connect all transmitters and switches to the PCS for monitoring, alarming, and control as applicable.

Table 16-5 : Filter Instrumentation

Application	Additional Criteria	Instrumentation Functions	PCS Functions (See Note 2)
Minimum Requirement if none of the below applies		PDG, PDSH (See Note 1)	PDAH
Systems serving electrically classified spaces		PDT, PDG	PDI, PDAH, PDAHH
Systems serving hazardous chemical spaces			
Systems where a plugged filter may impede human occupancy			
Filters on a media filtration system			
Systems with a design capacity ≥ 1,000 L/s			

Notes:

1. *The instrumentation functions indicated may be integrated. Please reference the City Tag naming standard*
2. *The PCS functions are typical minimum requirements and are not exhaustive.*

Table 16-6 : Damper Instrumentation

Application	Additional Criteria	Instrumentation Functions	PCS Functions (See Note 2)
Motorized on/off damper		ZSC, ZSO	XC, ZLC, ZLO
Modulating damper		ZT	*C (See Note 3), ZI

Notes:

1. *The instrumentation functions indicated may be integrated. Please reference the City Tag naming standard*
2. *The PCS functions are typical minimum requirements and are not exhaustive.*
3. *The initiating variable for the damper depends on the application. Typical initiating variables are T and P.*

Table 16-7 : Air Flow Instrumentation

Application	**Additional Criteria**	**Instrumentation Functions**	**PCS Functions** (See Note 1)
Supply air – Electrically classified hazardous locations	Used to lower the electrical classification as per NFPA 820	FIT (See note 3)	FI, FAL, FALL, FAH, FAHH
	Design flow capacity ≥ 500 l/s		
	Occupied at a frequency ≥ 1 per month		
Exhaust air – Electrically classified hazardous locations	Used to lower the electrical classification as per NFPA 820		
	Design flow capacity ≥ 500 l/s		
	Occupied at a frequency ≥ 1 per month		
Supply air - unclassified location	Design flow capacity ≥ 4000 l/s		
Exhaust air – unclassified location			
Return air - unclassified location			
Chemical- Under Development			

Notes:

1. *The PCS functions are typical minimum requirements and are not exhaustive. Designer/Integrator will create functions to meet the needs of the application*
2. *The flow rates indicated are the total flow for the system or space, whichever is greater.*
3. *Thermal dispersion type unless otherwise approved by the City.*

Table 16-8 : Pressure Instrumentation – HVAC Air Systems

<table>
<tr><th>Application</th><th>Additional Criteria</th><th>Instrumentation Functions</th><th>PCS Functions
(See Note 1)</th></tr>
<tr><td>Room – Entire room is Class I, Zone 1</td><td></td><td rowspan="8">PDIT
(See Note 2)</td><td rowspan="8">PDI, PDAL, PDALL, PDAH, PDAHH</td></tr>
<tr><td rowspan="4">Room – Entire room is Class I, Zone 2 and may contain partial Class I, Zone 1 areas</td><td>Area ≥ 100 m^2</td></tr>
<tr><td>Has an opening into a Class I, Zone 1 location (See Note 3)</td></tr>
<tr><td>Has an opening into a unclassified location (See Note 3)</td></tr>
<tr><td>Has two or more, or variable, ventilation rates</td></tr>
<tr><td>Room – Contains Class I, Zone 2 area(s) but is not completely classified</td><td>Has an opening into a Class I, Zone 1 location (See Note 3)</td></tr>
<tr><td>Room – Unclassified</td><td>Has an opening into a Class I, Zone 2 location (See Note 3)</td></tr>
<tr><td>Any</td><td>Where a hazard could be introduced by a pressurization failure that would not be otherwise alarmed to the PCS.</td></tr>
</table>

Notes:

1. *The PCS functions are typical minimum requirements and are not exhaustive. Designer/Integrator will create functions to meet the needs of the application*
2. *The room differential pressure will be measured relative to atmospheric pressure.*
3. *Openings include doors and openable windows, as well as process connection openings where there could be a Secondary grade of release as per IEC 60079-10-1.*

Table 16-9 : Temperature Instrumentation – HVAC Air Systems

Application	**Additional Criteria**	**Instrumentation Functions**	**PCS Functions** (See Note 2)
Coil – Heating or cooling with risk of freezing		TSL (See Note 3)	TAL
Outdoor air duct		TT	TI
Mixed air duct (outdoor air and return air)		TT	TI, TAL, TAH
Reheat air duct (After heat recovery or initial heating unit / coil)		TT	TI, TAL, TAH
Supply air duct		TT	TI, TAL, TALL, TAH, TAHH
Room < 10 m^2 and routinely occupied (See Note 4)		TT	TI, TAL, TALL, TAH, TAHH
Room ≥ 10 m^2			
Room with different zones or temperature profiles during normal or abnormal operation		Multiple TT as required.	

Notes:

1. *The instrumentation functions indicated may be integrated.*
2. *The PCS functions are typical minimum requirements and are not exhaustive. Designer/Integrator will create functions to meet the needs of the application*
3. *Hardwire interlock the low temperature switch with the supply air fan and other equipment as required.*
4. *Control rooms require temperature transmitters.*

Table 16-10 : Valve Instrumentation

Application	**Instrumentation Functions**	**PCS Functions** (See Note 2)
Motorized on/off valve	ZSC, ZSO	XC, ZLC, ZLO
Modulating valve	ZT	*C (See Note 3), ZI

Notes:

1. *The instrumentation functions indicated may be integrated.*
2. *The PCS functions are typical minimum requirements and are not exhaustive. Designer/Integrator will create functions to meet the needs of the application*
3. *The initiating variable for the damper depends on the application. Typical initiating variables are T.*

Table 16-11 : Miscellaneous Instrumentation

Application	Instrumentation Functions	PCS Functions (See Note 2)
Motorized on/off valve	ZSC, ZSO	XC, ZLC, ZLO
Modulating valve	ZT	*C (See Note 3), ZI

Notes:

4. *The instrumentation functions indicated may be integrated.*
5. *The PCS functions are typical minimum requirements and are not exhaustive. Designer/Integrator will create functions to meet the needs of the application*
6. *The initiating variable for the damper depends on the application. Typical initiating variables are T.*

16.4.2 Building Sumps (Non-Process)

1. Sumps with potentially significant flows of water that could present a flooding situation in the event of an instrument / control failure shall be provided with a secondary failsafe activation device. This instrument may be in common with the high sump level alarm instrument.
2. Provide a high level sensor for all sumps, connected to the PCS for alarming. The high level sensor shall be independent of the level instrumentation for primary pump control. Acceptable product types are:
    - 2.1 Flygt ball;
    - 2.2 Rod-based float switch; and
    - 2.3 Capacitance probe.
3. Provide ultrasonic-based instrumentation for pump control for sump pumps. Provide a stilling chamber as required.
    - 3.1

16.4.3 Gas Detection

1. General Requirements
    - 1.1 Provide a sufficient quantity of gas detection systems to adequately cover the entire space that is or may be occupied. Do not assume that a single gas detection sensor is sufficient to cover an entire room or space.
    - 1.2 Ensure gas detection systems are located appropriately to detect hazardous gases within the coverage area. Review ventilation flow patterns and locate the sensors appropriately. For example, it is not appropriate to locate a gas detection sensor adjacent to a supply air grille.
    - 1.3 Locate gas detection systems at the appropriate elevation, considering the toxic or hazardous gas density, ventilation patterns, and location of personnel.
    - 1.4 Utilize continuous sample draw based gas detection systems for:
        - 16.4.3.1.4.1 Locations where access is difficult, or there is significant impediment to occupancy; and
        - 16.4.3.1.4.2 Applications where pre-conditioning of the sample is required to provide sample accuracy or extended sensor life.

1.5 Where a dual-rate ventilation system is provided, interlock the gas detection with the ventilation system to ensure that a high-rate of ventilation is provided upon detection of a hazardous gas.

1.6 Ensure provision of detected gas levels to plant PCS (Profibus preferred). The only exception is that carbon monoxide sensors may simply transmit a discrete alarm to the plant PCS.

1.7 Provide means to calibrate all gas detection instruments without the use of temporary ladders, scaffolding, etc. This may require provision of remote calibration systems.

1.8 Provide visual and audible alarms in accordance with the Automation Design Guide. Ensure alarms are configured with setpoints that protect personnel from exceeding exposure limits; however, extraneous alarms shall be avoided while the space is unoccupied.

2. For H_2S gas detection:

2.1 Provide sensors capable of monitoring H_2S levels as low as 1 ppm.

3. For combustible gas detection:

3.1 Utilize long-life infrared-based detectors wherever possible.

3.2 Provide alarming upon gas levels that equal or exceed 5% of the lower explosive limit.

3.3 Where spaces have more than one rate of ventilation, interlock gas detection with ventilation / odour control systems to set ventilation at the highest level upon combustible gas levels that equal or exceed 10 percent of the lower explosive limit.

3.4 Where gas detection systems are provided, ensure that a hardwired interlock is provided to engage the high-rate of ventilation (if provided).In addition to the ventilation interlock, all gas detection systems shall provide the current detected gas level to the PCS, except that this requirement is not mandatory for carbon monoxide sensors. (Compare with above)

3.5

16.4.4 Permanent Gas Detection

1. Provide permanent fixed gas detection for hazardous and toxic substances as follows:

1.1 In accordance with Table 16-12;

1.2 Carbon Monoxide (CO) sensors in all locations where direct gas-fired equipment is utilized;

1.3 Oxygen deficiency sensors in all locations where there is an oxygen displacement risk, including all spaces with a floor elevation 10 meters or more below grade;

1.4 As required by codes and regulations; and

1.5 As appropriate based upon Good Industry Practice.

2. Provide permanent fixed gas detection for combustible gasses as follows:

2.1 In accordance with NFPA 820;

2.2 As required by codes and regulations; and

2.3 As appropriate based upon Good Industry Practice.

Table 16-12: Permanent Gas Detection of Toxic and Hazardous Substance - Minimum Requirements

Occupancy (See Note 1)	Normal Concentration (See Note 2)	Expected Abnormal Concentration (See Note 3)	Permanent Gas Detection Required
< 1 per year	Any	Any	No
≥ 1 per year AND < 1 per week	< TLV-TWA	Any	No
	≥ TLV-TWA	Any	Yes
≥ 1 per week AND < 1 per day	< TLV-TWA	< TLV-STEL	No
		≥ TLV-STEL	Yes
	≥ TLV-TWA	Any	Yes
≥ 1 per day	< TLV-TWA	< TLV-TWA	No
		≥ TLV-TWA	Yes
	≥ TLV-TWA	Any	See Note 4

Note(s):

1. *The Occupancy includes any period of occupancy by any personnel, of any duration.*
2. *The Normal Concentration includes both periods of occupancy and non-occupancy.*
3. *The Expected Abnormal Concentration is based upon the failure of any equipment or component.*
4. *Not acceptable as per exposure limits*

3. Comply with code and functional specification regarding implementation of gas detection controls.

16.4.5 Chemical Rooms

1.1 High speed ventilation shall be triggered by a local push button manually outside of the entrance of chemical areas to activate the emergency exhaust fans and supply fans.

16.4.6 Smoke Detectors

1. Provide duct smoke detectors only where required by the National Building Code or local code requirements.

16.4.7 Security

Table 16-13 : Door Monitoring

<table>
<tr><th>Application</th><th>Additional Criteria</th><th>Instrumentation Functions</th><th>PCS Functions
(See Note 1)</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Door is between an unclassified location and a Class I, Zone 2 location</td><td></td><td rowspan="2">ZSC (See Note 2)</td><td rowspan="2">ZAO (Typically with time delay)</td></tr>
<tr><td>Door is between an Class I, Zone 2 location and a Class I, Zone 1 location</td><td></td></tr>
</table>

Notes:

1. *The PCS functions are typical minimum requirements and are not exhaustive.*
2. *Ensure door switch is rated for the higher electrical classification.*

17 CONTROL REQUIREMENTS

17.1 HVAC Control

1. The design shall allow for occupied and unoccupied temperature setpoints, which may be outside the bounds of the values indicated in **Error! Reference source not found.**. Of the Building Mechanical design Guideline

2. Provide an adjustable deadband for control

3. Provide a setting to allow the heating to be disabled in summer state and the cooling to be disabled in winter state.

4. Unit heater control (including all mounted baseboard heaters, convectors, etc.):

   4.1 Ensure all heater control is integrated into the overall PLC based control system. Ensure that simultaneous heating and cooling of the space is prevented.

   4.2 Where there is a risk of building freezing due to the PLC being out of service, provide backup thermostats to override the PLC control upon low temperature.

   4.3 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.

18 PCS INTEGRATION

UNDER DEVELOPMENT

Table 18-1 : Fan Integration

Application	Input Signals	Output
Single Speed	Run TBC	CmdRun
Variable Speed	Auto Flt (Fault) Run I (Current) S (Speed)	CmdRun SCmd

Notes:

3. *The PCS functions are typical minimum requirements and are not exhaustive.*
4. *The room differential pressure will be measured relative to atmospheric pressure.*

19 POWER SUPPLY

19.1 General Requirements

Provide redundant 24 Vdc power supplies for all PLC system installations. Where the power supplies are associated with a PLC installation that replaced an existing DCS PCU, the 24 Vdc power supplies may be located inside the existing DCS cabinet. For PLC installations not meant to replace an existing DCS PCU, provide a separate “power supply panel” containing the redundant 24 Vdc power supplies.

Provide power supply panels to supply 24 Vdc power to neighbouring control panels, networking panels, and other process control system panels or devices that require 24 Vdc power.

Remote I/O panels in the field may contain 24 Vdc power supplies if they are not in close proximity to a power supply panel.

19.2 24 Vdc Power Supplies

Where a facility is equipped with an instrumentation ground, connect the common terminal on the output of each 24 Vdc power supply to the instrumentation ground. Otherwise, connect the common terminal of each 24 Vdc power supply to the electrical (safety) ground.

Provide monitoring of the 24 Vdc power supplies by the process control system via the dry contact outputs on the power supplies and/or redundancy module.

Power each 24 Vdc power supply from a separate 120 Vac source to improve availability. Power the first power supply from a 120 Vac UPS panelboard (i.e. a panelboard that is powered from a UPS), and the second power supply from a 120 Vac non-UPS panelboard (i.e. a panelboard that is not fed from a UPS, which may or may not have standby generator backup).

Provide individual fusing within power supply panels for each connected load. A fuse schedule shall be shown on the power distribution schematics, showing the fuse type and rating for each fuse.

Indicate the 24 Vdc power supply loading on the power supply distribution schematics so that it is clear how much spare capacity is available for future loads.

19.3 UPS Power

Critical automation equipment shall be powered from an uninterruptible power supply, either directly from a small individual UPS, or from a UPS panelboard. The decision to use a small individual UPS is appropriate where the number of UPS loads within a given physical area is limited and/or widely distributed. For remote locations it is often more appropriate to install a small individual or distributed UPS rather than extend UPS from a large centralized UPS. Typically, UPS power in a wastewater treatment facility will be centralized with distribution through a dedicated panelboard. Where small individual UPS units are used, the UPS shall be industrial-grade rather than commercial-grade. Direct current (dc) UPS units with a 24 Vdc output are acceptable for small loads, such as a single control panel.

For the most critical systems and where standby generation is not available, consideration should be given to utilization of two UPS systems with separate power supplies and separate distribution, feeding loads that are dual sourced (e.g. computer servers with dual power supplies). Note that the use of paralleled UPS units with a synchronized common distribution system is not a preferred redundancy solution.

Table 19-1-2 indicates the requirement for UPS power for various types of process control system equipment.

Table 19-1-2: Equipment Requiring UPS Power

Equipment	UPS Powered
HMI Servers	Yes
Historian Servers	Yes
HMI Operator Workstations and Monitors	Yes
Process Related Network Equipment	Yes
HMI Touchscreens, Field Mounted	No
Process Related PLCs and I/O	Yes
Non-Process Related PLCs and I/O	Optional
Process Related Instruments	Yes
Non-Process Related Instruments	Optional
Emergency Shutdown Systems	Yes
Programming/Maintenance Workstations and Monitors	Yes

The design battery duration rating of the UPS is dependent on the criticality of the load and degree of backup within the power supply system. Battery run time calculations shall be performed for all designs.

Table 19-3-4: UPS Design Battery Life

UPS Type	Backup Generator	Time	
		Low / Medium Reliability Requirement	High Reliability Requirement
Centralized (Large)	None	60 minute	120 minute
	Single Standby	30 minute	60 minute
	Redundant Standby	15 minute	30 minute
Distributed (Small, Individual)	None	45 minute	120 minute
	Single Standby	20 minute	60 minute
	Redundant Standby	10 minute	30 minute

Motor starters within MCCs will be powered by dedicated local 120 Vac control power transformers associated with each motor starter. Ensure that manual control capability, where provided, is not compromised due to the loss of any other power source, including the loss of UPS power.

20 HAZARDOUS LOCATIONS

20.1 General

Wastewater facilities typically have some hazardous locations due to the presence of combustible gas and liquids (Zone 0/1/2, previously known as Class I). Hazardous locations due to presence of combustible dust (Zone 20/21/22, previously known as Class II), or fibres or filings (Zone 20/21/22, previously known as Class III) are generally not found within wastewater treatment facilities.

Design, installation, selection of equipment and materials shall be based on the hazardous location drawings produced for the facility.

20.2 References

All installations shall comply with the latest codes regarding installations associated with hazardous locations, including but not limited to:

1. CSA C22.1, Section 18 – Hazardous locations.
2. CSA C22.1, Appendix F – Recommended installation practice for intrinsically safe and non-incendive electrical equipment and wiring.
3. Winnipeg Electrical Bylaw.

Use the following standards, along with sound engineering judgement, in the design of automation equipment installations associated with hazardous locations:

1. Definitions and Information Pertaining to Electrical Equipment in Hazardous (Classified) Locations, ANSI/ISA-12.01.01-2013.
2. Recommendations for the Preparation, Content, and Organization of Intrinsic Safety Control Drawings, ANSI/ISA-12.02.02-2014.
3. Recommended Practice for Wiring Methods For Hazardous (Classified) Locations, Instrumentation Part 1: Intrinsic Safety, ANSI/ISA-RP12.06.01.
4. NFPA 820.

Equipment associated with hazardous locations shall meet the applicable codes as follows:

1. Explosion proof enclosures used within hazardous (classified) locations shall meet CSA C22.2, No. 30.
2. Motors and generators used within hazardous (classified) locations shall meet CSA C22.2, No. 145.
3. Combustible gas detection equipment used within hazardous (classified) locations shall meet CSA C22.2, No. 152.
4. Intrinsically safe equipment used for hazardous (classified) locations shall meet CSA C22.2, No 157.
5. Cables and cable glands used within hazardous (classified) locations shall meet CSA C22.2, No. 174.
6. Non-incendive electrical equipment installed within Class I, Division 2 hazardous (classified) locations shall meet CSA C22.2, No. 213.

MTL TP1121-1, A definitive guide to earthing and bonding in hazardous areas, may also be used.

20.3 Design Requirements

20.3.1 General

All equipment shall have the appropriate Class, Division or Zone, Group, and Temperature Class ratings for the area in which they are installed. Exceptions to this include simple apparatus, which are field devices that will neither generate nor store more than 1.2 Volts, 0.1 Amps, 25 mW, or 20 µJ. Examples of simple apparatus include simple contacts, thermocouples, RTDs, LEDs, and non-inductive potentiometers and resistors.

20.3.2 Intrinsically Safe Systems

An intrinsically safe (IS) circuit is one which is incapable of causing ignition of the prescribed flammable gas, vapour, or dust upon the occurrence of any spark or thermal effect during normal use, or any conditions of fault likely to occur in practice.

An intrinsically safe system generally consists of three components:

1. The field device, referred to as the intrinsically safe apparatus,
2. The field cabling, and
3. The energy limiting device or barrier, referred to as the intrinsically safe associated apparatus.

For all designs incorporating intrinsically safe systems, the designer shall perform all entity parameter calculations to ensure that the complete installation meets the requirements of the intrinsically safe apparatus and associated apparatus, and is a safe installation. Specific manufacturers and model numbers, and the entity parameters, shall be indicated on the associated loop drawing.

Where associated apparatus are used, they shall be located as close as possible to the hazardous area to minimize cable length, thereby minimizing capacitance in the circuit.

Grounded associated apparatus that contain one or more shunt diode devices (e.g. Zener diodes) shall be grounded to a ground electrode and have a ground path resistance to the grounding electrode of less than 1 Ohm. Where it is not possible to achieve a ground path resistance of less than 1 Ohm, consideration should be given to using isolated repeater barriers, which do not require grounding, as opposed to the grounded type.

Where grounded associated apparatus are used, duplicate grounding conductors shall be provided to connect the associated apparatus to the designated ground electrode. The grounding conductors shall be minimum 12 AWG each. The grounding system shall be insulated from ground at all places except at the point of connection to the designated ground electrode.

Grounded associated apparatus may be connected directly to a ground electrode, but if multiple grounded associated apparatus are used then it is often beneficial to install intermediary grounding points (e.g. copper bus bars) to reduce the number of individual grounded conductors.

Where multiple grounded associated apparatus are installed in an enclosure, provide a copper barrier bus within the enclosure for grounding each barrier. Ground each barrier to the barrier bus using duplicate 12 AWG, insulated conductors.

Where multiple enclosures containing grounded associated apparatus are installed in the field, an IS master ground bus bar may also be provided in the building for grounding the enclosures. Installing an IS master ground bus also facilitates grounding of new IS enclosures that may be added in the future. Where an IS master ground bus bar is employed, it shall be isolated from structural steel and connected directly to the building star ground or electrode ground, or as close as practicable. Provide duplicate bonding connections between the IS enclosures and the IS master ground bus using larger, insulated conductors, such as with two (2) 4 AWG or 6 AWG conductors. Provide duplicate grounding conductors between the IS master ground bus and the final grounding connection using two (2) insulated copper conductors that are at minimum 2/0 AWG each. As previously stated, the ground path resistance between any grounded associated apparatus and the ground electrode shall be less than 1 Ohm.

All bonding and grounding connections shall be secure, permanent, visible, and accessible for routine inspection.

Refer to Section 22 for additional information on grounding.

Review the recommended practices for bonding of cable shields indicated in ANSI/ISA-RP12.06.01.

20.4 Preferred Methods of Protection

20.4.1 General

If possible, avoid locating equipment in hazardous locations to eliminate the additional installation requirements associated with hazardous locations. Where equipment must be located in a hazardous area, the preferred method of protection depends on the classification of the area.

Equipment utilizing isolation techniques such as pressurization, purging, and continuous dilution generally require frequent maintenance and inspections. For this reason, pressurization, purging, and continuous dilution shall only be used if they are deemed the only option for protection.

The preferred methods of protection are provided in the following sections.

20.4.2 Zone 0 Locations

The preferred method of protection in Zone 0 (previously known as Class I, Zone 0) locations is the intrinsically safe “ia” method.

20.4.3 Zone 1 Locations

The preferred method of protection in Zone 1 (previously known as Class I, Zone 1) locations is the intrinsically safe “ia” or “ib” method as this is typically the lowest cost solution and allows live work to be done in the hazardous area. If the intrinsically safe method is not an option, then the flameproof (d) method is preferred. Other methods may be acceptable but should be discussed with the City before use.

20.4.4 Zone 2 Locations

The preferred method of protection in Zone 2 (previously known as Class I, Zone 2) locations is the non-sparking, non-arcing “n” method as this is typically the lowest cost solution and allows for the simplest installation. If this method is not an option then the intrinsically safe “ia” or “ib” method or the flameproof “d” method is preferred. Other methods may be acceptable but should be discussed with the City before use.

21 SAFETY INSTRUMENTED SYSTEMS

21.1 General

A Safety Instrumented System (SIS) is engineered to perform safety function(s) that are intended to achieve or maintain a safe state for the equipment under control, in respect of a specific hazardous event. Examples of safety functions include functions that are required to be carried out as positive actions to avoid hazardous situations (for example switching off a motor) and functions that prevent actions being taken (for example preventing a motor starting).

A safety instrumented system is required when, after performing a Hazard and Risk analysis, the risk reduction provided by external risk reduction and other technology based systems is not enough to meet the target risk. External risk reduction examples include shielding, emergency management and containment system. Other technology-based systems include relief valves and credible basic process control system functions.

Each “external risk reduction” and “other technology” can be credited with risk reduction as an independent protection layer if:

1. They are effective in preventing the consequence,
2. They are independent of the initiated event,
3. They are independent of other credited independent protection layers for a given scenario, and
4. They can be audited.

After all of the risk reduction and mitigation impacts from the basic process control system and other layers of protection are taken into account, a user must compare the residual risk against their risk tolerance. If there is still an unacceptably high level of risk, a Risk Reduction Factor (RRF) is determined and a Safety Integrity Level (SIL) requirement is calculated. The RRF is the inverse of the Probability of Failure on Demand for the Safety Instrumented Function (SIF). A multidisciplinary approach is usually required to determine SIL and SIF.

Safety Integrity Level (SIL) is a discrete level (one out of a possible four), corresponding to a range of safety integrity values, where SIL 4 has the highest level of safety integrity and SIL 1 has the lowest.

A Safety Integrity Level (SIL) is not a property of a system, subsystem, element or component. The correct interpretation of the phrase “SIL n safety-related system” (where n is 1, 2, 3 or 4) is that the system is potentially capable of supporting safety functions with a safety integrity level up to n.

Safety integrity levels are used for specifying the safety integrity requirements of the safety functions to be allocated to the safety systems.

When a SIL 1 or higher electrical/electronic/programmable electronic safety related system is required, the design, implementation, and commissioning, and all documentation deliverables shall comply with ANSI/ISA-84.00.01-2001 (IEC 61511-1 Mod).

The process and documentation must be carried out with the participation of a functional safety engineer, F.S. Eng (TÜV Rheinland).

In general, the requirement for design and implementation of safety instrumented systems would be identified in the project scope of work.

21.2 Documentation Requirements

Documentation deliverables shall be provided for all safety instrumented systems and shall include at minimum the following:

1. Indication of the hazards or hazardous events that are being mitigated and associated probability and consequences of the events occurring.
2. The allocation of safety functions to protection layers.
3. Indication of the safety target, safety functions required, and the tolerable risk.
4. Identification of the external risk reduction facilities, if any.
5. Identification of applicable regulatory requirements, if any.
6. The safety requirements specification, including the functional requirements and safety integrity requirements of the safety instrumented system, and its required safety integrity level.
7. The type of safety function of the safety instrumented system, be it continuous mode or demand mode, and for the demand mode case whether the system is used for prevention functions or mitigation functions.
8. Sealed engineered drawings indicating the make and model number of each hardware and software component used in the design, and allowable substitutions where applicable.
9. The safety instrument system supporting data (e.g. hardware MTBF, etc.)
10. Requirements for the installation, testing, and commissioning of the safety instrumented system. A complete and detailed commissioning procedure shall be provided.
11. Required routine testing and maintenance procedures of the implemented safety instrumented system, including identification of department(s) involved and qualifications or certifications required.
12. Identification of the stages in the safety lifecycle at which point additional functional safety assessment activities are to be carried out. (e.g. after changes to the associated process system or upon identification of new hazards not previously considered, etc.).
13. Decommissioning procedures of the safety instrumented system.
14. Certifications of the safety instrumented system designer.

All documentation provided shall be accurate, easy to understand, suit the purpose for which it is intended, and be available in an accessible and maintainable form. Each piece of documentation shall have unique identification so it is possible to reference, shall have a revision index to allow for identification of different revisions, and be structured to make it possible to search for relevant information.

All documentation shall be revised, amended, reviewed, approved, and be under the control of an appropriate documentation control scheme.

21.3 General Design Principles

The SIS shall be separate from the basic process control system (BPCS) to ensure that a failure of a single device does not corrupt the control function and interlock system.

The SIS shall not be used for basic process control where a failure of the SIS results in a failure of basic process control function and places demand on the SIS.

Where an SIS is used for both safety and non-safety functions then all hardware and software that can negatively affect any safety instrumented function, under any condition, shall be treated as part of the SIS and comply with the requirements for the highest SIL.

Where an SIS is used to implemented safety instrumented functions at various safety integrity levels, the shared components shall meet the highest safety integrity level.

Methods for performing maintenance and testing shall be incorporated into the design of all safety instrumented systems.

The design of the SIS shall account for human capabilities and limitations and be suitable for the related tasks assigned to operators and maintenance personnel.

The SIS shall be designed in such a way that once it has placed the process in a safe state that the process shall remain in a safe state until a manually initiated reset is performed, unless otherwise dictated by the requirements of the system.

Manual means shall be provided to actuate the SIS final elements, unless otherwise dictated by the requirements of the system.

Safety instrumented functions with a safety integrity level higher than that associated with SIL 4 shall not be allocated to a safety instrumented system.

Applications which require the use of a single safety instrumented function of safety integrity level 4 are rare in the process industry, and such applications shall be avoided where reasonably practicable because of the difficulty of achieving and maintaining such high levels of performance throughout the safety life cycle. If analysis results in a SIL 4 being assigned to a safety instrumented function, the process design shall be changed in a way that makes it more safe or additional layers of protection shall be added. These changes could perhaps then reduce SIL requirements for the safety instrumented system.

Components as part of the SIS for SIL 1 to SIL 3 shall be either in accordance with IEC 61508 or shall meet the minimum requirements for hardware fault tolerance and be suitable based on prior use as per that defined in ANSI/ISA-84.00.01-2004.

Design and implement safety instrumented systems such that they are not likely to experience common cause failure, which is the result of one or more events ultimately leading to system failure.

Design all safety instrumented systems in a fail-safe manner such that failure of the system results in a safe and orderly shutdown or mode of operation of the associated process equipment.

Field devices shall be selected and installed in a manner so as to minimize failures or inaccuracies. This includes but is not limited to affects due to process or environmental conditions such as corrosion, freezing, high temperature and pressures, suspended solids, and condensation.

Each field device shall have its own dedicated wiring to the system inputs/outputs, except where sensors are wired in series or multiple final elements are connected to a single output.

22 GROUNDING

22.1 General

Automation equipment is generally more sensitive to noise and voltage spikes on the grounding system than electrical equipment such as MCCs, VFDs, and motors. For this reason, grounding of automation equipment often requires extra care to ensure the equipment does not fail as a result of continuous or momentary issues on the grounding system.

Automation equipment that is powered from a 120 Vac supply shall have the enclosure or chassis bonded to the electrical (safety) grounding system. This is to allow ground fault currents that are sourced from the 120 Vac supply to return to the source, which would trip the protective device (fuse or circuit breaker) feeding the equipment. Automation equipment that is powered from 24 Vdc and below should be connected to an isolated instrumentation ground, which is segregated from the electrical (safety) ground to the greatest extent possible. As discussed in Section 12.7, if automation equipment is powered from 120 Vac and also contains PLC I/O, 24 Vdc power supplies, or shielded network cabling, the equipment shall be provided with both an electrical (safety) ground for grounding the enclosure, and an isolated instrumentation ground for grounding the 24 Vdc common and the cable shields.

The grounded conductor associated with an isolated instrumentation ground should be connected as close as possible to a ground electrode so that noise and voltage spikes, as seen by the automation equipment, are kept to a minimum. If multiple pieces of automation equipment are being installed, it is typically not cost effective to install dedicated ground conductors between each piece of automation equipment and the ground electrode. Instead, it is more sensible to install an automation equipment grounding point (e.g. an isolated ground bus bar within an automation room), which allows for bonding multiple pieces of automation equipment to ground. The grounding point would be connected as close as practicable to a ground electrode with a single, insulated conductor. Where automation equipment groundings points are provided, they shall be isolated from building structural steel.

As per the electrical code, separate grounding systems may not be provided for a single building and therefore the automation grounds are not completely independent from the electrical (safety) ground, but are segregated to the greatest extent possible. The only common point of connection should be at the final connection point to the grounding system, near a ground electrode.

If only one or two PLCs or HMI clients are being installed in a building, installation of a dedicated automation ground would generally not be required due to the additional costs involved. In this case, the equipment may be connected to the electrical (safety) ground system if deemed acceptable.

Further discussion on the implementation of automation equipment grounding is provided in Section 22.2.

22.2 Implementation of Automation Equipment Grounding

22.2.1 Installations in Existing Buildings

The existing wastewater treatment facilities typically employ a single electrical (safety) ground within each building, and dedicated grounding points for automation equipment may or may not be provided.

Where new automation equipment is installed into an existing building with only an electrical (safety) ground, and it is not within the scope of work to provide dedicated automation grounding points, the automation equipment should be bonded as close as practicable to an existing ground electrode.

If a significant amount of new automation equipment is being installed into a building, new automation grounding points (e.g. isolated ground bus bars) should be installed for bonding the new automation equipment to ground. Multiple automation grounding points may be provided for serving equipment in separate areas of the building to minimize cable length, or for serving different types of automation equipment.

22.2.2 Installations in New Buildings

New buildings shall be constructed with dedicated automation grounding points. Multiple automation grounding points should be provided for serving equipment in separate areas of the building to minimize cable length, or for serving different types of automation equipment as required.

22.2.3 Typical Configurations

A typical building ground system is composed of two or more ground electrodes in close proximity, or a building perimeter ground with several ground electrodes distributed at regular intervals. When connecting automation equipment to a ground electrode, it is preferred to use an electrode that is not directly used by the electrical (safety) ground in order to reduce the potential rise, as seen by the automation equipment, during an electrical ground fault.

Insulated, 2/0 AWG conductors are typically used to ground equipment grounding points (e.g. ground bus bars) to ground. Intrinsically safe grounding points and electrical (safety) grounding points are grounded using duplicate grounding conductors for redundancy.

Typical grounding system implementations are provided in the following figures. Figure 22-1 illustrates a grounding system with three ground rods in close proximity, and the preferred method to connect the electrical and automation grounding points to the ground rods. Figure 22-2 illustrates a grounding system using a perimeter ground, with ground rods distributed at regular intervals, and the preferred method to connect the electrical and automation grounding points to the perimeter ground cabling.

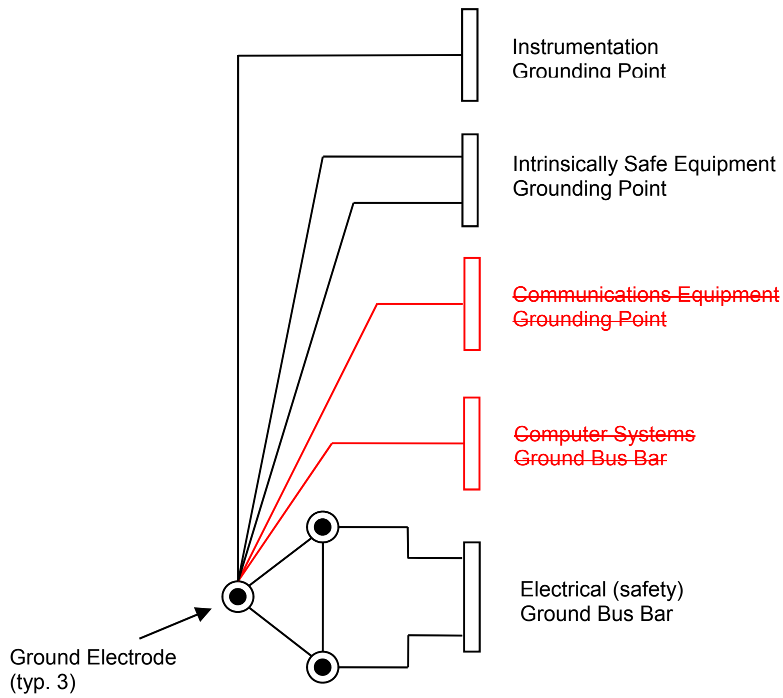

Figure 22-1: Typical Grounding System Implementation with Three Grounding Electrodes

Notes:

1. *The electrical (safety) ground bus bar is grounded to two ground electrodes to ensure proper connectivity to ground.*
2. *The instrumentation and intrinsically safe ground bus bars are grounded to a different ground electrode than those used by the electrical (safety) ground. This is done to minimize potential rise on these ground buses during an electrical ground fault. The negative effects resulting from electrical noise are also minimized.*
3. *Duplicate grounded conductors are provided for the Intrinsically Safe ground bus bar for safety reasons.*

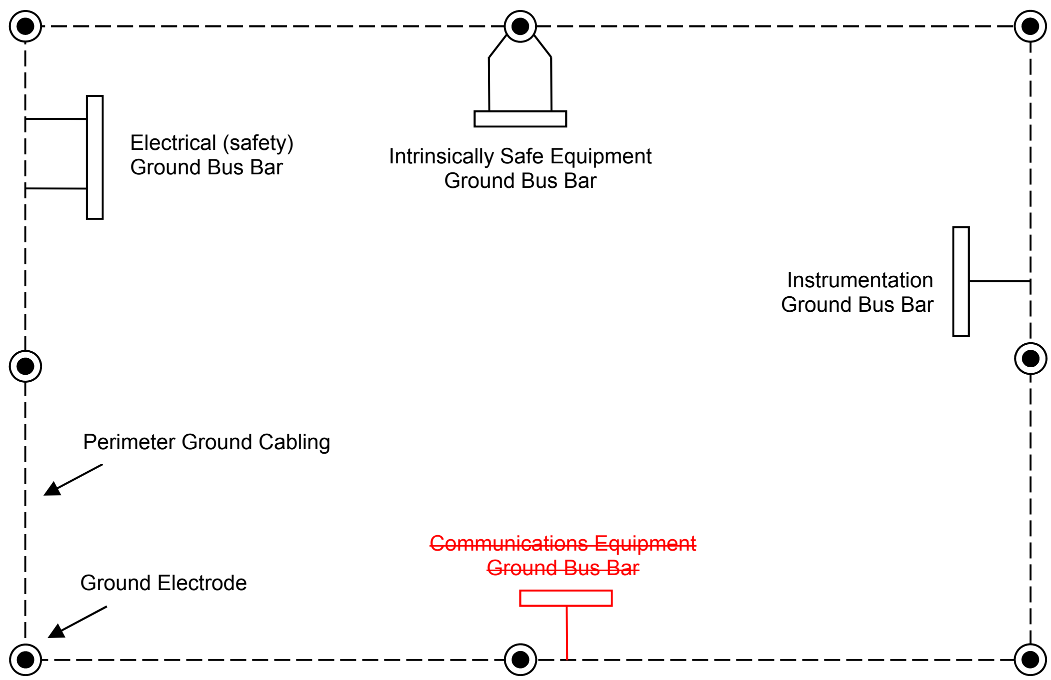

Figure 22-2: Typical Grounding System Implementation with a Perimeter Ground

Notes:

1. *The electrical (safety) ground bus bar is grounded using two ground conductors to ensure proper connectivity to ground. Ideally these are connected directly to two ground electrodes, but connection to the perimeter ground cabling, as shown, is also acceptable.*
2. *The grounding points for the instrumentation is shown connected to the perimeter ground cabling rather than directly to a ground electrode. This is acceptable provided that electrical equipment is not grounded at a point between it and the nearest ground electrode. It is preferred to have direct connections to a ground electrode.*
3. *The grounding point for the intrinsically safe equipment is shown connected directly to a ground electrode, which is the preferred method due to the sensitivity of intrinsically safe equipment. If this is not feasible, it may be connected to the perimeter ground cabling provided that no electrical equipment is grounded at a point on the perimeter ground between it and the nearest ground electrode.*
4. *Duplicate grounded conductors are provided for the Intrinsically Safe ground bus bar for safety reasons.*

22.3 Minimum Requirements

Panels containing I/O, 24 Vdc power supplies, and/or shielded network cabling shall be grounded as per the requirements indicated in Section 12.7.

Automation panels that are grounded to an instrumentation grounding point shall each have an independent bonding conductor to the grounding point, and not be connected in series with one-another.

Panels containing grounded intrinsically safe associated apparatus (IS barriers) shall have duplicate (redundant) bonding conductors between the IS panel and the grounding point, and not be connected in series with one-another.

Automation junction boxes and panels <u>without</u> I/O, 24 Vdc power supplies, or shielded network cabling shall be grounded to the building electrical (safety) ground only.

22.4 Good Practices

New buildings should be provided with an instrumentation grounding point, and if required, an IS master grounding point if practicable. Note that it may not be feasible to unearth the existing grounding electrodes for direct connection of new instrumentation and/or IS ground buses. In this case, these grounding points would be connected as close as possible to the ground electrodes.

Grounded associated apparatus (Zener barriers) should be connected directly to an intrinsic safety (IS) master ground bus or a building ground electrode. Refer to Section 20.3.2 for further information on grounded associated apparatus.

23 AUTOMATION ROOMS

23.1 Location of Equipment

UNDER DEVELOPMENT

23.2 General Requirements

Requirements of automation rooms include the following:

1. Ensure bare concrete floors are covered, painted, or sealed to reduce the build-up of concrete dust on automation equipment. Use of conductive surface hardeners for concrete floors is not permissible.
2. Locate automation rooms a minimum of 150mm above outdoor grade level.
3. Where automation rooms are subject to potential flood risk from a nearby process upset, locate the electrical room a minimum of 100 to 150 mm above the process floor level, or higher as required, to prevent a process flood incident from flowing into the electrical room.
4. No process piping shall run through the automation room.
5. No washroom or kitchen facilities shall be allowed directly above an automation room.
6. Hot water or glycol heating pipes or heaters shall not be located above automation rooms or anywhere such that a leak of liquid or steam could conceivably enter an automation room.
7. Evaporating coils for air handling units will be located and arranged to prevent condensation from running onto automation equipment in the event of a plugged drain.
8. Housekeeping pads:

   8.1 It is generally preferred that automation equipment be installed on housekeeping pads. Housekeeping pads are required in any application where there is potential for water leakage on the floor.

   23.2.1.8.1.1 Housekeeping pads may be omitted where not compatible with certain types of draw-out switchgear.

   8.2 Size housekeeping pads to extend 50mm past the equipment.

   8.3 Housekeeping pads to be between 110 and 152 mm high.

   8.4 Provide rebar as structurally required, but at minimum provide 10M rebar spaced at maximum 300 on center and anchor to the floor.

23.3 Space and Location Requirements

1. Design new automation rooms to provide a minimum of 25% usable floor space not allocated to installed equipment at the end of the project. In addition, a minimum of 10% of usable wall space shall be spare. This space provision shall not be utilized for equipment that only becomes defined as the project progresses.

Note: A common issue is that not all the electrical and automation equipment are known at the time of electrical room sizing. Automation room sizing at the preliminary design stage may need to be 150 – 200% of the size required for the equipment known at this stage. Consider undefined requirements at the time of automation room sizing.

24 ENGINEERING DESIGN TEAM RESPONSIBILITY

24.1 General

1. Responsibility for deliverables:
   1.1 All drawings and other deliverables related to a design are the responsibility of the design engineer.
2. All automation deliverables are to be sealed by a qualified professional engineer.
3. Completeness of drawings:
   3.1 All drawings shall be comprehensive in nature to allow for effective use in construction and maintenance.
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.
      4.1.1 Loop drawings, motor schematics, and wiring diagrams must always be updated.
      4.1.2 PLC system I/O schematic drawings must always be updated.
      4.1.3 Updates to or superseding existing P&ID drawings is mandatory. Partial P&ID diagrams showing a small portion of the process modifications are not acceptable.
      4.1.4 The update of existing instrument plan drawings to reflect new work is not typical, and is not required unless specifically identified by the City.
      4.1.5 The update of other existing automation drawings is dependent upon the design engineer’s scope.
5. As-Built Drawings:
   5.1 All automation 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.
   5.2 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).
6. Site Visits:
   6.1 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 equipment.
7. Demolition Requirements:
   7.1 It is generally required that the design 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.
   7.2 Where demolition requirements are significant, create dedicated demolition drawings.

7.3 Generally, abandoned equipment, wiring, etc. shall be removed unless specifically requested by the City that the equipment/wiring be retained, or removal is not practicable.

8. Acceptance Testing:

8.1 Acceptance testing requirements shall be defined for every project. Acceptance tests shall use industry approved methods.

8.2 Acceptance testing forms shall be completed for every project and included with the O&M manuals/Information.

8.3 The Design Team is responsible for reviewing the completed acceptance test forms to ensure that the installation complies with the specifications.

24.2 Drawings

The drawing requirements in this section are not exhaustive, but indicate general requirements for all projects, as applicable to the scope of work in the project. The automation drawings produced shall be comprehensive to cover the scope of the project, and shall be detailed to an “industrial” level of detail. “Commercial-grade” drawings that have excessive use of “typical” and general lack of detail are not acceptable.

All drawings that are converted to PDF must be searchable.

24.2.1 Architecture Block Diagrams

UNDER DEVELOPMENT

24.2.2 Loop Drawings

1. Requirement:

1.1 Loop Drawings are required for all field instruments that connect to a local control panel or programmable automation controller.

2. Content:

2.1 Divide the drawing into columns such that each column represents a physical location. Title each column with the physical location it represents.

2.2 Clearly show all instruments, terminals, devices, and wiring interconnections in each instrument loop.

2.3 Provide all instrument and/or device settings on the loop drawing, such as dip switch settings, dial settings, etc.

2.4 For analog loops, such as 4-20 mA and 0-20 mA loops, where there are multiple load devices within the loop, indicate the impedance of each device in the loop.

2.5 Indicate the source of power (and common / neutral connections) for all loops.

2.6 Provide an appropriate symbol within each special terminal to indicate the type of terminal:

2.6.1 Indicate fused terminals with a small fuse symbol inside the terminal. Provide the fuse rating below the terminal.

2.6.2 Indicate disconnect terminals with a small disconnect symbol inside the terminal.

2.6.3 Indicate potential earth terminals with a small ground symbol inside the terminal.

2.7 Show the instrument identifier within an instrument bubble symbol adjacent to and pointing at the instrument.

2.8 Show all field instrument and control panel device part numbers on loop drawings.

2.9 For intrinsically safe wiring, indicate the following:

2.9.1 The classification of the hazardous location (e.g. Class I, Zone 1, Group IIC),

2.9.2 For intrinsically safe apparatuses (field devices) other than simple devices, the manufacturer, model, and entity parameters of the apparatus,

2.9.3 Manufacturer/model and/or permissible entity parameters of the associated apparatus (e.g. IS barrier),

2.9.4 Maximum entity values for the cabling.

3. Format:

3.1 All loop drawings are to be produced on a standard B size drawing.

3.2 Drawing Scale: NTS

4. Standard of acceptance:

4.1 Refer to sample Instrument Loop Diagram, drawing SK-A103.

24.2.3 Instrument Segment Drawings

1. Requirement:

1.1 Instrument Segment Drawings shall be prepared for every project utilizing PROFIBUS instruments.

2. Content:

2.1 All new PROFIBUS instruments shall be shown on the instrument segment drawings.

2.2 Indicate all instrument and networking equipment identifiers.

2.3 Indicate the cable identifier and cable type for each cable on the drawing.

2.4 Indicate the estimated length for all cables on the drawing.

2.5 Indicate allowable minimum and/or maximum cable lengths on the drawing where applicable.

2.6 Indicate the network speed(s) on the drawing.

2.7 Indicate the location and type of terminations on the drawing.

2.8 Indicate the network address number of each device on the drawing.

2.9 Provide a Segment Schedule on the drawing, showing the number of devices, total length, and maximum spur length for each segment.

3. Format:

3.1 All instrument segment drawings are to be produced on a standard B size drawing.

3.2 Drawing Scale: NTS

4. Standard of acceptance:

4.1 Refer to sample Instrument Segment Diagram, drawing SK-A105.

24.2.4 Instrument Location Plan Drawings

1. Requirement:
   1.1 Instrument Location Plan Drawings shall be prepared for every project.
2. Content:
   2.1 All new instruments shall be shown on instrument location plan drawings.
   2.2 Provide instrument elevation drawings for instruments that are to be installed at a specific elevation and where sufficient detail cannot be provided in plan view.
   2.3 All instrument identifiers are to appear on the drawings.
   2.4 All mechanical equipment, if applicable, shall be shown with a lighter line weight.
3. Format:
   3.1 All instrument plan and elevation drawings are to be produced on a standard A1 size drawing.
   3.2 Drawing Scale:
      3.2.1 Recommended: 1:30

24.2.5 Instrument Installation Details

1. Requirement:
   1.1 Instrument installation details shall be provided for all instruments that require a specific means of installation.
   1.2 Specific (non-typical) installation details are required for all magnetic flow meter installations where the flow-tube is 350 mm (14”) or larger, where remote transmitters are used, or where specific site constraints must be addressed. Typical installation details may be used for flow meter installations where the flow-tube is 300 mm (12”) or smaller, with an integral transmitter, and without any site constraints.
   1.3 Typical installation details may be provided for ultrasonic level transducer installations unless a specific site constraint must be addressed.
   1.4 Specific installation details shall be provided for all differential pressure based level transmitter installations.
2. Content:
   2.1 Show all installation details including instrument orientation, mounting bracketry, cables, conduits, strain reliefs, pull boxes, and junction boxes as applicable.
   2.2 For magnetic flow meter installations, show grounding ring installation and connection details.
   2.3 All structural and mechanical equipment, if applicable, shall be shown with a lighter line weight.
3. Format:
   3.1 Instrument installation details are typically shown as a detail on a standard A1 size drawing.
   3.2 Drawing Scale:
      3.2.1 Recommended: 1:10

3.2.2 Maximum: 1:20

24.2.6 Control Panel Layouts

1. Requirement:
   1.1 Provide control panel layout drawings for all control panels that are to be constructed by a Contractor or where included in the project scope.
2. Content:
   2.1 Provide a bill of materials, indicating the quantities, manufacturer name, model name, and a description for each component.
   2.2 Show exterior panel dimensions.
   2.3 Show the exterior (typically the front door only) elevation of the control panel with all components to scale.
   2.4 Show the interior elevation panel layout of all components to scale. The only component not shown on the layout shall be the wires.
   2.5 Where dedicated wireways are required, indicate the type or category of wiring that may be installed in each wireway.
   2.6 For each terminal block, indicate which side is for field wiring side and which side is for internal wiring.
   2.7 Provide construction notes indicating specific construction details.
3. Format:
   3.1 All control panel layout drawings are to be produced on a standard A1 size drawing.
   3.2 Drawing Scale:
      3.2.1 Recommended: 1:4
      3.2.2 Maximum: 1:10
4. Standard of acceptance:
   4.1 Refer to sample Control Panel Layout, drawing SK-A101.

24.2.7 Control Panel Power Distribution Schematics

1. Requirement:
   1.1 Control panel power distribution schematics shall be provided for all control panels.
2. Content:
   2.1 Show the complete schematic for the power distribution, including component identifiers, terminals, terminal numbers, wires, and wire tags.
   2.2 Show where the source of power terminates to the control panel, and include the name and details of the power source (e.g. “120 VAC from PNL-R731, CCT 12”).
   2.3 Provide a fuse schedule on the drawing which lists the identifier, type, and rating of each fuse.
   2.4 Provide a power consumption schedule for each major voltage level used within the control panel that summarizes the current consumption from each device, including PLC inputs and outputs. The total current consumption shall be provided at the bottom of the table.

2.5 Provide a terminal layout (arrangement) on the drawing for terminal blocks associated with power distribution.

3. Format:

3.1 All control panel power distribution schematics shall be produced on a standard A1 size drawing.

4. Standard of acceptance:

4.1 Refer to sample PLC Power Schematic, drawing SK-A102 (Sheets 001 and 002).

24.2.8 I/O Module Wiring Diagrams

1. Requirement:

1.1 I/O module wiring diagrams shall be provided for all programmable automation controller I/O modules.

2. Content:

2.1 Show the I/O modules and their connections to the I/O (field) terminals. The field instruments and associated wiring to the I/O (field) terminals shall not be shown on I/O module wiring diagrams. The field wiring details must be shown on loop drawings or other automation / electrical diagrams.

2.2 Provide the I/O signal name and drawing reference beside each set of I/O (field) terminals associated with each I/O point.

2.3 Where fused I/O (field) terminals are used, provide a fuse schedule which lists the identifier, type, and rating of each fuse.

3. Format:

3.1 All I/O module wiring diagrams shall be produced on a standard A1 size drawing.

24.2.9 Network Diagrams

1. Requirement:

1.1 Network diagrams shall be provided for all new network equipment installations.

1.2 Use an Instrument Segment Drawing for all PROFIBUS instrumentation network drawings. See Section 24.2.3.

1.3 Existing network diagrams shall be updated where changes are made to an existing network.

2. Content:

2.1 Network diagrams shall show all networking equipment, including patch panels, network switches, routers, media converts, wireless devices, and cabling.

2.2 The port type (RJ45, FC, LC, ST, SC, etc.) shall be identified on the drawing using a specific symbol.

2.3 All port labels and/or port numbers for networking devices shall be indicated on the drawing in a manner that is consistent with the physical port labelling on the device.

2.4 All cable identifiers are to be shown on the drawing along with the cable types:

2.4.1 For copper network cables, indicate the number of conductors, conductor size, and type of cable. Example: “4 PR, 24 AWG, CAT 6”.

2.4.2 For fibre cables, indicate the type of fibre (single-mode, multi-mode, hybrid, etc.) number of strands, core diameter, cladding diameter, and signal compatibility.

2.5 For long runs of fibre or CAT5e/CAT6 Ethernet cabling, indicate the estimate length of the cabling on the drawing.

2.6 For Ethernet Networks, indicate the IP addresses of the devices on the drawing. ***Note IP addresses are not to be made available to the public.***

2.7 For Modbus/TCP, Modbus/RTU (serial), or other networks utilizing “Node” numbers, indicate all device node numbers on the drawing.

2.8 For outdoor wireless systems, show all antennae and lightning surge arrestors.

2.9 Provide a symbol legend on the drawing or on a standard legend sheet.

3. Format:

3.1 All network diagrams shall be produced on a standard A1 size drawing.

4. Reference:

4.1 Standard of acceptance: sample network diagram, SK-A104.

24.2.10 Automation Conduit Riser Diagrams

1. Requirement:

1.1 Where conduit sizing for the provision for future wiring is required, an automation conduit riser diagram shall be provided so that conduits are installed with the required spare capacity, and not sized by the installation contactor to the minimum size required by Code.

2. Content:

2.1 Show the conduit type and size for each conduit.

2.2 Show pull boxes, junction boxes, and panels as required.

2.3 Show area boundaries using boundary lines and show each pull box, junction box, and panel within the appropriate boundaries.

2.4 Provide a legend on the drawing or a standard legend sheet indicating the acronyms used. Examples:

ARC	Aluminum Rigid Conduit
LFMC	Liquidtight Flexible Metallic Conduit
PB	Pull Box
PVC	Polyvinyl Chloride

3. Format:

3.1 All automation conduit riser diagrams are to be produced on a standard A1 size drawing.

24.2.11 Process and Instrumentation Diagrams

Note: Process and Instrumentation Diagrams are officially categorized under the Process discipline, but rely heavily on input from automation engineers.

1. Requirement:

1.1 Process and Instrumentation Diagrams shall be provided for all processes including HVAC and Building Services.

2. Content:

2.1 Show the following automation details on P&IDs:

2.1.1 Instrument balloons for all discrete instruments (i.e. those that are not a subcomponent to a parent piece of equipment).

2.1.2 Alarm switch setpoints for all instruments used for alarming (e.g. temperature alarm setpoint for a TSH).

2.1.3 Manual control devices (pushbuttons, switches, pilot lights, etc.) associated with each piece of equipment. Type clarifications (e.g. HOA, HOR, L/O/R, E/S), shall be shown above Hand/Off/Auto, Hand/Off/Remote, Local/Off/Remote, and Emergency Stop switches.

2.1.4 Physical I/O (represented by triangle symbol) associated with process control system or automatic controller, along with functional signal designations.

2.1.5 Software control function blocks associated with equipment, which logically represent the control functionality provided by the PLC system or automatic controller. The major control loops shall be shown; however the level of detail shall be managed such that the process is not lost in excessive automation detail. Note that the Control Narratives (Section 24.3.7) together with the Functional Requirements Specifications (Section 24.3.8) provide the complete control strategy.

2.1.6 Major software interlocks and control signals between software control function blocks, as required. Where multiple PLCs or controllers provide control for one piece of equipment, indicate the controller identifier above each software control function block.

2.1.7 Hardwired interlocks and control signals.

2.1.8 Critical operating and alarm setpoints for major equipment.

2.1.9 Indication of communication protocol (e.g. PB-DP, PB-PA, MB-E) for communications cabling.

3. Format:

3.1 All process and instrumentation diagrams are to be produced on a standard A1 size drawing.

4. Design Responsibility:

4.1 Where appropriate, P&IDs should be sealed by both the appropriate process engineer and the automation engineer.

24.3 Other Documents

The documentation requirements in this section are not exhaustive, but indicate general requirements for all projects, as applicable to the scope of work in the project. The automation documents produced shall be comprehensive and shall be detailed to an “industrial” level of detail.

All documents converted to PDF format shall be searchable.

24.3.1 Instrument List

1. Requirement:
   1.1 An instrument list is required for every project where new instruments are installed.
2. Content:
   2.1 Provide an overall cover page, indicating client name, project title, document code, and document revisions. The cover page shall be sealed by the Design Engineer.
   2.2 The instrument list shall include the following fields:
      2.2.1 Instrument Tag (identifier)
      2.2.2 Description
      2.2.3 Communication (4-20mA, HART, PB DP, etc.)
      2.2.4 File name and version of associated EDDL/GSD/DTM, if applicable.
      2.2.5 Plan Drawing (reference to drawing number)
      2.2.6 P&ID Drawing (reference to drawing number)
      2.2.7 Schematic / Loop Drawing (reference to drawing number)
      2.2.8 Installation Detail Drawing (reference to drawing number)
      2.2.9 Mounting Method
      2.2.10 Supplied By (indicate which sub-trade should supply the instrument)
      2.2.11 Notes
      2.2.12 Revision of last change
3. Format:
   3.1 An instrument list shall be prepared in Microsoft Excel, but other formats may be accepted by the City with approval.
4. Standard of acceptance:
   4.1 Refer to sample Instrument List, document SD-A101.

24.3.2 Loop Numbering List

1. Requirement:
   1.1 A Loop Numbering List lists all of the loop numbers used at each facility to prevent inadvertent duplication of loop numbers and equipment identifiers.
   1.2 A Loop Numbering List is required for all projects where new equipment is installed.
   1.3 The Loop Numbering List shall be divided by process area.
2. Content:
   2.1 The Loop Numbering List shall include the following fields:
      2.1.1 Loop Number
      2.1.2 Loop/Equipment Description
      2.1.3 Reference Drawings (e.g. loop drawings, P&ID drawings)
      2.1.4 Notes

2.1.5 Revision of last change

24.3.3 I/O List

1. Requirement:

1.1 An I/O list is required for every project where changes to PLC system I/O are made.

1.2 Where possible, update an existing facility I/O list rather than creating a new I/O list. Alternatively, update the existing facility I/O list upon completion of the project.

2. Content:

2.1 Provide an overall cover page, indicating client name, project title, document code, and document revisions. The cover page shall be sealed by the Design Engineer.

2.2 I/O lists shall include the following fields:

2.2.1 I/O Module Address (e.g. rack number and/or slot number)

2.2.2 Module Point (I/O point number or channel number on module)

2.2.3 Tag (instrument or signal tag name)

2.2.4 Description

2.2.5 For discrete I/O:

2.2.5.1 “0 State” Description (description of signal when FALSE)

2.2.5.2 “1 State” Description (description of signal when TRUE)

2.2.5.3 Indicate which state is used for alarms (if applicable)

2.2.6 For analog I/O:

2.2.6.1 Type (4-20mA, 0-5 VDC, 0-10 VDC, etc.)

2.2.6.2 EU Range (engineering units range) including raw min and max if scaling occurs in SCADA rather than in the PLC. Indicate engineering unit of measure

2.2.7 P&ID drawing (reference to applicable P&ID drawing)

2.2.8 Loop/wiring drawing (reference to applicable loop/wiring drawing)

2.3 The list shall be grouped by I/O signal type:

2.3.1 Discrete Input

2.3.2 Discrete Output

2.3.3 Analog Input

2.3.4 Analog Output

2.3.5 HART Input

2.3.6 HART Output

3. Format:

3.1 An I/O list will typically be prepared in Microsoft Excel, but other formats may be accepted by the City with approval.

4. Standard of acceptance:

4.1 Refer to sample I/O List, document SD-A012.

24.3.4 Interface Maps

1. Requirement:
   1.1 Interface maps are required for projects where a new customizable controller is installed and makes data available to other controllers via a communication link. For example, a new standalone PLC is installed for an HVAC system, which is monitored by the facility PLC system using Modbus TCP.
2. Preparation and Completion:
   2.1 For non-packaged systems, preparation of interface maps falls under the responsibility of the Systems Integrator. The Design Engineer may provide templates to the Systems Integrator for completion.
   2.2 For packaged systems including equipment and a programmable controller or HMI, preparation of interface maps falls under the responsibility of the vendor.
3. Content:
   3.1 Interface maps shall include an overall cover page, indicating client name, project title, document code, and document revisions.
   3.2 Interface maps shall include the following fields:
      3.2.1 PLC Register or PLC Tag name,
      3.2.2 Protocol Address (e.g. Modbus address),
      3.2.3 Description,
      3.2.4 Analog Range – Raw,
      3.2.5 Analog Range – Engineering Units,
      3.2.6 Read/Write,
      3.2.7 In the case of packaged control systems alarm limits should also be indicated
      3.2.8 Digital I/O, should identify, register number and bit number and 1 and 0 states (alarm, etc.)
      3.2.9 Notes.
4. Format:
   4.1 An interface map will typically be prepared in Microsoft Excel, but other formats may be accepted by the City with approval.
5. Standard of acceptance:
   5.1 Refer to sample Interface Map, document SD-A103.

24.3.5 Automation Cable Schedule

1. Requirement:
   1.1 An automation cable schedule is required for every project.
2. Content:
   2.1 Provide an overall cover page, indicating client name, project title, document code, and document revisions. The cover page shall be sealed by the Design Engineer.
   2.2 All control cables shall be uniquely identified on the cable schedule. Cables shall not be entered as typical.

2.3 Where individual wires are routed in conduit, the wires shall be identified as an item in the cable schedule. This is not applicable to power wiring for minor circuits, such as lighting, receptacles, etc.

2.4 Cable schedules shall include the following fields:

2.4.1 Cable Identifier

2.4.2 Cable Type

2.4.3 From (Source)

2.4.4 To (Destination)

2.4.5 Spacing (typically not applicable to automation cabling)

2.4.6 Length (estimate)

2.4.7 Routing (brief description)

2.4.8 Notes

2.4.9 Revision of last change.

2.5 The length for each cable shall be estimated at design time to within ~10% accuracy for purposes of pre-bid cost estimating.

3. Format:

3.1 A cable schedule will typically be prepared in Microsoft Excel, but other formats may be accepted by the City with approval.

4. Standard of acceptance:

4.1 Refer to sample Automation Cable Schedule, document SD-A104.

24.3.6 Lamacoid Schedule

1. Requirement:

1.1 A lamacoid schedule is a requirement for every project.

1.2 Note that the creation of a lamacoid schedule at design time greatly assists the Contractor, helps provide a higher quality of identification lamacoids for maintenance personnel, and can be created for a minimum effort above that required to thoroughly review a Contractor-produced lamacoid schedule.

2. Content:

2.1 Provide an overall cover page, indicating client name, project title, document code, and document revisions.

2.2 All automation lamacoids shall be uniquely identified on the lamacoid schedule, except as follows:

2.2.1 Lamacoids for cables may reference the cable schedule.

2.3 Lamacoid schedules shall at minimum include the following fields:

2.3.1 Item

2.3.2 Line 1 (text to appear on row 1)

2.3.3 Line 2 (text to appear on row 2)

2.3.4 Line 3 (text to appear on row 3)

2.3.5 Text size

2.3.6 Notes

2.3.7 Revision of last change.

3. Format:

3.1 A lamacoid schedule will typically be prepared in Microsoft Excel, but other formats may be accepted by the City with approval.

4. Standard of acceptance:

4.1 Refer to sample Lamacoid Schedule, document SD-A105.

24.3.7 Process Control Narrative

1. Requirement:

1.1 Provide a Process Control Narrative for all projects where new process equipment is installed.

1.2 While this document is primarily written by process engineers, the automation engineers should review and provide input.

2. Content:

2.1 Provide an overall cover page, indicating client name, project title, document code, and document revisions.

2.2 Provide a listing of reference drawings (typically P&IDs).

2.3 Provide equipment and instrument listing, complete with identifiers (tag numbers) and descriptions.

2.4 Provide a detailed textual description of all the control modes of the process.

2.5 Indicate general arrangement details, such as equipment physical locale and configuration where required to clarify the process control.

2.6 For each operating mode describe the normal operation of each piece of equipment.

2.7 Describe the operation of equipment under abnormal circumstances (e.g. instrument failure, mechanical failure, etc.), where possible.

2.8 Indicate special requirements of the automation system to accommodate maintenance activities, as required.

2.9 Indicate operating setpoints for each operating mode.

2.10 Indicate process interlocks and major equipment protection interlocks. Standard interlocks (i.e. motor overload) can be detailed in the Functional Requirements Specification (Section 24.3.8).

2.11 Indicate required major alarms. The complete set of alarms will be in the Functional Requirements Specification.

3. Format:

3.1 A process control narrative will typically be prepared in Microsoft Word, but other formats may be accepted by the City with approval.

24.3.8 Functional Requirements Specifications

1. Requirement:
   - 1.1 Provide a Functional Requirements Specification (FRS) for all projects where programming of a PLC or similar system is required.
2. Content:
   - 2.1 Specific functional requirements for each piece of equipment in the design that is controlled by the programmable controller.
   - 2.2 Provide textual descriptions, cause-effect matrices, or high-level function block logic diagrams of the required equipment functionality as required.
     - 2.2.1 Use pseudo-code and function block logic diagrams only when necessary, i.e. when it is not possible to convey functionality using alternate means.
     - 2.2.2 Textual descriptions should be used to provide a general understanding where required, but should not be used alone to describe detailed logic.
   - 2.3 Logic in functional requirements specifications are to be based on the City's standard library of function blocks.
     - 2.3.1 Create additional standard function blocks that can be imported into the City's function block library as required.
3. Format:
   - 3.1 Functional requirements specifications are typically prepared in Microsoft Word, and may reference external documents such as cause-effect matrices that were generated using Microsoft Excel.
   - 3.2 Functional Requirements Specifications are split into multiple documents as follows:
     - 3.2.1 A Standard Function Block Class FRS – contains the standard set of function block classes that are used within the process control system associated with the City's Sewage Treatment Program. Standard function block classes provide high-level functionality for equipment monitoring and control and can be saved into a repository for re-use. The City is in the process of developing standard function block classes. Contact the City for information on the availability of the standard classes and the Standard Function Block Class FRS document.
     - 3.2.2 One or more Process Area FRSs – specific functional requirements specifications for the equipment controlled by the PLC system. The specific FRSs are broken down by process area so that they are manageable in size. If the work associated with the project is all within one process area then only one Process Area FRS would be provided. If the work spans multiple process areas then one FRS would be provided for each process area. These FRSs reference the standard classes defined in the Standard Function Block Class FRS.
4. Standard of acceptance:
   - 4.1 Refer to the included sample Functional Requirements Specifications:
     - 4.1.1 Sample document SD-A106: Area "A" – Standard Function Block Classes.
     - 4.1.2 Sample document SD-A107: Area "S" – Secondary Clarifiers.

24.4 Construction and Commissioning Documents

24.4.1 Instrument Test Forms

1. Requirement:
   1.1 Instrument test forms shall be provided with projects where new instruments will be installed.
2. Preparation and Completion:
   2.1 Instrument test forms shall be prepared by the Design Engineer and filled in by the installation contractor.
   2.2 Use standard City forms where available.
3. Content:
   3.1 Provide a header section at the top of the test form with the following fields, to be filled in by the contractor:
      3.1.1 Facility
      3.1.2 Project Name
      3.1.3 Plant Area
      3.1.4 Bid Opportunity number
      3.1.5 Document number
   3.2 Provide a sign-off section at the bottom. Test forms are to be signed and dated by the tester and a witness, where the witness is a person designated by the Contract Administrator.
   3.3 Provide sections for filling in the following:
      3.3.1 Sensor / element and transmitter details indicating at minimum:
         a. Units,
         b. Design range,
         c. Configured range,
      3.3.2 Inspection of instrument and installation.
      3.3.3 For discrete instruments:
         a. The setpoint trip point,
         b. The actual trip point,
         c. The setpoint time delay,
         d. The actual time delay, and
         e. Verification of the signal for each discrete state.
      3.3.4 For analog instruments, verification of the signal under various process or test conditions.
      3.3.5 For PROFIBUS instruments, the communication is functioning without error, the transmitter alarms are configured (as required), and the transmitter configuration is complete and saved.
4. Format:

4.1 Instrument test forms will typically be prepared in Microsoft Word, but other formats may be accepted by the City with approval.

24.4.2 I/O Module Test Forms

1. Requirement:
   1.1 I/O module test forms shall be provided for new PLC installations for verification that each I/O point and associated HMI object(s) are configured correctly.
2. Preparation and Completion:
   2.1 I/O module test forms shall be prepared by the Design Engineer and filled in by the Systems Integrator as part of the FAT documentation.
   2.2 Use City standard forms where available.
3. Content:
   3.1 Provide a header section at the top with the following fields, to be filled in by the contractor:
      3.1.1 Facility
      3.1.2 Project Name
      3.1.3 Plant Area
      3.1.4 Bid Opportunity number
      3.1.5 Document number
   3.2 Provide a sign-off section at the bottom. Forms are to be signed and dated by the tester and a witness, where the witness is a person designated by the Contract Administrator.
   3.3 Provide a section for filling in the associated PLC identifier, PLC description, rack number, slot number, and module type.
   3.4 Provide separate forms for each type of module (discrete input, discrete output, analog input, analog output, thermocouple input, RTD input, etc.).
   3.5 Provide columns within the forms for the I/O point number, I/O point tag name, I/O point description, 0 State (False state) description, 1 State (True state) description, and checkboxes for indicating that each state has been verified:
      3.5.1 at the PLC Input/output module,
      3.5.2 on the HMI graphic display, and
      3.5.3 on the HMI alarm system.
4. Format:
   4.1 I/O module test forms will typically be prepared in Microsoft Word, but other formats may be accepted by the City with approval.

24.4.3 PLC System Commissioning Checklist

1. Requirement:
   1.1 PLC system commissioning checklists shall be provided for new PLC installations for verification that each PLC system is installed and operating correctly.

2. Preparation and Completion:

   2.1 PLC system commissioning checklists shall be prepared by the Design Engineer and filled in by the Systems Integrator.

3. Content:

   3.1 Provide a header section at the top with the following fields, to be filled in by the contractor:

      3.1.1 Facility

      3.1.2 Project Name

      3.1.3 Plant Area

      3.1.4 Bid Opportunity number

      3.1.5 Document number

   3.2 Provide a sign-off section at the bottom. Checklists are to be signed and dated by the tester and a witness, where the witness is a person designated by the Contract Administrator.

   3.3 Provide a section for filling in the PLC identifier, PLC description, processor and network adapter module numbers, and rack number.

   3.4 Provide a section indicating that the following has been inspected:

      3.4.1 PLC cabinet is completely clean and there are no loose papers inside.

      3.4.2 Ventilation openings are not covered.

      3.4.3 Drawings are marked up as-built.

      3.4.4 Communications between PLC and HMI system is acceptable.

      3.4.5 Communications between PLC and remote racks is acceptable, as applicable.

      3.4.6 For redundant PLC applications, failover functionality from primary rack to secondary (standby) rack, then back to primary, is operational.

      3.4.7 Memory card(s) are installed and program has been transferred to the memory card(s), as applicable.

   3.5 Provide a section for filling in the following run-time information:

      3.5.1 Percentage processor (CPU) utilization.

      3.5.2 Percentage memory utilization.

      3.5.3 Program scan time.

4. Format:

   4.1 PLC system commissioning checklists will typically be prepared in Microsoft Word, but other formats may be accepted by the City with approval.

24.4.4 Valve Actuator Commissioning Checklist

1. Requirement:

   1.1 Valve actuator commissioning checklists shall be provided for all new valve actuator installations for verification that the valve actuator is correctly installed and configured.

2. Preparation and Completion:

   2.1 Valve actuator commissioning checklists shall be prepared by the Design Engineer and filled in by the installation contractor.

3. Content:

   3.1 Provide a header section at the top with the following fields, to be filled in by the contractor:

      3.1.1 Facility

      3.1.2 Project Name

      3.1.3 Plant Area

      3.1.4 Bid Opportunity number

      3.1.5 Document number

   3.2 Provide a sign-off section at the bottom. Checklists are to be signed and dated by the tester and a witness, where the witness is a person designated by the Contract Administrator.

   3.3 Provide a section for filling in the valve actuator details:

      3.3.1 Identifier (tag)

      3.3.2 Description

      3.3.3 Manufacturer

      3.3.4 Model

      3.3.5 Serial Number

      3.3.6 Design Range

      3.3.7 PROFIBUS network address

   3.4 Provide a section indicating that the following has been inspected:

      3.4.1 Actuator type and materials matches the P&ID and actuator data sheet

      3.4.2 Installation of actuator is correct

      3.4.3 Equipment tag is correct

      3.4.4 Configuration matches valve actuator settings sheet

      3.4.5 Open/close/position command from process control system is functioning

      3.4.6 Status monitoring by process control system is functioning

      3.4.7 Drawings are marked up as-built

      3.4.8 HMI graphic symbol, tag, and units are correct

4. Format:

   4.1 Valve actuator commissioning checklists will typically be prepared in Microsoft Word, but other formats may be accepted by the City with approval.

24.5 Design Calculations and Studies

1. All design decisions leading to important design activities, must be supported by an appropriate calculation, which may be required for verification and justification. The Design

Engineer shall prepare design calculations as required. It shall be the responsibility of the Design Team to collect, verify, and file all such calculations.

2. The software tools or vendor PLC packages used for the required calculations must be approved by the Lead Engineer for each specific project.

3. Calculations done by subcontractors, contractors or vendors will be permitted if the calculation requires specialized knowledge or experience that a typical automation design engineer would not possess. In these cases, it is the responsibility of the design engineer to ensure that the calculations follow all City standards and guidelines.

4. The calculations and studies shall only be deferred to the Contractor after review and agreement with the City.

5. The following are potential calculations that may be required by the design engineer depending on the size and complexity of the design:

   5.1 New control panels, power supply panels, networking panels:

      5.1.1 Wireway sizing / fill calculations, where there are a significant number of wires in the wireways and the percent fill is non-trivial,

      5.1.2 Heat load calculations,

      5.1.3 Power supply loading calculations,

   5.2 New junction boxes:

      5.2.1 Wireway sizing / fill calculations, where there are a significant number of wires in the wireways and the percent fill is non-trivial.

   5.3 Intrinsically safe installations:

      5.3.1 Indication of manufacturer, model number, and entity parameters of the intrinsically safe apparatus as they apply to the specific set(s) of terminals to be connected.

      5.3.2 Indication of manufacturer, model number, and entity parameters of the associated apparatus as they apply to the specific set(s) of terminals to be connected.

      5.3.3 Calculation of maximum allowable interconnecting cable entity parameters.

   5.4 Cable tray installations:

      5.4.1 Cable tray sizing (volume) and loading (weight) calculations.

   5.5 Conduit installations:

      5.5.1 Conduit fill calculations.

   5.6 Safety Integrity Calculations as per Section 21.

   5.7 Profibus installations:

      5.7.1 Bus voltage drop calculations.

      5.7.2 Bus current (loading) calculations.

      5.7.3 Max bus cable length (trunk and spur) calculations based on network speed and topology.

6. All design calculations relating to process control system performance and utilization should be included in the Operation and Maintenance Manuals for the associated areas.

25 SAMPLE DRAWINGS

SK-A101	Control Panel Layout
SK-A102	PLC Power Schematic
SK-A103	Instrument Loop Diagram
SK-A104	Network Diagram
SK-A105	Instrument Segment Diagram

26 SAMPLE DOCUMENTS

SD-A101	Instrument List
SD-A102	I/O List
SD-A103	Interface Map
SD-A104	Automation Cable Schedule
SD-A105	Lamacoid Schedule
SD-A106	Functional Requirements Specification: Area “A” – Standard Function Block Classes
SD-A107	Functional Requirements Specification: Area “S” – Secondary Clarifiers

APPENDIX L – WWD IDENTIFICATION STANDARD - R04 AND WWD IDENTIFICATION STANDARD APPENDICIES - R01

The City of Winnipeg

Water & Waste Department

Identification Standard

Document Code:
Revision: 04

Original Approved By:	C. Wiebe for G. Patton	Dec. 4, 2019
	Geoff Patton, Manager of Engineering	Date

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REVISION REGISTER					
Rev.	**Description**	**Date**	**By**	**Checked**	**Approved**
00	Issued for City Use	2013-05-31	C. Reimer	C. Reimer	C. Reimer
01	Miscellaneous Revisions	2016-04-04	C. Reimer	P. Biesse	C. Wiebe
02	Miscellaneous Revisions	2017-03-24	C. Reimer	P. Biesse L. Harrington	-
03	Added Sections 2.5.5 and 2.5.6 Added Fluid Commodity Codes Miscellaneous Minor Corrections / Revs.	2018-05-08	C. Reimer	P. Biesse L. Harrington	C. Wiebe
04	Updated Area Codes Appendices moved to separate document titled *Identification Standard Appendices*	2019-12-03	J. Coey L.Harrington	E. Campbell C. Wiebe	C. Wiebe

This document is owned and maintained by the Wastewater Planning and Project Delivery Branch of the Engineering Services Division. For questions, comments or revisions please contact the Wastewater Planning and Project Delivery Branch Head.

TABLE OF CONTENTS

1 INTRODUCTION

This Water and Waste Department Identification Standard is to be referenced for consistent and accurate identification for all process, mechanical, electrical, and automation equipment. The standard also provides guidance regarding architectural room identification and communication equipment. This document provides clear guidance to department personnel, as well as external consultants, regarding appropriate equipment identification. A consistent standard has been developed for all Water and Waste groups, including Collections, Land Drainage, and Solid Waste (as applicable), however it is acknowledged that some exceptions for various groups may be required due to special circumstances, or existing established precedent.

1.1 Scope of the Standard

This identification standard applies to all City-owned Water and Wastewater facilities, which includes the following facilities:

- The Water Treatment Plant
- Regional water pumping stations
- The Shoal Lake Intake Facility
- Remote water facilities, including standpipes, valve chambers, boathouses, etc.
- Wastewater treatment facilities
- Wastewater lift stations
- Flood pumping stations
- Underpass sites
- Wastewater diversion stations
- Deep well locations
- Fountain locations
- Land drainage facilities
- Combined Sewer Overflow facilities
- Current and future remote wastewater sites (outfalls, valve chambers, etc).

1.2 Application

Existing facilities do not necessarily comply with this standard. The expectations regarding application of this standard to existing facilities must be decided on a case-by-case basis, however general guidelines for application are presented as follows:

- All new facilities must comply completely with this standard.
- All major upgrades to a facility, or a larger facility’s area, must completely comply with this standard. Any existing equipment within the area being upgraded should be re-identified.
- All minor upgrades should utilize this standard as far as practical for new equipment, however in some cases compromise with the existing facility identification practice may be required.

For example, if adding a single pump to the WEWPCC facility, it is recommended to identify the pump as S230-P, rather than P-S230.

1.2.1 Re-identification

When equipment is re-identified to this new standard, it is recommended that the following be implemented:

- All equipment lamacoids and labels are to be replaced with the new identifier.
- All drawings that are being modified as part of the work are to utilize the new identifier. Major drawings such as P&IDs and Single Line Diagrams should display both the new and the old identifiers, in the following format:

  New-Identifier
  (was Old-Identifier)

- Generate a master equipment list with the new identifier, old identifier, and equipment description.

1.3 Document Revisions

Wastewater Planning and Project Delivery Branch (WWPPD) will issue revisions to the document on an as required basis. WWPPD will send out an email requesting review and comments by the division list below.

All proposed revisions shall be circulated to the following divisions and branches:

- Water Services Division
- Wastewater Services Division
- Solid Waste Services Division
- Engineering Division
  - Asset Management Branch
  - Design and Construction Branch
  - Drafting and Graphic Services Branch
  - Land Drainage and Flood Protection Branch
  - Wastewater Planning and Project Delivery Branch
  - Water Planning and Project Delivery Branch

After comments are incorporated into the finalized draft, WWPPD will send a copy of the approved PDF to the Business Communications Coordinator for upload to the Water and Waste Department Website.

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2 GENERAL

2.1 General Identification Requirements

General identification requirements are as follows:

- Unambiguous Identity
  - All equipment identifiers shall be unique. No two pieces of equipment within the same facility are to share a common identifier.
- Consistency
  - The identification system is to be consistent across all facilities.
  - Prior to addition of a new identifier type, all new additions to the standard should be vetted by a group, to avoid inconsistent additions to the standard.
  - Spaces within identifiers are not permitted. For example, PNL M10 is not a substitute for PNL-M10.

Allowable characters in equipment identifiers are as follows:

- Uppercase letters A through Z
- Numerals 0 through 9
- Hyphen "-" (or underscore "_" in software packages where hyphens are not supported)
- Period "."(or underscore "_" in software packages where periods are not supported)

No other symbols or characters or spaces shall be utilized in an identifier.

2.2 Facility Code

Each City of Winnipeg facility is assigned a unique, four-digit facility code. The facility code is to be used on drawings and documentation as required. The facility code appears within all City drawing numbers, but need not be shown within the content of the drawing. The facility code is deemed an optional component of equipment and instrument identifiers, with the preference to omit the facility code to reduce the overall length of identifiers.

Systems such as a central Supervisory Control and Data Acquisition (SCADA) system that monitors multiple facilities are to make use of the facility code to segregate components by facility. The implementation of the facility code may be by means of a hierarchical directory system whereby individual components are stored under a folder that is named by the facility code. If the database or system where the identifier is being stored supports an additional field for the facility code, or is based upon a hierarchical system where the identifier can be placed as a component off of a root facility branch, it is deemed to be acceptable to omit the Facility Code in the instrument identifier. For example, the City's current Computerized Work Management System (CWMS) has an integral asset list, where a field is provided for the facility. In this case, the facility code for the equipment identifier would not be entered.

A complete list of facility codes is provided in Appendix A.

2.3 Area Code

The Area Code (also historically identified as Process Area Codes) identifies the physical area or building in which the equipment is located. A single letter character from A to Z represents a physical area. Some specific recommendations regarding implementation and designation of area codes are:

- For new construction, ensure that areas codes are allocated for a large enough area, such that the 26 available area codes are not exhausted.
- The Area Code represents the physical location of the equipment, not the equipment function. For example, a hot water pump located in the P area is designated as having a P area code, not a B (Boilers) area code. This is much more straightforward for both assignment and maintenance personnel.
  - Note however, that in some cases there are multiple pieces of equipment, all associated with the same primary piece of equipment, but in different locations with different area codes. In this case, the equipment Area Code should be selected based upon the major or primary equipment. For example, the motor starter for pump P-M101 would be identified as MS-M101, even if the motor starter is in the S area. The motor starter is directly associated with the pump and it would be confusing and unsafe to have different identifiers. An example is provided in Figure 6-4.
- For similar facilities, it is beneficial, but not mandatory, that similar process codes are utilized. For example, ideally the letter P should represent the Primary Clarifier area at all wastewater treatment plants, but would represent something different for water facilities.

The Area Codes for existing facilities are listed in Appendix B.

2.4 Functional Designations

The functional designation represents the function of the equipment. A complete list functional designations, for all disciplines, is shown in Appendix C.

It may be required to add new functional designations, where the existing list does not cover a new application. It is recommended that the following be reviewed prior to the addition of new designations:

- Functional designations for equipment are to be limited to a maximum of four characters. While most instrument designations will be four characters or less, it is possible to have up to five characters in a instrumentation designation, as per ISA 5.1.
- Utilize general, rather than specific, functional designations. For example, utilize the general pump designation P and avoid specific pump designations such as:
  - CWSP Chilled Water Supply Pump
  - CHRP Chilled Water Return Pump
  - ELP Effluent Lift Pump
  - CFP Chemical Feed Pump
  - SLP Sludge Pump
- Update the master list in Appendix C, and ensure there is no overlap with other disciplines.
- It is acceptable to re-utilize an existing designation at an existing facility, even if is not listed in Appendix C, if it is deemed that there are too many existing documentation references to modify. In this case, the designation will be a unique special case, and is not to be added to Appendix C.
- Consider the use of the letter U to designate the equipment if the quantity of the equipment is low.

2.5 Equipment Number

2.5.1 Uniqueness

The equipment number is a number utilized to identify a specific instance of a piece of equipment within a certain *Area Code*. Equipment numbers may be re-used within different *Area Codes*.

Generally, equipment numbers should be unique for each piece of equipment, but equipment that is functionally related, and has a one-to-one relationship, may (but is not required to) share a common equipment number. The overall equipment identifier must still be unique. See Figure 2-1 for an example.

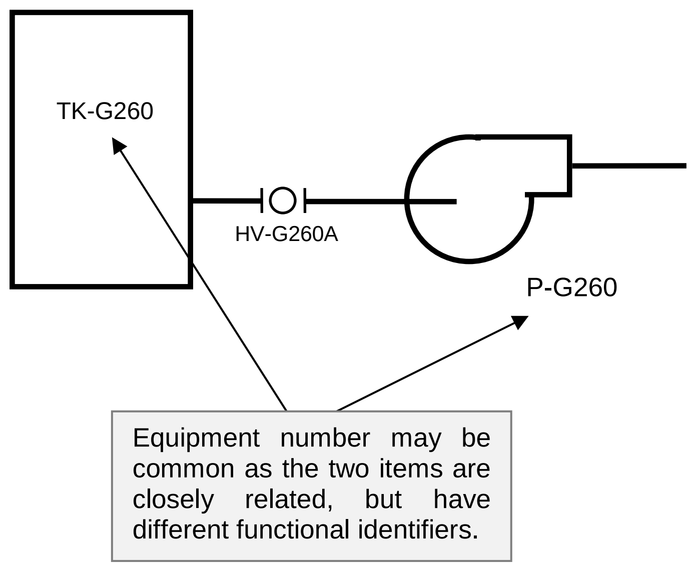

Figure 2-1: Equipment Number Example – Functionally Related

Notes:

1. *Electrical and mechanical equipment, that are not functionally related, must not share a common equipment number. For example, a MCC-M100, and a P-M100 should not exist within the same facility.*
2. *As per Sections 6 and 7, all related electrical and automation, including instrumentation, equipment identification will be based upon the associated Equipment Number. When proposing a common Equipment Number for multiple equipment items, consider the impact on the Electrical and Automation disciplines to ensure that the proposed numbering is effective for all disciplines.*

2.5.2 Number of Digits

Equipment numbers will typically be comprised of three digits in medium to large size facilities. However in small facilities, with less than 50 equipment identifiers, it is permissible to utilize two digit equipment numbers. Use of two digit equipment numbers will be typical for most Collections facilities, such as wastewater lift stations and flood pumping stations. Note that where two digit equipment numbers are utilized, the instrument loop number will also be shortened by a digit, to a total of three digits. In addition, the NEWPCC Facility is very large and requires the use of four digit equipment numbers and five digit instrument loop numbers.

Table 2-1 : Identifier Length

Facility	Estimated Equipment Identifiers	Equipment Number of Digits	Instrument Loop Number of Digits	Example Equipment Number
Small	< 50	2	3	P-M01
Medium to Large	50 – 3000	3	4	P-M101
NEWPCC	> 3000	4	5	P-M1101

2.5.3 Equipment Number Ranges

For each facility, the equipment numbers are grouped and allocated in ranges to specific process functions. The range allocations are on a site by site basis, although efforts should be made to utilize common ranges for similar types of facilities.

Equipment number ranges are defined in Appendix D.

Note that for wastewater treatment plants, the WSTP Project Document Numbering Standard (IMS Document PG-RC-PC-05) identifies a Process Code. The Process Code is analogous to the Equipment Number Ranges, and both are indicated in Appendix D for wastewater treatment plants.

2.5.4 Sequential Logical Numbering

Provide equipment numbering with regards to logical sequencing of the equipment numbers as per process flow. Gaps in sequential numbering are acceptable and appropriate provided that they do not excessively waste equipment number ranges. Group process or equipment trains such they utilize a common range. See the examples in Figure 2-2.

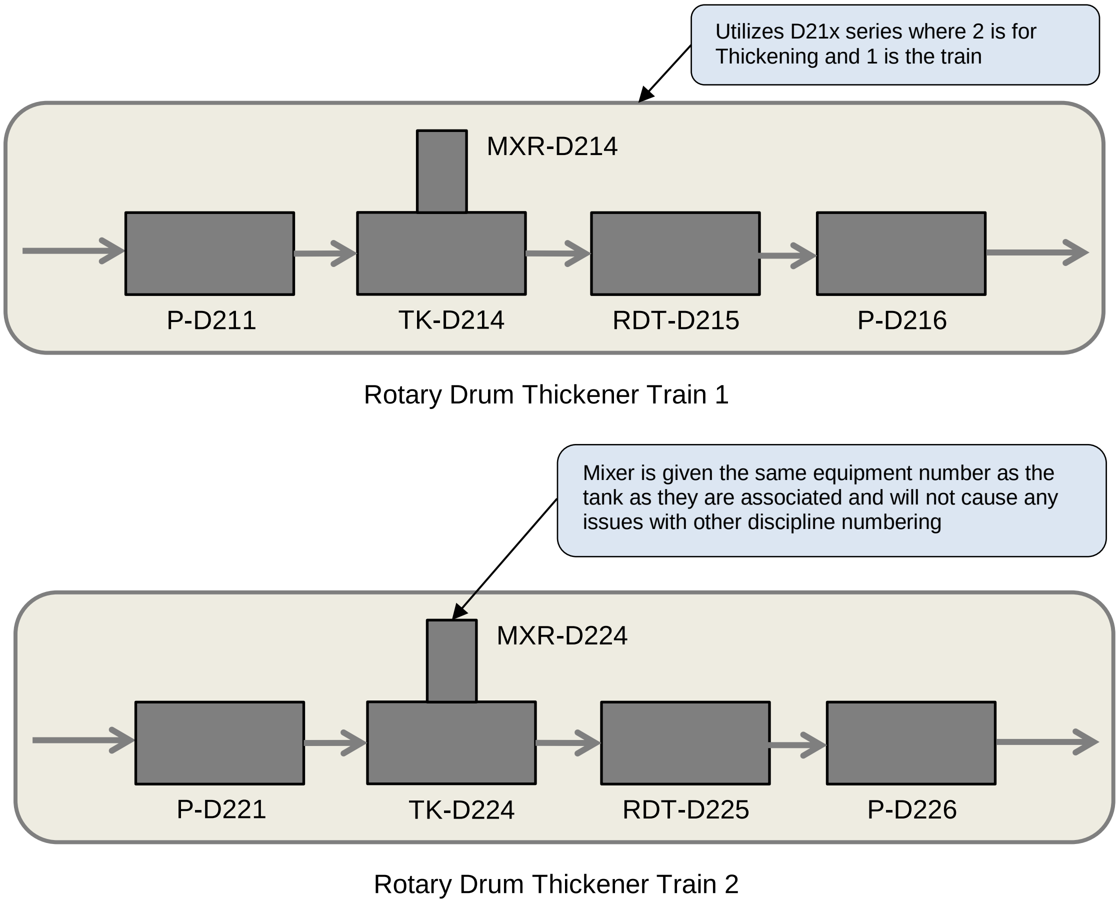

Figure 2-2 : Sequential Logical Numbering Example

2.5.5 Coordination with Equipment Descriptions

As far as practical, ensure that the last digit(s) of equipment numbers matches the equipment descriptions.

Examples:

P-G201	The identifier for “Grit Pump 1”
P-G202	The identifier for “Grit Pump 2”

2.5.6 Additional Requirements for Wastewater Treatment Facilities

2.5.6.1 Coordination of Equipment with Electrical Power Supply

The majority of electrical distribution within wastewater treatment facilities is typically configured in a redundant manner. Where redundant electrical distribution is provided, identify the electrical distribution such that the distribution normally fed from Bank 1 ends in an odd number and the distribution normally fed from Bank 2 ends in an even number.

For equipment, as far as practical, provide:

- An odd equipment number for equipment fed from an odd numbered electrical distribution equipment.
- An even equipment number for equipment fed from an even numbered electrical distribution equipment.

Examples:

P-G201	Fed from MCC-G701, which is connected ultimately to Bank 1.
P-G204	Fed from MCC-G702, which is connected ultimately to Bank 2.

2.6 Subcomponents

In some cases, it is appropriate for equipment to be designated as a component of another identified piece of equipment, rather than an independent unit. Equipment subcomponents will typically be expressed as using a dot "." field, followed by the subcomponent identifier.

2.6.1 Subcomponent Identifier Format

E*	.	SSSS	-	N
Equipment Identifier		Subcomponent Functional Designation	-	Subcomponent Number

Where,

E*	is the *Equipment Identifier*, of the base equipment, as designated in this document.
SSSS	is the *Subcomponent Functional Designation*, which is one to four letters. Typical subcomponent designations are shown in other sections of this document.
N	is the *Subcomponent Number*, an optional field to be utilized when there are multiple subcomponents within the base equipment.

Some examples of subcomponents are as follows:

CMP-R521.LOP	Lube oil pump for compressor CMP-R521, where the pump is integrated into the compressor skid and driven by the compressor motor.
PNL-P712.MCB	Panelboard PNL-P712 main breaker
VFD-G612.RCTR-1	Line reactor for VFD-G612 (integrated in VFD enclosure)

In a full hierarchical system, almost every piece of equipment could potentially be viewed as a subcomponent or child of another system. For example, an agitator could potentially be viewed as a component of a tank. However, this approach would lead to an extensive hierarchical system that is not recommended for general plant identification. Thus, the following rules of thumb are presented as a guide for classification of an item as a subcomponent.

Identification of a device as a subcomponent should be considered when:

- The device is a constituent component that is physically enclosed in, or attached to, the larger equipment;
- The device is normally grouped as a component of the larger equipment when the equipment is purchased; and
- Operations personnel would normally refer to the device as a component of the larger equipment, rather than a separate device.

2.6.2 Use of Subcomponent System

It is deemed that there are numerous benefits to utilizing the subcomponent system, as indicated below:

- Due to the naming structure of subcomponents, it is clear as to what parent component the subcomponent belongs to.
- Subcomponents allow for smaller instrument bubbles to show functionality such as limit switches, without wasting drawing space. For devices such as large multi-turn actuators, with internal torque switches, hand switches, and limit switches, as well as many other types of equipment, this can be a significant savings in drawing space without any loss of identification capability.
- The use of subcomponents helps avoid the case where the subcomponent devices are placed on the equipment or instrument list, and confuse personnel because they cannot be found in the field. This is also particularly important to construction personnel, who must coordinate the purchase, storage, installation, and commissioning of these devices.
- The use of subcomponents aligns more closely with the current direction of control system software implementations, where the database and system model have hierarchical attributes, rather than a simple linear list of tags.

2.6.3 Subcomponent Examples

Two examples of the use of subcomponents are shown in Figure 2-3 and Figure 2-4.

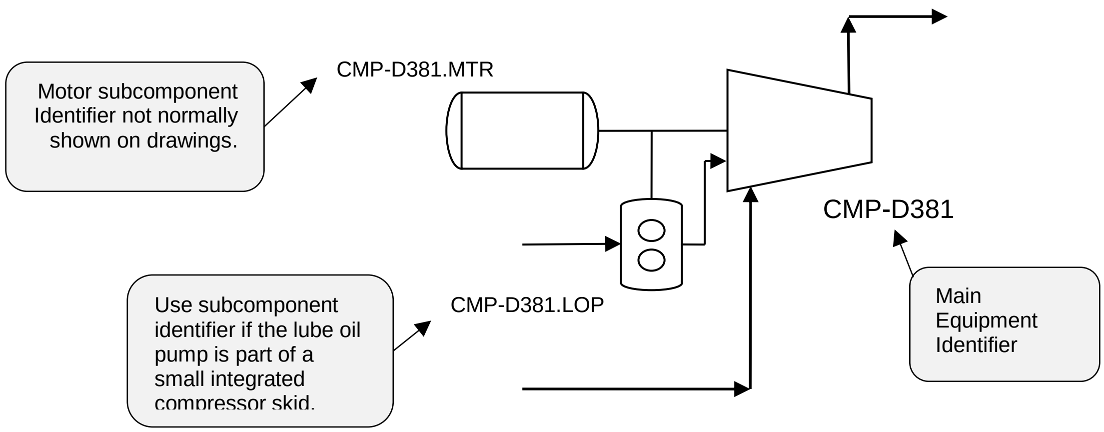

Figure 2-3 : Lube-Oil Pump Subcomponent Example

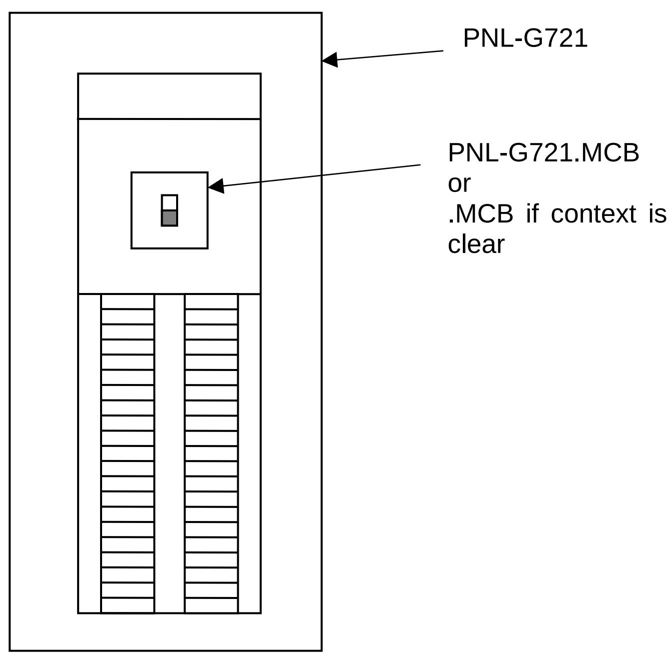

Figure 2-4 : Electrical Subcomponent Example – Main Circuit Breaker

3 ARCHITECTURAL

3.1 Room Identifier

It is required to identify room numbers for architectural purposes and to allow for identification of specific equipment that is associated with rooms. Fire alarm system and security system component identification, as discussed in Sections 6.7 and 6.8, are associated with room numbers. Room numbers will be identified as follows:

FFFF	**-**	**RM**	**-**	**A**	**-**	**L**	**RR**	**S**
Facility Code (Optional)	-	Room Designation	-	Area Code	-	Level	Room Number	Suffix (Optional)

Where,

FFFF is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.

RM is the *Room Designation*, which is comprised of the letters RM.

A is the *Area Code*, which is based on Section 2.3.

L is the *Level*, which shall typically be one or two characters, as described in Section 3.1.1.

RR is the *Room Number*, which shall typically be two digits, except as described in Section 3.1.1.

S is the *Suffix*, which can be utilized to indicate room divisions as required. This should only be utilized for cases such as rooms that are divided by a movable barrier.

Examples:

RM-S-115 Room 15 in the Secondary Clarifier area, on the main level.

RM-M-222 Room 22 in the Main Building area, on the second level.

RM-G-BA9 Room 9 in the Grit area, lower level 2.

Note: A hyphen is utilized between the Area Code and level, to ensure that room numbers are not potentially confused with equipment numbers.

3.1.1 Building Level Designation

The building level designation shall be based upon Table 3-1 below.

Table 3-1 : Building Level Identifiers

Level	Description	Room Number Digits	Example
4	Fourth Floor	2	RM-M-405
3	Third Floor	2	RM-M-320
2	Second Floor	2	RM-M-251
1	Main / First Floor	2	RM-M-123
B	Lower Level 1 / Basement	2	RM-M-B52
BA	Lower Level 2	1	RM-M-BA5
BB	Lower Level 3	1	RM-M-BB1
EX	Exterior (See Note 4)	1	RM-M-EX1

Notes:

1. *Level 1 should be the uppermost floor entered at grade or at most, one half stair flight above.*
2. *Large mezzanines shall be numbered as a whole floor. Example: When a mezzanine exists between the first floor and the next whole floor, it will be numbered as the second floor and the next whole floor would be the 3rd floor.*
3. *Usable attic floors and penthouse levels should be numbered as if they are whole floors. For example, a two-story penthouse atop a three floor building will be numbered as the fourth and fifth floors. Do not use prefixes such as "R" for roof level.*
4. *Use of the EX designation for exterior spaces is optional. One example where this designation may be required is for outdoor security equipment. It is recommended that the outdoor space be designated into zones, which replace the room number.*

3.1.2 Drawing Representation

Room numbers on drawings may be presented as shown in Figure 3-1. Note that the room designation “RM” may be omitted on drawings, when used with the ellipse symbol.

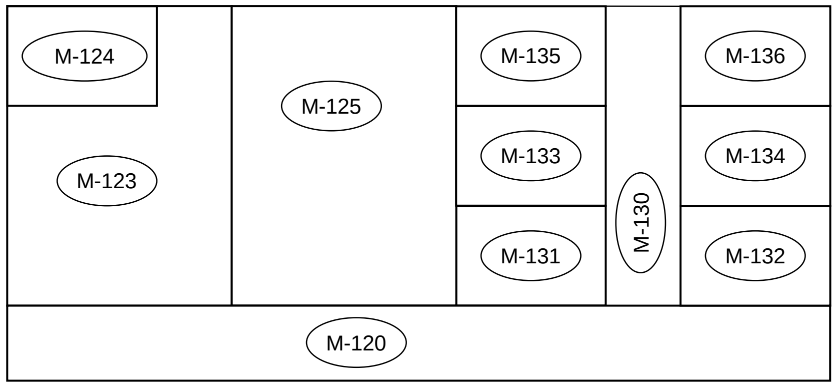

Figure 3-1 : Room Numbering on Drawings – Plan View

3.1.3 Room Numbering Guidelines

Utilize the following as a guide for room numbering:

- Numbers should flow from one end of the building to the other.
- Where corridors are present, use odd numbers on one side of a corridor and even numbers on the other side.
- Skip numbers as required to maintain succession of room numbering
  - In some instances, room numbers on one side of a corridor shall be skipped in order to maintain succession with the room numbers on the opposite side of the corridor. This may occur, for example, when a suite of rooms or large space is accessed through a single door and there are no other doors on that same side until further down the corridor. This will allow for future renovations that may convert suites or large spaces into separate or small rooms with a corridor door.
- Provide all accessible spaces with room numbers.
  - In addition to rooms, all interior spaces that can be directly accessed, such as corridors, vestibules, stairwells, elevator shafts, and accessible pipe spaces shall be numbered in a manner as consistent as possible with standard room spaces. Where doors or walls separate different areas of these spaces, each area shall receive its own unique number.
- Room numbers shall be assigned in a cohesive fashion between existing, new and modified facilities. Duplicate room numbers are not permitted under any circumstance.
- Identify stairwells with a single room identifier, with the main floor as the level. If the stairwell is not accessible from the main floor, utilize the access level closest to the main floor as room level designation. See Figure 3-2 for examples.

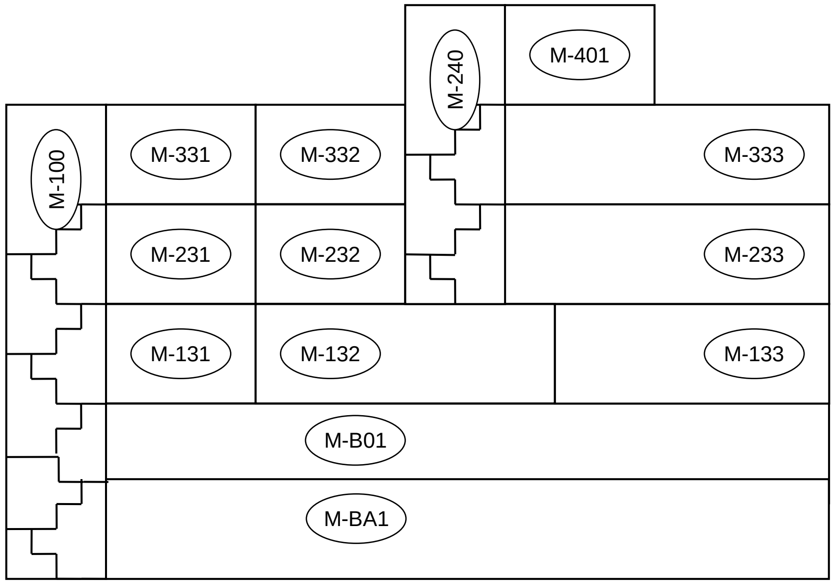

Figure 3-2 : Stairwell Identification Examples – Elevation View

- Rooms that span multiple levels should be identified with a level corresponding to the primary access level. See Figure 3-2 for examples of multi-level room identification.

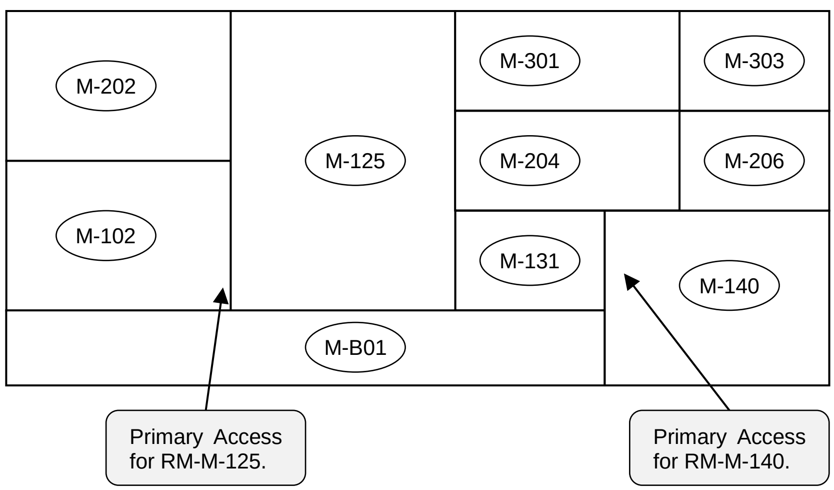

Figure 3-3 : Multi-Level Room Examples – Elevation View

3.2 Door Identification

It is required to identify door identifiers for architectural purposes and to allow for identification of specific equipment that is associated with rooms. Security system component identification, as discussed in Sections 6.8, are associated with door identifiers. Doors will be identified as follows:

FFFF	**-**	**D**	**-**	**A**	**-**	**L**	**RR**	**S**
Facility Code (Optional)	-	Door Designation	-	Area Code	-	Level	Room Number	Suffix

Where,

FFFF — is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.

D — is the *Door Designation*, which is comprised of the letter D.

A — is the *Area Code*, which is based on Section 2.3.

L — is the *Level*, which shall typically be one or two characters, as described in Section 3.1.1.

RR — is the *Room Number*, which shall typically be two digits, except as described in Section 3.1.1.

S — is the *Suffix*, which is utilized to indicate the specific door. Double doors are to be identified with a single identifier.

Examples:

D-S-115A — Door A for Room 15 in the Secondary Clarifier area, on the main level.

D-M-222C — Door C for Room 22 in the Main Building area, on the second level.

D-G-BA9A — Door A for Room 9 in the Grit area, lower level 2.

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4 MECHANICAL / PROCESS EQUIPMENT

4.1 Identifier Format

Mechanical / process equipment will be identified as follows:

FFFF	-	EEEE	-	A	NN(N)(N)	-	XX
Facility Code (Optional)	-	Equipment Functional Designation	-	Area Code	Equipment Number	-	Component Number (Optional)

Where,

FFFF — is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.

EEEE — is the *Equipment Functional Designation*, which is comprised of 1 to 4 characters from Section 4.1.14.2.

A — is the *Area Code*, which is based on Section 2.3.

NN(N)(N) — is the *Equipment Number* of the associated equipment. This will be three digits for medium to larger facilities, two digits for smaller facilities, such as Collections facilities, and four digits for very large facilities (NEWPCC).

XX — is the optional Component Number, which can be one or two digits, and shall be applied as per Section 4.1.1.

Examples:

CMP-G201 — A compressor in the G area.

P-M645 — A glycol pump in the M area.

R-R102 — An oxygen reactor in the R area.

SF-F61 — A supply fan in a flood station. Note the two digit equipment number for Collections facilities.

P-L01 — The first lift pump in a wastewater lift station. Note that the equipment number for collections facilities in only two digits long.

UH-K631-2 — The second unit heater that is controlled by the same thermostat or PLC output as unit heater K-631-1 (the unit heaters will always be on simultaneously)

4.1.1 Component Numbers

Component Numbers are suffixes to equipment numbers that are utilized to designate multiple components of a single system. Component numbers will increment starting at 1. Use of a component number is only acceptable if:

- The equipment with the same *Equipment Number* is functionally associated, and
- The equipment has no associated process control or the process control is common or the equipment is part of a common skid package.

Component Numbers shall not be utilized in the following scenarios:

- To address a shortage of available equipment numbers in a given series;
- Where the equipment is not functionally associated; or
- Where the equipment can be manually or automatically controlled to run independently.

Note: Use of the Component Number should not be common.

Examples of acceptable uses of Component Numbers:

If AHU-G634 is an air handler, and there is more than one fan in the air handler, it is acceptable to utilize component numbers to designate the individual fans.

4.2 Functional Designations

The functional designation represents the function of the equipment. A complete list functional designations is shown in Table 4-1.

Table 4-1 : Process / Mechanical Equipment Functional Designations

Functional Designation	Description	Notes
AD	Air Dryer	
AF	Aeration Fan	
AG	Agitator	
AHU	Air Handling Unit	Includes make-up air unit.
B	Blower	
BD	Balance Damper	See Section 5.2.5.
BDD	Backdraft Damper	See Section 5.2.5.
BFP	Back Flow Preventer	
BLR	Boiler	
~~BS~~	~~Bar Screen~~	Use SCR
BV	Balancing Valve	Manual mechanical balancing valve (not typically adjusted by operations). See Section 5.2.3
BVA	Automatic Balancing Valve	Automatic mechanical balancing valve. See Section 5.2.3
CAL	Calibration Column	
CC	Cooling Coil	
CDR	Condenser	
CE	Centrifuge	
CHLR	Chiller	
CM	Clarifier Mechanism	
CMP	Compressor	
CNV	Conveyor	Includes skimmers

Functional Designation	Description	Notes
CRN	Crane	
CT	Cooling Tower	
CU	Condensing Unit	
CV	Check Valve	See Section 5.2
CYC	Cyclone	
EDU	Eductor	
EF	Exhaust Fan	
F	Fan - General	
FA	Flame Arrestor	
FC	Fan Coil	
FD	Fire Damper	See Section 5.2.5. Utilize same equipment number as air handler / fan.
FDR	Feeder	Examples screw feeder, chlorinator, glycol make-up unit
FEX	Fire Extinguisher	
FG	Flap Gate	
FIL	Filter	
GR	Grille / Louvre – General	See Section 4.3.
GRD	Grille – Diffuser	
HC	Heating Coil	
HCE	Heating Coil, Electric	Duct based heater.
HE	Heat Exchanger	
HO	Hoist	
HOP	Hopper	
HP	Heat Pump	
HRC	Heat Recovery Coil	
HTR	Heater	General heaters, radiant, convectors, etc.
HUM	Humidifier	
HV	Hand/Manual Valve	See Section 5.2
INJ	Injector	
MXR	Mixer	
OD	Overhead Door	
P	Pump	
PCV	Pressure Control Valve (Pressure Regulator)	See Section 5.2.3
PSV	Pressure Safety/Relief Valve	See Section 5.2.3
R	Reactor (various processes)	

Functional Designation	Description	Notes
RDT	Rotary Drum Thickener	
RES	Reservoir	Large water containment structure.
S	Skid Package	
SA	Sampler	
SCBR	Scrubber	
SCR	Screen	Utilized for screening systems such as bar screens and perforated plate screens.
SD	Smoke Damper	See Section 5.2.5. Utilize same equipment number as air handler / fan.
SF	Supply Fan	
SL	Stop Logs	See Section 5.2.3
SLG	Sluice Gate	May only be utilized within existing facilities where the use of the SLG identifier is well established. The designation may not to be utilized for new or upgraded WSTP facilities. Identify as a valve (HV, XV, FV, etc).
STR	Strainer	See Section 5.2
TK	Tank	
TU	Terminal Unit (HVAC)	Includes CAV/VAV/Dual Duct boxes. Dampers are to be identified as per Section 7.1 – Instrumentation.
U	Miscellaneous Equipment Not In List	e.g. water softener
UH	Unit Heater	
UVR	Ultra-Violet (UV) Reactor	
V	Vessel, Pressure Vessel	e.g. air receiver, glycol expansion tank
W	Weir	
WCP	Washer / Compactor	Typical for wastewater screenings
WGB	Waste Gas Burner	

Notes:

1. *Equipment Functional Designations are to be unique, including electrical, automation, communication, and security equipment. Instrument Functional Designations may overlap Equipment Functional Designations.*
2. *See Appendix C for a master list of Equipment Functional Designations.*

4.3 HVAC Grilles

HVAC grilles, louvres and diffusers, will be identified as follows:

FFFF	-	EEEE	-	A	NN(N)(N)	-	XX
Facility Code (Optional)	-	Equipment Functional Designation	-	Area Code	Equipment Number	-	Component Number

Where,

FFFF is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.

EEEE is the *Equipment Functional Designation*, which is comprised of 2 to 4 characters from Section4.2.

A is the *Area Code*, which is based on Section 2.3.

NN(N)(N) is the *Equipment Number* of the associated equipment. Where an equipment number is not associated, allocate an equipment number.

XX is the *Component Number*, which can be one or two digits, and will increment starting at 1.

Examples:

GRD-M645-1 The first diffuser grille associated with SF-M645.

GR-P682-1 Intake louvre associated with SF-P682.

GR-P682-22 The 22nd grille associated with SF-P682.

4.4 Subcomponents

The following designations are to be utilized for mechanical equipment subcomponents. See Section 2.6 for general rules on application of subcomponents.

Table 4-2 : Mechanical Equipment Subcomponents

Subcomponent Designation	Description	Notes
CMP	Compressor	e.g. component of a chiller.
F	Fan	
CC	Cooling Coil	May be a subcomponent of a AHU
HC	Heating Coil	May be a subcomponent of a AHU
HRC	Heat Recovery Coil	May be a subcomponent of a AHU
LOP	Lube Oil Pump	
MTR	Motor	
SWP	Swash Plate	
VSD	Variable Speed Drive	Includes fluid couplings and magnetic couplings. Utilize electrical VFD designation for variable frequency drives.

Examples:

P-G261.MTR	The motor associated with P-G261.
CMP-M502.LOP	The lube oil pump associated with compressor CMP-M502.
CHLR-M621.CMP-1	Compressor 1 of chiller CHLR-M621.

5 PIPING AND DUCT

5.1 Pipe and Duct Designation

The identification format for piping and ductwork is as follows.

P	**-**	**CCC**	**-**	**MMNN**	**-**	**SNN**	**-**	**LLLL**
Pipe Nominal Size	-	Fluid Commodity Code	-	Pipe Specification Code (Optional)	-	Insulation Specification Code (Optional)	-	Line Number (Optional)

Where,

P — is the nominal pipe size in millimetres, and may be from 1 to 4 digits. See Table 5-1. For rectangular conduits and ducts, express the size as width x height. See example below.

CCC — is the *Fluid Commodity Code*, which is 2 to 4 characters from Section 5.1.2.

MMNN — is the optional *Pipe Specification Code*, where MM is the material from Table 5-3, and NN is a number referencing the specific specification. Note that MM must be letters. See Notes 1 and 2.

SNN — is the optional *Pipe Specification Code*, where S is the insulation material / type from Table 5-4, and NN is a number indicating the thickness of the insulation in mm. Note that S must be a letter.

LLLL — is the optional *Line Number*. The *Line Number* must be unique across the entire facility, for each *Fluid Commodity Code*. See Note 3.

Note:

1. *It is recommended that a common set of pipe specifications be developed for each type of facility.*
2. *For existing facilities, where the exact pipe specification is not known, the Pipe Specification Code may be omitted.*
3. *It is not expected that Line Numbers will be utilized on all projects. Coordinate with the City project manager for specific requirements regarding the applicability of Line Numbers.*
4. *The Fluid Commodity Code together with the Line Number must be unique across the facility, where Line Numbers are utilized.*

Examples:

150-PW-CS11 — A 150mm (6”) potable water pipe, with specification code CS11. No line numbers utilized.

600-RAS — A 600mm (24”) Return Activated Sludge pipe, with an unknown pipe specification and no line number.

600x1200-SE — A 600 x 1200mm secondary effluent conduit. The pipe/conduit specification and line number are not specified.

25-CLG-SS31-1151 — A 25mm (1”) chlorine gas pipe, with pipe specification SS31, and line number 1151.

400-RW-CS52-1151	A 400mm (16”) chlorine gas pipe, with pipe specification SS31, and line number 1151. Note that this could be in the same facility as piping 25-CLG-SS31-1151.
1350-TRW-040	A 1350mm diameter treated water pipe. The pipe specification code is omitted. The line number code 040 is differentiated from the pipe specification code in that it does not begin with a letter.

5.1.1 Nominal Pipe Sizes

Table 5-1 : Nominal Pipe Sizes (Metric)

mm	Inches	mm	Inches	mm	Inches	mm	Inches
6	1/8	**80**	3	**275**	11	**750**	30
8	¼	**90**	3 ½	**300**	12	**800**	32
10	3/8	**100**	4	**350**	14	**850**	34
15	½	**112**	4 ½	**400**	16	**900**	36
20	¾	**125**	5	**450**	18	**950**	38
25	1	**150**	6	**500**	20	**1000**	40
32	1 ¼	**175**	7	**550**	22	**1100**	44
40	1 ½	**200**	8	**600**	24	**1200**	48
50	2	**225**	9	**650**	26	**1300**	52
65	2 ½	**250**	10	**700**	28	**1400**	56

5.1.2 Fluid Commodity Codes

Table 5-2 : Fluid Commodity Code Designations

Code	Commodity - Water	Commodity - Wastewater
AA	Aqua Ammonia	
AHP	Air, High Pressure	Air, High Pressure
ALP	Air, Low Pressure	Air, Low Pressure
AS	Air Scour	
BLS		Ballasted Sludge
BS	Brine Solution	
BSD		Biosolids, Dewatered
BSL		Biosolids, Liquid
BWS	Backwash Supply	
BWW	Backwash Wastewater	
CA	Compressed Air	Compressed Air
CCW	Circulating Cooling Water	
CDR	Condenser Water Return	Condenser Water Return
CDS	Condenser Water Supply	Condenser Water Supply
CE		Centrate
CEF		Centrate - Final
CEI		Centrate - Intermediate
CG		Calibration Gas
CHR	Chilled Water Return	Chilled Water Return
CHS	Chilled Water Supply	Chilled Water Supply
CL2	Chlorine	Chlorine
CLG	Chlorine Gas	
CLS	Chlorine Solution	
CO2	Carbon Dioxide	Carbon Dioxide
CON		Condensate (including Digester Gas Condensate)
CRW	Clarified Discharge Water	
CS	Caustic (Sodium Hydroxide)	Combined Sewer
CWR	Cooling Water Return	Cooling Water Return
CWS	Cooling Water Supply	Cooling Water Supply
D	Drain	Obsolete (was Drain non-process) Use SAN or LDS
DCW	Domestic Cold Water	(use PW)
DD	Deacon Effluent (Post UV)	
DDW	Demineralized Water	

Code	Commodity - Water	Commodity - Wastewater
DEA	Dilute Acid	
DEC	Dilute Caustic	
DF	DAF Float	
DG		Digester Gas
DGC		Digester Gas - Conditioned
DGH		Digester Gas, High Pressure
DFR	Diesel Fuel Return	Diesel Fuel Return
DFS	Diesel Fuel Supply	Diesel Fuel Supply
DHR	Domestic Hot Water Return	Domestic Hot Water Return
DHW	Domestic Hot Water	Domestic Hot Water
DL		Decant Liquor
DP		Dry Polymer
DRA	Drainage (Floors)	
DRN	Drains (Clean Drains)	
DRS	Subdrain	
DS	Deacon Suction	Digester Sludge
DSW	Distilled Water	
DU	Deacon UV (Pre UV)	
EA		Exhaust Air
EE	Engine Exhaust	
ES	Electric Supply	Electric Supply
EXP	Expansion Tank Equalizer Line	
FC	Ferric Chloride	Ferric Chloride
FE		Final Effluent
FED	Filter Media Eduction	
FIN	Filter Influent	
FIR	Firewater	
FLT		Filtrate
FOA		Foul Air
FOR	Fuel Oil Return	
FOS	Fuel Oil Supply	
FOV	Fuel Oil Vent	
FPG	Fire Protection Glycol Solution	Fire Protection Glycol Solution
FPW	Fire Protection Water	Fire Protection Water
FSF		Fermented Sludge Filtrate
FSL		Fermenter Sludge
FSU		Fermenter Supernatant
FSW		Flushing Water

Code	Commodity - Water	Commodity - Wastewater
		(Plant Effluent Water)
FTR	Filter To Recycle	
FW	Filtered Water	
GE		Grit Effluent
GOX	Gaseous Oxygen	
GR	Glycol Return	Glycol Return
GRS		Grit Slurry
GRT		Grit (Solids / Dewatered)
GS	Glycol Supply	Glycol Supply
HCO	Hydraulic Oil	Hydraulic Oil
HFS	Hydrofluosilicic Acid	
HFW		Hot Flushing Water
HP	Hydrogen Peroxide	
HPS	High Pressure Steam	
HR	High Pressure Condensate	
HRE		High-Rate clarifier Effluent
HRS		High-Rate clarifier Sludge
HST	12% Hypochlorite Solution	
HWS		Hot Water Supply
HWR		Hot Water Return
H2		Hydrogen
HYP	0.8% Hypochlorite Solution	
IAS	Instrument Air Supply	Instrument Air Supply
LCP		Liquid Concentrated Polymer
LDS		Land Drainage Sewer
LGO	Lubricating Oil	Lubricating Oil
LOX	Liquid Oxygen	Liquid Oxygen
LPC	Low Pressure Condensate	
LPS	Low Pressure Steam	Low Pressure Steam
MA		Mixed Air
MC		Magnesium Chloride
MET		Methanol
ML		Mixed Liquor
MP		Mixed Polymer
MPC	Medium Pressure Condensate	
MPS	Medium Pressure Steam	
MU	Make-Up Water	
N2		Nitrogen Gas

Code	Commodity - Water	Commodity - Wastewater
N2L		Nitrogen Liquid
NG	Natural Gas	Natural Gas
NPH		Non-Potable Water - Hot
NPT		Non-Potable Water - Tempered
NPW		Non-Potable Water (Potable Water segregated by backflow preventer and for general use such as hose bibs and pump seals)
OA		Outdoor Air
O2		Oxygen Gas
OF	Overflow	
OZG	Ozone Off Gas	
OZO	Ozonated Oxygen	
OZW	Ozonated Water	
PRO	Propane	
PC	Pumped Condensate	
PD		Process Drain
PE		Primary Effluent
PEF	Phosphate Feed	
PLD	Dry Polymer	
PLS	Polymer Solution	
PO		Process Overflow
PS		Primary Sludge
PSW	Plant Service Water	
PV		Process Vent
PW	Potable Water	Potable Water
R	Refrigerant	Refrigerant
RA		Return Air
RAS		Return Activated Sludge
RD	Roof Drain	
RS		Raw Sewage
RW	Raw Water	Rain/Roof Water
RWL	Rain Water Leader	
SA		Supply Air
SAM	Sample	Sample
SAN	Sanitary Drainage	Sanitary Drainage
SBS	Sodium Bisulphite	Sodium Bisulphite
SC		Scum

Code	Commodity - Water	Commodity - Wastewater
SCA	Sulphuric Acid	
SCB		Sodium Carbonate (Soda Ash)
SCD		Scum - Dewatered
SCP		Scum - Primary
SCRS		Screened Raw Sewage
SCS		Screenings
SDR	Saturated Recycle Water	
SE		Secondary Effluent
SEA		Service Air
SHC	Sodium Hypochlorite	Sodium Hypochlorite
SHD		Sodium Hydroxide
SLC		Sludge Cake
SLH		Sludge – Hauled
SLI		Sludge - Dewatered
SLO	Seal Oil	
SLP		Sludge – Phosphorus Released
SLS		Sludge - Screened
SLU	Sludge	
SND		Sand (solid)
SNS		Sand Slurry
SPD	Sump Pump Discharge	Obsolete (was Sump Pump Discharge) Use SAN or LDS.
SRS		Storm Relief Sewer
SSC		Scum - Secondary
STD	Salt Dry	
STS		South End Thickened Sludge
SUB		DAF Subnatant
SUP	Supernatant	
SVT		Struvite
SW	Seal Water	Seal Water (only used for separately derived systems. Typically NPW is utilized for seal use).
SWD	Stormwater Drainage	
TBS		Thickened Bottom Sludge
TCE		Treated Centrate
TDW	Tempered Domestic Water	Tempered Domestic Water
TFS		Thickened Fermented Sludge

Code	Commodity - Water	Commodity - Wastewater
TO		Thermal Oxidizer
TRW	Treated Water	
TS		Thin Sludge
TW	Tempered Water	
TWAS		Thickened Waste Activated Sludge
VAC	Vacuum	Vacuum
VTA	Vent To Atmosphere	Vent to Atmosphere
W		Water
WA		Waste Air
WAS		Waste Activated Sludge
WS	Softened Water	
WSF		Waste Activated Sludge Filtrate
WWS		Wastewater Sewer

5.1.3 Piping Material

Table 5-3 : Piping and Tubing Material

Designation	Description
AL	Aluminum and Alloys
BA	Aluminum Bronze
GS	Galvanized Carbon Steel
CS	Carbon Steel
CU	Copper
DI	Ductile Iron
FP	Fiberglass Reinforced Plastic
KB	Concrete
PA	ABS (Acrylonitrile-butadiene styrene)
PD	HDPE (High Density Polyethylene)
PF	PFA (Perfluoroalkoxy)
PK	PVDF (Polyvinylidene Fluoride, i.e. Kynar®)
PP	PP (Polypropylene)
PV	PVC (Polyvinyl Chloride)
SS	Stainless Steel

5.1.4 Insulation Material / Type

Table 5-4 : Insulation Material / Type

Designation	Description
E	Elastomeric - flexible pipe insulation, closed cell structure (ASTM C534)
F	Fibreglass, UL-rated, preformed, sectional rigid with factory applied, Kraft paper with aluminum foil vapor barrier jacket
G	Cellular glass.
M	Mineral fibre (ASTM C553).
S	Calcium Silicate (ASTM C533)

5.2 Piping and Duct Components

5.2.1 Manual Valve Identifier Format – Minor Valves

The identification format for minor manual valves (and dampers), without instrumentation, is as follows.

FFFF	**-**	**HV**	**-**	**A**	**NN(N)(N)**	**S**
Facility Code (Optional)	-	Manual Valve Designation	-	Area Code	Equipment Number	Suffix

Where,

FFFF is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.

HV is the Manual Valve Designation.

A is the *Area Code*, which is based on Section 2.3.

NN(N)(N) is the *Equipment Number* of the associated equipment. If no equipment is associated, allocate an *Equipment Number* specific for the applicable valve or group of valves.

S is the *Suffix*, a single letter to designate the specific valve. Always apply a suffix, regardless if there are one or more valves with the same equipment number. Where there are insufficient letters (A-Z), double letters may be utilized (AA through ZZ). The requirement to utilize double letters should be rare.

Notes:

1. *Manual valves, check valves, and strainers may utilize common equipment numbers and suffixes. For example, it is acceptable to have a HV-G638A and a CV-G638A.*
2. *Large valves and controlled valves will be identified via the instrumentation standard identified in Section 7.1.*
3. *Typically, significant valves not associated with a specific piece of equipment would be identified as per Section 5.2.2, however the designers discretion may be applied.*

Examples:

HV-G201A	A manual valve in the G area, associated with pump P-G201.
HV-M645B	A manual valve in the M area.
HV-R102A	A manual valve in the R area.

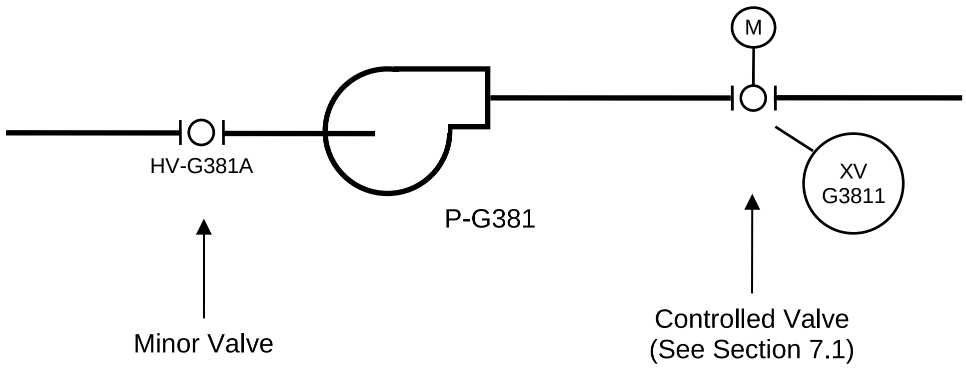


Figure 5-1 : Valve Identification

5.2.2 Manual Valve Identifier Format – Major Valves and Valves with Instrumentation

The identification format for major valves (and dampers) and any manual valve (and damper) with instrumentation, is based upon the instrumentation standard identified in Section 7.1. The format of the identifier is as follows.

FFFF	**-**	**HV**	**-**	**A**	**NN(N)(N)**	**T**
Facility Code (Optional)	-	Manual Valve Designation	-	Area Code	Equipment Number	Instrument Number
					Loop Number	

Where,

FFFF — is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.

HV — is the Manual Valve Designation.

A — is the *Area Code*, which is based on Section 2.3.

NN(N)(N) — is the *Equipment Number* of the associated equipment. If no equipment is associated, allocate an *Equipment Number* specific for the applicable valve or group of valves.

T — is the *Instrument Number*, where the number increments from the number 1 through 9. Use of the number 0 should be infrequent, reserved for special instruments or those where the instrument ending with 0 is a common instrument that serves other instruments.

NN(N)(N)T — is the Loop Number, comprised of the *Equipment Number* together with the *Instrument Number*.

Examples:

HV-G2011 — A manual valve in the G area, associated with pump P-G201, and contains open and closed limit switches.

HV-M6451 — A manual valve in the M area, with a position transmitter.

HV-R1022 — A manual valve in the R area, with a limit switch.

UT-S1510 — A multi-variable transmitter that connects to multiple sensors from various loops. Note the use of the 0 for the Instrument Number for this special case where it is handling multiple loops.

5.2.3 Manual Valve Identifier Format – Instrumentation Isolation and Bypass Valves

The identification format for minor instrumentation isolation and bypass valves, is as follows. Identification of simple, small isolation valves (i.e. gauge pressure transmitter) is not mandatory.

<table>
<tr><th>FFFF</th><th>-</th><th>HV</th><th>-</th><th>A</th><th>NN(N)(N)</th><th>T</th><th>S</th></tr>
<tr><td rowspan="2">Facility Code (Optional)</td><td rowspan="2">-</td><td rowspan="2">Manual Valve Designation</td><td rowspan="2">-</td><td rowspan="2">Area Code</td><td>Equipment Number</td><td>Instrument Number</td><td rowspan="2">Suffix</td></tr>
<tr><td colspan="2">Loop Number</td></tr>
</table>

Where,

FFFF — is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.

HV — is the Manual Valve Designation.

A — is the *Area Code*, which is based on Section 2.3.

NN(N)(N) — is the *Equipment Number* of the associated equipment.

T — is the *Instrument Number*, where the number increments from the number 1 through 9. Use of the number 0 should be infrequent, except for special instruments, or those where the instrument ending with 0 is a common instrument that serves other instruments.

NN(N)(N)T — is the Loop Number, comprised of the *Equipment Number* together with the *Instrument Number*.

S — is the *Suffix*, a single letter to designate the specific valve. Always apply a suffix, regardless if there are one or more valves with the same equipment number. Where there are insufficient letters (A-Z), double letters may be utilized (AA through ZZ). The requirement to utilize double letters should be rare.

Notes:

1. The Loop Number will typically be the nearest associated instrument. In some cases, Loop Numbers may be designated for allocation of manual valves.

5.2.4 Miscellaneous Piping Equipment Identifier Format

Miscellaneous piping equipment, which includes the following:

- Balancing Valves (Manual and Automatic)
- Check Valves
- Strainers
- Pressure Regulators (Pressure Control Valves)
- Pressure Safety Valves
- Stop Logs

are to be identified as follows:

FFFF	**-**	**EEE**	**-**	**A**	**NN(N)(N)**	**S**
Facility Code (Optional)	-	Equipment Functional Designation	-	Area Code	Equipment Number	Suffix

Where,

FFFF	is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.
EEE	is the *Equipment Functional Designation*, which is comprised of 2 to 4 characters from Section 4.2.
A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number* of the associated equipment.
S	is the *Suffix*, a single letter to designate the specific valve.

Notes:

1. *The Equipment Number will typically be the nearest associated equipment. In some cases, Equipment Numbers may be designated for allocation of miscellaneous piping equipment.*
2. *Miscellaneous Piping Manual valves, check valves, and strainers may utilize common equipment numbers and suffixes. For example, it is acceptable to have a HV-G638A and a CV-G638A.*
3. *Miscellaneous equipment with significant instrumentation will be identified via the instrumentation standard identified in Section 7.1.*

Examples:

BVA-K302B	An automatic balancing valve in the K area.
CV-G201A	A check valve in the G area, associated with pump P-G201.
CV-M645B	A check valve in the M area.
STR-R102A	A strainer in the R area.
SL-K151A	A stop log in the K area.

5.2.5 Miscellaneous Ducting Equipment Identifier Format

Miscellaneous duct equipment, which includes the following:

- Balancing Dampers (Manual and Automatic),
- Back-draft Dampers,
- Fire Dampers, and
- Smoke Dampers

are to be identified as follows:

FFFF	**-**	**EEE**	**-**	**A**	**NN(N)(N)**	**S**
Facility Code (Optional)	-	Equipment Functional Designation	-	Area Code	Equipment Number	Suffix

Where,

FFFF	is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.
EEE	is the *Equipment Functional Designation*, which is comprised of 2 to 4 characters from Section 4.2.
A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number* of the associated equipment.
S	is the *Suffix*, a single letter to designate the specific valve.

Notes:

1. *The Equipment Number will typically be the nearest associated equipment. In some cases, Equipment Numbers may be designated for allocation of miscellaneous ducting equipment.*
2. *Balancing dampers, backdraft dampers, and fire dampers may utilize common equipment numbers and suffixes. For example, it is acceptable to have a BD-G638A and a BDD-G638A.*
3. *Where balancing dampers are integrated with the grille / diffuser, identify as the grille / diffuser (i.e. GRD-M645-1).*
4. *Miscellaneous ducting equipment with significant instrumentation will be identified via the instrumentation standard identified in Section 7.1.*

Examples:

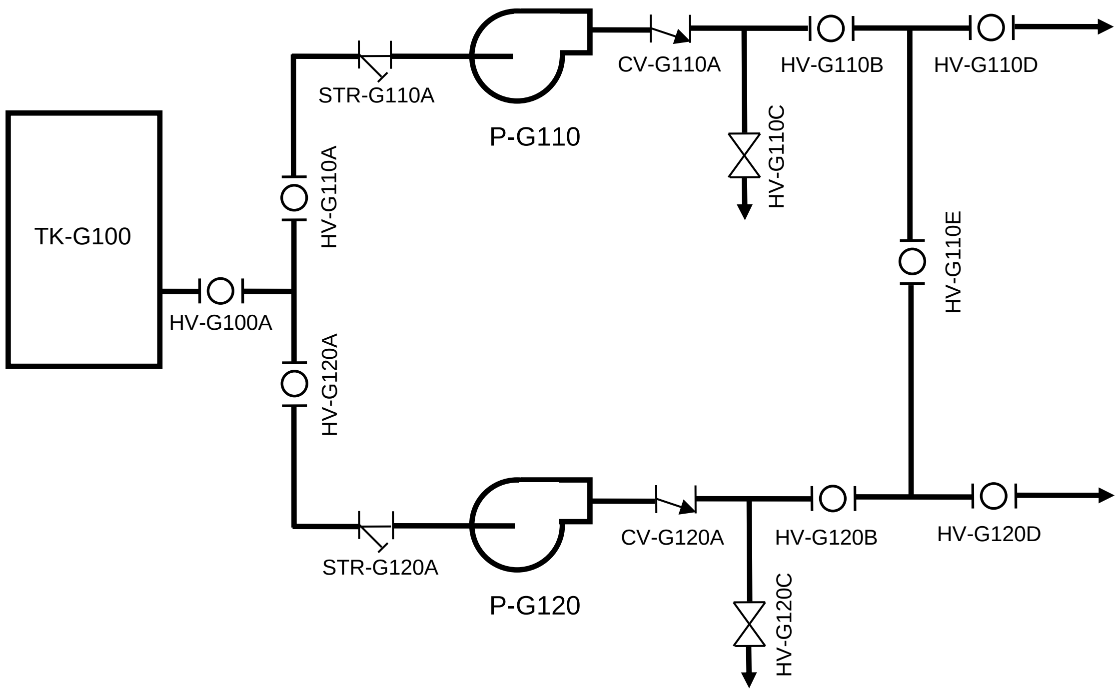
BD-K602B	The second balancing damper in the K area associated with AHU-K602.
BDD-G601A	A back-draft damper in the G area, associated with air handling unit AHU-G601.
FD-M645B	The second fire damper in the M area associated with AHU-M645.
SD-M645D	The fourth smoke damper in the M area associated with AHU-M645.

5.2.6 Cathodic Protection Components

The identification of cathodic protection system elements is to be developed at a later date.

5.2.7 Sample P&ID

See Figure 5-2 for a sample P&ID segment depicting the identification of manual valves, check valves, and strainers.



Note: All devices above have an implied facility code prefix of 0102- (or similar).

Figure 5-2 : Sample P&ID – Manual Valve, Strainer, and Check Valve Indication

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6 ELECTRICAL

6.1 Equipment Identifier Format

The identification format for electrical equipment is as follows.

FFFF	-	EEEE	-	A	NN(N)(N)	T	-	S
Facility Code (Optional)	-	Equipment Functional Designation	-	Area Code	Equipment Number	Type Modifier (Optional)	-	Suffix (Optional)

Where,

FFFF is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.

EEEE is the *Equipment Functional Designation*, which is comprised of 2 to 4 characters from Section 6.2.

A is the *Area Code*, which is based on Section 2.3.

NN(N)(N) is the *Equipment Number*. Select numbers consistent with the ranges in Appendix D.

T is the Type Modifier, an optional field that is utilized to designate essential or UPS powered equipment. See Section 6.3.

S is the Suffix, an optional numeric or letter code to distinguish between multiple pieces of equipment with a common equipment number. Generally, numbers are utilized for equipment in series, and letters for equipment in parallel.

Examples:

0101-MCC-M7210	A MCC located in the M area of the NEWPCC facility.
DS-G510	A disconnect switch for pump P-G510.
CB-M023-B	The second (alternate) breaker feeding PNL-M023.
PNL-S025E	Essential power panelboard located in the S area.
XFMR-H711	Transformer within a regional water pumping station.
MCC-L71	MCC within a wastewater lift station (Note the two digit equipment number)

6.2 Electrical Functional Designations

Table 6-1 : Electrical Equipment Functional Designations

Functional Designation	Description	Notes
ATS	Automatic Transfer Switch	
BAT	Battery	
BC	Battery Charger	
BUS	Busway	
C	Cable (Power)	
CAP	Capacitor	Typically individual unit. See PFC.
CB	Circuit Breaker	Includes air, vacuum, SF6, and moulded case circuit breakers
CBUS	Cable Bus	
CON	Contactor	
CP	Control Panel	Includes miscellaneous electrical control panels, such as a heat trace control panel.
CPR	Cathodic Protection Rectifier	
CSTE	Customer Service Termination Equipment	
DP	Distribution Panel	Typically 600V panel, for distributing power to other points of the electrical distribution system.
DS	Disconnect Switch (non-fusible)	
EDP	Electrical Device Panel	Use for metering panels, protection panels and other miscellaneous electrical panels.
ELB	Emergency Lighting Battery Pack	May have integrated lights.
FAAP	Fire Alarm Annunciator Panel	
FACP	Fire Alarm Control Panel	
FAS	Fire Alarm System	
FDS	Fusible Disconnect Switch	
FU	Fuse	
GEN	Generator	
HCC	Heater Coil Controller	Includes SCR and contactor based controllers.
HF	Harmonic Filter	
INV	Inverter	
JB	Junction Box	

Functional Designation	Description	Notes
K	Interlocking Key (Kirk Key)	See Section 6.4.5
LC	Lighting Contactor	A lighting control panelboard would be identified as a PNL..
LDB	Load Bank	
MCC	Motor Control Centre	
MCP	Motor Circuit Protector	
MCS	Moulded Case Switch	
MMS	Manual Motor Starter	
MS	Motor Starter	
MSP	Motor Starter Panel	
MTR	Motor	
MTS	Manual Transfer Switch	
NGR	Neutral Grounding Resistor	
PB	Pull Box	
PFC	Power Factor Correction Unit	
PM	Power Meter	
PNL	Panelboard	
PS	Power Supply	24VDC power supply
PSP	Power Supply Panel	Panel containing 24VDC power supplies, fire alarm booster power supply.
RCFR	Rectifier	
RCPT	Receptacle	
RCTR	Reactor	Includes VFD line and load reactors.
RLY	Protection Relay	
~~SCR~~	~~Silicon Controlled Rectifier~~	Utilize RCFR
SGR	Switchgear	
SPL	Splitter	
SS	Soft Starter	
SW	Switch	
TVSS	Transient Voltage Surge Suppressor	
UPS	Uninterruptible Power Supply	
VFD	Variable Frequency Drive	
XFMR	Transformer	

6.3 Type Modifier

Electrical equipment that is deemed critical to the operation of a facility is typically backed up by one or more generators or some form of uninterruptible power supply. Electrical equipment of this nature is to be identified with a type modifier to provide indication that the equipment is critical in nature.

The following type modifiers will be used on electrical equipment based on the type of backup power system it is supplied by:

Type Modifier	Description
E	Essential – Distribution is deemed to be of higher criticality and is typically backed up by a generator, or at minimum has a transfer switch between multiple sources.
U	Uninterruptible – The distribution equipment is powered by a UPS

Notes:

1. *The Type Modifier is utilized only for essential and uninterruptible power systems.*
2. *The Type Modifier is not to be used on generators or UPS units as these devices are the sources of the backup power supply.*

6.4 Device-Specific Identifier Formats

6.4.1 Receptacle Identifiers

Receptacles are not necessarily required to be uniquely identified, but where they are, the receptacle identification is as follows.

RCPT	**-**	**A**	**NN(N)(N)**	**-**	**KK**	**S**	**-**	**MM**
Receptacle Designation	-	Area Code	Equipment Number of Source Panel	-	Circuit Number	Switched Sub-Circuit (Optional)	-	Incrementing Number (Optional)

Where,

RCPT	is the receptacle designation.
A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number* of the source panel.
KK	is the *Circuit Number* of the source panel. Where circuit numbers are not applicable, utilize an incrementing number beginning with 1.
S	is the optional *Switched Sub-Circuit* utilized to identify cables that are switched.
MM	is an optional *Incrementing Number*, utilized to indicate the specific receptacle powered by the circuit.

Examples:

RCPT-S022-14-2	A uniquely identified receptacle fed from Circuit 14 of PNL-S022. In this case, it is the 2^{nd} receptacle on the circuit.
RCPT-M701-1	A uniquely identified receptacle fed from MCC-M701. In this case, it is the only receptacle on the circuit, and as circuit numbers are not typically applied to MCCs, the number 1 is assigned to the circuit number.

The RCPT designation may be implied on plan drawings, as shown in Figure 6-1 below.

Figure 6-1 : Receptacle Identification on Plan Drawings

6.4.2 Power Cables Associated with Identified Equipment

The identification format for power cables is as follows.

C	-	A	NN(N)(N)	-	S
Cable Designation	-	Area Code	Equipment Number of Load	-	Suffix (Optional)

Where,

C	is the Cable Designation. For power cables, the letter C is utilized. For busway, BUS is utilized.
A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number* of the load equipment.
S	is the *Suffix* utilized to identify the specific cable associated with the equipment. The Suffix is not required if a single cable is associated with the equipment. Utilize sequential numbers for cables in series, or for different purposes, and letters for cables in parallel. Utilize the letter T to designate tie connections. Where the load equipment identifier has a suffix in the identifier, set the suffix of the cable to be the suffix of the load identifier plus an additional digit (See receptacle example below)

Notes:

1. *In the event the cable does not serve a specific load, such as a tie cable between two MCCs, select one of the two units of equipment as the prime equipment number for the cable.*
2. *See Section 7.3 for automation cable identification.*

Examples:

C-G683-1	The feeder for a motor disconnect, DS-G683.
C-G683-2	The motor cable feeding exhaust fan EF-G683, and fed from disconnect switch DS-G683.
C-M002	The feeder for MCC-M002
C-M003-A	The normal power feeder to ATS-M003.
C-M003-B	The emergency power feeder to ATS-M003.
C-M001-T	A cable used as a tie between MCC-M001 and DP-M002.
C-L01	Cable feeding Lift Pump P-L01 in a wastewater lift station.
C-M710-21	The cable feeding receptacle RCPT-M710-2.

6.4.3 General Purpose Cables – Lighting & Receptacles

The identification format for general purpose cables, for single phase loads, is as follows.

C	**-**	**P**	**NN(N)(N)**	**-**	**KK**	**S**
Cable Designation	-	Area Code	Equipment Number of Source Panel	-	Circuit Number	Switched Sub-Circuit (Optional)

Where,

C	is the Cable Designation.
A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number* of the source panel.
KK	is the *Circuit Number* of the source panel
S	is the optional *Switched Sub-Circuit* utilized to identify cables that are switched.

Note:

1. *It is expected that three-phase loads will all have equipment numbers assigned.*

Examples:

C-S022-14	Circuit 14 of PNL-S022.
C-S022-14A	Switched sub-circuit of circuit 14, fed from PNL-S022.

6.4.4 Junction Boxes - Power

The identification format for power junction boxes is as follows.

JB	-	A	NN(N)(N)	T	-	S
Junction Box Designation	-	Area Code	Equipment Number	Circuit Number	-	Suffix (Optional)

Where,

JB	is the Junction Box designation.
A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number* of the load equipment. If not associated with a specific piece of equipment, use a unique *Equipment Number* in the electrical equipment range, not associated with other equipment, in accordance with the *Equipment Number* ranges in Appendix D.
T	is the *Type Modifier*, optional to electrical equipment as per Section 6.3.
S	is the *Suffix* utilized to identify multiple junction boxes associated with an equipment number.

Examples:

JB-U421	Junction box associated with pump P-U421.
JB-C001	Junction box associated with MCC-C001.
JB-R600	Junction Box associated with numerous pieces of equipment, within a wastewater treatment facility.
JB-M751	Junction Box associated with numerous pieces of equipment, within a regional water pumping station.

6.4.5 Interlock Keys

The identification format for interlock (Kirk) keys is as follows.

K	NNNN
Interlocking Key Designation	Number

Where,

K — is the *Interlocking Key* designation.

NNNN — is the *Key Interchange Number*, which is unique for each facility. The *Key Interchange Number* can be from 1 to 4 digits long. For larger facilities, a drawing should be created with an index of Key Interchange Numbers for reference.

Note:

1. *The interlock key identifier will be the same for all interlocks associated with the system. Thus, for a system with four breakers interlocked with four locks and three keys, all four interlocks and keys have the same identifier.*
2. *Area Codes are not utilized as key interlocks could span over multiple areas.*

Example:

K1 — First key interlock system for a facility.

K52 — 52nd key interlock system associated with a facility.

6.4.6 Wire Tags

6.4.6.1 Lighting and Receptacle Circuits - AC

The identification format for lighting and receptacle circuits is as follows.

A	NN(N)(N)	-	CC	S
Area Code	Equipment Number of Source	-	Circuit Number or Neutral Designation	Switched Sub-Circuit (Optional)

Where,

A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number* of the source panelboard.
CC	is the *Circuit Number* of the source panelboard, or N for a neutral wire.
S	is the *Switched Sub-Circuit Designation*, and is an incrementing letter for a conductor that is switched.

Note: The Equipment Functional Designation, typically PNL, is implied to reduce the length of the wire tags.

Examples:

G701-32	Line (Hot) conductor of circuit 32, associated with PNL-G701.
W752-N	Neutral conductor associated with PNL-W752.
S702-12B	The second switched sub-circuit line (hot) conductor, associated with PNL-S702 circuit 12.

6.4.6.2 DC Power Circuits

DC power circuits, such as from large switchgear DC power supply units require unique identification as follows:

P	NN(N)(N)	-	C	S	D
Area Code	Equipment Number of Source	-	Circuit Number	Switched Sub-Circuit (Optional)	Power Designation

Where,

A — is the *Area Code*, which is based on Section 2.3.

NN(N)(N) — is the *Equipment Number* of the source panelboard.

C — is the *Circuit Number* of the source panelboard.

S — is the *Switched Sub-Circuit Designation*, and is an incrementing letter for a conductor that is switched.

D — is the *Power Designation*, which is based on Table 6-2.

Note: The Equipment Functional Designation, typically PNL, is implied to reduce the length of the wire tags.

Table 6-2 : DC Power Circuit Wire Tag Power Designations

Power Designation	Description
C	DC Common (0V)
G	Ground
+	DC Positive
-	DC Negative

Note: The Ground designation is not typically required, provided that the ground wire is green.

Examples:

G751-22+ — Positive wire of circuit 22, fed from PNL-G751.

G751-22- — Negative wire of circuit 22, fed from PNL-G751.

G751-22A+ — Positive wire of switched circuit 22, fed from PNL-G751.

6.4.6.3 Three Phase Power Wiring

The identification format for three phase power wire tags is as follows.

A	NN(N)(N)	-	X	H
Area Code	Equipment Number	-	Sequence Number (Optional)	Phase

Where,

A — is the *Area Code*, which is based on Section 2.3.

NN(N)(N) — is the *Equipment Number* of the load equipment. If not associated with a specific piece of equipment, use of *Equipment Number* in the electrical range is preferred, in accordance with the *Equipment Number* ranges in Appendix D.

X — is an optional *Sequence Number* that is typically a numeric character, utilized when there are multiple power cables associated with an *Equipment Number*.

H — is the *Phase*, and should be labelled A, B, C, or N.

Three phase power wiring wire tagging is required, except where the conductors are color coding, are in a dedicated cable or conduit, and the routing is obvious.

Examples:

G681-A — Phase A conductor of a power cable associated with EF-G681. The wire is in common conduit with other power cables.

W1511-2B — Phase B conductor of the second power circuit associated with centrifuge CE-W1511 at the NEWPCC facility.

\- — No wire tags are needed for the conductors of a pump, fed via a Teck power cable, where the conductors are color coded and the overall cable is identified and labelled.

6.4.6.4 Motor Control Circuits

The identification format for motor control circuits is as follows:

A	NN(N)(N)	-	WWW	S
Area Code (Optional)	Equipment Number (Optional)	-	Wire Number	Suffix (Optional)

Where,

A	is the *Area Code*, which is based on Section 2.3. It is not required for wires exclusively within the motor starter.
NN(N)(N)	is the *Equipment Number* of the associated equipment. It is not required for wires exclusively within the motor starter.
WWW	is the *Wire Number*, an incrementing number.
S	is an optional *Suffix*, and is utilized where it is desired to utilize the same wire number, but the signal has changed.

Notes:

1. *It is desirable, but not mandatory, that the wire number in a motor starter match the terminal number.*
2. *It is deemed acceptable to omit the Area Code and Equipment Number for wires exclusively within the motor starter, as it is common industry practice, and MCC manufacturers only typically provide numeric wire numbers.*

Examples:

8	Control wire 8 located in the motor starter for AHU-G652, and lands on terminal 8 in the motor starter.
8A	Control wire 8A located in the motor starter for AHU-G652, which does not land on a terminal strip.
G652-8	Control wire 8, located in external field wiring, associated with AHU-G652.

6.5 Subcomponents

The following designations are to be utilized for electrical equipment subcomponents. See Section 2.6 for general rules on application of subcomponents. Note that numerous equipment functional designations, shown in Table 6-1, can also be utilized as subcomponent designations, as shown in Table 6-3 below.

Table 6-3 : Electrical Equipment Subcomponents

Subcomponent Designation	Description	Notes
AM	Ammeter	
B	Bus	
CAP	Capacitor	
CB	Circuit Breaker	
CON	Contactor	
CPT	Control Power Transformer	
CR	Control Relay	
CT	Current Transformer	Phase identification may be utilized as part of the subcomponent identifier. i.e. CT-1A, CT-1B
DS	Disconnect Switch	
F	Fan	
FDS	Fused Disconnect Switch	
FU	Fuse	
M	Motor Contactor	
MCB	Main Circuit Breaker	
MCP	Motor Circuit Protector	
MCS	Moulded Case Switch	
MMC	Motor Management Controller	Also known as intelligent overload.
OL	Overload Relay	
PM	Power Meter	
PS	Power Supply	
PT	Potential Transformer	Phase identification may be utilized as part of the subcomponent identifier. i.e. PT-1A, PT-1B
RCFR	Rectifier	
RCTR	Reactor	
RLY	Protection Relay	Utilize IEEE Number for suffix if appropriate.
~~SCR~~	~~Silicone Controlled Rectifier~~	Utilize RCFR
TVSS	Transient Voltage Surge Suppressor	
VM	Voltmeter	

Notes:

1. *A motor starter is not typically deemed to be a subcomponent.*

Subcomponent Examples:

MS-G261.CAP	A capacitor that is an internal component of MS-G261. If the capacitor were a separate component mounted externally, it would be identified as CAP-G261.
MCC-P011.MCB	Integrated Main Circuit Breaker for Motor Control Centre MCC-P011
MCC-P011.TVSS.CB	Circuit Breaker for Motor Control Centre MCC-P011 TVSS

A sample single line diagram with subcomponents is shown in Figure 6-2. Note that the full identifier is not written out, provided that the parent identifier is clear from the drawing context.

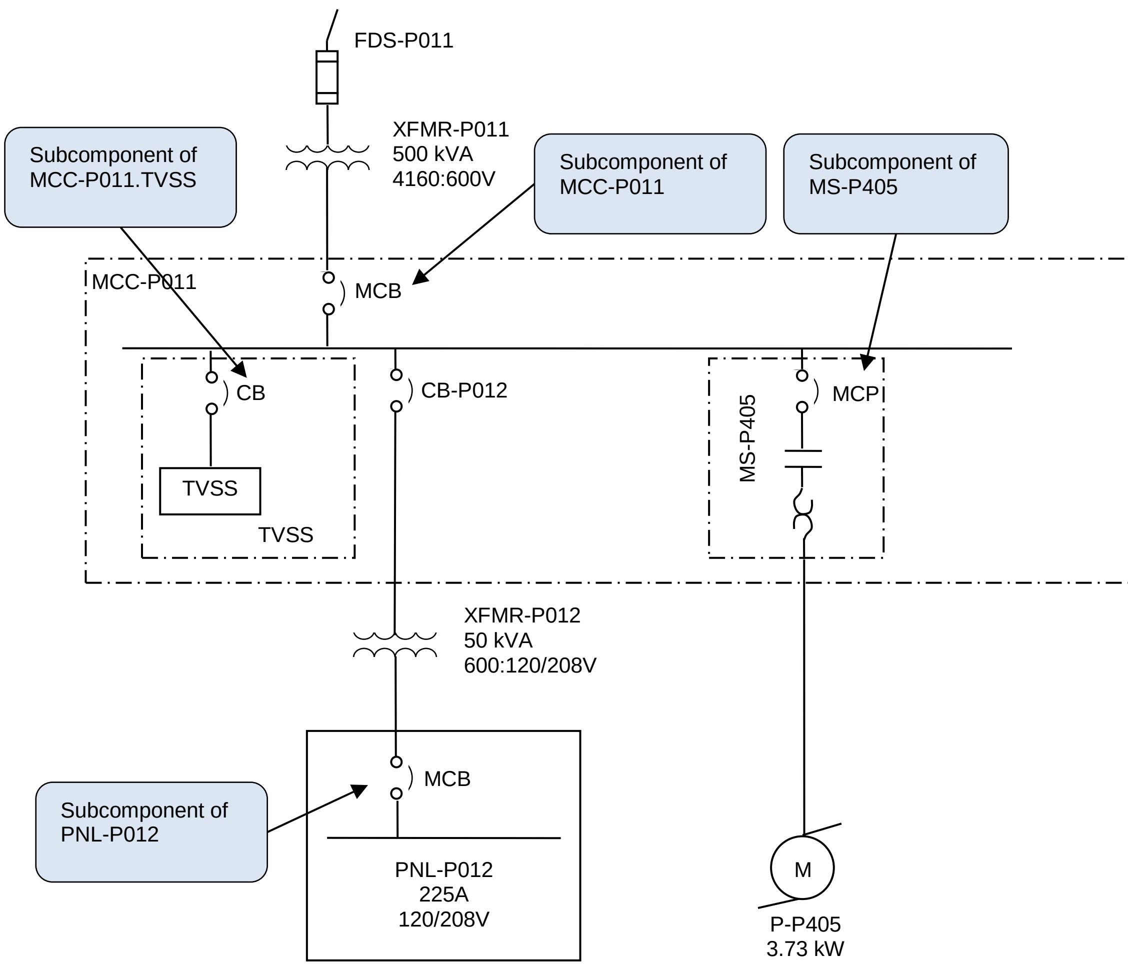


Figure 6-2 : Subcomponents – Electrical Equipment

6.5.1 Tie Circuit Breakers

Tie breakers are used to connect electrical buses together. Tie breakers are considered to be subcomponents of the switchgear / panel that they are located in. The identification format for tie circuit breakers is in accordance with Section 2.6, except that the letter T is used instead of a number for the component number.

Examples:

SGR-U701.CB-T	A tie breaker between SGR-U701 and SGR-U002
SGR-P711.CB-T	A tie breaker between SGR-P711 and SGR-P712

illustrates a sample electrical single line diagram with tie breakers.

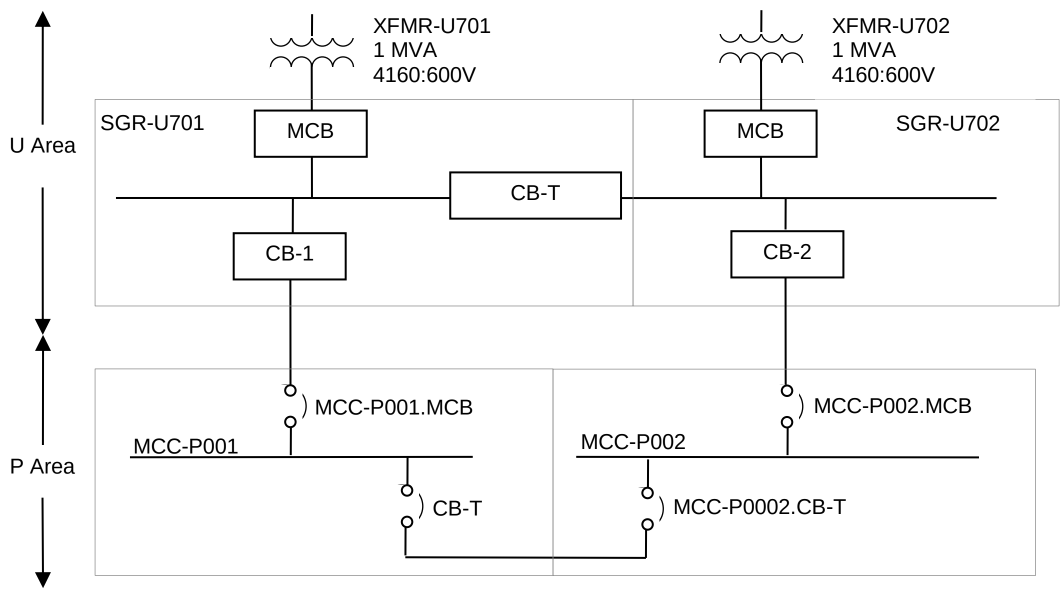


Figure 6-3 : Sample Tie Breaker Identification

Note:

1. *All breakers in Figure 6-3, whether specifically shown or not, are subcomponents.*

6.6 Examples

6.6.1 Example 1

An example single line diagram is shown in Figure 6-4.

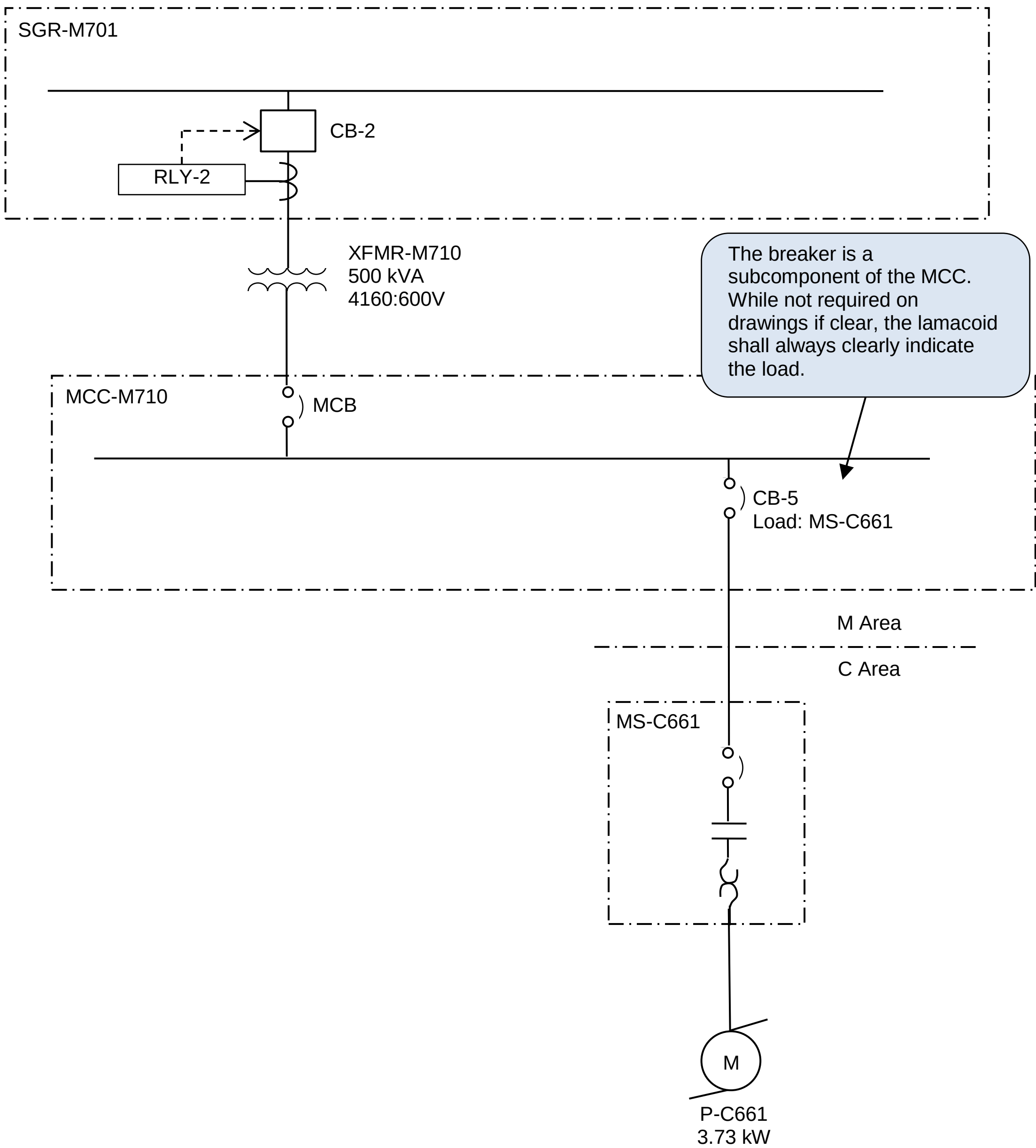


Figure 6-4 : Example Identification by Load Equipment

6.7 Fire Alarm System Devices

6.7.1 Identifier Format

The identification of all fire alarm system components is based upon room numbers rather than equipment numbers. This allows for more rapid recognition of the component location, and avoids utilization of a significant portion of the equipment numbering range for fire alarm system components.

<table>
<tr><th>FFFF</th><th>-</th><th>FAS</th><th>-</th><th>A</th><th>-</th><th>L</th><th>RR</th><th>-</th><th>D</th><th>NN</th></tr>
<tr><td rowspan="2">Facility Code (Optional)</td><td rowspan="2">-</td><td rowspan="2">Fire Alarm Design-ation</td><td rowspan="2">-</td><td>Area Code</td><td>-</td><td>Level</td><td>Room Number</td><td rowspan="2">-</td><td rowspan="2">Device Designation</td><td rowspan="2">Device Number</td></tr>
<tr><td colspan="4">From Room Number Designation</td></tr>
</table>

Where,

FFFF	is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.
FAS	is the *Fire Alarm Designation*, which is comprised of the letters FAS.
A	is the *Area Code*, which is based on Section 2.3.
L	is the *Level*, which shall typically be one or two characters, as described in Section 3.1.
RR	is the *Room Number*, which shall be assigned as described in Section 3.1.
D	is the Device Designation, which is comprised of a single letter from Section 6.7.2
NN	is the *Device Number*, which uniquely identifies a specific device within a room.

Examples:

FAS-S-115-D01	The first smoke detector in room 15 on the main level of the Secondary Clarifier area.
FAS-M-222-A02	The second horn/strobe in room 22 on the second floor of the M area.

6.7.2 Fire Alarm Device Designations

Table 6-4 : Fire Alarm Device Designations

Device Designation	Description
A	Annunciation Device (Horn / Strobe)
C	Control Relay Module
D	Detection Device (Heat / Smoke)
E	End-of-line Device
I	Isolation Module
M	Addressable Monitor / Input Module
P	Pullstation
R	Automatic Door Release Device
S	Signal Module

6.7.3 Drawing Format

The format of fire alarm system devices on drawings will typically be as shown in Figure 6-5 below. Note a significant portion of the device identifier is determined via context. Where the context is not clear, use full device identifiers.

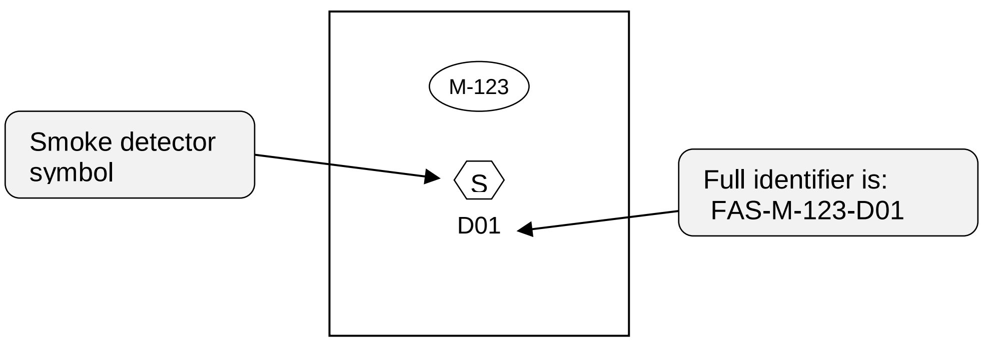


Figure 6-5 : Room Numbering on Drawings – Plan View

6.7.4 Wire Tags

The identification format for fire alarm circuits is as follows.

A	**NN(N)(N)**	**-**	**TTT**	**-**	**CC**
Area Code	Equipment Number of Source Panel	-	Type of Circuit	-	Circuit Number

Where,

A — is the *Area Code* of the source panel or equipment. Typically, this will be the fire alarm control panel, but it could also be a booster power supply.

NN(N)(N) — is the *Equipment Number* of the source panel or equipment.

TTT — is the *Type of Circuit*, selected as follows:

- DLC Data Communication Link
- IDC Initiating Device Circuit
- NAC Notification Appliance Circuit

CC — is the *Circuit Number*, an incrementing number.

Examples:

P901-NAC-01 Notification appliance circuit 01 out of FACP-P901.

R921-NAC-02 Notification appliance circuit 02 out of BPS-R921.

P901-DLC-03 Digital Communication Link circuit 03 out of FACP-P901.

6.8 Security Devices

The identification of security system components is dependent upon the system that the device is connected to. If the security device is connected to a dedicated security system, it shall be identified as per this section. However, devices directly connected to the process control system (i.e. PLC) shall be identified as per Section 7.1.

6.8.1 Device Identifier Format

The security device identifier format is based upon room numbers rather than equipment numbers. This allows for more rapid recognition of the component location, and avoids utilization of a significant portion of the equipment numbering range for security system components.

FFFF	**-**	**SCY**	**-**	**A**	**-**	**L**	**RR**	**S**	**-**	**DD**	**N**
Facility Code (Optional)	-	Security Design-ation	-	Area Code	-	Level	Room Num	Suffix (Opt)	-	Device Design -ation	Device Number
				From Room Number Designation							

Where,

FFFF	is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.
SCY	is the *Security Designation*, which is comprised of the letters SCY.
A	is the *Area Code*, which is based on Section 2.3.
L	is the *Level*, which shall typically be one or two characters, as described in Section 3.1. For outdoor locations, it is recommended that the EX designation be utilized, as described in Section 3.1.
RR	is the *Room Number*, which shall be assigned as described in Section 3.1.
S	is the Suffix (optional), which corresponds to the Door Identifier for security devices associated with doors
DD	is the Device Designation, which is comprised of two letters from Section 6.8.2.
N	is the *Device Number*, which uniquely identifies a specific device within a room.

Examples:

SCY-S-115B-DC1	The first door switch in on door B of room 15 on the main level of the Secondary Clarifier area.
SCY-M-222-AH2	The second horn/strobe in room 22 on the second floor of the M area.
SCY-S-115A-CR1	The access card reader outside the door (A) to room 15 on the main level of the Secondary Clarifier area.
SCY-A-EX1-VC1	An outdoor video camera in the A area, exterior zone 1.

6.8.2 Security Device Designations

The security device designations are independent of the Process / Mechanical / Electrical / Automation designations, and may overlap those designations.

Table 6-5 : Security Device Designations – Room/Door Specific

Device Designation	**Description**	**Type Modifiers** *(See Note 2)*
AH	Annunciation Device (Horn / Strobe)	H Horn S Strobe
CR	Access Card Reader (See Note 1)	
DC	Door Contact	
EL	End-of-line Device	
ES	Electric Strike (Subcomponent of Door)	
EX	Exit Button	Includes “Request to Exit” and crash bars.
GB	Glass-Break Contact	
IM	Addressable Monitor / Input Module	
IS	Isolation Module	
KP	Keypad	
MD	Motion Detector	
PB	Panic Button	
VC	Camera	FM Flush Mount PTZ Pan/Tilt/Zoom SM Surface Mount

Note:

1. *Access Card Readers will be designated by the door identifier.*
2. *Show the type modifier next to the device as applicable.*

6.8.3 Security Equipment Designations

Some security equipment is preferably identified as major equipment, and not associated with a specific room. The Security equipment designations are shown in Table 6-6.

Table 6-6 : Security Equipment Designations

Equipment Designation	Description
ACP	Access Control Panel
SCP	Security / Intrusion Alarm Control Panel
SVM	Security Video Monitor
SVR	Security Video Recorder

Note:

1. The above equipment will be identified in a manner consistent with Section 6.1.

6.8.4 Equipment Subcomponent Designations

Table 6-7 : Security Equipment Subcomponent Designations

Equipment Subcomponent Designation	Description
MOD	Input / Output Module
PS	Power Supply
PU	Processing Unit

Note:

1. The above equipment will be identified in a manner consistent with Section 6.5.

6.8.5 Wire Tags

The identification format for security circuits is as follows.

A	NN(N)(N)	-	TTT	-	CC
Area Code	Equipment Number of Source Panel	-	Type of Circuit	-	Circuit Number

Where,

A — is the *Area Code* of the source panel or equipment. Typically, this will be the fire alarm control panel, but it could also be a booster power supply.

NN(N)(N) — is the *Equipment Number* of the source panel or equipment.

TTT — is the *Type of Circuit*, selected as follows:

- DLC Data Communication Link
- IDC Initiating Device Circuit
- NAC Notification Appliance Circuit

CC — is the *Circuit Number*, an incrementing number.

Note:

1. The Type of Circuit requires review. The Designer may propose alternate types to the City for review and approval.

Examples:

P951-NAC-01 Notification appliance circuit 01 out of SCP-P901.

P951-DLC-03 Digital Communication Link circuit 03 out of SCP-P901.

7 AUTOMATION

7.1 Instrumentation

7.1.1 Instrument Identifier Format

The identification format for instrumentation is as follows.

FFFF	-	XXXX	-	A	NN(N)(N)	T	-	S
Facility Code (Optional)	-	Instrument Functional Designation	-	Area Code	Equipment Number	Instrument Number	-	Suffix
					Loop Number			

Where,

FFFF	is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.
XXXX	is the *Instrument Functional Designation*, which is typically comprised of 2 to 4 characters from Section 7.1.3. Note that five character *Instrument Functional Designations* are possible, but should be quite rare.
A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number* of the associated equipment. If no equipment is associated, allocate *Equipment Numbers* specific for the applicable instrumentation. Do not suppress 0's for equipment numbers, as all loop numbers at a site should have the same number of digits in the loop number.
T	is the *Instrument Number*, where the number increments from the number 0 through 9. Utilize the number 0 for instruments directly associated with motor starters and control. The *Instrument Number* does not increment for every instrument, but rather increments for every instrument loop.
NN(N)(N)T	is the Loop Number, comprised of the *Equipment Number* together with the *Instrument Number*. Medium to large facilities will utilize four digit loop numbers, while smaller facilities such as wastewater collections facilities will use three digit loop numbers. The NEWPCC facility will utilize five digit loop numbers
S	is the *Suffix*, which is used in the cases of multiple instruments on the same or redundant loops. All suffixes are to be numeric.

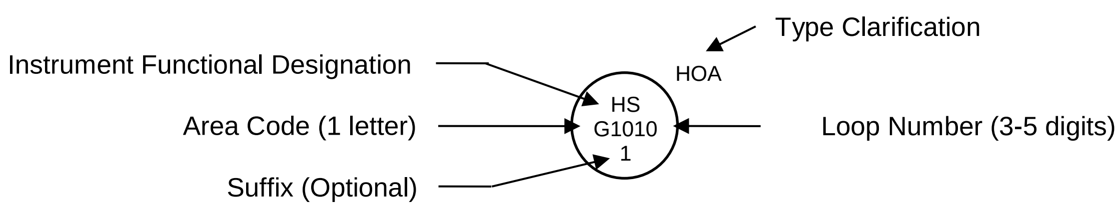
Examples:

XY-G2501	A solenoid for the valve XV-G250, where the solenoid is remote from the valve.
LT-M1011-2	Redundant Wet Well level transmitter.
0650-PT-M3011	A pressure transmitter associated with pump M301 at the Hurst Pumping Station. Note that the facility code is optional.
HSR-R1100	A start pushbutton associated with pump P-R110.

TY-B1500	A temperature relay that takes signals from TT-B1501, TT-B1502, TT-B1503, and TT-B1504 and converts to a Modbus protocol.
FV-R12311	A flow valve at the NEWPCC facility, with five digit loop numbers.
ZSS-F3212	A safety switch for CNV-F321.
HS-L010	A start pushbutton for P-L01 at a wastewater lift station.
PG-S1102	A pressure gauge for pump P-S110.

7.1.2 Drawing Format

The format for instrumentation on drawings, such as P&IDs, is shown below:



7.1.3 Instrument Functional Designations

An instrument functional designation represents the function of the instrument, and is based upon ISA 5.1. Note that it is possible for an instrument functional designation to be common with a mechanical equipment functional designation, as they will be differentiated by the identifier format. Instrument identifiers will have a four digit loop number, compared with mechanical equipment, which has a three digit equipment number. Thus, even without context, it is possible to differentiate between instruments and other equipment.

Due to the many types of instruments available, a comprehensive list of instrument identifiers is not provided, but rather instrument identifiers are derived from Table 7-1 in a manner that is consistent with ISA 5.1. An instrument functional designation is selected as follows:

- Select the first character from the first column of Table 7-1, based upon the measured or initiating variable of the loop. Optionally, select a second character from the second Modifier column, to indicate a special function associated with the measured or initiating variable. For example, an instrument ultimately part of a safety loop associated with level would have the first two characters designated as LS.
- Select the next character (second or third, depending on whether a second column Modifier is utilized), from either the third or fourth columns. The third column is for Readout or Passive Functions, while the fourth column is for Output Functions.
- Finally, if appropriate, append a letter from the fifth Modifier column, to clarify the function of the instrument. In some cases two characters may be selected from the fifth Modifier column.

A list of common instrument functional designations is provided in Table 7-2.

Table 7-1 : Instrument Functional Designations

	First Letter		Succeeding Letters		
	Measured or Initiating Variable	**Modifier**	**Readout or Passive Function**	**Output Function**	**Modifier**
A	Analysis		Alarm		
B	Burner, Combustion				
C	Conductivity (1)			Control (2)	Close
D	Density (3)	Difference, Differential			Deviation
E	Voltage		Sensor, Primary Element		
F	Flow, Flow Rate	Ratio			Failure / Fault (14)
G			Glass, Gauge Viewing Device (4)		
H	Hand (Manual)				High (15)
I	Current		Indicate (5)		
J	Power		Scan		
K	Time, Schedule	Time Rate of Change		Control Station	
L	Level		Light (6)		Low (16)
M	Moisture, Humidity (7)				Middle, Intermediate
N					
O	Torque		Orifice, Restriction		Open
P	Pressure		Point (Test Connection)		
Q	Quantity	Integrate, Totalize	Integrate, Totalize		
R	Radiation		Record		Run (8)
S	Speed, Frequency	Safety (9)		Switch	Stop (10)
T	Temperature			Transmitter	
U	Multivariable		Multifunction	Multifunction	
V	Vibration, Mechanical Analysis			Valve, Damper, Louver	
W	Weight, Force		Well, Probe		
X	Unclassified (11)	X Axis	Unclassified	Unclassified	Unclassified
Y	Event, State, or Presence	Y Axis		Auxiliary Device (12)	
Z	Position, Dimension	Z Axis, Safety Instrumented System (13)		Driver, Actuator, Unclassified Final Control Element	

Notes for Instrument Functional Designations:

1. *The use of the letter C for conductivity is a City specific user assignment.*
2. *Utilize the output designation C for an automatic device or function that receives an input signal and generates a variable output signal that is used to modulate or switch a valve or otherwise control a final drive element. Do not utilize the C designation for a control valve, unless the valve independently measures the process variable and determines the appropriate valve position. Thus, the use of TCV, FCV, or LCV is not common. The use of PCV is more common, for pressure regulators. In addition, do not use the C controller designation for switches that directly control a device or equipment. For example, a unit heater on/off thermostat would be a TS, not a TC.*
3. *The use of the letter D for density is a City specific user assignment.*
4. *Utilize the letter G for all pressure gauges (i.e. PG), thermometers (i.e. TG), and viewing glasses (e.g. LG).*
5. *The Readout/Passive Function letter I is to be utilized for analog or digital readouts of a measurement or input signal. Do not utilize for indication of discrete on/off signals.*
6. *The Readout/Passive Function letter L is to be utilized for indication of discrete on/off states. Do not utilize for alarms, which should utilize the A designation.*
7. *It is recommended to utilize the initial letter M as a designation for moisture, which is common industry practice. The City has historically applied the letter M for Motor, however this use is not consistent with ISA 5.1 and it is recommended that this use be discontinued.*
8. *Utilize the modifier R to designate a Run or Start modifier. Note that this designation was added in the 2009 revision to ISA-5.1.*
9. *Utilize the letter S as a modifier for safety components not part of a Safety Instrumented System (SIS). The letter S modifier is to be utilized for self-actuated emergency protective primary and final control elements only when used in conjunction with Measured/Initiating Variables flow [F], pressure [P] or temperature [T]. An example is a PSV for a pressure safety relief valve utilized to protect against emergency conditions that are not expected to normally occur.*
10. *Utilize the modifier S to designate a Stop modifier. Note that this designation was added in the 2009 revision to ISA-5.1.*
11. *The letter X is to be defined at the time of use, and may be used for multiple definitions where no other letter is applicable. The letter X is commonly applied to controlled on-off valves, where the initiating variable is not clearly defined.*
12. *The use of output function Y is to be utilized for a device that connects, disconnects, transfers, computes, and/or converts air, electronic, electric, or hydraulic signals or circuits. Use for a current to pressure signal converter would be appropriate.*
13. *Variable modifier Z is to be utilized for all components of a safety instrumented system (SIS). An example is a SIS system pressure transmitter, designated PZT.*
14. *The use of the letter F as a Modifier to represent Failure or Fault is an extension to ISA-5.1.*
15. *Where more than one switch or alarm within the same control loop is designated with a High designation, the second switch or alarm (at a higher level) shall be designated with a High-High designation. An instrument shall not be designated with a High-High designation unless there is an instrument with a High designation already present. For example: A LSH is a first level switch at a high level and a LSHH would be a second level switch at a higher level. Either switch may have associated alarms or interlocks.*
16. *Where more than one switch or alarm within the same control loop is designated with a Low designation, the second switch or alarm (at a lower level) shall be designated with a Low-Low designation. An instrument shall not be designated with a Low-Low designation unless there is an instrument with a Low designation already present. For example: A LSL is a first level*

switch at a low level and a LSLL would be a second level switch at a lower level. Either switch may have associated alarms or interlocks.

Table 7-2 : Common Instrument Functional Designations

Designation	Direct Translation	Example
AA	Analysis Alarm	Gas detection horn / strobe
AAH	Analysis High Alarm	H_2S gas detection high level alarm
AT	Analysis Transmitter	H_2S gas detection transmitter
DT	Density Transmitter	Density transmitter without local indication
EG	Voltage Viewing Device	Capacitive voltage indicator
EL	Voltage Light	Pilot light indicating voltage is present
EI	Voltage Indicator	Voltage meter with numeric scale, or digital meter
ES	Voltage Switch	General voltage relay
ESL	Voltage Switch - Low	Undervoltage relay
ET	Voltage Transmitter	Voltage transducer
FAL	Flow Alarm - Low	Pilot light indicating low flow
FCV	Flow Control Valve	Integrated valve to limit the flow below a setpoint. The valve is not externally controlled.
FE	Flow Element	Magnetic flowtube, orifice plate
FIT	Flow Indicating Transmitter	Magnetic flowmeter transmitter with local indication
FT	Flow Transmitter	Magnetic flowmeter transmitter without local indication
FV	Flow Valve	Butterfly valve with positioner, modulated by a signal initiated by a flowmeter.
HS	Hand Switch	Hand/Off/Remote switch
HSR	Hand Switch – Start/Run	Start pushbutton
HSS	Hand Switch - Stop	Stop pushbutton, including emergency stop pushbuttons, unless associated with a Safety Instrumented System.
JIT	Power Indicating Transmitter	Power meter
KS	Time Switch	Timing relay
LSH	Level Switch - High	Sump pit high level switch
LSL	Level Switch - Low	Sump pit low level switch
LE	Level Sensor	Ultrasonic level transducer
LIT	Level Indicating Transmitter	Ultrasonic level transmitter with local indication
LT	Level Transmitter	Ultrasonic level transmitter without local indication

Designation	Direct Translation	Example
ME	Moisture Sensor	Moisture sensor. Includes submersible pump/mixer leakage detector.
OSH	Torque Switch - High	Torque limit switch
PG	Pressure Gauge	Mechanical pressure gauge local to piping
PI	Pressure Indicator	Pressure display remote from piping, with scale.
PSL	Pressure Switch - Low	Low pressure switch on air receiving tank
PSH	Pressure Switch - High	High pressure switch on air receiving tank
PT	Pressure Transmitter	Analog pressure transmitter
ST	Speed Transmitter	Speed pulse encoder
TE	Temperature Element	Thermocouple or RTD temperature sensor
TG	Temperature Gauge	Local temperature gauge
TSH	Temperature Switch - High	High temperature switch
TI	Temperature Indicator	Digital temperature indicator or local analog indicator based upon a capillary tube
TSL	Temperature Switch - Low	Low temperature switch. The switch may be associated with process control, interlock, alarm or any combination thereof.
TSLL	Temperature Switch – Low-Low	A second low temperature switch that has a setpoint lower than the first low temperature switch. The switch may be associated with process control, interlock, alarm or any combination thereof.
TT	Temperature Transmitter	Analog temperature transmitter
VE	Vibration Sensor	Vibration sensor
VIT	Vibration Indicating Transmitter	Vibration transmitter with local indication
XV	Unclassified Valve	Typically use for on/off valves
YS	Presence Detector	Use for motion detectors that are connected to the process control system and not to a security system. Use Section 6.8 for security systems.
ZSC	Position - Closed	Valve closed limit switch
ZSO	Position - Open	Valve opened limit switch
ZT	Position Transmitter	Linear position transmitter

7.1.4 Loop Numbers

The equipment number (2-4 as applicable) digits of a loop number shall be identical to the equipment with which the instrument is associated.

Motor controls of motorized equipment should have an *Instrument Number* of 0. For example, a local start/stop switch for pump P-S305 should be designated as HS-S3050 or with a suffix such as HS-S3050-2. Nothing precludes the use of a 0 *Instrument Number* for instruments not associated with motorized equipment.

The *Loop Number* should generally be unique for each instrument loop. For example, outdoor air, mixed air, and supply air temperature transmitters on an air handling unit should all have different loop numbers as they are measuring different temperatures.

Exceptions will only be permitted where:

- The two instrument loops are performing the identical function. For example, two thermal dispersion flowmeters measuring the same point and being averaged in software should utilize the same loop number with different suffixes.
- No other good alternatives exist. Note that use of a common loop number for multiple loops will require careful attention in wiring and signal tagging.

7.1.5 Type Clarification

The instrument *Type Clarification* is an optional additional field on the outside of the instrument tag bubble, as shown in Section 7.1.2. The *Type Clarification* is not part of the identifier, but rather additional information that is useful to the P&ID reader. The site P&ID legend sheet should contain all type clarifications utilized at the site. Examples are provided in Table 7-3 on the next page, and additional examples are provided in Table 5.2.2 of ISA 5.1.

Table 7-3 : Type Clarification Examples

Functional Identifier	Type Clarification	Description
AIT	CO	Carbon monoxide transmitter
AIT	COMB	Combustible gas transmitter
AIT	H2S	Hydrogen sulphide transmitter
AIT	O2	Oxygen transmitter
FE	COR	Coriollis flow element
FE	MAG	Magnetic flow element
FE	US	Ultrasonic flow element
HS	H/O/A	Hand / Off / Auto Switch
HS	H/O/R	Hand / Off / Remote Switch
HS	O/A	Off / Auto Switch
HS	O/O	Off / On Switch
HS	RST	Reset
HSS	EMG	Emergency Stop Switch
LE	CAP	Capacitance level element
LE/LT	DP	Differential pressure level element
LE	RAD	Radar level element
LE/LT	SDP	Submersible differential pressure
LE	US	Ultrasonic level element
PT	ABS	Absolute pressure transmitter
PT	VAC	Vacuum pressure transmitter
TT	TC	Thermocouple temperature transmitter
TT	RTD	Resistance temperature transmitter

7.1.6 Valve Identification

Historically there has been some confusion regarding valve identification, and the purpose of this section is to clarify the appropriate functional identification for valves, as per ISA 5.1.

7.1.6.1 Manual Valves

All manual valves are to be identified as HV, as per Sections 5.2.1, 5.2.2 and 5.2.3.

Valves that have an actuator, but are always operator controlled remotely via a PLC, DCS, or some other control system are to be identified as per Sections 7.1.6.4 and 7.1.6.5.

Instrument isolation valves less than or equal to 12mm do not require identification if there is no requirement to identify them in an operations procedure.

7.1.6.2 Actuated Valves with Internal Controller

A self-actuating valve that has a process signal as an input is a *control valve*, where the initial letter is the measured process variable. Examples are as follows:

FCV	Flow Control Valve – a valve with an internal mechanism or logic that measures flow and controls it to some setpoint. For example, this could be a Foundation Fieldbus Controlled valve. A valve that has flow as it's initiating variable, but receives a position signal from an external controller is **not** a FCV, but a FV (as per ISA 5.1)
PCV	Pressure Control Valve – a valve with an internal mechanism or logic that measures pressure and controls it to some setpoint. For example, this could be a Foundation Fieldbus Controlled valve with an integral PID controller. A valve that controls pressure, but receives a position signal from an external controller is **not** a PCV (as per ISA 5.1). Note that while a mechanical pressure regulator is functionally identified as a PCV, it is identified as per 5.2.3.

7.1.6.3 Actuated Valves with External Controller

A valve with an actuator that is positioned by an external signal is a *control valve*, where the initial letter is the measured process variable. Examples are as follows:

FV	Flow Valve – a valve with or without a positioner, that is positioned by an external controller based upon a measured or initiating flow signal. The signal from the external controller to the valve is a position command signal. Note that many valves control the flow within a pipe, but not all such valves are necessarily *Flow Valves*, as per ISA 5.1. Only valves that have a control loop with flow as the initiating variable are *Flow Valves*.
LV	Level Valve – a valve with or without a positioner, that is positioned by an external controller, that uses level as its initiating or measured variable. The signal from the external controller to the valve is a position signal. Note that while the valve may control the flow within the pipe, it is not a *Flow Valve* if the initiating variable is *Level*.
PV	Pressure Valve – a valve with or without a positioner, which is positioned by an external controller based upon level as its initiating or measured variable. The signal from the external controller to the valve is a position command signal. Note that while the valve may control the flow within the pipe, it is not a *Flow Valve* if the initiating variable is *Pressure.*
UV	Multivariable Valve – a valve with or without a positioner, that is positioned by an external controller based upon multiple variables as input into the

controller. The signal from the external controller to the valve is a position command signal. Note that while the valve may control the flow within the pipe, it is not a *Flow Valve* if there are multiple initiating variables.

7.1.6.4 Actuated Valves (Modulated) with Operator Control

A valve with an actuator that is positioned by a signal controlled by a human operator is to be identified by the major initiating variable that the operator would reference. Note that this definition is only marginally consistent with ISA 5.1, as a direct interpretation of ISA 5.1 would likely result in a HV – *Hand Valve* identification. Discussions with City personnel have indicated that it is not desirable to identify these valves as *Hand Valves*, which in their opinion, should be reserved for manual valves. Not that this identification only applies to modulating valves and not to on/off valves.

Examples:

FV-T4061 An valve actuated from a signal, that is controlled by an operator via an HMI interface. The operator periodically monitors a flow rate in the process and manually adjusts the position setpoint for the valve.

7.1.6.5 Actuated On/Off Valves

An on/off valve with an actuator that is controlled by an external controller is to typically be identified as an XV, or *Undefined Valve*. ISA 5.1 is not clear on how to address the identification of on/off valves, and while YV (State Valve) or UV (Multivariable Valve) are potential identifiers, common industry practice is that XV is commonly utilized. Discretion must be applied, and while there are cases where on/off valves with other initial variables would be appropriate, it is recommended that all on/off valves, where the initiating variable is not clear, be identified as XV. On/Off valves with remote operator control are also to be identified as XV, unless the initiating variable that the operator is responding to is absolutely clear.

Examples:

XV-G6011 An on/off intake damper on an air handler, AHU-G601, which closes when the air handler is not in operation.

XV-M1511 An on/off discharge valve on a pump, P-M151, which closes when the pump is not in operation.

LV-S2032 An on/off valve that shuts off when the level in tank TK-S203 exceeds a setpoint. This is an example where the initiating variable is clearly level, and the valve should be identified as such.

XV-R325 An on/off valve that interconnects two forcemains in a wastewater forcemain application, that is actuated by operator control. Note that the loop number is only three digits as this is a *Collections* application.

7.1.7 Multi-Function Instruments

Each discrete physical instrument shall only be given one instrument identifier, regardless of the number of functions within that instrument. For example, a submersible pump protection relay may have a temperature relay and a leak detection relay within one device. The instrument would be identified with a single identifier and a functional designation of UY. If it is desired to show the specific functionality of the instrument, then the subcomponent format described in Section 7.6 shall be utilized.

7.1.8 Additional Clarifications

7.1.8.1 Submersible Pumps and Mixer Leak Detection

Submersible pump and mixer leak detection sensors shall be identified with a functional designation of ME (Moisture Element).

7.1.8.2 Temperature Transmitters

Temperature transmitters with integrated temperature elements shall be identified with a functional designation of TT or TIT. In the event that the integrator temperature element of the temperature transmitter requires identification, utilize the subcomponent format (i.e. S682-TT.TE). On P&IDs, do not show the temperature element if integrated with the temperature transmitter. Refer to Figure 7-1 for examples.

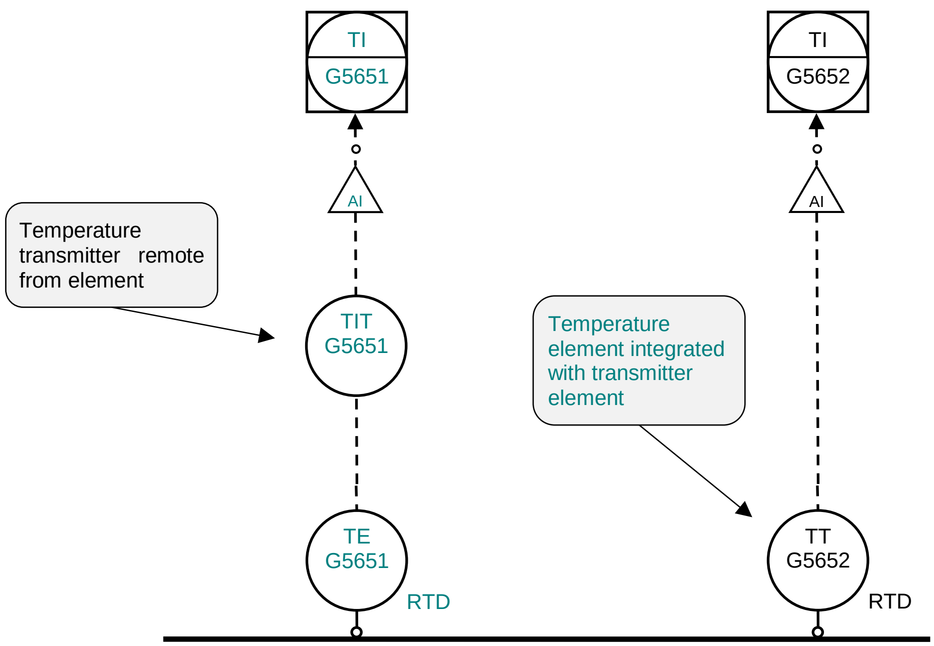


Figure 7-1: Example Temperature Transmitters

7.2 Automation Equipment

7.2.1 Identifier Format

The identification format for automation equipment, other than instrumentation, is as follows.

FFFF	-	EEEE	-	A	NN(N)(N)	-	S
Facility Code (Optional)	-	Equipment Functional Designation	-	Area Code	Equipment Number	-	Suffix (Optional)

Where,

FFFF — is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.

EEEE — is the *Equipment Functional Designation*, which is comprised of 2 to 4 characters from Section 7.2.2.

A — is the *Area Code*, which is based on Section 2.3.

NN(N)(N) — is the *Equipment Number*. Select numbers consistent with the ranges in Appendix D.

S — is the Suffix, an optional numeric or letter code to distinguish between multiple pieces of equipment with a common equipment number. Generally, numbers are utilized for equipment in series, and letters for equipment in parallel.

Examples:

0101-PLC-G8101	A PLC located in the Grit area of the NEWPCC facility.
PLC-G110	A PLC dedicated to pump P-G110.
RIO-G110-1	Remote I/O associated with PLC-G110
JBA-G851	A junction box not associated with a specific mechanical unit of equipment, and thus numbered in the 800 series equipment numbers.
JBA-L52	An automation junction box in a Collections Facility.

7.2.2 Functional Designations

Table 7-4 : Automation Equipment Functional Designations

Functional Designation	Description	Notes
ADP	Automation Device Panel	
CA	Cable (Automation)	
CP	Control Panel / Cabinet	
CS	Computer Server	
CW	Computer Workstation - General	
CWD	Computer Workstation - Development	
CWO	Computer Workstation - Operator	
DCS	Distributed Control System	
FDP	Field Device Panel	Use for new installations should not be common.
GDC	Gas Detection Controller	
LHMI	Standalone Human Machine Interface (HMI) Terminal	e.g. local touchscreens
ISB	Intrinsic Safety Barrier	Typically only a subcomponent.
JBA	Junction Box (Automation)	
LCP	Local Control Panel	
PLC	Programmable Logic Controller	
PRN	Printer	
RIO	Remote I/O	
RTU	Remote Terminal Unit	
TB	Terminal Block	Subcomponent only.

Notes:

1. *Avoid overlap of Automation Equipment Functional Designations with Electrical, Mechanical, or Process Functional Designations.*

7.2.3 IT Equipment Designations

Equipment within the domain of the City's Information Technology division may utilize a City IT specific identifier. Where this IT identifier is utilized, it is recommended that it is utilized in parallel to the identifiers in this standard. The rationale for this is as follows:

- The IT identifiers are created and tracked by a separate division within the City and are not managed by the same groups responsible for the remainder of the assets of the Water and Waste department.
- The IT identifiers are not consistent with this standard.
- The IT identifiers are applied in a "serial number" style to a specific piece of hardware, and not utilized as an asset identifier, as per the equipment within this standard. For example, if a computer is replaced, the IT identifier would change. However, for computers shown on automation drawings, use of the IT identifier in the automation domain would require that all relevant drawings with identifiers be updated.
- It is recommended to segregate the IT and Automation domains as much as possible.

7.3 Automation Cables

7.3.1 Instrumentation Cables

The identification format for automation cables is as follows. Note that the identification of power cables is discussed in Sections 6.4.2 and 6.4.3.

CA	**-**	**A**	**NN(N)(N)T**	**-**	**S**
Cable Designation	-	Area Code	Loop Number of Instrumentation	-	Suffix (Optional)

Where,

CA — is the *Cable Designation*, which for automation cables is comprised of the letters CA.

A — is the *Area Code*, which is based on Section 2.3.

NN(N)(N)T — is the *Loop Number* of the associated instrument. Where the cable connects two instrumentation devices with different loop numbers, identify the cable by the device that provides the signal.

S — is the *Suffix* utilized to identify the specific cable associated with the loop The Suffix is not required if a single cable is associated with the instrument loop. Utilize sequential numbers for cables in series, or for different purposes, and letters for cables in parallel.

Examples:

CA-G6831 — A cable from FSL-G6831 to a control panel.

CA-S5011-1 — A signal cable from a flowmeter to a control panel mounted instrument, FC-S5011.

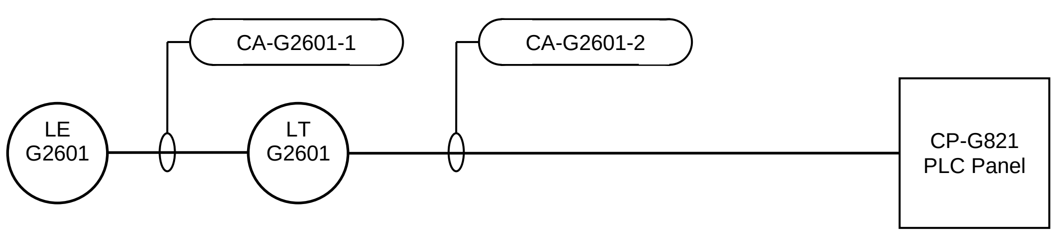


Figure 7-2: Instrument Cable Identification Example – Level Transmitter

7.3.2 Cables Associated with Identified Equipment

The identification format for automation cables is as follows.

CA	-	A	NN(N)(N)	-	S
Cable Designation	-	Area Code	Equipment Number of Associated Equipment	-	Suffix (Optional)

Where,

CA — is the *Cable Designation*, which for automation cables is comprised of the letters CA.

A — is the *Area Code*, which is based on Section 2.3.

NN(N)(N) — is the *Equipment Number* of the associated equipment. Where the cable connects two pieces of equipment, identify by the downstream, or serviced piece of equipment.

S — is the *Suffix* utilized to identify the specific cable associated with the equipment. The Suffix is not required if a single cable is associated with the equipment. Utilize sequential numbers for cables in series, or for different purposes, and letters for cables in parallel.

Note: In some cases, a cable could be considered either associated with instrumentation (4 digit loop number as per Section 7.3.1) or equipment (3 digit equipment number as per this section). It is left up to the designer to select the most appropriate cable identifier.

Examples:

CA-G683-1 — A 120 VAC control cable for pump P-G683.

CA-F723 — A control cable for UPS-F723

CA-P711 — A cable with a signal from a breaker status in PNL-P711.

Figure 7-3: Instrument Cable Identification Example – Identified Equipment

7.4 Sample P&ID

A sample pump P&ID is provided below to illustrate typical conventions for identifying instrumentation.

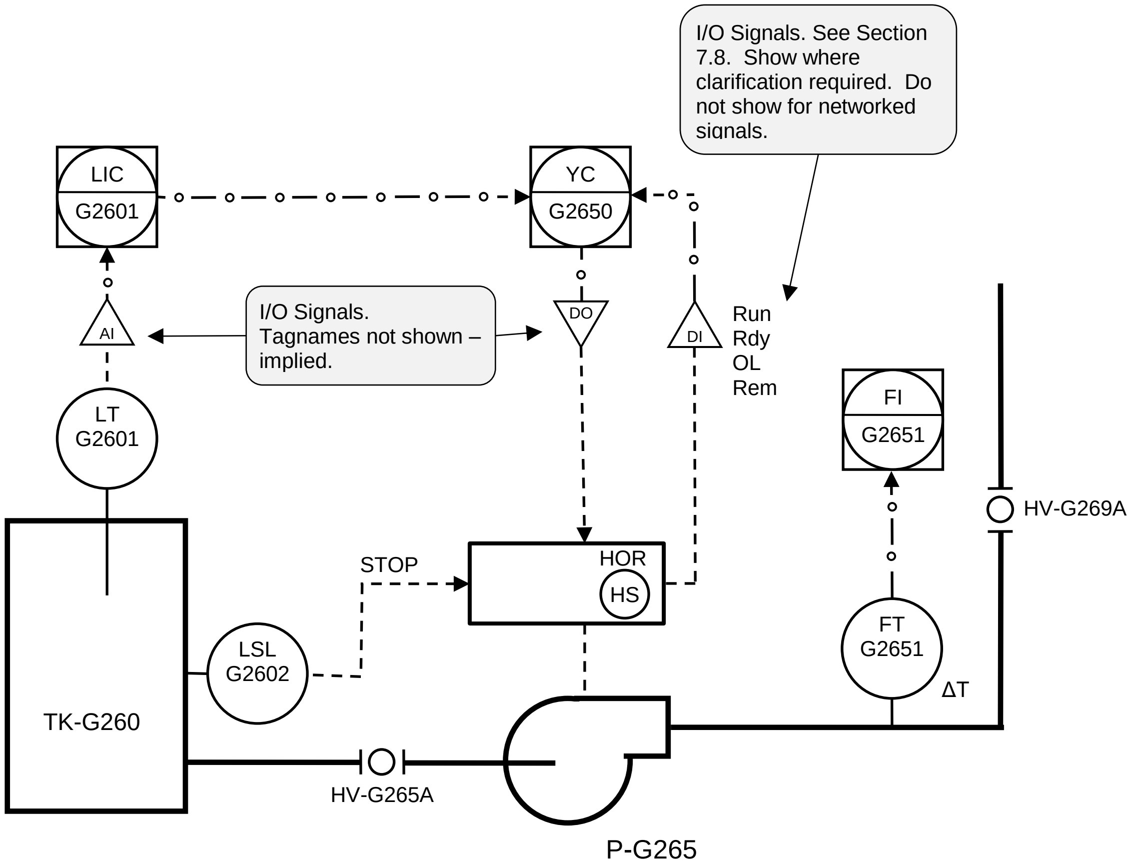


Figure 7-4: Sample Pump P&ID

7.5 Wire Tags

7.5.1 Power Circuits within Control Panels

Power circuits within control panels only require unique identification within the control panel. Where power circuits extend outside the panel, they will typically be based upon the wire tagging scheme identified in Sections 7.5.2 and 7.5.3.

The identification format for power circuit wire tags within control panels is as follows.

D	**W**
Power Designation	Wire Number

Where,

D is the *Power Designation*, which is based upon Table 7-5.

W is the *Wire Number*, an incrementing number.

Table 7-5 : Wire Tag Power Designations

Power Designation	Description
C	DC Common (0V)
G	Ground
L	AC Power (Hot)
N	AC Neutral
P	DC Positive
NEG	DC Negative (not grounded)

Note: The Ground designation is not typically required, provided that the ground wire is green.

Examples:

L1 Main 120VAC circuit within a control panel.

L11 120VAC sub-circuit, after fuse FU-11.

N1 AC Neutral associated with circuit L1.

P22 24VDC circuit

C1 24VDC common wire (0V)

7.5.2 Control Circuits

The identification format for automation control circuits is as follows:

A	**NN(N)(N)**	**T**	**-**	**W**	**S**
Area Code	Equipment Number	Instrument Number	-	Wire Number	Suffix (Optional)
	Loop Number				

Where,

A is the *Area Code*, which is based on Section 2.3.

NN(N)(N) is the *Equipment Number* of the associated equipment. If no equipment is associated, allocate *Equipment Numbers* specific for the applicable instrumentation.

T is the *Instrument Number*, where the number increments from the number 1 through 9. Use of the number 0 should be infrequent, except for special instruments, or those where the instrument ending with 0 is a common instrument that serves other instruments.

NN(N)(N)T is the Loop Number, comprised of the *Equipment Number* together with the *Instrument Number*.

W is the *Wire Number*, which is typically an incrementing number. For power wires the *Wire Number* shall be based on Table 7-5.

S is an optional *Suffix*, and is utilized where it is desired to utilize the same wire number, but the signal has changed.

Notes:

1. *It is not required that the Wire Number match the control panel terminal number.*
2. *See Section 6.4.6.4 regarding wire numbering for motor control circuits.*

Examples:

G6521-11 Control wire 11 associated with TSH-G6521.

G6521-11A Control wire 11A associated with TSH-G6521.

G6522-P 24VDC Power wire for FT-G6522.

G6522-C 24VDC Common wire for FT-G6522.

7.5.3 Analog Signal Circuits - Instruments

The identification format for analog signal circuits associated with instruments is as follows:

A	**NN(N)(N)**	**T**	**-**	**W**	**A**
Area Code	Equipment Number	Instrument Number	-	Wire Number (Optional)	Analog Designation
	Loop Number				

Where,

A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)T	is the Loop Number, comprised of the *Equipment Number* together with the *Instrument Number*.
W	is the *Wire Number*, an incrementing number. The wire number may optionally be omitted for two wire control.
A	is the Analog Designation, which is typically either “+” or “–“. For power wires the designation shall be based on Table 7-5.

Notes:

1. *It is not required that the Wire Number match the control panel terminal number.*
2. *For two-wire signals, use “+” and “-“ designations. Do not utilize a power designation “-P” for two wire signals.*

Examples:

G6523+	Signal wire + associated with TT-G6523.
G6523-	Signal wire - associated with TT-G6523.
M4215-1+	Signal wire 1+ associated with FT-M4215
M4215-P	24VDC power wire associated with FT-M4215 (Four wire signal).

7.5.4 I/O Wiring

I/O wiring within a control panel is designated by the I/O address rather than the connected instrument. This allows for a more straightforward control panel layout, and avoids relabeling internal panel wiring upon reallocation of I/O. The identification format for I/O wiring in a control panel is as follows:

DD	**R**	**.**	**M**	**.**	**N**	**S**
I/O Designation	Rack Number (Optional)		Module Number (Optional)		I/O Number	Suffix Designation (Optional)

Where,

DD is the *I/O Designation*, which is based on Table 7-6.

R is the *Rack Number*, which is typically one or two digits. A Rack Number is not applicable to all I/O systems.

M is the *Module Number*, which is typically one or two digits. A *Module Number* is not applicable to all I/O systems.

S is the *Suffix Designation*, if applicable, which is based on and typically is either “+” or “–“.

Table 7-6 : I/O Designations

Power Designation	**Description**
AI	Analog Input
AQ	Analog Output
I	Discrete Input (AC or DC)
Q	Discrete Output (AC or DC)

Table 7-7 : Suffix Designations

Suffix Designation	Description
C	Utilize for isolated DC discrete input modules to designate the specific common line.
L	Utilize for isolated output modules and relay modules to designate an AC incoming line.
N	Utilize for isolated AC discrete input modules to designate the specific neutral line.
P	Utilize for isolated output modules and relay modules to designate an DC incoming line.
+	Analog positive or incoming wire.
-	Analog negative or outgoing wire.

Notes:

1. *The I/O Wiring Designation is to be utilized within a control panel only. Utilize wire designations based upon Sections 7.5.2 and 7.5.3 for wiring outside the control panel.*
2. *It is acceptable for a wire on one side of a terminal to be designated by an I/O designation and to have an alternate identifier for the wire on the other side of the terminal.*

Examples:

AI1.0.1+	Analog input + wire associated with rack 1, module 0, point 1.
AQ5.3-	Analog output – wire associated with module 5, point 3. The rack number is not applicable.
I52	Discrete input 52. The rack number and module number are not applicable.
I5.3.31	Discrete input associated with rack 5, module 3, point 31.
Q2.1.5	Discrete output associated with rack 2, module 1, point 5.
Q3.2.5L	Incoming AC line signal for discrete output relay associated with rack 3, module 3, point 5.

7.6 Subcomponents

7.6.1 Instrumentation Subcomponents

As described in Section 2.6, devices that are an inherent component of a larger unit of equipment or instrumentation are designated as subcomponents. With a strict implementation of ISA 5.1, these subcomponents would potentially be given full identifiers. However, in assigning full identifiers for these signals, the relationship between the subcomponent and its parent piece of equipment is not always clear. Additionally, more identifiers are used as a result of having to assign an identifier to each subcomponent. A good example of instrumentation subcomponents is a valve with limit switches. The limit switches are typically deemed to be a subcomponent of the valve.

As described in Section 2.6, subcomponents can be identified by extending the containing equipment name with a suffix. The parent equipment identifier and suffix are to be separated by a period. This system creates a hierarchy, allowing for rapid identification of subcomponents and reduces programming efforts when integrating these signals into an automation system.

A good example for a mechanical piece of equipment that contains subcomponents is a valve actuator with integrated open and closed limit switches. The limit switches would not typically be labelled separately in the field, as there is no specific discrete equipment to attach the label to, other than the valve actuator as a whole. The suffix would be based upon the subcomponent's functional identification. For example, a P&ID example with a subcomponent is shown in Figure 7-5. Note that the subcomponents of the valve are the limit switches, identified as follows:

XV-G381.ZSO	The open limit switch of the valve XV-G3811
XV-G381.ZSC	The closed limit switch of the valve XV-G3811
MS-6381.HS	The *Hand-Off-Remote* switch on motor starter MS-G381.

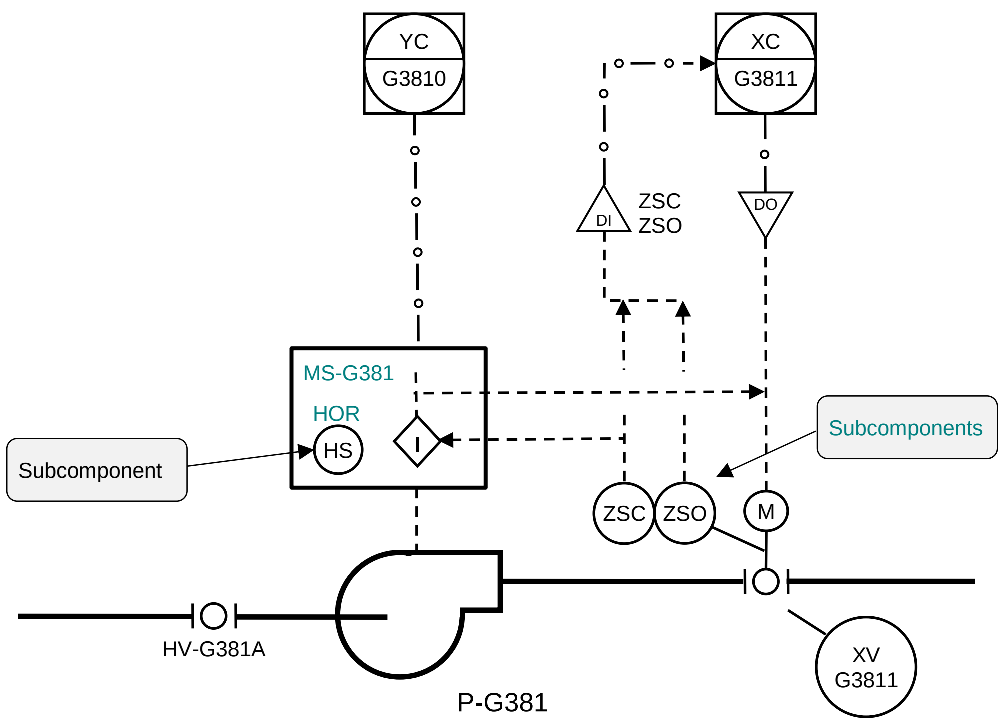


Figure 7-5 : Subcomponents – Electrical and Instrumentation

7.6.2 Panel Subcomponents

Devices within control panels, automation device panels, junction boxes, and other panels should typically be identified as subcomponents unless they are accessed separately from the containing panel. Examples of equipment not to be identified as subcomponents are shown in Table 7-8.

Table 7-8 : Automation Equipment Not To Be Identified as Subcomponents

Functional Designation	Description
CS	Computer Server
CW	Computer Workstation - General
CWD	Computer Workstation - Development
CWO	Computer Workstation - Operator
GDC	Gas Detection Controller
LHMI	Standalone Human Machine Interface (HMI) Terminal
PLC	Programmable Logic Controller
PRN	Printer
RIO	Remote I/O
RTU	Remote Terminal Unit

7.7 Software Configuration File Naming

Where software to configure automation equipment does not include integral version management, software configuration file names shall be composed as follows.

FFFF		**E***		**YYYY**	**MM**	**DD**	**-**	**X**
Facility Code (Optional)	-	Equipment Identifier	-	Year	Month	Day	-	Revision Modifier (Optional)
				Date				

Where,

FFFF	is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be included in the filename where required.
E*	is the unique *Equipment Identifier*, as identified by other sections of this document.
YYYYMMDD	is the date of the last edit.
X	is the *Revision Modifier*, which a letter beginning with A, B, C…. used to indicate intra-day revisions.

Examples:

PLC-G250-20120819	A PLC program for PLC-G250 last edited on August 19, 2012.
LT-M1011-20120501-B	A configuration file for level transmitter LT-M1011, dated May 1, 2012, second revision.
NSW-C901-20121231	A network switch configuration file dated December 31, 2012.

7.8 I/O and Signal Tags

7.8.1 Discrete Input Signals

Identification of discrete input signals (I/O) will be as follows:

E*	**.**	**F**	**_**	**S**
Base Equipment / Instrument Identifier	.	Functional Signal Designation		Suffix (Optional)

Where,

E* is the *Base Equipment / Instrument Identifier*, based upon other parts of this document. See the examples for clarification.

F is the *Functional Signal Designation*, which represents the type of discrete signal. The *Functional Signal Designation* shall utilize ISA-5.1 style naming convention where applicable, but if not applicable, shall be based on Table 7-9.

S is the optional *Suffix*, which is a number utilized to differentiate between multiple similar signals.

Table 7-9 : Discrete Input Functional Signal Designations – Non ISA

Signal	**Description**
.Auto	Hand Switch Auto Position
.Byp	Hand Switch Bypass Position
.Flt	Faulted (See Note 5)
.HS_*	Signal from Hand Switch Integrated into Equipment. (See Note 4)
.Loc	Hand Switch Local Position
.Man	Hand Switch Manual Position
.Occ	Hand Switch Occupied Position
.Off	Hand Switch Off Position
.Rdy	VFD / Motor Starter Ready
.Rem	Hand Switch Remote Position
.Rst	Hand Switch Reset Pushbutton
.Run	Motor Running
.RunHi	Motor Running High Speed
.RunLo	Motor Running Low Speed
.Start	Hand Switch Start Pushbutton
.Stop	Hand Switch Start Pushbutton

Notes:

1. *The above list does not indicate ISA 5-1 style functional designations, based upon Table 7-1, where applicable. This table is to be utilized only when an ISA 5-1 style designation is not appropriate or clear.*
2. *The above list is not exhaustive, and the designer is expected to follow a similar convention to the above when assigning new signal names. Commonly used signal names should be added to the table.*
3. *ISA 5.1 style designations are to utilize capital letters only. Non ISA-5.1 designations are to use a first capital letter, followed by lowercase letters.*
4. *A combination of ISA and non-ISA designations is permissible, provided they are connected via an underscore. For example: HS_Rem represents a hand switch remote position for a non-identified switch on a piece of equipment.*
5. *Utilize Flt (Fault) rather than an overload designation for the signal coming from a motor overload. With current electronic overloads, multiple conditions other than just an overload can cause an alarm/trip and the fault designation is more appropriate.*

Examples:

HSS-G1051	Stop pushbutton signal from HSS-G1051, which is associated with pump P-G105. Note that no Functional Signal Designation is required, as only a single, unambiguous signal is provided from the switch.
P-G105.Rem	The switch in *Remote* signal from the *Hand-Off-Remote* switch HS-G105, which is associated with pump P-G105. A Functional Signal Designation is required to clarify the indicated specific switch position.
VFD-G101.Flt	VFD fault signal for pump P-G101. As the fault is associated with the VFD, the VFD is deemed to be the *Source Equipment / Instrument Identifier*.
AHU-M602.Run	Running signal from AHU-M602 motor starter. As the air handling unit is deemed to be the functional source of the running signal, it is deemed to be the *Source Equipment / Instrument Identifier*.
FT-S6021.Flt	Fault signal associated with flow transmitter FT-S6021.
XV-S3810.ZSC	Closed limit switch signal from valve XV-S3810.
XV-S3810.Auto	Hand switch in auto signal from valve XV-S3810.
TSH-G1051	A high temperature signal from TSH-G1051.
TSH-G1052-1	A high temperature signal from TSH-G1052-1.
TY-G1053.TSH	A high temperature output signal from a temperature relay.

Acceptable Alternate

In some cases, equipment may be complex, and it may be desired to associate all I/O directly with the source instrument / device / equipment, even for motor control. If this scheme is implemented, it is to be consistent across the facility. Note that this scheme is not currently accepted for wastewater facilities.

Example:

HS-G1050.Rem	The switch in *Remote* signal from the *Hand-Off-Remote* switch HS-G105, which is associated with pump P-G105. In this alternate scenario, note that the Base Equipment / Instrument Identifier is the actual instrument rather than the associated equipment. A Functional Signal Designation is required to clarify the indicated specific switch position.

7.8.2 Discrete Output Signals

Identification of discrete output signals (I/O) will be as follows:

E*	**.**	**Cmd**	**F**	**_**	**S**
Controlled Equipment / Instrument Identifier	.	Output Designation	Functional Signal Designation		Suffix (Optional)

Where,

E*	is the *Controlled Equipment / Instrument Identifier*, based upon other parts of this document.
Cmd	Is the *Output Designation*, utilized to identify all outputs signals.
F	is the *Functional Signal Designation*, which represents the type of discrete signal. The *Functional Signal Designation* shall be based on Table 7-10.
S	is the optional *Suffix*, which is a number utilized to differentiate between multiple similar signals.

Examples:

AHU-M602.CmdRun	Motor run output signal for AHU-M602.
VFD-M602.CmdEnb	Enable command to the VFD-M602, which is associated with AHU-M602. The *Controlled Equipment / Instrument Identifier* is deemed to be the VFD, as the enable command is deemed to be specific to the VFD.
YL-M6011.CmdOn	Output signal to turn on pilot light YL-M6011.
XV-S3810.CmdCls	Close signal command to valve XV-S3810.

Table 7-10 : Discrete Output Functional Signal Designations

Signal	Description
.CmdRun	Run Command
.CmdRunHi	Run Command – High Speed
.CmdRunLo	Run Command – Low Speed
.CmdRst	Fault Reset Command
.CmdCls	Close Command
.CmdOpn	Open Command
.CmdEnb	Enable Command
.CmdExt	Extend Command (utilize for samplers)
.CmdRet	Retract Command (utilize for samplers)

Notes:

1. *The above list is not exhaustive, and the designer is expected to follow a similar convention to the above when assigning new signal names. Commonly used signal names should be added to the table.*
2. *All discrete outputs are to be prefixed with the Cmd designation.*

7.8.3 Analog Signals Generated From Equipment

Identification of analog control system software I/O and signal tags, where the source of the signal is not identified as an instrument, will be as follows:

E*	**.**	**F**	**_**	**S**
Equipment Identifier	.	Functional Variable		Suffix (Optional)

Where,

E* is the *Equipment Identifier*, based upon other parts of this document.

F is the *Functional Variable*, which represents the type of analog signal. This field is only required for multivariable transmitters. The *Functional Variable* shall be based on the first column of Table 7-1, with an optional character from the second column. Note that the *Functional Variable* is based upon ISA 5.1.

S is the optional *Suffix*, which can be any short designation appropriate to represent the specific signal. Ideally the suffix will be four characters or less. The *Suffix* is separated from the Functional Variable by an underscore.

Note:

1. Do not use this format for analog signals from identified instruments. Refer to Section 7.8.4.

Examples:

UPS-G702.E_Bat	UPS–G702 Battery Voltage Level
UPS-G702.E_In	UPS–G702 Input Voltage Level
UPS-G702.E_Out	UPS–G702 Output Voltage Level
VFD-G101.T	VFD-G101 internal temperature.
CB-M01.RLY.E_An	The voltage signal between phase A and neutral for the protection relay associated with circuit breaker CB-M01.
MS-S501.I_A	The phase A current associated with motor starter MS-S501.

7.8.4 Analog Measured Signals Generated From Instruments

Identification of analog control system software I/O and signal tags, where the source of the signal is an instrument, will be as follows:

I*	.	F	_	S
Instrument Identifier	.	Functional Variable (Optional)		Suffix (Optional)

Where,

I*	is the *Instrument Identifier*, based upon other parts of this document.
F	is the *Functional Variable*, which represents the type of analog signal. This field is only required for multivariable transmitters. The *Functional Variable* shall be based on the first column of Table 7-1, with an optional character from the second column. Note that the *Functional Variable* is based upon ISA 5.1.
S	is the optional *Suffix*, which can be any short designation appropriate to represent the specific signal. Ideally the suffix will be four characters or less. The *Suffix* is separated from the *Functional Variable* via an underscore.

Examples:

MT-G6231	Moisture signal of MT-G6231
FT-S5122.P	Pressure signal of differential pressure based flow transmitter FT-S5122.
FT-S5122.F	Flow signal of multivariable transmitter FT-S5122.
FT-S5122.T	Temperature signal of multivariable transmitter FT-S5122.
FV-G6821.Z	Position of damper FV-G6821.
PDT-G4231.P_H	High side pressure of differential pressure transmitter PDT-G4231.
PDT-G4231.P_L	Low side pressure of differential pressure transmitter PDT-G4231.
PDT-G4231.PD	Differential pressure of differential pressure transmitter PDT-G4231.
TT-M613	TT-M613 temperature signal

7.8.5 Analog Output Signals

Identification of analog control system software I/O and signal tags, where the source of the signal is a controller such as a PLC, will be as follows:

E*	**.**	**Cmd**	**F**	**-**	**S**
Controlled Equipment / Instrument Identifier	.	Output Designation	Functional Variable	-	Suffix (Optional)

Where,

E* is the *Controlled Equipment* / *Instrument Identifier*, based upon other parts of this document. The *Controlled Equipment* / *Instrument Identifier* should be the ultimate controlled equipment.

Cmd Is the *Output Designation*, utilized to identify all outputs signals.

F is the *Functional Variable*, which represents the type of analog signal. The *Functional Variable* shall be based on the first column of Table 7-1, with an optional character from the second column. Note that the *Functional Variable* is based upon ISA 5.1 and in this case will represent the specific output signal, not necessarily the loop identification.

S is the optional *Suffix*, which can be any short designation appropriate to represent the specific signal. Ideally the suffix will be four characters or less. The *Suffix* is separated from the *Functional Variable* via an underscore.

Examples:

FV-M2151.CmdZ Valve position command signal from flow indicating controller FIC-M2151. Note that while the control loop is based on flow, the specific signal is a Z, driving the valve position.

P-M210.CmdS Pump speed command signal. Note that the pump is the ultimate controlled equipment and not the variable speed drive.

BLR-B610.CmdT Boiler temperature command signal. This would be appropriate when the destination of this signal is a boiler that has an integral dedicated controller.

HCE-B619.CmdJ Power command signal (in % of full power) to an electric heating coil controller. In the event that the signal represented a specific temperature setpoint, then the *Functional Variable* would be a T.

TC-B610.CmdT Temperature command / setpoint signal to an external temperature controller TC-B610.

TV-G6822.CmdZ Temperature valve position command signal.

7.8.6 Control System Software Implementation

Where a control system software implementation does not support the use of the "." character used in the signal identification, it is recommended to replace the period "." character with an underscore ("_"). For example:

P-G101.Flt would become P-G101_Flt

8 COMMUNICATION EQUIPMENT

8.1 Identifier Format

The identification format for communication equipment is as follows.

FFFF	-	EEEE	-	A	NN(N)(N)	-	S
Facility Code (Optional)	-	Equipment Functional Designation	-	Area Code	Equipment Number	-	Suffix (Optional)

Where,

FFFF	is the *Facility Code*, from Appendix A. The *Facility Code* will typically be implied, and would only be fully written where required.
EEEE	is the *Equipment Functional Designation*, which is comprised of 2 to 4 characters from Section 8.2.
A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number*. Select numbers consistent with the ranges in Appendix D.
S	is the Suffix, an optional numeric or letter code to distinguish between multiple pieces of equipment with a common equipment number. Generally, numbers are utilized for equipment in series, and letters for equipment in parallel.

Examples:

NSW-G901	An Ethernet switch located in the G area.
JBN-G110	A networking junction box associated with pump P-G110.
NJ-G901-1	A networking jack associated with NSW-G901.

8.2 Functional Designations

Table 8-1 : Communication Equipment Functional Designations

Functional Designation	Description	Notes
ANT	Antenna	
CN	Network Cable	
CNP	Network Cable - Patch	
JBN	Junction Box - Network	
MDM	Modem	
NAP	Network Access Point	
ND	Network Device	Utilize for general devices not otherwise in list. Example: network terminators
NFW	Network Firewall	
NGW	Network Gateway	
NJ	Network Jack	
NJT	Network Jack – Telephone	
NMC	Network Media Converter	
NP	Networking Panel / Cabinet	
NPP	Networking Patch Panel	
NRD	Network Radio	
NRP	Network Repeater	
NRT	Network Router	
NSP	Network Segment Protector	Typically used for PROFIBUS PA
NSW	Network Switch, Ethernet	
NT	Network Terminator	

Notes:

1. *Avoid overlap of Communication Equipment Functional Designations with Electrical, Mechanical, and Automation Functional Designations*

8.3 Network Cables

The identification format for network cables is as follows.

CN	-	A	NN(N)(N)	-	S
Cable Designation	-	Area Code	Equipment Number of Associated Equipment	-	Suffix (Optional)

Where,

CN	is the *Cable Designation*, which for network cables is comprised of the letters CN.
A	is the *Area Code*, which is based on Section 2.3.
NN(N)(N)	is the *Equipment Number* of the associated equipment. Where the cable connects two pieces of equipment, identify by the downstream, or serviced piece of equipment.
S	is the *Suffix* utilized to identify the specific cable associated with the equipment. The Suffix is not required if a single cable is associated with the equipment. Utilize sequential numbers for cables in series, or for different purposes, and letters for cables in parallel. Utilize the letter T to designate tie connections.

Examples:

CN-G901-1	An uplink network cable for NSW-G901.
CN-M2531	A network cable that connects level transmitter LT-M2531.
CN-M801	A network cable that connects PLC-M801 to NSW-M910.

The following Appendices have been moved to a separate document titled *Identification Standard* Appendices managed by the Wastewater Planning and Project Delivery Branch. To request a copy of the document, please contact the Wastewater Planning and Project Delivery Branch Head.

Appendix A Facility Codes

Appendix B Facility Area Codes

Appendix C Master Equipment Functional Designations

Appendix D Equipment Number Ranges

Appendix E Sample Drawings

Winnipeg

The City of Winnipeg

Water & Waste Department

Identification Standard Appendices

Document Code:

Revision: 01

Approved By:	Duane Griffin Duane Griffin, Wastewater Planning Branch Head	June 2, 2020 Date

REVISION REGISTER					
Rev.	**Description**	**Date**	**By**	**Checked**	**Approved**
00	Created as a separate document for Identification Standard Appendices	2019-12-02	L. Harrington	E. Campbell C. Wiebe	C. Wiebe
01	Updated Facility Codes	2020-06-02	K.Schimke	D.Griffin	D.Griffin

This document is owned and maintained by the Wastewater Planning and Projects Delivery Branch of the Engineering Services Division. For questions, comments or revisions please contact the Wastewater Planning and Projects Delivery Branch Head.

TABLE OF CONTENTS

1 INTRODUCTION

This Water and Waste Department (WWD) Identification Standard Appendices (appendices) document is to be referenced for consistent and accurate identification for facilities. The appendices will be coordinated with the Identification Standard and document numbering standards as appropriate.

1.1 Document Revisions

Wastewater Planning and Project Delivery Branch (WWPPD) will issue revisions to the document on an as required basis. WWPPD will send out an email requesting review and comments by the division list below.

All proposed revisions shall be circulated to the following divisions and branches:

- Water Services Division
- Wastewater Services Division
- Solid Waste Services Division
- Engineering Division
    - Asset Management Branch
    - Design and Construction Branch
    - Drafting and Graphic Services Branch
    - Land Drainage and Flood Protection Branch
    - Wastewater Planning and Project Delivery Branch
    - Water Planning and Project Delivery Branch

Appendix A Facility Codes

Each City of Winnipeg facility is assigned a unique, four-digit facility code. The facility code is to be used on drawings and documentation as required. The facility code appears within all City drawing numbers, but need not be shown within the content of the drawing. The facility code is deemed an optional component of equipment and instrument identifiers, with the preference to omit the facility code to reduce the overall length of identifiers.

Systems such as a central Supervisory Control and Data Acquisition (SCADA) system that monitors multiple facilities are to make use of the facility code to segregate components by facility. The implementation of the facility code may be by means of a hierarchical directory system whereby individual components are stored under a folder that is named by the facility code. If the database or system where the identifier is being stored supports an additional field for the facility code, or is based upon a hierarchical system where the identifier can be placed as a component off of a root facility branch, it is deemed to be acceptable to omit the facility code in the instrument identifier. For example, the City's current Computerized Work Management System (CWMS) has an integral asset list, where a field is provided for the facility. In this case, the facility code for the equipment identifier would not be entered.

A.1 Project Facility Codes

It is the responsibility of the Project Manager to notify Drawing Control and Underground Structures (UGS) Approval Process Technologist from the Design and Graphics Branch (D&G) of any consultant or in-house projects requiring City drawings numbers during the Planning phase of a project. In the email, provide the project name, description of the project and the anticipated deliverables (drawings), facility code(s) and any applicable area codes.

A.1.1 Creating New Facility Codes

It is the responsibility of the Project Manager to notify the WWPPD when a new facility code is required for a project. Request a new facility code by emailing WWPPD (cc. Drawing Control and UGS Approval Process Technologist from D&G) the following information:

- Project name
- Description of the project
- Proposed facility code name
- Type of facility (i.e. Collection Facility)

A review of the request will be undertaken by WWPPD in consultation with D&G and appropriate business unit (if required). WWPPD will update the Facility Codes Document and send an email with the assigned facility code to D&G and the Project Manager.

A.1.2 Revising Existing Facility Codes

Only WWPPD can revise the WWD Facility Codes. If it is determined that a facility code needs to be revised, Project Managers should send an email to the WWPPD (cc. Drawing Control and UGS Approval Process Technologist from D&G) informing them of why the change is needed. Some examples that would warrant a revision include:

- Naming errors (need to align with WWD naming structure and asset categories)
- Duplication of facility codes
- Decommissioning of a facility
- Merging of two facilities

A review of the request will be undertaken by WWPPD in consultation with D&G and appropriate business unit (if required). If accepted, WWPPD will update the Facility Codes and send an email to D&G and the Project Manager.

A.2 Definitions

Future: Facility code reserved for upcoming project.

Spare: Facility code available for use within the specified facility category or sub-category (i.e. 'Sewage Treatment Facilities').

Unused: Facility codes available for a new facility category.

Discontinued: Facility code is no longer in use and is not to be reassigned.

Facility Code	Facility
0001	**General – to be used only when no other facility codes apply**
0002 - 0099	**Unused**
0100 - 0109	**Sewage Treatment Facilities**
0100	General – Sewage Treatment Facilities
0101	North End Sewage Treatment Plant (NEWPCC)
0102	South End Sewage Treatment Plant (SEWPCC)
0103	West End Sewage Treatment Plant (WEWPCC)
0104-0109	Spares
0110 - 0299	**Collections Facilities – Lift, Flood Pumping, CSO & Diversion Stations**
0110	General – Collections Facilities
0111	DISCONTINUED (was Perimeter Road Pumping Station, now part of the WEWPCC Facility Code)
0112	Alexander Diversion Station
0113	Armstrong Diversion Station
0114	Ash Lift and Flood Pumping Stations (separate buildings on neighbouring properties)
0115	Assiniboine Flood Pumping Station
0116	Aubrey Lift and Flood Pumping Stations (separate buildings on neighbouring properties)
0117	Baltimore Lift and Flood Pumping Stations (separate buildings on neighbouring properties)
0118	Bannatyne Flood Pumping Station
0119	Barker Lift Station
0120	Bournais / Mission Gardens Lift Station
0121	Burrows Lift Station
0122	Camiel Lift Station
0123	Chataway Lift and Flood Pumping Station (combined station)
0124	Clarence Lift Station
0125	Clifton Lift and Flood Pumping Stations (separate buildings)
0126	Cloutier Lift Station
0127	Cockburn Lift and Flood Pumping Station (combined station) and Diversion Chamber
0128	Colony Flood Pumping Station (formerly included in Colony Diversion Station – see 129)
0129	Colony Diversion Station
0130	Community Row Lift Station
0131	Conway Lift Station
0132	Cornish Flood Pumping Station
0133	Cornish Lift Station

Facility Code	Facility
0134	Crane Lift Station
0135	D'Arcy Lift Station
0136	Despins Lift and Flood Pumping Stations (separate buildings)
0137	Dublin Lift Station
0138	Dugald Road Lift Station
0139	Dumoulin Lift and Flood Pumping Station (combined station) and Diversion Chamber
0140	Elmhurst Lift Station
0141	Ferry Road Lift Station
0142	Galt Flood Pumping Station
0143	Grandmont Lift Station (underground) and Generator Building
0144	Hart Lift and Flood Pumping Stations (separate buildings on neighbouring properties)
0145	Hawthorne Lift and Flood Pumping Station
0146	Heritage Lift Station
0147	Holland Lift Station
0148	Jefferson Flood Pumping Station (formerly included Diversion Chamber – see 150)
0149	Jessie Lift and Flood Pumping Stations (separate buildings)
0150	Jefferson & Main Diversion Station
0151	Kilkenny Lift Station
0152	King Edward Lift Station
0153	Larchdale Lift Station
0154	Laverendrye Flood Pumping Station
0155	Linden Lift and Flood Pumping Stations (separate buildings)
0156	Louelda Lift Station
0157	Mager Drive Lift and Flood Pumping Stations (separate buildings on neighbouring properties)
0158	Manitoba Lift Station
0159	Marion Lift and Flood Pumping Stations (separate buildings on neighbouring properties)
0160	Mayfair Lift and Flood Pumping Station (combined station)
0161	Metcalfe Flood Pumping Station
0162	Metcalfe Lift Station
0163	Mission Flood Pumping Station
0164	Montcalm Lift Station
0165	Munroe Diversion Chamber
0166	Newton Flood Pumping and Diversion Stations (separate buildings)
0167	Notre Dame Lift Station
0168	Oak Grove Lift Station

Facility Code	Facility
0169	Olive Lift Station
0170	Pandora Lift Station
0171	Parklane Lift Station
0172	Parkwood Lift Station
0173	Polson Flood Pumping and Diversion Stations (separate buildings)
0174	Portsmouth Lift Station
0175	Pulberry Lift Station
0176	DISCONTINUED (was Ravelston Land Drainage Pumping Station, now part of 447)
0177	Ridgedale Lift Station
0178	Riverbend Lift Station
0179	Roland Flood Pumping Station
0180	Ryan Lift Station
0181	Selkirk Flood Pumping and Diversion Station (separate buildings)
0182	Somerville Lift Station
0183	Jefferson and Jones Diversion Chamber
0184	St. Charles Lift Station
0185	St. Johns Flood Pumping Station and Diversion Chamber
0186	St. Norbert / X-Kaley Flood Pumping Gate Chamber
0187	St. Norbert Lift Station
0188	Strathmillan Diversion Chamber
0189	Syndicate Lift and Flood Pumping Stations (separate buildings)
0190	Thibault Lift Station
0191	Trappiste Lift Station
0192	Tuxedo Lift Station
0193	Tylehurst Lift Station
0194	Westwood Lift Station
0195	Wexford Road Lift Station
0196	Willow Lift Station
0197	Windsor Park Lift Station
0198	Woodhaven Lift Station
0199	Assiniboine Park Lift Station
0200	Canora Flood Pumping Gate Chamber
0201	Crescent Drive Lift Station
0202	Ducharme High Level Site Manhole
0203	Enfield Crescent Lift Station
0204	Fort Rouge Park Flood Pumping Gate Chamber
0205	Irving Place Lift Station

Facility Code	Facility
0206	Kildare Flood Pumping Station
0207	Kildonan Park Lift Station
0208	Perimeter West Lift Station
0209	Kildonan Park Rainbow Stage Lift Station
0210	Saskatchewan Lift Station
0211	University of Manitoba Lift Station
0212	University of Winnipeg CSO Storage
0213	Victoria Crescent Lift Station
0214	DISCONTINUED (was Mazenod Lift Station, now part of 5-1 St Boniface Industrial Facility Code)
0215	St. Boniface Lift Station
0216	Assiniboine Park Lift Station
0217	Barker Standby Generator Building
0218	McDermot Dry Weather Overflow Manhole/CSO
0219	Windsor Park Standby Generator Building
0220-0299	Spares
0300 – 0399	**Land Drainage Facilities – Pumping Sites and Outfalls**
0300	Land Drainage Facilities - General
0301	Archibald Underpass Station
0302	Bishop Grandin Underpass Station
0303	Outfalls
0304	Keewatin Underpass Station
0305	Kenaston Underpass Station
0306	Kilkenny & Rice Flood Pumping Manhole
0307	Spare
0308	McPhillips Underpass Pumping Station
0309	Metro Route 20 Underpass Pumping Station
0310	Metro Route 90 Underpass Pumping Station
0311	Transit Underpass Pumping Station (Osborne)
0312-0313	Spares
0314	St. James Underpass Pumping Station
0315	Spare
0316	Turnbull Drive Flood Pumping Manhole
0317	Pembina Underpass Pumping Station
0318	Pembina Wye Track Pumping Station
0319	Waverley Underpass Pumping Station
0320	Plessis Road Underpass Pumping Station
0321	Chief Peguis Underpass Pumping Station (on warranty)

Facility Code	Facility
0322	Beaujolais Flood Pumping Gate Chamber
0323-0399	Spares
0400	**Brady Road Landfill**
0401 - 0599	**Land Drainage – Storm Retention Basins**
0401	1-1 Weston, south of Alexander Avenue
0402	Private Storm Retention Basins
0403-0411	Spares
0412	2-2 St. James, off Isbister Street, north of Hamilton Avenue
0413	2-3 St. James, south-west of Lumsden Avenue and Lake Ridge Road
0414	2-4 St. James, north of South Lake Drive
0415	2-5 Omand's Creek Industrial, north of Whitfield Avenue in Omand's Creek Industrial Park
0416	2-6 The Oaks Along the Assiniboine, west pond
0417	2-7 The Oaks Along the Assiniboine, east pond
0418-0420	Spares
0421	3-1 Maples, south-east corner of King Edward Street and Selkirk Avenue
0422	3-2 Maples, north-east corner of King Edward Street and Burrows Avenue
0423	3-3 Maples, north of Burrows Avenue at Benbow Road
0424	3-4 Maples, north-east corner of Garton Avenue and Belton Street
0425	3-5 Riverbend, north-west of Red River Boulevard and Riverstone Road
0426	3-6 Maples, north of Templeton Avenue and west of McPhillips Street
0427	Spare
0428	3-8 Maples, east of Keewatin Street and south of Adsum Drive
0429	3-9 Maples, Foxwarren Drive, west of Ritchie Street
0430	3-10 Amber Trails, west of Amber Trail and Ambergate Drive
0431	3-11 North Inkster Industrial, east of Meridian Drive and Inksbrook Drive
0432	3-12 North Inkster Industrial, east of Meridian Drive and north of Commercial Avenue
0433	3-13 Amber Trails, east of Strasbourg Drive and south of Thorn Drive
0434	3-14 Amber Trails, west of Massalia Drive
0435	3-15 Castlebury Meadows, south-west of Jefferson Avenue and King Edward Street
0436	3-16 Waterford Green, south of Jefferson Avenue and east of Brooksmere Trail
0437	3-17 Waterford Green, north of Commonwealth Path and east of Brooksmere Trail
0438	3-18 Aurora – North Point Village, south of North Point Boulevard, between Atlas Crescent
0439	3-19 Amber Gates, north of Templeton Avenue, between Cartesian Gate and Tennant Gate

Facility Code	Facility
0440	3-20 North Inkster Industrial, south of Haggart Avenue and west of King Edward Street
0441	Spare
0442	4-2 East Kildonan, off Gateway Road north, of Springfield Road (Bunn's Creek)
0443	4-3 Transcona, Cordite Ditch
0444	4-4 Kilcona Park, north-east Park Recreation Area (Harbourview Complex)
0445	4-5 Transcona, north-west corner of Devonshire Drive and Clouston Drive
0446	4-6 Transcona, south-east of Devonshire Drive and Kildonan Meadow Drive
0447	4-7 Transcona, Deep Pond, south-west Ravelston Avenue
0448	4-8 Kilcona Park, north-east corner of Lagimodiere Boulevard and Springfield Road
0449	4-9 Harbourview South, south of McMahon Place off McLellan Drive
0450	4-10 East Kildonan, north of Ragsdale between East Spring and West Spring
0451	4-11 Eaglemere, south of Eaglemere Drive
0452	4-12 East Elmwood, north-west of Lagimodiere Boulevard and Callsbeck Avenue
0453	Spare
0454	4-14 Arrowwood, south of Headmaster Row and west of Mitchelson Way
0455	4-15 Harbourview South, east of Lagimodiere Boulevard and north of Concordia Avenue
0456	4-16 Devonshire Village, south of Cal Gardner Drive and east of Peguis Street
0457	Spare
0458	4-20 Crocus Meadows, north-west corner of Peguis Street and Ravelston Avenue West
0459	4-21 Starlight, north of El Tassi Drive and west of Fiorentino Street
0460	4-22 Devonshire Park, south of Devonshire Drive West, west of Sheilagh Ball Cove
0461	5-1 St Boniface Industrial, west of Beghin Avenue at Paquin Road
0462	5-2 St Boniface Industrial, east of Paquin Road
0463	5-3 St Boniface Industrial, south of Camiel Sys Street, east of Ray Marius Road
0464	5-38 Waterside Estates, west of Plessis Road south of Dugald Road
0465	5-5 Southdale, north-east corner of Lakewood Boulevard and Edgewater Drive
0466	5-6 Southdale, west of Beaverhill Boulevard and north of Edgewater Drive
0467	5-7 Southdale, north-west corner of Lakewood Boulevard and Beaverhill Boulevard
0468	5-8 Southdale, south of Edgewater Drive between Sweetwater Bay and Beaverhill Boulevard
0469	5-9 Southdale, east corner of Shamrock Drive and Newcroft Road
0470	5-10 Southdale, south of Willowlake Crescent at Willow Point Road
0471	5-11 North St Vital, north of Bishop Grandin Boulevard at Kearney Street
0472	5-12 North St Vital, north of Bishop Grandin Boulevard at Glen Meadow Street

Facility Code	Facility
0473	5-13 North St Vital, north of Bishop Grandin Boulevard at River Road
0474	5-14 St Boniface Industrial, north of Dynamic Machine (1417 Dugald Road)
0475	5-15 Island Lakes, south of Island Shore Boulevard
0476	5-16 St Vital, south-west of Burland Avenue and Healy Crescent
0477	5-17 St Vital, south-east of Burland Avenue and Westbourne Crescent
0478	5-18 St Vital, east of Dakota Street and south of John Forsythe Avenue
0479	5-19 Island Lakes, south of Island Lakes Drive
0480	5-20 Island Lakes, north-west of Island Lakes Drive and De la Seigneurie Boulevard
0481	5-21 Southland Park, north-east of Royal Mint Drive
0482	5-22 Royalwood, south-west corner of Shorehill Drive and Aubin Drive
0483	5-23 South Transcona, north-west of St. Boniface Road and Murdock Road
0484	5-24 Royalwood, along Westwater Drive
0485	5-25 Royalwood, east of Shorehill Drive and Bridgetown Drive
0486	5-26 Buhler Recreational Park, south of the Parking Lot
0487	5-27 Buhler Recreational Park, north of Lake Shirley
0488	5-28 Sage Creek, north of Warde Avenue and east of Lagimodiere Boulevard
0489	5-29 Sage Creek, west of Des Hivernants Boulevard and north of Woodsage Crescent
0490	5-30 Sage Creek, north of Tallgrass Crescent and east of Des Hivernants Boulevard
0491	5-31 Sage Creek, east of Hydro ROW, north of Red Lily Road and south of Blue Sun Drive
0492	5-32 Sage Creek, north of Warde, west of Blue Sun Drive and east of Red Lily Road
0493	5-33 Sage Creek, east of Lagimodiere Boulevard and west of Burning Glass Road
0494	5-34 Sage Creek, north of David Friesen Road between Des Hivernants Boulevard and Burning Glass Road
0495	5-35 Sage Creek, east of Des Hivernants Boulevard and west of Hydro ROW
0496	5-36 Sage Creek, west of Wild Iris Walk and North of Prairie Smoke Drive
0497	5-37 Sage Creek, east of Wild Iris Walk and South of Vireo Lane
0498	5-39 Sage Creek, south of Warde Avenue and east of Robert Bockstael Drive
0499	5-40 Sage Creek, south of Sundog Drive
0500	5-41 Sage Creek, east of Ed Turner Drive and south of West Plains Drive
0501	5-42 Bonavista, west of Evelyne Reese Boulevard and north of Bow Water Drive
0502	5-43 Bonavista, east of Evelyne Reese Boulevard and south of Bonaventure Drive East
0503-0510	Spares
0511	6-1 Assiniboine Forest, south of Grant Avenue and east of Chalfont Road

Facility Code	Facility
0512	Spare
0513	Spare
0514	6-4 West Fort Garry Business, Lot 16 Drain west of Waverley Street
0515	6-5 Fort Garry Industrial, ditch along Bishop Grandin Boulevard
0516	6-6 Waverley Heights, north of Chancellor Drive between Swan Lake Bay and Lake Grove Bay
0517	6-7 Waverley Heights, along Lake Lindero Road
0518	6-8 Waverley Heights, south of Markham Road at Forest Lake Drive
0519	6-9 Waverley Heights, north of Markham Road and west of Forest Lake Drive
0520	6-10 Fort Richmond, north of Dalhousie Drive and east of Pembina Highway
0521	6-11 Fort Richmond, south of Dalhousie Drive and east of Pembina Highway
0522	6-12 St Norbert, north of Grandmont Boulevard and west of Nolin Avenue
0523	6-13 St Norbert, south of Grandmont Boulevard and west of Delorme Bay
0524	6-14 West Fort Garry Business, east of Kenaston Boulevard and south of Scurfield Boulevard
0525	6-15 Lindenwoods, west of Shorecrest Drive
0526	6-16 Richmond West, Point West Drive
0527	6-17 Whyte Ridge, south-west of Scurfield Boulevard and Columbia Drive
0528	6-18 Lindenwoods, north of Shoreline Drive and south of Queens Park Crescent
0529	6-19 Tuxedo West, south of West Taylor Drive and west of Dumbarton Boulevard
0530	6-20 Whyte Ridge, west of Scurfield Drive and south of Vanderbilt Drive
0531	6-21 St Norbert, south of Bellemer Drive (Grandmont Park)
0532	6-22 Lindenwoods, north of Wilkes Avenue and west of Waverly Street
0533	6-23 Tuxedo Industrial, west of Kenaston Boulevard
0534	6-24 Lindenwoods, east of Lindenwoods Drive West
0535	6-25 Linden Ridge, east of Dovercourt Drive
0536-0538	Spares
0539	6-29 Fairfield Park, south of Lee Boulevard and west of Raphael Street
0540	6-30 Kenaston Common, north of Lindenwood Drive East and west of Kenaston Boulevard
0541	6-31 Marlton, east of Oakdale Drive between Roblin Boulevard and Grant Avenue
0542	6-32 Waverley West (South Pointe), west of Autumnview Drive and east of Cypress Ridge Road
0543	6-33 Waverley West (South Pointe), west of Yorkvalley Way and north of Kirkbridge Drive
0544	6-34 Waverley West (South Pointe), south of Kirkbridge Drive and west of Waterstone Drive
0545	6-35 Waverley West (South Pointe), south of Northern Lights Drive and north of Turnstone Terrace

Facility Code	Facility
0546	6-36 Waverley West (Bridgwater Forest), south of Bridgeland Drive and east of Prominence Point
0547	6-37 Waverley West (Bridgwater Forest), west of Highland Creek Road and north of Hunterbrook Road
0548	6-38 Waverley West (Bridgwater Forest), west of Park Valley Road and south of North Town Road
0549	Spare
0550	6-40 Waverley West (South Pointe), west of Waverly Street and east of Stan Baile Drive (Not accepted by City, Naturalized, Started Warranty)
0551	4-18 Bridgewood Estates, east of Edward Schreyer opposite Concordia Avenue East
0552	6-41 Waverley West (Bridgwater Centre), west of Cooper's Town Road
0553	6-42 Waverley West (Bridgwater Centre), north-east corner of Park East Drive and Kenaston Boulevard
0554	6-43 Waverley West (Bridgwater Centre), west of Jacob's Creek Road
0555	6-44 Waverley West (Bridgwater Centre), east of Jacob's Creek Road
0556	6-45 Waverley West (Bridgwater Forest), south-east corner North Town Road and Hill Grove Point
0557	6-46 Waverley West (Bridgwater Lakes), south of Montpellier Point
0558	6-47 Waverley West (Bridgwater Lakes), south of Clear Spring Road
0559	6-48 Waverley West (Bridgwater Lakes), north-west of Bluemeadow Road and Water Bend Road
0560	6-49 Waverley West (Bridgwater Lakes), north-west of Bridge Lake Drive and Lake Bend Road
0561	6-50 Waverley West (South Pointe), south of Canvasback Cove
0562	6-51 Waverley West (South Pointe), south-west of Northern Light Drive and Stan Bailie Drive
0563	Spare
0564	6-54 Waverley West (Bridgwater Trails), north-west of Rose Lake Court
0565	6-55 Waverley West (Bridgwater Trails), north-east of Rose Lake Court
0566	6-56 Waverley West (Bridgwater Trails), south-west of Rose Lake Court
0567	6-57 Waverley West (Bridgwater Trails), south-east of Rose Lake Court
0568	6-58 Waverley West (Bridgwater Trails), east of Eaglewood Drive between Valley Brook Road and Bridge Lake Drive
0569	6-59 Waverley West (Bridgwater Trails), east of Landover Drive between Willow Creek Road and Rowntree Avenue
0570	6-60 Waverley West (Bridgwater Trails), south of Appleford Gate and west of Landover Drive
0571	6-61 Waverley West (Bridgwater Trails), south-east of Wildflower Road and north of Silver Creek Road
0572	6-62 South Pointe Phase 2, west of Kenaston Boulevard and east of Ken Oblik Drive

Facility Code	Facility
0573	6-63 South Pointe Phase 2, south of Waverly Street and west of Ken Oblik Drive
0574	6-64 Scotswood Meadows, south-west of the intersection at ScotsWood Drive South and Rannock Avenue
0575	6-65 Ridgewood West, east of Peregrine Point and south of McKellar Drive
0576	6-66 Ridgewood West, north of Couture Crescent and east of Cassowary Lane
0577	6-68 Bishop Grandin Crossing, north of Ballantrae Drive and east of New Market Boulevard
0578	6-69 SouthPointe Phase 2, between Berry Hill Road and Hawkridge Road
0579	6-70 South Pointe Phase 2, south of Berry Hill Road and north of Granite Grove Road
0580-0599	Spares
0600 - 0799	**Water System Facilities**
0600	Shoal Lake Aqueduct Intake Facility (Yard and M97.51 Backbone Repeater)
0601	Water Treatment Plant (Yard and M12.87 Backbone Repeater)
0602-0619	Spares
0620	DISCONTINUED (was Deacon Booster Pumping Station, now part of the Water Treatment Plant Facility Code)
0621-0629	Spares
0630	MacLean Regional Pumping Station, MacLean Reservoir
0631-0639	Spares
0640	McPhillips Regional Pumping Station, McPhillips Reservoir and M01.00 Backbone Repeater McPhillips Control Centre Collections Building
0641-0649	Spares
0650	Hurst Regional Water Pumping Station, Wilkes Reservoir
0651-0659	Spares
0660	Tache Booster Pumping Station, Tache Surge Tower
0661-0700	Spares
0701	DISCONTINUED (was General Shoal Lake Aqueduct & GWWD, now part of the Shoal Lake Aqueduct and Greater Winnipeg Water District (GWWD) Railway Facility Codes)
0702	St. Boniface Yards (552 and 598 Plinguet St)
0703-706	Spares
0707	Ross (Yard and M39.00 Backbone Repeater)
0708-0750	Spares
0751	Shoal Lake Aqueduct (includes Branch 1 Aqueduct)
0752	Branch 2 Aqueduct
0753	Aqueduct Interconnection

Facility Code	Facility
0754	Greater Winnipeg Water District (GWWD) Railway
0755-0797	Spares
0798	Feeder Mains and Large Diameter Water Mains
0799	General Water Facilities
0800 - 0849	**Public Water Outlets and Remote Pressure Monitoring Locations**
0800	General Public Water Outlets and Pressure Monitoring
0801	Public Water Outlet – 1539 Waverley Street
0802	Public Water Outlet– Portage Avenue at Perimeter Highway (McCarthy St. and Oxbow Bend Road)
0803-0811	Spares
0812	Pressure Monitoring Location - Gateway - Gateway Road and Springfield Road
0813	Spare
0814	Pressure Monitoring Location - Brookside - Brookside Boulevard and Inkster Boulevard
0815	Spare
0816	Pressure Monitoring Location - John Black - John Black Avenue and Main Street
0817	Spare
0818	Pressure Monitoring Location - Smugglers Cove - Lagimodiere Boulevard and Smugglers Cove
0819	Spare
0820	Pressure Monitoring Location - Charing Cross - Paddington Road and Charing Cross Crescent
0821	Spare
0822	Pressure Monitoring Location - University - Pembina Highway and Chancellor Matheson Road
0823	Spare
0824	Pressure Monitoring Location - Devonshire - Plessis Road and Devonshire Drive
0825	Spare
0826	Pressure Monitoring Location – Redonda - Redonda Street and Kildare Avenue
0827	Spare
0828	Pressure Monitoring Location - Rouge Road - Rouge Road and Assiniboine Ave
0829	Spare
0830	Pressure Monitoring Location - St. Norbert - Rue Des Trappistes and Villeneuve Boulevard
0831	Spare
0832	Pressure Monitoring Location - Sargent - Sargent Avenue and St. James Street
0833-0849	Spares
0850 - 0899	**Solid Waste Facilities, Excluding Brady Road Landfill**

Facility Code	Facility
0850	General Solid Waste Facilities
0851	Pacific Avenue 4R Depot
0852	Panet Road 4R Depot
0853	Closed Landfills
N/A	Brady Road Landfill (See FC 400)
0854-0899	Spares
0900 - 0999	**Unused - Spares**

Appendix B Facility Area Codes

Area Codes – Shoal Lake Aqueduct Intake Facility

Area Code	Description
A	General or area code is not applicable
C	Chlorine Area
D	Dechlorination Building
E	Engine Shed
H	Electrical Shed
G	Gatehouse
P	Pumphouse (including Electrical & Control Room)
R	Residences
S	Staff House
U	Scada

Area Codes – Shoal Lake Aqueduct

Area Code	Description
A	General or area code is not applicable (Scada)
B	Backbone Repeater
C	Boathouse
D	Remote Terminal Units
M	Manholes
N	Underdrains
O	Overflow
P	Shoal Lake Aqueduct (Pipe)
Q	Branch 1 Aqueduct (Pipe)
R	G.W.W.D. Railway
S	Drainage Siphon
T	Communication Tower
U	Road Crossing
V	Venturi
W	Valve Chamber

Area Codes – Water Treatment Plant

Area Code	Description
A	Administration
B	Main Treatment Plant Building
C	Chemical Feed Systems (Polymer, SBS, Hydrogen Peroxide)
D	Deacon Booster Pumping Station (includes Ultraviolet Light Disinfection)
E	Electrical Substation
F	Filtration
G	Standby Power Generation
H	Plant Utilities
I	Inlet Works and Raw Water Pumping
J	Hypochlorite Generation and Feed Building
K	Enclosed Bridge
L	Dewatering Cells (Freeze Thaw Pond) / Force Main
M	General Plant Services / Miscellaneous (incl. Fire Pump Room and Electrical Room)
N	Aqueduct Bridges
O	Ozone
P	Flocculation and DAF
R	Residuals Handling
S	Bulk Chemical Storage and Feed Building
T	Treated Water Storage (Clearwell)
U	Instrumentation (Scada)
V	Civil Maintenance and Aqueduct Storage Building
W	*Future*
X	Pilot Plant
Y	Yard Piping and Valve Chamber
Z	Deacon Chemical Feed Building

Note: The current application of area codes does not meet the intent of this standard in that it is not based upon a physical location. For example, the H area code is for all plant utilities across the entire building.

Area Codes – Regional Water Pumping Stations

Area Code	Description
A	General or area code is not applicable
B	Collections Building (McPhillips only)
C	Chlorine Building / Area
M	Main Pumping Station Building
P	SCADA, PLC, RTU
R	Reservoir and Ancillary Buildings
S	Control Centre Building (McPhillips Only)
Y	Yard Piping and Valve Chambers/ Drain Building

Area Codes – Feeder Mains and Large Diameter Water Mains

Area Code	Description
A	General or area code is not applicable
B	Valve Chambers
C	Railroad Crossings
D	Road Crossings
E	River Crossings
F	Feeder Mains
W	Large Diameter Water Mains

Area Codes – St. Boniface Yards (552 and 598 Plinguet St)

Area Code	Description
A	General or area code is not applicable
C	Civil Maintenance Buildings
G	G.W.W.D. Railway Station (Building 1)
M	Meter Shop (Building 15)
N	552 Plinguet - North Building (Building 3)
O	Storage Buildings
P	598 Plinguet - Railway Shop (Building 2)
R	Rail Car Storage (Buildings 19 & 20)
S	552 Plinguet - South Building – Shop (Building 4)
T	Track #9 Depot
W	St. Boniface Water Tower (Building 14)
Y	Yard Piping and Valve Chambers

Area Codes – Land Drainage

Area Code	Description
A	General or area code is not applicable
B	Storm Retention Basin (SRB)
F	Flood Pumping Manhole
G	Gate Chambers
L	Land Drainage Pumping Station
O	Outfalls
U	Underpass Pumping Station
W	Deep Well Pump

Area Codes – NEWPCC

Area Code	Description
A	General or area code is not applicable
B	Boilers
C	Centrate Treatment
D	Digesters
E	Electrical Building and Substation
F	Phosphorous Removal Facility
G	Pre-Aeration and Grit Removal
H	*HOLD – Potentially reserve for Headworks area code. Decision to be made under the sewage treatment upgrade program.*
M	Main Building
P	Primary Clarifiers
R	Oxygen Reactors
S	Secondary Clarifiers
U	UV Disinfection Facility
W	Sludge Dewatering
X	Leachate Receiving Facility
Y	Hauled Wastewater Receiving Facility

Notes:

1. *The NEWPCC area codes will be updated as part of the NEWPCC Upgrade project.*

Area Codes – SEWPCC

Area Code	Description
A	General or area code is not applicable
B	Service Building (includes Boilers and Storage Building)
C	Chemical / Electrical Building
D	Fermenters / Sludge Thickeners
G	Headworks
H	Sludge Gas – Thermal Oxidizer
K	High-Rate Clarification Building
M	Administration Building
P	Primary Clarifiers
R	BioReactors / Blower Building
S	Secondary Clarifiers
T	Biofilter / Odour Control
U	UV Disinfection Building, Outfall
Y	Yard / Electrical Substation

Area Codes – WEWPCC

Area Code	Description
A	General or area code is not applicable
F	Primary Sludge Fermenters
G	DISCONTINUED - Formerly Headworks
H	Headworks
L	General and Site Works
M	Perimeter Road Pumping Station
P	Primary Clarifiers
S	Secondary Clarifiers and BioReactors
T	DAF (Dissolved Air Flotation) Thickeners
U	Utility Building HOLD – Possible re-allocation for future UV Disinfection
V	HOLD – Possible re-allocation as the Utility Building. (See Note 1)
Y	*HOLD – Possible use for Yard. Decision to be made under the sewage treatment upgrade program.*
Z	Ponds, Effluent and Outfall

Notes:

1. *Some equipment in the WEWPCC Utility Building has already been re-identified as V.*

Area Codes – Wastewater Collections

Area Code	Description
A	General or area code is not applicable
F	Flood Pumping Stations
L	Wastewater Lift Stations
S	Sewer

Area Codes – Solid Waste BRRMF

Area Code	Description
A	General or area code is not applicable
B	Biosolids and LYW Composting
C	Administration Building
R	Brady 4R Winnipeg Depot

Area Codes – Solid Waste

Area Code	Description
A	General or area code is not applicable
C	Closed Landfills
R	4R Depot

Appendix C Master Equipment Functional Designations

Functional Designation	Description	Type	Notes
ACP	Access Control Panel	Security	
ACU	Air Conditioning Unit	Mechanical	
AD	Air Dryer	Mechanical	
ADP	Automation Device Panel	Automation	
AF	Aeration Fan	Mechanical	
AG	Agitator	Mechanical	
AHU	Air Handling Unit	Mechanical	Includes Make-Up Air Units
ANT	Antenna	Communication	
ATS	Automatic Transfer Switch	Electrical	
B	Blower	Mechanical	
BAT	Battery	Electrical	
BC	Battery Charger	Electrical	
BD	Balance Damper	Mechanical	See Section **Error! Reference source not found.**.
BDD	Backdraft Damper	Mechanical	
BFP	Back Flow Preventer	Mechanical	
BLR	Boiler	Mechanical	
~~BS~~	~~Bar Screen~~	~~Mechanical~~	Use SCR
BV	Balancing Valve	Mechanical	Manual mechanical balancing valve (not typically adjusted by operations). See Section **Error! Reference source not found.**
BVA	Balancing Valve Automatic	Mechanical	Automatic mechanical balancing valve. See Section **Error! Reference source not found.**
BUS	Busway	Electrical	
C	Cable (Power)	Electrical	
CA	Cable (Automation)	Automation	
CAL	Calibration Column	Mechanical	
CAP	Capacitor	Electrical	Typically individual unit. See PFC.
CB	Circuit Breaker	Electrical	Includes air, vacuum, SF6, and moulded case circuit breakers
CBUS	Cable Bus	Electrical	
CC	Cooling Coil	Mechanical	
CDR	Condensor	Mechanical	

Functional Designation	Description	Type	Notes
CE	Centrifuge	Mechanical	
CHLR	Chiller	Mechanical	
CM	Clarifier Mechanism	Mechanical	
CMP	Compressor	Mechanical	
CN	Network Cable	Communication	
CNP	Network Cable - Patch	Communication	
CNV	Conveyor	Mechanical	Includes skimmers
CON	Contactor	Electrical	
CP	Control Panel	Electrical	
CP	Control Panel	Automation	
CPR	Cathodic Protection Rectifier	Electrical	
CRN	Crane	Mechanical	
CS	Computer Server	Automation	
CSTE	Customer Service Termination Equipment	Electrical	
CT	Cooling Tower	Mechanical	
CU	Condensing Unit	Mechanical	
CV	Check Valve	Mechanical	
CW	Computer Workstation - General	Automation	
CWD	Computer Workstation - Development	Automation	
CWO	Computer Workstation - Operator	Automation	
CYC	Cyclone	Mechanical	
DCS	Distributed Control System	Automation	
DP	Distribution Panel	Electrical	
DS	Disconnect Switch (non-fusible)	Electrical	
EDP	Electrical Device Panel	Electrical	Use for metering panels, protection panels and other miscellaneous electrical panels.
EDU	Eductor	Mechanical	
EF	Exhaust Fan	Mechanical	
ELB	Emergency Lighting Battery Pack	Electrical	May have integrated lights.
F	Fan - General	Mechanical	
FA	Flame Arrestor	Mechanical	
FAAP	Fire Alarm Annnunciator Panel	Electrical	

Functional Designation	Description	Type	Notes
FACP	Fire Alarm Control Panel	Electrical	
FAS	Fire Alarm System	Electrical	
FC	Fan Coil	Mechanical	
FD	Fire Damper	Mechanical	Utilize same equipment number as air handler.
FDP	Field Device Panel	Automation	
FDR	Feeder	Mechanical	Examples: screw feeder, chlorinator, glycol make-up unit
FDS	Fusible Disconnect Switch	Electrical	
FEX	Fire Extinguisher	Mechanical	
FG	Flap Gate	Mechanical	
FIL	Filter	Mechanical	
FU	Fuse	Electrical	
GDC	Gas Detection Controller	Automation	
GEN	Generator	Electrical	
GR	Grille / Louvre – General	Mechanical	See Section **Error! Reference source not found.**.
GRD	Grille – Diffuser	Mechanical	See Section **Error! Reference source not found.**.
HC	Heating Coil	Mechanical	
HCC	Heater Coil Controller	Electrical	Includes SCR and contactor based controllers.
HCE	Heating Coil, Electric	Mechanical	Duct based
HE	Heat Exchanger	Mechanical	
HF	Harmonic Filter	Electrical	
HMI	Standalone Human Machine Interface (HMI) Terminal	Automation	
HO	Hoist	Mechanical	
HOP	Hopper	Mechanical	
HP	Heat Pump	Mechanical	
HRC	Heat Recovery Coil	Mechanical	
HTR	Heater	Mechanical	General heaters, radiant, convectors, etc.
HUM	Humidifier	Mechanical	
HV	Hand/Manual Valve	Mechanical	See Section 5.2
INJ	Injector	Mechanical	
INV	Inverter	Electrical	
ISB	Intrinsic Safety Barrier	Automation	Typically only a subcomponent.
JB	Junction Box	Electrical	

Functional Designation	Description	Type	Notes
JBA	Junction Box (Automation)	Automation	
JBN	Junction Box - Network	Communication	
K	Interlocking Key (Kirk Key)	Electrical	
LC	Lighting Contactor	Electrical	A lighting control panelboard would be identified as a PNL.
LCP	Local Control Panel	Automation	
LDB	Load Bank	Electrical	
MCC	Motor Control Centre	Electrical	
MCP	Motor Circuit Protector	Electrical	
MCS	Moulded Case Switch	Electrical	
MDM	Modem	Communication	
MMS	Manual Motor Starter	Electrical	
MS	Motor Starter	Electrical	
MSP	Motor Starter Panel	Electrical	
MTR	Motor	Electrical	
MTS	Manual Transfer Switch	Electrical	
MXR	Mixer	Mechanical	
NAP	Network Access Point (Wireless)	Communication	
ND	Network Device	Communication	Utilize for general devices not otherwise in list. Example: network terminators
NFW	Network Firewall	Communication	
NGR	Neutral Grounding Resistor	Electrical	
NGW	Network Gateway	Communication	
NJ	Network Jack	Communication	
NJT	Network Jack - Telephone	Communication	
NMC	Network Media Converter	Communication	
NP	Networking Panel	Communication	
NRA	Network Radio	Communication	
NRP	Network Repeater	Communication	
NRT	Network Router	Communication	
NSP	Network Segment Protector	Communication	Typically used for PROFIBUS PA
NSW	Network Switch, Ethernet	Communication	
NT	Network Terminator	Communication	
OD	Overhead Door	Mechanical	
P	Pump	Mechanical	
PB	Pull Box	Electrical	

Functional Designation	Description	Type	Notes
PCV	Pressure Control Valve (Pressure Regulator)	Mechanical	See Section **Error! Reference source not found.**
PFC	Power Factor Correction Unit	Electrical	Bank of capacitors. May contain reactors.
PLC	Programmable Logic Controller	Automation	
PM	Power Meter	Electrical	
PNL	Panelboard	Electrical	
PRN	Printer	Automation	
PS	Power Supply	Electrical	24VDC power supply
PSP	Power Supply Panel	Electrical	Panel containing 24VDC power supplies, fire alarm booster power supply
PSV	Pressure Safety/Relief Valve	Mechanical	See Section **Error! Reference source not found.**
R	Reactor (various processes)	Mechanical	
RCFR	Rectifier	Electrical	
RCPT	Receptacle	Electrical	
RCTR	Reactor	Electrical	
RDT	Rotary Drum Thickener	Mechanical	
RES	Reservoir	Mechanical	Large water containment structure.
RIO	Remote I/O	Automation	
RLY	Protection Relay	Electrical	
RTU	Remote Terminal Unit	Automation	
S	Skid Package	Mechanical	
SA	Sampler	Mechanical	
SCBR	Scrubber	Mechanical	
SCP	Security Control Panel	Security	
SCR	Screen	Mechanical	Utilized for screening systems such as bar screens and perforated plate screens.
SD	Smoke Damper	Mechanical	Utilize same equipment number as air handler.
SF	Supply Fan	Mechanical	
SGR	Switchgear	Electrical	
SL	Stop Logs	Mechanical	

Functional Designation	Description	Type	Notes
SLG	Sluice Gate	Mechanical	May only be utilized within existing facilities where the use of the SLG identifier is well established. The designation may not to be utilized for new or upgraded WSTP facilities. Identify as a valve (HV, XV, FV, etc).
SPL	Splitter	Electrical	
SS	Soft Starter	Electrical	
STR	Strainer	Mechanical	See Section 5.2
SVM	Security Video Monitor	Security	
SVR	Security Video Recorder	Security	
SW	Switch	Electrical	
TB	Terminal Block	Automation	Subcomponent Only
TBC	Travelling Bridge Collector	Mechanical	
TK	Tank	Mechanical	
TU	Terminal Unit	Mechanical	Includes CAV/VAV/Dual Duct boxes. Dampers to be identified as per Section 7.1 – Instrumentation.
TVSS	Transient Voltage Surge Suppressor	Electrical	
U	Miscellaneous Equipment Not In List	Mechanical / Electrical / Automation	Example: Water Softener
UH	Unit Heater	Mechanical	
UPS	Uninterruptible Power Supply	Electrical	
UVR	Ultra-Violet (UV) Reactor	Mechanical	
V	Vessel, Pressure Vessel	Mechanical	e.g. air receiver, glycol expansion tank
VFD	Variable Frequency Drive	Electrical	
W	Weir	Mechanical	
WCP	Washer / Compactor	Mechanical	
WGB	Waste Gas Burner	Mechanical	
XFMR	Transformer	Electrical	

Appendix D Equipment Number Ranges

Equipment Number Ranges – Shoal Lake Intake Facility

Area Code	Range	Description
All Areas	001 - 049	Major Pumping
	050 - 099	Future
	100 – 499	Process Equipment
	500 – 599	Misc Building Equipment – Air Compressors, Sump Pumps, Fuel Systems, etc.
	600 - 699	HVAC Equipment
	700 - 799	Electrical Equipment
	800 – 899	Automation Equipment
	900 – 999	Misc, including communication and security

Equipment Number Ranges – Shoal Lake Aqueduct

Area Code	Range	Description
All Areas	TBD	Needs to be developed.

Equipment Number Ranges – Water Treatment Plant

Area Code	Range	Description
C – Chemical Feed	001 - 099	Process – Polymer
	100 – 899	Process – Future
	700-799	Electrical Equipment
	800 – 999	Chemical Systems
	900 – 949	Chemical Systems – Hydrogen Peroxide
	950 – 979	Chemical Systems – Sodium Bisulphite
D - Deacon Booster Pumping Station	001 - 049	Major Pumping
	050 - 099	Future
	100 - 499	Process Equipment
	500 – 599	Misc Building Equipment – Air Compressors, Sump Pumps, etc.
	600 – 699	HVAC
	700-799	Electrical Equipment
	800-899	Automation Equipment
	900 – 999	Misc, including communication and security
F - Filtration	001 – 999	Process
H – Plant Utilities	001 - 099	HVAC
	100 - 199	Fire Pumps
	200 - 299	Auxiliary Building HVAC
	300 - 399	Building Safety and Security
	400 - 499	Process Pumps
	500 - 599	Sanitary Sumps
	600 - 699	Electrical Distribution
	700 - 799	Potable Water
	800 - 899	Unallocated
	900 - 950	Emergency Generator
	951 - 999	Electrical Substation
I – Inlet and Raw Water	001 - 999	Process
J – On-Site Hypochlorite Generation	001 - 999	Process
L – Freeze Thaw Pond	001 - 999	Process
O - Ozone	001 - 999	Process
P – Flocculation and DAF	001 - 999	Process
R – Residuals Handling	001 - 999	Process
S – Bulk Chemical Storage	001 - 999	Process
T – Treated Water Storage and Handling (Clearwell)	001 - 999	Process
U – Ultraviolet Light Disinfection	001 - 999	Process

Area Code	Range	Description
X – Pilot Plant	001 - 999	Process
Y – Yard Piping and Valve Chambers	001 - 099	Surge Towers
	100 - 199	Yard Piping
	200 - 299	Yard Lighting
Z – Deacon Chemical Feed Building	001 – 099	Process Equipment
	100 - 199	Chemical Systems – Hydrofluosilicic Acid
	200 - 299	Chemical Systems – Phosphoric Acid
	300 - 499	Process Equipment
	500 - 599	Misc Building Equipment – Air Compressors, Sump Pumps, etc.
	600 - 699	HVAC
	700 - 799	Electrical Equipment
	800 - 899	Automation Equipment
	900 - 999	Misc, including communication and security

Note: The above WTP process ranges are largely based upon existing designations. In the event of future significant upgrades, some realignment may be required to fully align with this standard.

Equipment Number Ranges – Regional Water Pumping Stations

Area Code	Range	Description
All Area Codes	001 - 049	Major Pumping
	050 - 099	Future
	100 – 499	Process Equipment
	500 – 599	Misc Building Equipment – Air Compressors, Sump Pumps, etc.
	600 - 699	HVAC Equipment
	700 - 799	Electrical Equipment
	800 – 899	Automation Equipment
	900 – 999	Misc, including communication and security

Equipment Number Ranges – Collections Facilities

Area Code	Range	Description
L – Wastewater Lift Stations or F – Flood Pumping Station or U – Underpass Pumping Station	01 – 49	Reserved for Process Equipment
	01 - 09	Pumps
	10 – 19	Wet Well / Intake Equipment
	20 - 39	Misc Process
	40 - 49	Discharge / Forcemain
	50 - 59	Misc Building Equipment – Air Compressors, Backflow Preventer, etc.
	60 - 69	HVAC Equipment
	70 - 79	Electrical Equipment
	80 – 89	Automation Equipment
	90 - 99	Misc, including communication and security
S – Sewer	01 – 79	Sewer – Misc.
	80 - 89	Sewer – Before Outfall
	90 - 99	Sewer - Outfall

Note: *The Collections facilities utilize two digit equipment numbers due to the limited amount of equipment located within each facility. Instrumentation loop numbers within Collections facilities have three digits.*

Equipment Number Ranges – SEWPCC and WEWPCC Wastewater Treatment Facilities

Area Code	Range	Process Code	Description
All Area Codes	001 - 099	0	Area Specific Processes
	100 – 199	1	Area Specific Processes
	200 – 299	2	Area Specific Processes
	300 – 399	3	Area Specific Processes
	400 – 499	4	Area Specific Processes
	500 – 599	5	Misc. Building Equipment – Air Compressors, Backflow Preventer, etc. (May be allocated for process as required)
	600 - 699	6	HVAC Equipment
	700 - 799	7	Electrical Equipment
	800 – 899	8	Automation Equipment
	900 – 999	9	Misc., including communication and security

Note: *Refer to the IMS for further definition of Equipment Number ranges and Process Codes within the Wastewater Treatment Facilities.*

Equipment Number Ranges – NEWPCC Wastewater Treatment Facility

Area Code	Range	Process Code	Description
All Area Codes	0001 - 0999	0	Area Specific Processes
	1000 – 1999	1	Area Specific Processes
	2000 – 2999	2	Area Specific Processes
	3000 – 3999	3	Area Specific Processes
	4000 – 4999	4	Area Specific Processes
	5000 – 5999	5	Misc. Building Equipment – Air Compressors, Backflow Preventer, etc. (May be allocated for process as required)
	6000 – 6999	6	HVAC Equipment
	7000 – 7999	7	Electrical Equipment
	8000 – 8999	8	Automation Equipment
	9000 – 9999	9	Misc., including communication and security

Note: *Refer to the IMS for further definition of Equipment Number ranges and Process Codes within the Wastewater Treatment Facilities.*

Appendix E Sample Drawings

The following process and instrumentation diagram drawings were created as sample drawings.

South End Water Pollution Control Centre

City Drawing Number	Sheet	Rev	Project / Area	TITLE
1-0102A-SK01	001	00		PROCESS & INSTRUMENTATION DIAGRAM, LEGEND AND DETAILS
1-0102A-SK01	002	00		PROCESS & INSTRUMENTATION DIAGRAM, LEGEND AND DETAILS
1-0102A-SK01	003	00		PROCESS & INSTRUMENTATION DIAGRAM, LEGEND AND DETAILS
1-0102S-SK02	001	00	SECONDARY CLARIFIERS	PROCESS & INSTRUMENTATION DIAGRAM, CLARIFIER 1, PROPOSED IDENTIFICATION
1-0102S-SK03	001	00	SECONDARY CLARIFIERS	PROCESS & INSTRUMENTATION DIAGRAM, CLARIFIER 2, PROPOSED IDENTIFICATION
1-0102S-SK04	001	00	SECONDARY CLARIFIERS	PROCESS & INSTRUMENTATION DIAGRAM, CLARIFIER 3, PROPOSED IDENTIFICATION
1-0102S-SK05	001	00	SECONDARY CLARIFIERS	PROCESS & INSTRUMENTATION DIAGRAM, SECONDARY CLARIFIER EFFLUENT & SAMPLE SYSTEM, PROPOSED IDENTIFICATION
1-0102S-SK06	001	00	SECONDARY CLARIFIERS	PROCESS & INSTRUMENTATION DIAGRAM, RETRUN ACTIVATED SLUDGE PUMP P-S101, PROPOSED IDENTIFICATION
1-0102S-SK07	001	00	SECONDARY CLARIFIERS	PROCESS & INSTRUMENTATION DIAGRAM, REPURN ACTIVATED SLUDGE PUMPS P-S102 & P-S103, PROPOSED IDENTIFICATION
1-0102S-SK08	001	00	SECONDARY CLARIFIERS	PROCESS & INSTRUMENTATION DIAGRAM, REPURN ACTIVATED SLUDGE PUMPS P-S108 & P-S109, PROPOSED IDENTIFICATION
1-0102S-SK09	001	00	SECONDARY CLARIFIERS	PROCESS & INSTRUMENTATION DIAGRAM, RAS HEADER, PROPOSED IDENTIFICATION
1-0102S-SK10	001	00	SECONDARY CLARIFIERS	PROCESS & INSTRUMENTATION DIAGRAM, WASTE ACTIVATED SLUDGE PUMPS P-S202 & P-S203, PROPOSED IDENTIFICATION

Marion Wastewater Pumping Station

City Drawing Number	Sheet	Rev	Project / Area	TITLE
1-0159L-SK01	001	00		PROCESS & INSTRUMENTATION DIAGRAM, WASTEWATER PUMPING
1-0159L-SK02	001	00		PROCESS & INSTRUMENTATION DIAGRAM, VENTILATION

MacLean Water Pumping Station

City Drawing Number	Sheet	Rev	Project / Area	TITLE
1-0630A-SK01	001	00		PROCESS & INSTRUMENTATION DIAGRAM, LEGEND & DETAILS
1-0630A-SK01	002	00		PROCESS & INSTRUMENTATION DIAGRAM, LEGEND & DETAILS
1-0630A-SK01	003	00		PROCESS & INSTRUMENTATION DIAGRAM, LEGEND & DETAILS

City Drawing Number	Sheet	Rev	Project / Area	TITLE
1-0630C-SK01	001	00		PROCESS & INSTRUMENTATION DIAGRAM, CHLORINE CYLINDER SHUTOFF VALVES
1-0630C-SK02	001	00		PROCESS & INSTRUMENTATION DIAGRAM, CHLORINATION SYSTEM
1-0630M-SK02	001	00		PROCESS & INSTRUMENTATION DIAGRAM, SUCTION HEADER
1-0630M-SK03	001	00		PROCESS & INSTRUMENTATION DIAGRAM, PUMP P-M021
1-0630M-SK04	001	00		PROCESS & INSTRUMENTATION DIAGRAM, PUMP P-M022
1-0630M-SK05	001	00		PROCESS & INSTRUMENTATION DIAGRAM, PUMP P-M023
1-0630M-SK07	001	00		PROCESS & INSTRUMENTATION DIAGRAM, PUMP P-M025
1-0630M-SK08	001	00		PROCESS & INSTRUMENTATION DIAGRAM, PUMP P-M026
1-0630M-SK09	001	00		PROCESS & INSTRUMENTATION DIAGRAM, DISCHARGE HEADER
1-0630M-SK10	001	00		PROCESS & INSTRUMENTATION DIAGRAM, COMPRESSED AIR SYSTEM
1-0630M-SK11	001	00		PROCESS & INSTRUMENTATION DIAGRAM, GEN-M751 & GEN-M752
1-0630M-SK12	001	00		PROCESS & INSTRUMENTATION DIAGRAM, MISCELLANEOUS
1-0630R-SK01	001	00		PROCESS & INSTRUMENTATION DIAGRAM, RESERVOIR FILL VALVES
1-0630R-SK02	001	00		PROCESS & INSTRUMENTATION DIAGRAM, RESERVOIR CELLS
1-0630Y-SK01	001	00		PROCESS & INSTRUMENTATION DIAGRAM, DISCHARGE TO FEEDERMAINS

APPENDIX M – WSTP PROJECT DOCUMENT NUMBERING STANDARD (DOCUMENT NUMBER: PG-RC-PC-05) - R2016-02-02

Winnipeg Sewage Treatment Program Integrated Management System

Project Document Numbering Standard

DOCUMENT NUMBER: PG-RC-PC-05

This document supersedes PG-RC-PC-03 Technical Document Numbering System.

Rev	Prepared by	Reviewed by	Date	Approved by	Date
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TABLE OF CONTENTS

1 INTRODUCTION

1.1 Scope of the Document

This document is a procedure that implements a common document numbering standard for all project documents, including design documents and drawings within the scope of the Winnipeg Sewage Treatment Program (WSTP). The procedure will allow for consistent file naming in an organized fashion to allow for systematic storage of all project and contract related files.

Note that this document is not applicable to facilities outside of the scope of the WSTP.

The phasing of implementation is governed by procedure PG-RC-PC-04 Technical Document Numbering Systems Management Procedure.

1.2 Definitions

For the purpose of this standard, the following definitions are utilized in the document types:

Class A Document	A Class A document is required to be maintained as a facility lifecycle document for records and maintenance purposes. All Class A Documents should be "as-built" upon project completion and stored in an accessible location for Operations' use.
DMS	Document Management System
List	A document containing a sequence of connected items, not related to a historical occurrence.
Log	A document containing a register (list) of an event, occurrence, issue, or status.
Plan	A document that outlines the processes and tasks required to implement a project or goal.
Procedure	A document that defines the specific instructions necessary to perform a task or process.
Record	An official document which permanently contains the particulars regarding a specific event, issue, or occurrence. For example, a worker orientation record that documents the orientation of a specific or group of workers. However, a document which tracks the orientation of all workers would be a log.
Report	A document which contains an account given of a particular subject, after thorough investigation or consideration by the author.
VDR	Vendor Document Requirement (See Section 5.2.4)
WBS	Work Breakdown Structure

2 DOCUMENT NUMBERING FORMATS

Documents are numbered as per the format designated in Table 2-1.

Table 2-1 : Document Numbering Formats

Document	Description	Reference
Class A Documents	Technical design documents and drawings produced to describe the work and utilized as a facility lifecycle document for records and maintenance purposes. Most Class A documents are drawings, but they also include equipment lists, process control narratives, and other documents maintained throughout the facility life. Class A documents should be “as-built” upon project completion and stored in an accessible location for Operations use.	Section 3
Project Documents	Project documents are created for and utilized during the execution of projects. For example, contract administration documents would be under this format. They include many design documents, but exclude Class A documents (including drawings) and contractor submittals.	Section 4
Contractor Submittals	Contractor Submittal documents are typically shop drawings and product datasheets produced by the contractor or other vendors. The submittals indicate specific manufacturing and construction details, but not overall design concepts.	If project uses a DMS: Section 4. If the project does not use a DMS:Section 5

3 CLASS A DOCUMENTS

3.1 Description

Class A Documents are technical design documents and drawings produced to describe the work and utilized as a facility lifecycle document for records and maintenance purposes. Most Class A documents are drawings, but they also include equipment lists, process control narratives, and other documents. Class A documents should be "as-built" upon project completion and stored in an accessible location for Operations use.

3.2 Format

The organization, structure and coding of the design documents and drawings is derived from the City Drawing Standard numbering system, with some additions and/or changes introduced to fulfill the system objectives. These are explained in the following sections.

See Table 3-1 for the Class A Document number format.

Table 3-1 : Document Number Format – Class A Documents

Field	Source Code		Facility Code		Discipline Code	Document Type		Area Code	Process Code	Sequence Number		Sheet Number (Optional)		Suffix (Optional)
Format	C	-	NNNN	-	L	LLL	-	L	C	NN	-	CC	_	*
Example	1	-	0102	-	C	GAD	-	A	1	01	-	01	_	C01

Legend: N= numeral, L= Letter, C= character (i.e. =N or L), * = Multiple Characters

Notes:

1. *The file extension, such as ".docx" or ".pdf" would be appended to the end of the filename, but is not technically considered to be part of the document number.*
2. *The suffix is separated by an underscore (_), not a hyphen (-).*
3. *The suffix is technically not part of the document number, but rather an extension to be utilized in special case scenarios.*

3.2.1 Source Code

See Table 3-2 for a list of Source Codes and their definition.

Table 3-2 : Source Codes

Code	Description
-	Drawings
1	Design drawings
~~2~~	~~Manufacturer's drawings~~ (See Note 2)
~~3~~	~~Construction drawings~~ (See Note 3)
4	~~Demolition drawings~~ (See Note 3)
-	Non-Drawings
A	Design documents (Class A)
~~C~~	~~Construction documents~~ (See Note 3)

Notes:

1. *Sections of the table are shown in strikethrough format to show change from the previous Technical Document Numbering Standard. Where a project has been started with source codes 2, 3, 4, or C coordinate with the City Project Manager for specific direction.*
2. *Number manufacturer's drawings as per Section 5.*
3. *Temporary construction and demolition drawings/documents shall be indicated via the Process Code, as described in Section 3.2.6.1.*

Implementation Note:

1. *The use of the Source Code has been reworked to provide more logical document sorting.*

3.2.2 Facility Code

The Class A Document Numbering System uses the same facility codes as the City Water and Waste Drawing Standard, and in addition introduces the code "0100" as a virtual facility for Program standard documents that are not specific to a particular site.

Table 3-3 : WSTP Facility List

Code	Description
0100 to 0109	Wastewater Treatment Facilities
0100	WSTP standard documents (not specific to a site)
0101	NEWPCC (North Plant)
0102	SEWPCC (South Plant)
0103	WEWPCC (West Plant)

(Other codes for facilities not included in the Program do not pertain to this document).

3.2.3 Discipline Code

The disciplines are coded as per Table 3-4. The discipline should generally be chosen based upon the group responsible for creating and/or implementing the work. For example: A motor starter schematic is an electrical document, even though it might be associated with a unit of process equipment.

In the event that a discipline is not applicable, or the document is truly multi-disciplinary, the *D - General* discipline code should be selected.

Table 3-4 : Discipline Codes

Code	Discipline	Examples
A	Automation	Instrumentation and Control including Control system block diagrams, instrument loop diagrams, networking drawings (if associated with automation system), control system functional requirements specification.
B	Building-Architectural	General architectural including building layouts and architectural finishes.
C	Civil-Geotechnical	Civil surveys, erosion control, grading, roads, fencing, landscaping, underground utilities.
D	General	Legends, code summary, General site plan, orientation maps, staging areas.
E	Electrical	Electrical site plans, grounding drawings, lighting, motor starter schematics, telecommunications, hazardous location plans.
I	Internal	Utilize for internal documents
M	Mechanical (*Includes HVAC/Plumbing)*	Domestic water plumbing, sanitary and storm drainage, ductwork, air handling equipment, HVAC piping, fire protection systems.
O	Operations	Area Manual, Operating and Maintenance Manual, Standard Operating Procedures.
P	Process *(Process and Process Mechanical)*	Process Flow Diagrams, Process and Instrumentation Diagrams, Process Equipment General Arrangement, Process Piping, Process hydraulics, Odour Control General Arrangement.
S	Structural	Structural Site Plan, Foundations, Reinforcement, Piers, Piling, Slabs and Retaining Walls, Structural Framing, Floor and Roofs.
Y	Commissioning	Commissioning Design Plan, Commissioning Calculations.

3.2.4 Document Type

3.2.4.1 Drawings

The Document Type coding for drawings is as per Table 3-5.

Table 3-5 : Document Type - Drawings

Code	Description	Discipline Codes									
		A	B	C	D	E	M	O	P	S	Y
		Automation	Building / Architectural	Civil	General	Electrical	Mechanical	Operations	Process	Structural	Commissioning
AAA	Legend & General Notes *(sort first)*	1	1	1	1	1	1	1	1	1	1
BDG	Block diagram	1				1					1
CBD	MCC / Cabinets drawing	1				1					1
CDW	Cable drawing	1				1					1
CTR	Cable Trays / Conduit / Cable Routing	1				1					
DRN	Drains			1							
DTL	Discipline Specific Standard details	1	1	1	1	1	1	1	1	1	1
ENV	Environmental			1							
FAF	Fixture and Furniture		1								
FAS	Fire Alarm System					1					
FDW	Foundation drawings									1	
FNC	Fencing			1							
GAD	General Arrangement drawing *(including section views)*	1	1	1	1	1	1	1	1	1	1
GRD	Earthing/grounding					1					1
HLC	Hazardous Location Classification *(Plans / Sections)*					1		1			1
HYD	Hydraulic line								1		1
IDW	Installation drawing	1				1	1				1
IFS	Instrumentation Fieldbus Segment Drawings	1									1
ILD	Instrumentation Loop Diagrams	1									1
ISO	Piping isometrics						1		1		1
LSC	Landscaping			1							

Class A Documents

Code	Description	Discipline Codes									
		A	B	C	D	E	M	O	P	S	Y
		Automation	Building / Architectural	Civil	General	Electrical	Mechanical	Operations	Process	Structural	Commissioning
LTG	Lighting Drawings *(Plan and schematics)*					1					
LYT	Layout			1							1
MCL	Motor Control *(Includes, motor starter schematics and connection diagrams)*	1				1					
MOD	3D Models		1	1	1	1	1		1	1	
MST	Master/Extraction Files		1	1	1	1	1		1	1	
NET	Networking	1				1					
PCC	Precast concrete									1	
PFD	Process Flow Diagram							1	1		1
PID	Process and Instrumentation Diagram								1		1
RDW	Reinforcement drawing									1	
RSW	Roads and sidewalks			1							
SCH	Discipline Specific Schedules *(Door, Hardware, Luminaire, HVAC, etc.)*	1	1	1	1	1	1	1	1	1	1
SCY	Security	1				1					
SDW	Form drawings.									1	
SLD	Single line diagram					1					1
SST	Structural steel									1	
SVY	Survey			1							
TDW	Terminal drawing					1					1
TLD	Three-line diagram					1					1
UTY	Utilities *(site utilities such as buried piping and electrical services)*			1							
WDG	Wiring / connection diagram	1				1					1

3.2.4.2 Class A Documents Other Than Drawings (Technical Documents)

The Document Type coding for Class A Documents, other than drawings, is as per Table 3-6.

Table 3-6 : Document Types – Class A Documents Other Than Drawings

Code	Description	Discipline Codes									
		A	B	C	D	E	M	O	P	S	Y
		Automation	Building / Architectural	Civil	General	Electrical	Mechanical	Operations	Process	Structural	Commissioning
DTS	Datasheet (Equipment/Instrument)	1	1	1	1	1	1		1	1	1
FRS	Functional (Requirements) Specification	1									
MAN	Manual (i.e. Area Manual)							1			
PCN	Process Control Narrative / Process Control Philosophy								1		
SOP	Standard Operating Procedure							1			
SUR	Survey (Report)			1	1	1					
TLI	Technical List (Equipment, Instruments, I/O, cables etc)	1	1	1	1	1	1		1	1	1

3.2.5 Area Code

The area code is composed of a single letter, which represents a specific location in the Facility. Where a document is not specific to an area, then the following general area code shall be used:

A General or area not applicable

For area codes specific to each facility, refer to the following documents:

NEWPCC CD-RC-RF-01 NEWPCC Facility Process Areas
SEWPCC CD-RC-RF-02 SEWPCC Facility Process Areas
WEWPCC CD-RC-RF-03 WEWPCC Facility Process Areas

3.2.6 Process Code

For most Class A documents, the *Process Code* is a single digit that refers to a specific process within each area (Area Code). The set of *Process Codes* are unique for each Area Code within each facility and the same digit will typically represent different processes within different areas. However, standard process codes are also available for certain scenarios, as described below.

3.2.6.1 Standard Process Codes

Standard process codes are shown in Table 3-7

Table 3-7 : Standard Process Codes

Code	Title	Description
0	General	The document / drawing is not associated with a specific process, or is associated with multiple processes.
1 – 9	Specific	See Section 3.2.6.2.
D	Demolition	The document / drawing is a demolition document.
T	Temporary Construction	The document / drawing is a temporary construction document that will have no purpose after the construction is complete.

3.2.6.2 Specific Process Codes

The Process Code digits 1 – 9 are reserved for specific codes, unique for each Area Code within each facility. The same digit will typically represent different processes within different Area Codes. For example:

1-0102-PPID-G**1**01	Process Code 1 represents Raw Sewage Pumping in the SEWPCC G area.
1-0102-PPID-R**1**01	Process Code 1 represents Tanks, Mixing and Chemicals in the SEWPCC R area

For process codes specific to each facility and area, refer to the following documents:

NEWPCC	CD-RC-RF-01 NEWPCC Facility Process Areas
SEWPCC	CD-RC-RF-02 SEWPCC Facility Process Areas
WEWPCC	CD-RC-RF-03 WEWPCC Facility Process Areas

3.2.7 Sequence Number

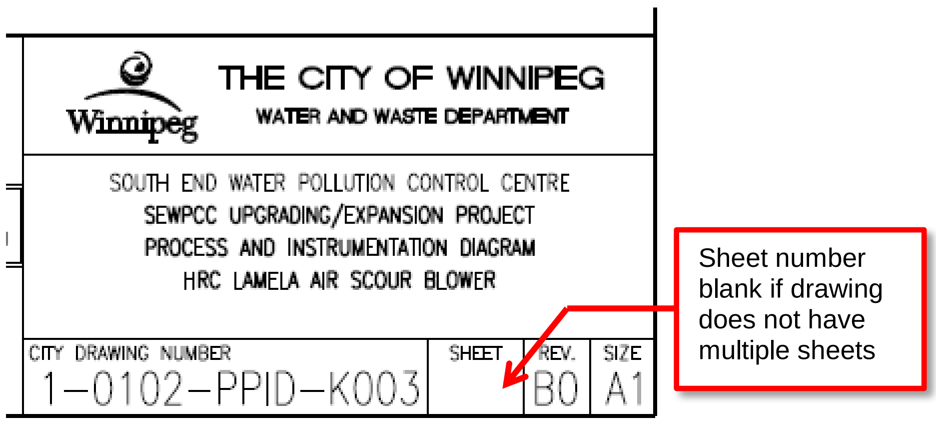
The sequence number is two digits long and identifies the individual documents within the document numbering scheme. The user may chose non-sequential numbering if deemed appropriate for the situation.

3.2.8 Sheet Number - Optional

The sheet number is a two digit field used for multiple sheet drawings. Multiple sheet drawings are utilized when the content cannot fit within one drawing sheet. Multiple sheet drawings shall have the same title. If it is desired to have a different title, then a new document number shall be utilized. Some examples of situations where multi-sheet drawing are appropriate are as follows:

- A complicated motor starter schematic that cannot fit on one drawing.
- Document lists that cannot fit on one drawing.
- A room layout plan that cannot fit on one drawing.

Documents without multiple sheets shall have a sheet number indicated as a (Blank) on the document itself. However, the DMS may require that the number 00 be entered in the Sheet number field, if multiple sheets do not exist. For example:



For non-drawing Class A documents, the number of sheets will typically not be utilized; however it may be utilized to manage large documents that are split into multiple parts. For example, a large engineering list could be split as follows to allow for smaller file sizes (for e-mailing):

A-0102-DELI-A005-01	Part 1 of a technical list.
A-0102-DELI-A005-02	Part 2 of a technical list.

Sheet numbers shall not be utilized to attach documents together, which are otherwise intended to be identified as separate documents.

3.2.9 Suffix

Implement the suffix as per Section 6.3.

3.3 Additional Information Elements

The following additional information elements are not part of the actual document number; however, they provide useful metadata which will be utilized for tracking documents. This information should be attached as metadata when supported by the document management system (DMS).

3.3.1 Revision Number

Implement as per Section 6.2.

Implementation Note:

1. *The superseded Technical Document Numbering System utilized a specific coding system to indicate the level of design stage. To provide consistency with the other document numbering formats in this standard, which do not have revisions that correspond to the level of design stage; the design stage specific revision codes have been eliminated. For existing documents, at the next revision stage implement the next appropriate revision code as per this standard. For example, a drawing might have last been released as a D1 revision, and is being subsequently revised during the design stage. Select the appropriate revision level as per Section 6.2, which would be a preliminary P series revision, such as PE.*

3.3.2 Document Size

The document size shall be shown on all drawings, and recorded in the metadata of the DMS. Typically the size is shown on the border of the drawing.

Table 3-8 : Document Size Code

Code	Size
A	8.5 x 11 Inches (215.9 x 279.4 mm)
B	11 x 17 Inches (279.4 x 431.8 mm)
A2	420 x 594 mm (16.5 x 23.4 Inches)
A1	594 x 841 mm (23.4 x 33.1 Inches)
B1	707 x 1000 mm (27.8 x 39.4 Inches)
A0	841 x 1189 mm (33.1 x 46.8 Inches)

Notes:

1. *Sizes refer to true ANSI Engineering or true ISO formats*
2. *Dimensions in brackets indicate approximate measurement*

3.4 Special Cases and Clarifications

3.4.1 Conceptual and Preliminary Design Documents

Documents created for conceptual or preliminary design stages, which are not likely to be directly utilized for construction, will not be filed within the City's drawing management system for Operations' use. Thus, these preliminary technical documents shall utilize a slightly modified document number where the *Source Code* and *Facility Code* are removed, as follows:

Table 3-9 : Document Number Format – Class A Documents

Field	Preliminary Code		Discipline Code	Document Type		Area Code	Process Code	Sequence Number		Sheet Number (Optional)		Suffix (Optional)
Format	PD	-	L	LLL	-	L	C	NN	-	CC	_	*
Example	PD	-	C	GAD	-	A	1	01	-	01	_	C01

Legend: N= numeral, L= Letter, C= character (i.e. =N or L), * = Multiple Characters

Utilizing this system will avoid tying up document numbers for documents which may never need to be referenced by Operations.

For example, this shortened document numbering system would be utilized if a consultant were engaged to provide a preliminary design, but not the detailed design of a facility. In the event that the same party were providing both the preliminary and detailed design documents, full document numbers may be utilized at the preliminary design stage if the documents will be carried over into the design and construction.

3.5 Organization and Referencing

3.5.1 Referencing Design Documents

Design documents may be referenced within the body of any base document within an overall design package.

When referenced in a base document within the same design package, the first 2 fields (source code and facility code) of the document that are common to the base document are optional. Additional information fields are not indicated.

Example 1:

Full document number of reference: 1-0102-AGAD-P601

Document reference shown: AGAD-P601

Example 2:

Full document number of reference: 1-0102-AILD-R101-02

Document reference shown: AILD-R101-02

3.5.2 Document Sorting

The sorting of documents outside the DMS should be alphabetical from left to right, within a given document package or set. This provides the most intuitive system for people to find documents and will match computer sorting of the documents. However, document filtering may be utilized to package documents by other criteria, such as area code.

Examples are indicated below:

Document Package – No Filtering

1-0102-AGAD-P001
1-0102-AGAD-S001
1-0102-EGAD-P001
1-0102-EGAD-S001
1-0102-PGAD-P001
1-0102-PGAD-S001
4-0102-BGAD-P001

Document Package – Area Code P	**Document Package – Area Code S**
1-0102-AGAD-P001	1-0102-AGAD-S001
1-0102-EGAD-P001	1-0102-EGAD-S001
1-0102-PGAD-P001	1-0102-PGAD-S001
4-0102-BGAD-P001	

Minimum Requirement: Unless otherwise indicated, document snapshot sets should be filtered and packaged by area code.

3.6 Electronic File Name

3.6.1 Single Documents

3.6.1.1 General Case within a Document Management System

Table 3-10 : File Name Format – Within DMS

Field	Document Number	Extension
Format	As per Table 3-1	.LLL(L)
Examples	1-0102-CGAD-B601	.pdf
	1-0102-CGAD-B602-01	.pdf

Note:

1. *The Revision Code is not included as document revision management is handled within the DMS system.*

3.6.1.2 General Case for Documents Managed Manually in a Windows Environment

This case is applicable when documents are managed in a standard file-based network drive.

Table 3-11 : File Name Format – Managed Manually

Field	Document Number	Revision	Extension
Format	As per Table 3-1	_RNN	.LLL(L)
Examples	1-0102-CGAD-B601	_R00	.pdf
	1-0102-CGAD-B602-01	_R02	.pdf

Implementation Note:

1. *The inclusion of the _R code in front of the Revision Code to allow for consistency with Tender Drawing filenames.*

3.6.1.3 Tender Drawings

When drawings are included within a tender package posted on the City Materials Management web site, the file name convention must be modified to meet the Materials Management naming convention (refer to Materials Management document “Bid Opportunity document file naming convention) adapted as in the following example;

Table 3-12 : File Name Format – Tender Drawings

Field	Prefix	Document Number	Revision	Extension
Format	####-YYYY_Drawing_	As per Table 3-1	_RNN	.LLL(L)
Examples	682-2014_Drawing_	1-0102-CGAD-B601	_R00	.pdf
	682-2014_Drawing_	1-0102-CGAD-B602-01	_R02	.pdf

3.6.2 Document Snapshot Sets

Document snapshot sets (also known as document sets) allow for multiple documents to be contained within a single file. The snapshot set is not to be considered an official document, and in no way eliminates the requirements in the other parts of this document. The use of document snapshot sets in no way eliminates the requirement to load individual documents into the DMS.

The most common use of a document set is to package multiple drawings in a single PDF file to allow for simplified distribution. All of the documents within a document set shall still have unique document numbers and be tracked by revision.

The following rules shall apply to document snapshot sets:

- The documents within a set shall be applicable to a single Source Code.
- The documents within a set shall be applicable to a single Facility.
- The documents within a set may be applicable to either a single or multiple disciplines. If multiple disciplines are within the set, a lowercase “x” character shall be utilized for the Discipline Code in the set filename.
- The documents within a set may have either a single or multiple Document Types. If multiple disciplines are within the set, a lowercase “xxx” document type shall be utilized in the set filename.
- The documents within a set may have a single or multiple Area Codes. Where multiple Area Codes are in the set, the Area Codes shall be coded as “x” in the set filename.
- The documents within a set may have a single or multiple Process Codes. Where multiple Process Codes are in the set, the Process Code shall be coded as “x” in the set filename.
- The Sequence Number for the set shall be indicated as “xx” to reflect that multiple documents are in the set.
- The document snapshot set does not have a revision, but rather a date. The documents within the set shall be the most recent published versions on the date that the snapshot set is created. The date shall be included in the set filename in “YYYY-MM-DD” format, after the “SET_” prefix.
- Document snapshot sets shall not be loaded into the Technical Document Library of the DMS. An alternate storage location will be provided.

Example: File with a set of mechanical drawings for the SEWPCC facility.

SET_2014-08-01_1-0102-Mxxx-xxxx.pdf

Example: File with a set of Bioreactor P&ID drawings for the SEWPCC facility.

SET_2014-08-01_1-0102-PPID-Rxxx.pdf

3.7 Examples

Examples of Class A document numbers are indicated below:

Document Number	Title
A-0102-ETLI-S001	SEWPCC – Secondary Clarifier Area – Electrical Load List
A-0103-CSUR-Y001	WEWPCC – Yard – Survey of West Field
1-0102-PPID-G105	SEWPCC Raw Sewage Pumping P&ID
1-0102-BGAD-K011	SEWPCC – HRC – Architectural Section D

4 GENERAL PROJECT DOCUMENTS

4.1 Description

Project documents are created for and utilized during the execution of projects, and are not design documents, submittals, or quality test results. For example, contract administration or construction documents would be under this format.

4.2 Format

The document number format for general project documents is shown in Table 4-1, with a description of each field in the subsequent sections.

Table 4-1 : Document Number Format – General Project Documents

Field	Project Code		WBS Code	Category Code	Discipline Code		Document Type Code		Sequence Number		Suffix (Optional)
Format	LNNNN	-	NN	L	L	-	LLL	-	NNNN	_	*
Examples	S0926	-	01	C	D	-	CCN	-	0001	_	R01
	S0926	-	00	P	F	-	BUD	-	0001		

Legend: N = numeral, L= Letter, * = Multiple Characters.

Notes:

1. *The file extension, such as ".docx" or ".pdf" would be appended to the end of the filename, but is not technically considered to be part of the document number.*
2. *The suffix is separated by an underscore (_), not a hyphen (-).*
3. *The suffix is technically not part of the document number, but rather an extension to be utilized in special case scenarios.*

4.2.1 Project Code

The *Project Code* is the City of Winnipeg project number assigned by Records Management, without a hyphen and with four numeric digits. Examples of Records Management assigned project numbers and the corresponding *Project Code* are shown below.

Records Project Number	Project Code for Use in Document Numbering Standard
S-926	S0926
S-1521	S1521
S-2111	S2111

4.2.2 WBS Code

A Work Breakdown System (WBS) Code is provided for medium and large sized projects, to provide an organizational structure to the documents. It is a two digit code that is set up by the Project Manager on a case-by-case basis. For small projects, the WBS Code may be fixed at 00, if so decided by the project manager.

The WBS may follow the contract structure of the project, but may follow another logical organization, as applicable for the work. It would be desirable, but not mandatory, that the WBS Code follow the high level work-breakdown structure utilized for project management. Three example WBS coding structures are shown in Table 4-2 below.

Table 4-2 : Sample WBS Code Structures

WBS Code	Description
Small Projects WBS	
00	All aspects of the project are grouped under a single WBS item.
Contract-Based WBS	
00	General Project Development
01	Consultant Contract
02	Civil Works Contract
03	Building Construction Contract
04	Electrical / Mechanical Installation Contract
11	Equipment Supply Contract 1
12	Equipment Supply Contract 2
21	Chemical Delivery Contract 1
Work-Based WBS	
00	General Project Development
01	NEWPCC RAS Gallery Pipe Replacement
02	WEWPCC Secondary Flushing Water Pipe Replacement
03	WEWPCC Perimeter Road Water Pipe Replacement

4.2.3 Category Code

The *Category Code* provides an organizational structure to the document numbering system. See Table 4-3 for a list of *Category Codes*.

Table 4-3 : Category Codes

Code	Description	Notes
B	Bid and Contract	Bid Opportunity or RFP bids as well as associated evaluation documents.
C	Construction	Documents associated with the implementation of construction. The audience of these documents would typically include the design team and possibly the contractor. Example: Daily construction reports
D	Design Documents – Project	Documents which may or may not be of a technical nature associated with the specific project design, but would not necessarily be utilized for the operation and maintenance of the facility.
-	Drawings (Class A)	Drawings (Class A) are required for operation and maintenance of the facility. Use Class A Document Numbering System as per Section 3.
-	Technical Documents (Class A)	Technical Documents (Class A) are required for operation and maintenance of the facility. Use Class A Document Numbering System as per Section 3.
P	Project Management	Management of the overall project or a specific contract. Includes meeting minutes, correspondence, contract change orders, invoices, etc.
S	Contractor Submittals	Shop drawings and product datasheets produced by the contractor or other vendors. The submittals indicate specific manufacturing and construction details, but not overall design concepts. If project uses a DMS, Submittal documents are numbered as per Section 4. If the project does not use a DMS, Submittal documents are numbered as per Section 5.
Q	Quality	If project uses a DMS, Quality documents are numbered as per Section 4, If the project does not use a DMS, Quality documents are numbered as per Section **Error! Reference source not found.**.

4.2.4 Discipline Code

The disciplines for Project Documents are coded as per Table 3-4. Note that the disciplines are the same as those for Class A documents, as per Section 3.2.3; however additional codes are included for Project Documents. The discipline should generally be chosen based upon the group responsible for creating and/or implementing the work. For example: a structural technical memo should be identified with a structural discipline code even though it may be associated with a building.

In the event that a discipline is not applicable, or the document is truly multi-disciplinary, the *D - General* discipline code should be selected. For example, most *Minutes of Meetings* will have a *D- General* discipline.

Table 4-4 : Discipline Codes

Code	**Discipline**
A	Automation
B	Building-Architectural
C	Civil-Geotechnical
D	General
E	Electrical
F	Financial
I	Internal (See Notes 1, 2)
M	Mechanical (*Includes HVAC/Plumbing)*
O	Operations
P	Process *(Process and Process Mechanical)*
R	Safety
S	Structural
Y	Commissioning

Note:

1. *The Internal discipline should only be utilized when it is desired to separate internal documents from official project documents, to allow sequence numbering to be maintained. For example, if a Contractor is performing a construction inspection for their own internal use, and does not wish to interfere with the sequencing of the official construction inspections, the I – Internal discipline may be utilized. Please note that the DMS may sequentially number I – Internal documents, regardless of organization. Thus, if a contractor creates an internal document and the City creates and internal document, they cannot have the same document number.*
2. *The Internal discipline should be used only in scenarios where required. It should not take precedence over other discipline codes. For example, just because a document is an internal document, does not mean that it should have an I-Internal discipline assigned.*

4.2.5 Document Type Code

The *Document Type Code* describes the general subject or nature of the document. Note that the *Document Type Code* does not describe the detailed document content, which should be identified in the Document Title as per Section 6.1. For example, the following documents are both coded with the same type code (Project Management Plan), but have different titles.

Document Number	Title
S5812-00PD-PLA-0001	WEWPCC Bioreactor Project Charter
S5812-00PD-PLA-0002	WEWPCC Bioreactor Project Plan

The document types are coded as per Table 4-5.

Table 4-5 : Document Type Codes

Code	Description	Typical Category	Description / Examples
ACC	Contract Change Order Approved Contract Change / Consultant Services Change Order	P	Includes both contractor and consultant change orders.
BCA	Business Case	P,D	
BDC	Tender Document / Bid Document	B	Bid Opportunity or RFP documents. See Section 4.3.2.
BID	Bid / Bid Submission	B	The bid documents submitted by the bidders.
BOD	Basis of Design	D	
BUD	Budget	P	
BUL	Bulletin	C	Notice to employees / contractor regarding a safety issue.
CCN	Contemplated Change Notice / Proposed Change Notice	P	Includes both consultant and contractor contemplated / proposed change notices.

General Project Documents

Code	Description	Typical Category	Description / Examples
CER	Certificate	P	Examples: Certificate of Substantial Performance Certificate of Total Performance Certificate of Acceptance
		C	Examples: Certificate of Equipment Delivery Certificate of Readiness to Install Certificate of Satisfactory Installation Certificate of Commissioning Completion Certificate of Equipment Satisfactory Performance Certificate of Satisfactory Process Performance
CIR	(Construction) Inspection Report	Q	
CLA	Claim	P	Contractor Claims
COR	Correspondence	B, P	Formal and informal correspondence. Note that document numbering of informal correspondence (i.e. e-mails) is not mandatory. Examples: Letters (i.e. bid clarification, formal consultant notice), memos.
CON	Contract	B	Letter of Intent, Contract Award, POs
CRD	Daily Report	C	Daily Construction Report
DCA	Design Calculations and Analysis	D	
EST	Estimate	P, C	Typically financial estimate.
EVA	Bid Evaluation	B	Bid evaluation documents, bid clarification analysis.
FIN	Field Instruction / Design Field Instruction	C	Instruction from the design team to the contractor.
FWA	Field Work Authorization	P	Authorizes the contractor to proceed with a limited contract change to expedite the contract change process.

General Project Documents

Code	Description	Typical Category	Description / Examples
GEN	General / Miscellaneous	P	Document that does not fall under any other document type.
INS	Insurance	P	Insurance documents.
INV	Invoice	P	
IRC	Incident Report	C	Example: Near Miss Report
JSA	Job Safety Analysis / Job Hazard Assessment	C	
LIC	Licence / Regulatory	P	Any document associated with a regulatory licence. Example: Sewage Treatment Licence, Licence Clarification
LIS	List	B, C, D, P, Q	Any type of list document that is not a record (log of event that has occurred)
LOG	Log	B, C, D, P, Q	A document which a register (list) of an event, occurrence, issue, or status.
MAG	Meeting Agenda	P	
MOM	Meeting Minutes	P	
NCR	Non-Conformance Report / Quality Deficiency Report	Q	
OER	Over Expenditure Report	P	City internal document to approve a contract change. This document type is not implemented on the DMS. If uploading over-expenditure reports on the DMS, utilize the *Report* document type.
PER	Permit	C	Construction permit, building permits and other government permits.
PES	Progress Payments / Progress Estimate	P	Contractor Progress Estimate (Basis of Payment)
PHO	Photograph	B, C, D, P, Q	

General Project Documents

Code	Description	Typical Category	Description / Examples
PLA	Plan	C	Example: Traffic Management Plan Contractor Safety Manual, Safe Work Plan, Emergency Response Plan
		P	Any plan document written from a project management perspective. Examples: Consultant Services Management Plan, Project Charter, Project Plan
		Q	Quality Plan
POR	Purchase Order	B	A purchase order associated with a contract. For example, a chemical purchase.
PRE	Presentation	C,D,P	Presentation (i.e. PowerPoint)
PRO	Procedure / Protocol	P	Project Management Procedure
		C	Construction Procedure or Protocol: Example: Construction shutdown procedure Safety Procedure: Examples: Lockout/Tag out Procedure Commissioning procedure (Discipline Y)
		Q	
PRP	Progress Report	P	Progress reports and status reports.
PRR	Press Release	P	
PTW	Permit to Work / Work Permit	C	Safety work permit. Examples: Confined Space Permit, Critical Lift Permit, Hot Work Permit
QTR	(Quality) Test Result	Q	Examples: Concrete strength testing, acoustic noise testing, electrical insulation testing result
REF	Reference Document	D	A document that is a reference for a design. Examples include a technical paper or vendor data.
RFI	Request for Information	C,D, P	Contractor or designer request and response. Note that Materials Management compliant naming may be required for procurement RFIs.
RIS	Risk Register	P	

General Project Documents

Code	Description	Typical Category	Description / Examples
RPM	Technical Memorandum / Report - Memorandum	D	Small reports including technical memorandums.
RPT	Report	B, C, D, P, Q	Reports including design reports, award reports and general reports other than those identified with a specific document type code.
SCD	Schedule	P	Any project time schedule document. Example: Commissioning Schedule. See Note 2
SPC	Specification	D	Construction Specifications. See Section XXX
SKT	Sketch	C, D	
SUB	Submittal	S	Contractor Technical Submittal (i.e. shop drawings and product data) – Used for DMS projects only. Use Section 5 for non-DMS projects.
TRA	Transmittal	P	May not be a document type within a DMS as the DMS generates an internal transmittal.
TRC	Training Attendance (Record)	C	Example: Worker Orientation Record
VID	Video	C	
WAR	Warranty	C	Contract warranty documents

Note:

1. *It is required that the Document Types for General Project Documents do not conflict with the Document Types for Class A Documents.*
2. *The Code SCD was utilized rather than SCH for the Project Schedule document type as the SCH document type is utilized in Table 3-5.*

4.2.6 Sequence Number

The *Sequence Number* is a four digit number to uniquely identify the specific document, with a given *Project Code*, *Category Code* and a specific *Document Type Code*. It is usually assigned in a sequential manner with the first document assigned a *Sequence Number* of 0001 and the next document 0002.

Notes:

1. *Where documents are not auto-numbered (outside of the DMS), assignment of the Sequence Number will typically be performed by searching for the last document with the given Project Code and Document Type Code, and incrementing the sequence number. For example, if the last meeting minutes document for S0924 was S0924-00PD-MOM-0014 the next meeting minute document would be identified as S0924-00PD-MOM-0015.*
2. *If not auto-numbered via a DMS, The project manager may assign a specific coding system to the sequence number for a specific project, if so required. For example 1000 series document may be associated with phase one of the project and 2000 series documents may be associated with phase two of the project.*

4.2.7 Suffix

See Section 6.3.

4.3 Special Cases and Clarifications

4.3.1 Class A Documents

Class A Documents will be identified as per Section 3. Class A Documents are technical design documents and drawings produced to describe the work and utilized as a facility lifecycle document for records and maintenance purposes.

4.3.2 Tender Documents

Tender (Bid Opportunity and Request for Proposal) documents will be identified as per Materials Management file naming convention, as described in Naming_conventions.pdf.

4.3.3 Specifications

Specifications in NMS / MasterSpec format will be numbered in accordance with Materials Management file naming convention. Specifications should be broken out into one file per division for delivery to the City or posting to Materials Management.

Examples:

601-2015_NMS_Division-10

601-2015_NMS_Division-26

4.4 Example Project Documents

The following examples demonstrate correct application of this standard to project documents.

Document Number	Title	Description
S0926-01CF-CCO-0003	New SF-G652	(Contract Change Order)Approved Contract Change 0003, which is regarding a new supply fan SF-G652 for project contract 1 (123-2014).
S0926-01CF-CCO-0003_APP01	SF-G652 Datasheet	Appendix to CA-ACC-0003
S0926-01CF-CCN-0001_RES01	Additional Concrete	Contractor response (quote) to S0926-01CF-CCN-0001 document regarding Additional Concrete.
S0926-01F-PES-0015_S	2014-10-31	Signed copy of Progress Estimate 15 for the period ending 2014-10-31.
S0926-02PD-MOM-0001	2014-09-10 Progress Meeting	Minutes of Meeting for the Contractor Progress Meeting dated 2014-09-10.
S0926-11CY-PRO-0001	Commissioning Procedure	
253-2015_NMS_Division-03	Division 03 Specifications	Division 03 specifications for the contract represented by the project WBS code 02.
S0926-02SE-SUB-0020	Panel board submittal	Format to be utilized only in a DMS environment.
S0926-02PF-RPT-0002	Over Expenditure Report	City internal document to approve a contract change.

5 CONTRACTOR SUBMITTAL DOCUMENTS

CAUTION: Utilize this section only for non-DMS projects.

5.1 Description

Contractor Submittal documents are typically shop drawings and product datasheets produced by the contractor or other vendors. The submittals indicate specific manufacturing and construction details, but not overall design concepts. Design documents (including drawings), produced either by a consultant, or as part of a design build project, shall be numbered as per the Class A Document format shown in Section 3 or the Project Document format shown in Section 4, as appropriate.

If utilizing a DMS for the project, see Section 4 for appropriate numbering.

5.2 Format

The document number format for Contractor Submittal documents is shown in Table 5-1, with a description of each field in the subsequent sections. This format is applicable to projects not utilizing the DMS. For projects utilizing DMS the format will be as per Section 4.

Table 5-1 : Contractor Submittal Document Number Format

Field	**Project Code**		**WBS Code**	**Category Code**	**Discipline**		**VDR Code** (See Note 2)		**Sequence Number**		**Suffix (Optional)**
Format	LNNNN	-	NN	L	L	-	[L]CCC[CCC]	-	NNN	_	*
Example	S0926	-	11	S	E	-	001	-	001	_	R01

Legend: N = numeral, L= Letter, C= character (i.e. =N or L), * = Multiple Characters

Notes:

1. *The Category Code is always S for project Contractor Submittal documents.*
2. *Two alternatives for VDR Codes are presented in Section 5.2.4.*
3. *The file extension, such as ".docx" or ".pdf" would be appended to the end of the filename, but is not technically considered to be part of the document number.*
4. *The suffix is separated by an underscore (_), not a hyphen (-).*

5. *The suffix is technically not part of the document number, but rather an extension to be utilized in special case scenarios.*

5.2.1 Project Code

The *Project Code* is implemented as per Section 4.2.1.

5.2.2 WBS Code

The *WBS Code* is implemented as per Section 4.2.2.

5.2.3 Category Code

The *Category Code* is implemented as per Section 4.2.3. The *Category Code* is always S for Contractor Submittal documents.

5.2.4 Discipline

Select the appropriate discipline as per Section 4.2.4.

5.2.5 VDR Code

The Vendor Document Requirement (VDR) Code is a number that uniquely identifies each submittal package required from the Contractor. The *VDR Code* is to be between three and six numbers, depending upon the coding system utilized on the project. The two available VDR coding systems are described in the following sections.

5.2.5.1 VDR Code Scenario 1 – Custom VDR List

In this scenario, the project manager has decided that a custom Vendor Document Requirement (VDR) list is created and that the submittal requirements are to be organized and referenced based upon a custom list for the project. This list shall include discipline coding, as per Table 3-4. The discipline should generally be chosen based upon the primary group responsible for creating and/or implementing the work. For example: A process pump datasheet is a process document, even though it might have electrical motor data included.

Scenario 1 is the recommended format for large projects, to ensure that submittals are not missed. Example document numbers for this scenario are shown below, based on the sample VDR schedule shown in Table 5-2.

Document Number	Title
S0926-12SS-S104-01	Structural - HRC Building Foundation Concrete mix design
S0926-12SS-S104-02	Structural - HRC Building Wall Concrete mix design
S0926-12SS-E103-01	Electrical - Distribution Panel DP-G701 submittal
S0926-12SS-E104-01	Electrical - Distribution Panel PNL-S702 submittal

Contractor Submittal Documents

Table 5-2 : Sample VDR Schedule

VDR	Discipline	Description
S1**	Structural	Head works and Grit
S101		Excavation Plan
S102		Shoring Plan / Shop Drawings
S103		Piles
S104		Concrete Mix Design
S2**		High-Rate Clarifier Building
S201		Excavation Plan
S202		Shoring Plan / Shop Drawings
S203		Piles
S204		Concrete Mix Design
E1**	Electrical	Headworks and Grit
E101		Transformers - MV
E102		Transformers - LV
E103		Panelboards – 600V
E104		Panelboards – 120/208V
E2**		High-Rate Clarifier Building
E202		Transformers - LV
E203		Panelboards – 600V
E204		Panelboards – 120/208V

5.2.5.2 VDR Code Scenario 2 – VDR Based upon Construction Specification Reference

In this scenario, the project manager has decided that no custom Vendor Document Requirement (VDR) list is created and that the submittal requirements are to be organized and referenced purely upon the specification reference number. The specification reference number is typically based on the Construction Specifications Institute (CSI) format, which is sometimes referred to as National Master Specifications (NMS) format. Examples for this scenario are shown below.

Document Number	**Title**
S0926-12SS-033000-001	Structural - HRC Building Foundation Concrete mix design
S0926-12SS-033000-002	Structural - HRC Building Wall Concrete mix design
S0926-12SE-262417-001	Electrical - Distribution Panel DP-R701 submittal
S0926-12SE-262417-002	Electrical - Distribution Panel DP-S702 submittal

5.2.6 Sequence Number

The *Sequence Number* is a three digit number to uniquely identify the specific document, with a given *Project Code, WBS Code, Category Code* and *VDR Code*. It is usually assigned in a sequential manner with the first document assigned a Sequence Number of 001 and the next document 002.

5.2.7 Suffix

Implement the suffix as per Section 6.3.

6 GENERAL REQUIREMENTS

The general requirements apply to all documents.

6.1 Document Titles

Every document shall have a document title clearly indicated on the cover of the document. The document number and document title are independent fields. Where a DMS is utilized, the title shall also be entered into the DMS document metadata.

Document titles should contain concise descriptive information regarding the content of the document, without duplicating information that is found in the document type. The information, together with the document number should provide users with sufficient information to identify the document. Where dates are applicable, they shall be in YYYY-MM-DD format.

6.2 Revision Codes

Every document shall clearly have a revision code indicated on the cover page of the document. The revision shall be in the format as per Table 6-1.

Table 6-1 : Revision Codes

Code	Description
PA - PZ	Preliminary / Draft Release
00	First Official Revision (Tender / Construction)
01 - 99	Subsequent Official Released Revisions
##[A-Z]	A draft release of changes to the ## revision release, which when approved would be incremented to the next release. For example: revision 01B is the second draft of the changes to the 01 release document, and when approved, would later become the 02 release document.

The revision code is not part of the document number, but shall be shown on the cover page / title block of all documents.

6.2.1 Revision Description

All documents should indicate a Revision Description, to indicate the purpose of the issue, or the changes made. Examples are indicated below:

Revision	Revision Description
PA	Initial Concept
PC	Issued for 60% Review
00	Issued for Tender
01	Modified pump horsepower

6.3 Suffix Codes

The *Suffix Code* is technically not part of the document number, but rather an optional extension to be utilized in special case scenarios. The *Suffix Code* consists of one to three letters and an optional subsequent sequence number. While the information in the suffix is limited, it should be noted that the document title should be utilized to fully describe the document. See Table 6-2 for a list of *Suffix Codes* and their definition.

Table 6-2 : Suffix Code Designations

Code	Description	Applicable With DMS
APP	Appendix	Yes
C	Commented version of the document	No (See Note 2)
NAT	Native format of the document	Yes
RES	Response to document. (Example – CCN Quote)	No
R	Revision of a document	No
S	Signed / approved version of the document	No

Note:

1. *Stacking of multiple suffix codes is acceptable where required to indicate the document content. The suffixes are to be separated utilizing an underscore character.*
2. *For commented versions of the document, responses to documents, revisions of documents and signed versions of the document in a DMS environment, simply replace / supercede the previous version of the document with the revised / response / commented / signed version. The original version of the document is still available on the DMS by accessing previous revisions.*

6.3.1 Appendix Files

Appendix files are additional documents appended to a main document. In some cases they may have a completely independent document number, but in other cases it is appropriate to number the document as an appendix to the main document by utilizing the APP suffix code.

Note:

1. *For the Aconex DMS, implementation of Appendix files will require the use of the Bulk Processing Tool to allow the auto-numbering for a document to be overridden and allow the use of the suffix.*

6.3.2 Commented Files

During project implementation, documents are reviewed and commented on. The comments can either be integrated into the native document, such as Microsoft Word comments, or into a PDF file. The commented files are not official versions of the document, and thus require a separate filename. The filename is to be appended with

"_C#", where # is a sequential number to be applied. Multiple comment files can be produced with respect to a single document. Where a comment file is applicable to a single revision, the revision number should also be included in the filename.

Note:

1. *If the DMS incorporates a commenting system, it shall be utilized rather than the use of commented files.*

6.3.3 Native Format of the Document

6.3.3.1 Microsoft Windows Implementation

It is acceptable to have both native file and PDF versions of the document with the same document number. The filename could be the same, except for different filename extensions.

6.3.3.2 DMS Implementation

Where a DMS cannot have the multiple files linked to the same document numbers, a document number suffix should be utilized to differentiate the native file from the published (PDF) file. Native files are the original Word, AutoCAD, Excel or other application data files that were utilized to generate the document. For example, document S0926-10PD-ACC-0001 is a signed document with some sketches integrated into the PDF file, it may still be desired to upload the original Word document. In this case, the Word document would be identified with a _NAT suffix (S0926-10PD-ACC-0001_NAT).

Note:

1. *The requirement to upload both native and PDF files shall be based upon the specific project contractual requirements and the direction of the Project Manager.*
2. *This does not mandate that all native files shall have the _NAT suffix. It is acceptable to load only the native (i.e. Word, Excel) files on the DMS, provided this does not contradict contractual requirements. The suffix shall be utilized when the primary file is in a different format (i.e. PDF).*
3. *For the Aconex DMS, implementation of native file suffix will require the use of the Bulk Processing Tool to allow the auto-numbering for a document to be overridden and allow the use of the suffix.*
4. *In the event that a native file is uploaded as a document (i.e. S0926-10DD-RPT-0001) and then at a later that the PDF file is uploaded, the document numbering should be corrected to meet the above standard. For this example, S0926-10DD-RPT-0001 should be assigned to the PDF file and S0926-10DD-RPT-0001_NAT to the native file.*

6.3.4 Examples

The following examples demonstrate correct application of suffixes.

Document Number With Suffix Extension	Title	Description
S0924-01DE-RPT-0001_C0		Excel review log on a design report that is applicable to all revisions of the document
S0924-11PF-PES-0015_S	2014-10-31	Signed copy of Progress Estimate 15 for the period ending 2014-10-31.
S0924-12CF-CCO-0003_APP01	SF-G652 Datasheet	Appendix to CA-CCO-0003
S0924-12CF-CCN-0001_RES01	Additional Concrete	Contractor response (quote) to CA-CCN-0001 document regarding Additional Concrete.
S0924-12PF-PES-0015_S	2014-10-31	Signed copy of Progress Estimate 15 for the period ending 2014-10-31.
S0924-12PD-MOM-0001_NAT	2014-09-10 Progress Meeting	Native Word File for the Progress Meetings
S0924-12PD-MOM-0001_R01	2014-09-10 Progress Meeting	Revision 01 of the Minutes of Meeting for the Contractor Progress Meeting dated 2014-09-10.
1-0102-CGAD-B601_RPA_C0		1st Commented file on PA rev.
1-0102-CGAD-B601_RPB_C0		1st Commented file on PB rev
1-0102-CGAD-B601_RPB_C1		2nd Commented file on PB rev
S0924-11DD-RPT-0001_C0	Document Comments	Excel comment file applicable to all revisions of the document (alternative to examples above)

7 DOCUMENT MANAGEMENT SYSTEM IMPLEMENTATION

7.1 Metadata Fields

The following metadata fields shall be tracked for each document within the DMS:

Table 7-1 : DMS Metadata Fields

Field	Mandatory	Notes
Document Number	Y	Drawings (Class A) are numbered manually. The document number for most project documents is auto generated.
Project Code	Y	Should be automatically entered for each document without user intervention. See Section 4.2.1.
WBS Code	Y	WBS codes are configured in the DMS as set up by the PM. For Class A documents, select the most appropriate WBS code, as per Section 4.2.2, even though the WBS code in not within the document number.
Document Type	Y	Corresponds to the Document Type Code. For project documents this is as per Section 4.2.5. For drawings (Class A), only a generic Drawing document type needs to be selected, however the appropriate document type shall be coded in the document number as per Section 3.2.4.1. For Class A Technical Documents, the document type shall be selected as per Section 3.2.4.2.
Category	Y	The Category shall be selected as per Section 4.2.3.
Discipline	Y	The Discipline shall be selected as per Section 4.2.4.
Area Code	N	The Area Code, while not mandatory, should be selected for all documents that are specific to an area code. See Section *3.2.5.*
Status	Y	Refers to document status. Refer to the DMS documentation.

8 FAQ – FREQUENTLY ASKED QUESTIONS

Why do Class A Documents have a different coding system than General Project Documents?

Class A Documents have a different lifecycle than General Project Documents. Project documents, such as a progress estimate or meeting minutes, do not typically need to be referenced past the life of the project. However, Class A Documents, including drawings, have a life for as long as the facility is in service. Thus, Class A Documents have a document number coded by facility and area rather than by project.

How should a HAZOP workshop report be numbered?

Workshop reports are not considered to be design documents, and thus should be numbered as General Project Documents per Section 4. For example, a valid project document number would be:

S0926-05DD-RPT-0005 HRC Building HAZOP Report

What should the Revision Code be for a preliminary drawing, sealed by a professional engineer for costing purposes?

Preliminary drawings should be coded with a Revision Code in the PA to PZ series, regardless of whether the drawing is an authenticated sealed drawing. An example is shown below:

Document Number:	1-0102-PPID-S201
Revision	PC
Revision Description:	Issued for Costing

What should the Revision Code be for a drawing issued for tender, but not sealed by a professional engineer?

A drawing issued for tender is an official release. If this is the first official release of the drawing, it should have a Revision Code of 00. A subsequent revision to issue the drawing for construction and seal the document would have a Revision Code of 01.

FAQ – Frequently Asked Questions

A drawing is currently at the as-built stage and changes are proposed as part of a new construction package. Should a new document be created? How should the Revision Code be applied?

If the changes to the document are minor and do not change the overall design intent, then modify the existing drawing. The following is an example sequence of drawings revisions, which would be appropriate for the indicated situation:

Document Number	Revision	Revision Description
1-0101-PPID-D521	02	As-Built – Bid Opp. 123-2015
1-0101-PPID-D521	02A	Proposed Modifications
1-0101-PPID-D521	02B	Issued for City Review
1-0101-PPID-D521	03	Issued for Tender – Bid Opp. 456-2018

How should National Master Specification (NMS) format specifications be numbered?

Response to be developed.

How should Construction Inspections by the Engineer be numbered?

Construction inspections reports by the engineers are considered to be Construction documents, not Quality Test Results. Construction documents are organized by discipline, as per Table 4-3. The Document Type Code for construction inspection reports is found in Table 4-5 to be CIR. Thus, for a structural inspection report for project S-924 and WBS Code 11, the document code would be:

S0924-11CS-CIR-0001

Where 0001 is the next available incremental number.

If a project is in the construction stage, and the contract administrator holds a meeting with the City, how should the meeting minutes be numbered?

Meeting minutes of meeting held with the contractor during the contract administration phase are typically numbered with a discipline of *D - General* as follows:

S0924-21PD-MOM-0001, S0924-21PD-MOM-0002, etc.

The concern is that a meeting held without the contractor should not interrupt the official meeting number sequence. Thus, if internal meetings are held without the other party, it is recommended to utilize the *I – Internal* discipline to differentiate the meetings as follows:

S0924-21PI-MOM-1001, S0924-21PI-MOM-1002, etc

How can I tell which organization created the document for the document number?

The document number does not indicate who created the document. The document's originator should be shown on the document's title page. In addition, if a DMS is utilized on the project, the DMS should have a metadata field for the document's originator.

What is the document number for a single comment file that applies to a large group of drawings?

The document number should utilize the LIS (List) document type. For example:

S0976-11DD-LIS-0001 WSTP Level 2 Design Report Comment List

APPENDIX N – WWD ELECTRICAL DESIGN GUIDE - R05

Winnipeg

The City of Winnipeg

Water & Waste Department

Electrical Design Guide

Document Code: 510276-0000-47ER-0001

Revision: 05

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TABLE OF CONTENTS

1 INTRODUCTION

This Water and Waste Department Electrical Design Guide is intended to serve as a reference for consistent design of new electrical systems for City of Winnipeg owned facilities. This document provides design requirements to department personnel, as well as external design engineers, regarding electrical design standards and requirements.

1.1 Scope of the Standard

These design requirements will apply to the following facilities:

- Water treatment plants
- Water pumping stations
- Wastewater treatment plants
- Flood pumping stations
- Wastewater lift pumping stations
- Land drainage and underpass pumping stations.
- Other collections facilities including pumping.

1.2 Application

The scope and intent of this document is to convey general design guidance regarding electrical systems at Water and Waste Department facilities. This document addresses specifics related to equipment type, selection, and configuration; however the designs are presented without knowledge of the specific process implementation. It is not within the scope of this document to provide detailed design direction, and it will be the responsibility of the respective system designers to fully develop the electrical design 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 respective engineer in each instance, and must be performed in conformance with all applicable codes and standards, as well as good engineering practice.

Where significant deviations from this standard are deemed to be appropriate by the design engineer, these shall be approved by the City. As technology evolves and new application requirements are identified, it is recommended that this document is updated to ensure that it remains relevant and applicable.

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

- All new designs, not related to an existing facility, are expected to comply with this standard. All major upgrades to a facility, or a larger facility's process area, 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 shall use this guide as far as practical for new equipment, however in some cases compromise may be required to accommodate the configuration of the existing facility design and installation, which will be retained after an upgrade.

1.3 Document Revisions

Wastewater Planning and Project Delivery Branch (WWPPD) will issue revisions to the document on an as required basis. WWPPD will send out an email requesting review and comments by the division list below.

All proposed revisions shall be circulated to the following divisions and branches:

- Water Services Division
- Wastewater Services Division
- Solid Waste Services Division
- Engineering Division
  - Asset Management Branch
  - Design and Construction Branch
  - Drafting and Graphic Services Branch
  - Land Drainage and Flood Protection Branch
  - Wastewater Planning and Project Delivery Branch
  - Water Planning and Project Delivery Branch

After comments are incorporated into the finalized draft, WWPPD will send a copy of the approved PDF to the Business Communications Coordinator for upload to the Water and Waste Department Website.

1.4 Definitions

A	Amperes
ATL	Across-the-Line
ATS	Automatic Transfer Switch
AWG	American Wire Gauge
BIL	Basic Impulse Level
CCTV	Closed Circuit Television
CPT	Control Power Transformer
CT	Current Transformer
CSA	Canadian Standards Association
CSO	Combined Sewer Overflow
DC	Direct Current
DCS	Distributed Control System
DOL	Direct-On-Line
EMT	Electrical Metallic Tubing
E-Stop	Emergency Stop
E&I	Electrical and Instrumentation
FAT	Factory Acceptance Test
FVNR	Full Voltage Non-Reversing (Starter)
GFCI	Ground Fault Circuit Interrupter

H_2S	Hydrogen Sulfide
HMI	Human Machine Interface
HOA	Hand – Off – Auto (switch)
hp	Horsepower
HPS	High Pressure Sodium
HVAC	Heating Ventilation and Cooling
I/O	Input / Output
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
kcmil	Thousand Circular mil (cable size)
kVA	Kilovolt-Amperes
kVAR	Kilovolt-Amperes Reactive
kW	Kilowatt
LC	Lucent Connector (fibre)
LED	Light Emitting Diode
MCB	Moulded Case Circuit Breaker
MCC	Motor Control Centre
MCM	Thousand Circular Mil (old version – utilize kcmil for new projects)
MH	Metal Halide
MMC	Motor Management Controller
MTBF	Mean Time Between Failure
MV	Megavolt
MVA	Megavolt-Amperes
MW	Megawatt
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NGR	Neutral Grounding Resistor
PA	Public Address
PDF	Portable Document Format
PID	Proportional Integral Derivative
PLC	Programmable Logic Controller
PFC	Power Factor Correction
PT	Potential Transformer
PVC	Polyvinyl Chloride
RMS	Root Mean Square
RTD	Resistance Temperature Device

RW90	Rubber-insulated building wire, 90°C rated
SCADA	Supervisory Control and Data Acquisition
SCCR	Short Circuit Current Rating
TDD	Total Demand Distortion
Teck90	PVC jacketed armoured cable, 90°C rated
TEFC	Totally Enclosed Fan Cooled
THD	Total Harmonic Distortion
TVSS	Transient Voltage Surge Suppressor
Unit Substation	As Defined in Section 6.13of this Design Guide
UPS	Uninterruptible Power Supply
UV	Ultraviolet
V	Volts
VA	Volt-Amperes
VAC	Volts Alternating Current
VDC	Volts Direct Current
VFD	Variable Frequency Drive
VRLA	Valve Regulated Lead Acid
WSTP	Winnipeg Sewage Treatment Program
XLPE	Cross-linked polyethylene insulation

2 GENERAL

2.1 General Design Requirements

General design requirements are as follows:

1. All designs will comply with municipal, provincial, and national codes and bylaws.
2. All electrical systems, materials, and equipment will be of a type and quality intended for use in a permanent water or wastewater facility as appropriate. Industrial-grade design requirements apply.
3. The electrical systems will provide proper protection, continuity of service and a safe working environment.
4. All electrical systems and equipment will be designed and configured with due regard for the associated specific process and nature of installation. Standard commercial-grade practices will not be adequate unless specifically permitted in this design guide.
5. Designs will incorporate the principle that change will be a constant and inevitable fact within facilities. All systems will be constructed so as to facilitate this change while minimizing the cost of change and the amount of interruption to the operation of the facility. Electrical rooms, equipment and system control panels are to have extra space and provisions for future expansion.
   5.1 Designs will clearly demonstrate the concept for serving the future expansion. For example: future electrical distribution equipment should be shown dotted in the extra space in electrical rooms and spare capacities allowed for in the main equipment (transformers, diesel generators, UPS, and associated switchboards and panelboards) for the future expansion should be separately identified in the equipment sizing calculations.
6. Electrical systems and equipment will be designed and installed in a coordinated fashion. The design will take advantage of current best available proven technology and provide reliable electrical systems performance for the current project and into the future.
7. Unless approved by the City, 4160 V equipment will not be located below grade. This will include but not limited to:
   7.1 Transformers with primary voltage 4160 V or higher
   7.2 Switchboards
   7.3 Distribution Equipment
   7.4 VFD’s

2.2 References

2.2.1 General

Where this document, codes, standards, and other referenced documents differ in content, the most stringent shall generally apply.

2.2.2 City of Winnipeg Standards

In addition to any other City of Winnipeg standards, the following standards shall be used:

- Water and Waste Department Identification Standard
- WSTP Automation Design Guide

2.2.3 Codes and Standards

API	American Petroleum Institute
CSA	Canadian Standards Association
NBC	National Building Code (as applicable to Manitoba)
CEC	Canadian Electrical Code (modified by Winnipeg regulations)
cUL	Underwriters Laboratories (approved for compliance with Canadian Electrical Code
ANSI	American National Standards Institute
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
NFPA	National Fire Protection Association
ULC	Underwriters Laboratories of Canada
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
IES	Illuminating Engineering Society
ICEA	Insulated Cable Engineers Association
IEC	International Electro-technical Commission
ISA	International Society of Automation
ISO	International Organization for Standardization
TIA	Telecommunications Industry Association
WSHA	The Workplace Safety and Health Act (Manitoba)

2.2.4 Design Codes and Standards

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

- Canadian Electrical Code
- Manitoba Electrical Code
- Winnipeg Electrical Bylaw
- Manitoba Building Code (National Building Code of Canada with Manitoba Amendments)
- Manitoba Energy Code / National Energy Code

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

CAN/CSA C282	Emergency Electric Power Supply for Buildings
CSA Z462	Workplace Electrical Safety (Z462)
IEEE 1584	Guide for Performing Arc–Flash Hazard Calculations (IEEE 1584)
IEEE 141	IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE 141, or the Red Book)
IEEE 241	IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (IEEE 241, or the Grey Book)
IEEE 242	IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE 242, or the Buff Book)
IEEE 399	Recommended Practice for Industrial and Commercial Power System Analysis (IEEE 339, or the Brown Book)
IEEE 519	Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
IEEE 551	IEEE Recommended Practice for Calculating Short–Circuit Currents in Industrial & Commercial Power Systems (IEEE 551, or the Violet Book)
IEEE 1015	Recommended Practice For Applying Low Voltage Circuit Breakers Used in Industrial and Commercial Power Systems (IEEE 1015, or the Blue Book)
IEEE 1250	IEEE Guide for Identifying and Improving Voltage Quality in Power Systems
ANSI / IEEE C37.10	IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (IEEE C37.10)
ANSI / IEEE C37.13	IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures (IEEE C37.13)

2.2.5 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. Exceptions are as follows:

1. Electrical conductor sizes are to be shown using units of AWG or kcmil and the wire size is not to be preceded with the number sign (#). For example: 14 AWG or 250 kcmil.
2. Arc flash energies are to be expressed in cal/cm^2
3. Motor power is to be expressed on all drawings and formal documents with both metric and imperial units. For example: 37 kW (50 hp).

2.3 Identification

All equipment shall be given an identifier that conforms to the latest version of the City of Winnipeg WWD Identification Standard. All equipment shall be identified on the drawings, documentation in the field and in software, where applicable, with the same identifier.

2.3.1 Identification Lamacoids

1. All lamacoids to be 3 mm thick plastic lamacoid nameplates, white face, black lettering.
2. Mechanically attach with self-tapping stainless steel screws. Where mechanically fastened lamacoids will compromise the enclosure rating ot the electrical equipment or are not practical adhesive such as 3M 467MP is allowable.
3. Apply lamacoids as per Table 2-1. Additional information shall be provided where required.
4. Provide warning and caution lamacoids in conformance with the latest requirements of the CEC. Lamacoids will have white lettering on a red background.

Table 2-1 : Lamacoid Requirements

Application	Text Size	Text
Electrical Equipment - General	5 mm	Line 1: Identifier
Circuit Breaker - Separate	5 mm	Line 1: Identifier Line 2: Load: Load Identifier And if Load Identifier not clear: Line 3: Load Description
Disconnect Switch - Separate	5 mm	Line 1: Identifier Line 2: Load: Load Identifier And if Load Identifier not clear: Line 3: Load Description
Fire Alarm Devices	8 mm	Line 1: Identifier
Light Switches	3 mm	Source Panel and Circuit Number
Motor Control Centre	8 mm	Line 1: Identifier Line 2: Description (Optional) Line 3: System Voltage Line 4: Fed By
Motor Starter or MCC Bucket	5 mm	Line 1: Load Identifier Line 2: Load Description And where applicable: Line 3: One of # sources of electrical power (where more than one source of power feeds the equipment)
Panelboards	8 mm 5mm may be used for space limitations	Line 1: Identifier Line 2: Description (Optional) Line 3: System Voltage Line 4: Fed By
Protection Relays	5 mm	Line 1: Identifier Line 2: Description
Receptacles	3 mm	Source Panel and Circuit Number
Switchgear	8 mm	Line 1: Identifier Line 2: Description (Optional) Line 3: System Voltage Line 4: Fed By
Switchgear Breaker or Switch	8 mm	Line 1: Load Identifier Line 2: Load Description
Transformer – Indoor	8 mm	Line 1: Identifier Line 2: Rating, System Voltage Line 3: Fed By
Transformer - Outdoor	10 mm	Line 1: Identifier Line 2: Rating, System Voltage Line 3: Fed By

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3 DESIGN REQUIREMENTS

3.1 Service Conditions

1. Minimum requirements for service conditions applicable to all outdoor electrical installations are as follows:
   1.1 Minimum Temperature: -40°C
   1.2 Maximum Temperature: 40°C

3.2 Voltage Levels

3.2.1 System Voltage Levels

The acceptable system voltage levels to be utilized are shown in Table 3-1. See Section 7.2 regarding the relationship of motor voltage levels to system voltage levels. Note that the supply voltage level may be dependent upon the utility.

Selection of a higher voltage over a lower voltage shall be utilized where:

1. The required current levels at the lower voltage are high (> 2000 A);
2. The utility is unable to supply the required power at the lower voltage; or
3. The potential arc flash energies at the lower voltage are at dangerous levels (> 40 cal/cm2).

3.3 System Configuration Concepts

The electrical system configuration for a facility is typically selected in the early planning stages for design. This section presents various system configuration concepts to guide the designer in typical configurations that may be applicable to the project at hand. Note that a facility could potentially use multiple concepts from the proposed configurations. For larger facilities, it is expected that the overall system configuration will be complex, and will not necessarily be categorized in the indicated configurations.

Notes:

1. The system distribution must always be designed by a professional engineer registered in the Province of Manitoba. The indicated system configurations are typical and are not necessarily appropriate for all installations. Detailed review of the specific constraints and risks associated with the particular application must be performed to identify potential modifications or additions required to the proposed system configurations.
2. The term “standby generator” is utilized in this section to represent a generator that is not rated for continuous duty. If the generator is utilized to power life-safety systems, it must be designated as an emergency generator, as discussed in Section 11.

Table 3-1 : Acceptable System Voltage Levels

Line-to-Line Voltage Level	Application	Notes
66 kV	Supply	Receive bulk power from the utility at large facilities
	Distribution	Not recommended to be typical.
	Utilization	Not applicable.
12.47 kV	Supply	Receive bulk power from the utility at medium to large sized facilities.
	Distribution	Preferred voltage for distribution at new large facilities, with cumulative distribution capacity > 7.5 MVA.
	Utilization	Motor loads > 1500 kW (2000 hp). Not expected to be typical.
4.16 kV	Supply	Receive bulk power from the utility at medium sized facilities.
	Distribution	For in-plant distribution at a medium to large sized facility, with cumulative distribution capacity in the approximate range of 1.5 to 7.5 MVA
	Utilization	For powering motor loads 260 kW – 1500 kW (350 hp to 2000 hp)
600 V	Supply	Preferred supply voltage for small to medium sized facilities up to 2000 kVA.
	Distribution	For in-plant distribution over short distances, up to 2 MVA.
	Utilization	Preferred voltage for motors 0.37 kW (0.5 hp) to 260 kW (350 hp).
480 V	Supply	Not recommended.
	Distribution	Not recommended.
	Utilization	Where required to feed specific equipment only available with a 480 V utilization voltage.
208/120 V	Supply	Acceptable supply voltage for small facilities (< 50 kVA load)
	Distribution	Not recommended.
	Utilization	Fractional horsepower motors, lighting, and other small misc. plant loads. Preferred over 120/240 V 1Ø systems in facilities with 3Ø distribution systems.
120/240 V 1Ø	Supply	Acceptable supply voltage for small facilities (< 30 kVA load)
	Distribution	Not recommended.
	Utilization	Fractional hp motors, lighting, and other small misc. plant loads.

Note:

1. There will be exceptions to the above table. Exceptions are to be reviewed and approved on a case-by-case basis.

3.3.1 Configuration A - 208/120 V

Configuration A, which is a simple system with 208/120 V supply from the utility, is only applicable to the smallest of facilities. It would typically only be utilized for small buildings without any significant loads. A single phase 120/240 V service could also be considered where no significant motor loads are present. A single line diagram is shown in Figure 3-1.

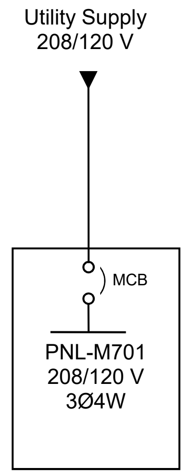

Figure 3-1: Configuration A - 208/120 V

3.3.2 Configuration B – 600 V Distribution

Configuration B, which is a simple radial system with a 600 V supply from the utility, is applicable to the facilities with lower reliability requirements. A sample single line diagram is shown in Figure 3-2.

Internal distribution within the facility, if any, is at 600 V. While not shown on the sample drawing, additional 600 V panels or MCCs fed from the main distribution could be included with this configuration.

No redundancy, or standby generation, is provided by this configuration. While any power failure or equipment failure will result in an outage, operation is simple.

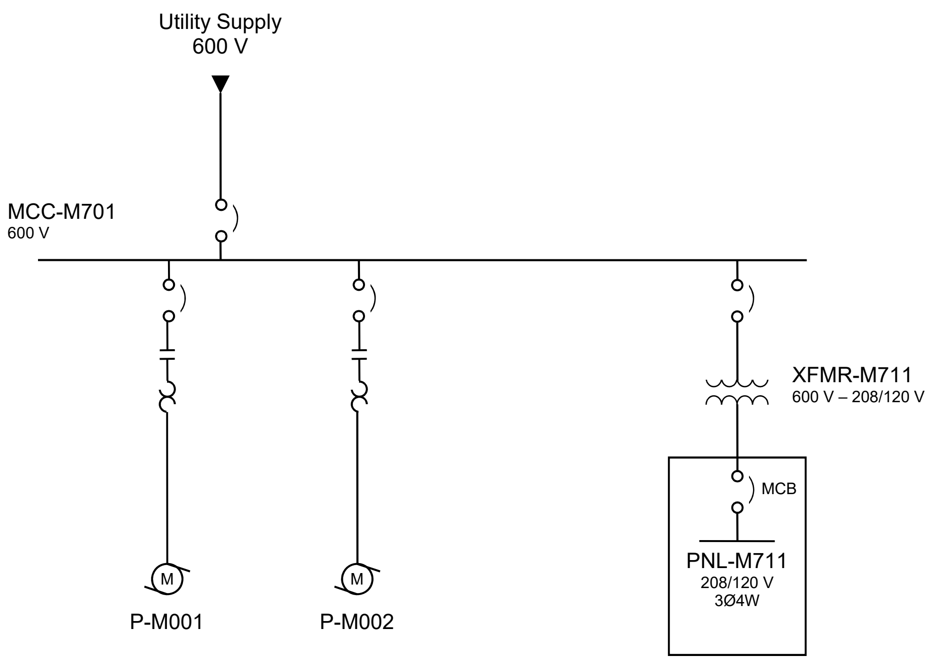

Figure 3-2: Configuration B - 600 V Distribution

3.3.3 Configuration C - 600 V Distribution with Portable Generator Provision

Configuration C is similar to Configuration B, except that a provision for a temporary standby generator is provided for the whole facility. This would typically only be applicable for facilities with less than 400 A of essential 600 V load, and delay in provision of the standby power is acceptable. It should also be noted that confirmation of the City's current available portable generator ratings should be undertaken. A sample single line diagram is shown in Figure 3-3.

This configuration may be considered when short term (< 3 hours) power failures are determined to be acceptable, but longer power failures are not.

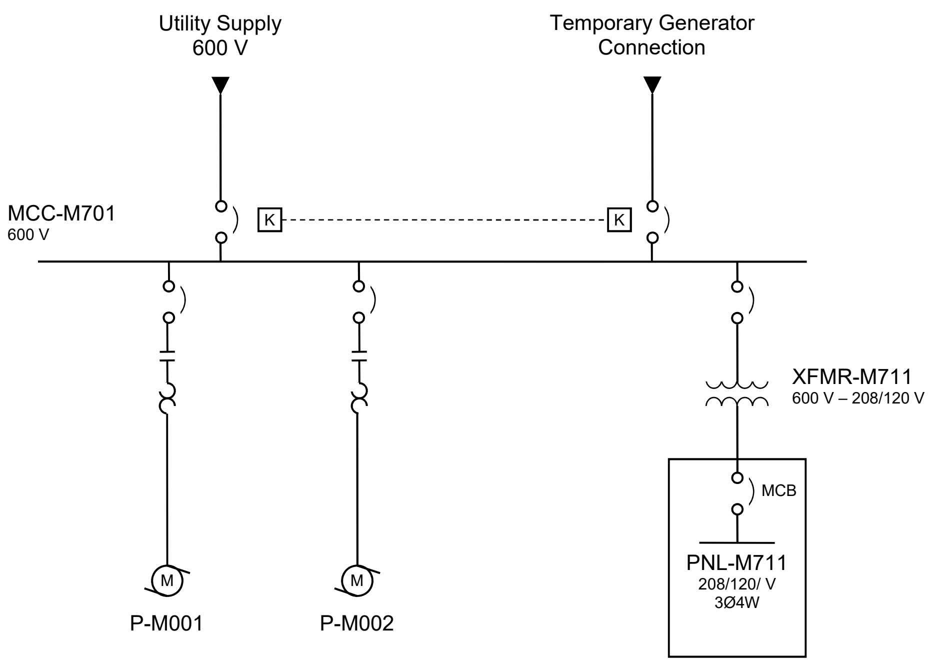

Figure 3-3: Configuration C - 600 V Distribution with Portable Generator Provision

Note:

1. If the maximum demand load is larger than the capacity of the temporary generator, it may be discussed with the City whether manual load shedding may be utilized to allow for partial operation under temporary generator power.

3.3.4 Configuration D - 600 V Distribution with Standby Generator

Configuration D is similar to Configuration C, except that a standby generator is provided to increase availability in the event of a utility power failure. In this configuration, the standby generator is sized to provide power for the entire facility load. A sample single line diagram is shown in Figure 3-4.

This configuration should be considered when:

Power failures are not acceptable;
The plant can be taken offline for maintenance, with proper planning; and
Rare events of equipment failure that cause a total plant outage are an acceptable risk.

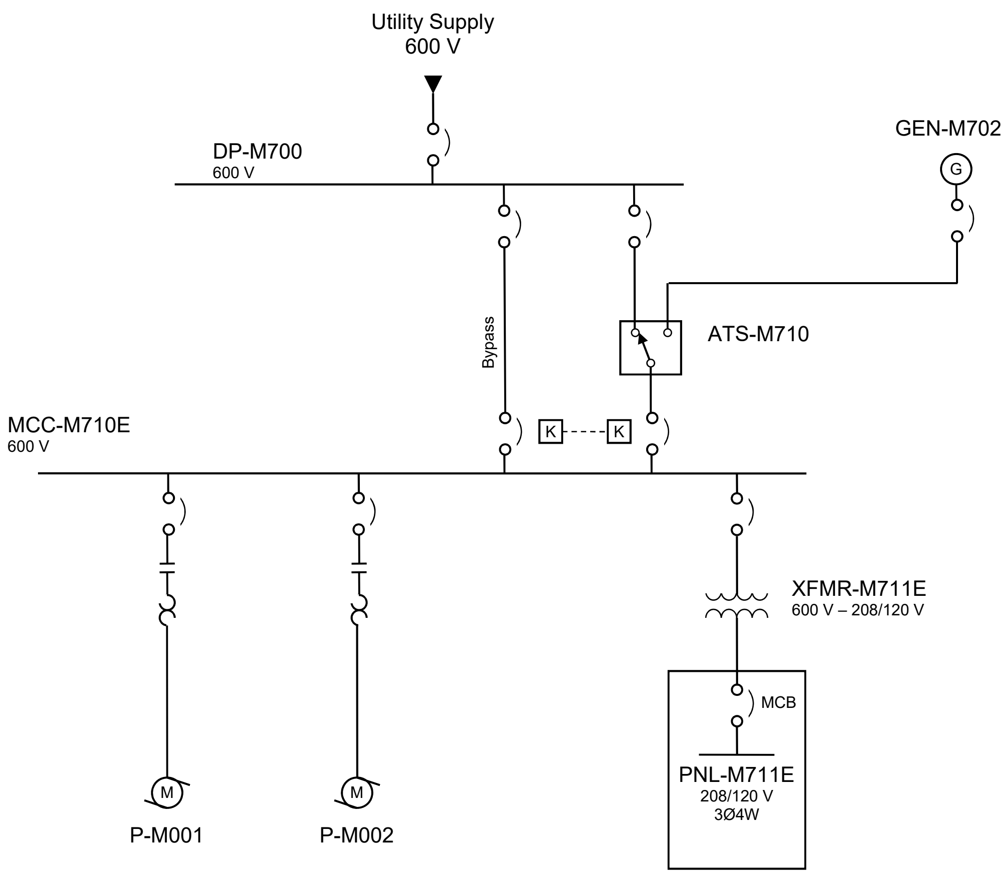

Figure 3-4: Configuration D - 600 V Distribution with Standby Generator

Note:

1. The above system configuration includes a bypass around the transfer switch to allow for servicing. The bypass may be optional in less critical installations.

3.3.5 Configuration E - 600 V Distribution with Essential Bus

Configuration E, 600 V Distribution with Essential Bus, is the same as Configuration D, 600 V Distribution with Standby Generator, except that the loads are split between essential and non-essential loads. The standby generator only services critical loads, allowing the standby generator rating to be reduced. This configuration would be appropriate when a significant portion of the total load is non-essential. See Figure 3-5 for an example simplified single line diagram.

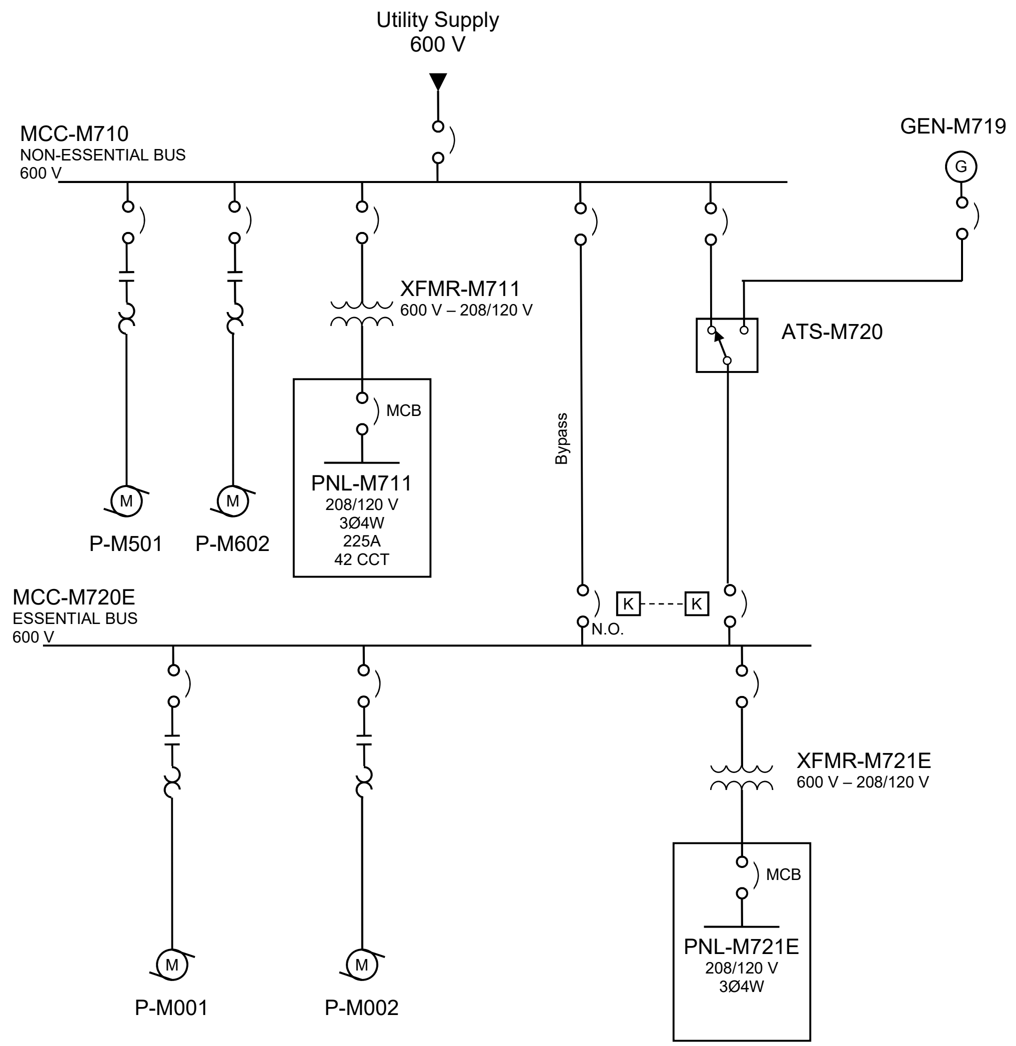

Figure 3-5: Configuration E - 600 V Distribution with Essential Bus

Note:

1. The above system configuration includes a bypass around the transfer switch to allow for servicing. The bypass may be integral to the transfer switch in less critical installations.

3.3.6 Configuration F - 600 V Redundant with Standby Generation

Configuration F provides redundancy for the electrical distribution system. In addition, a standby generator is provided to address power failure of one or both of the electrical services. A sample single line diagram is shown in Figure 3-6. This configuration should be considered when the size and criticality of the facility warrants redundancy, and power failures are not acceptable. Some variations of the shown single line diagram are possible where full standby generation for the entire facility is not deemed to be required.

It is typically required that each service is sized to accommodate the total facility load from a single service. If load shedding is required to operate with a single service active, this should be clearly indicated on the drawings and approved by the City.

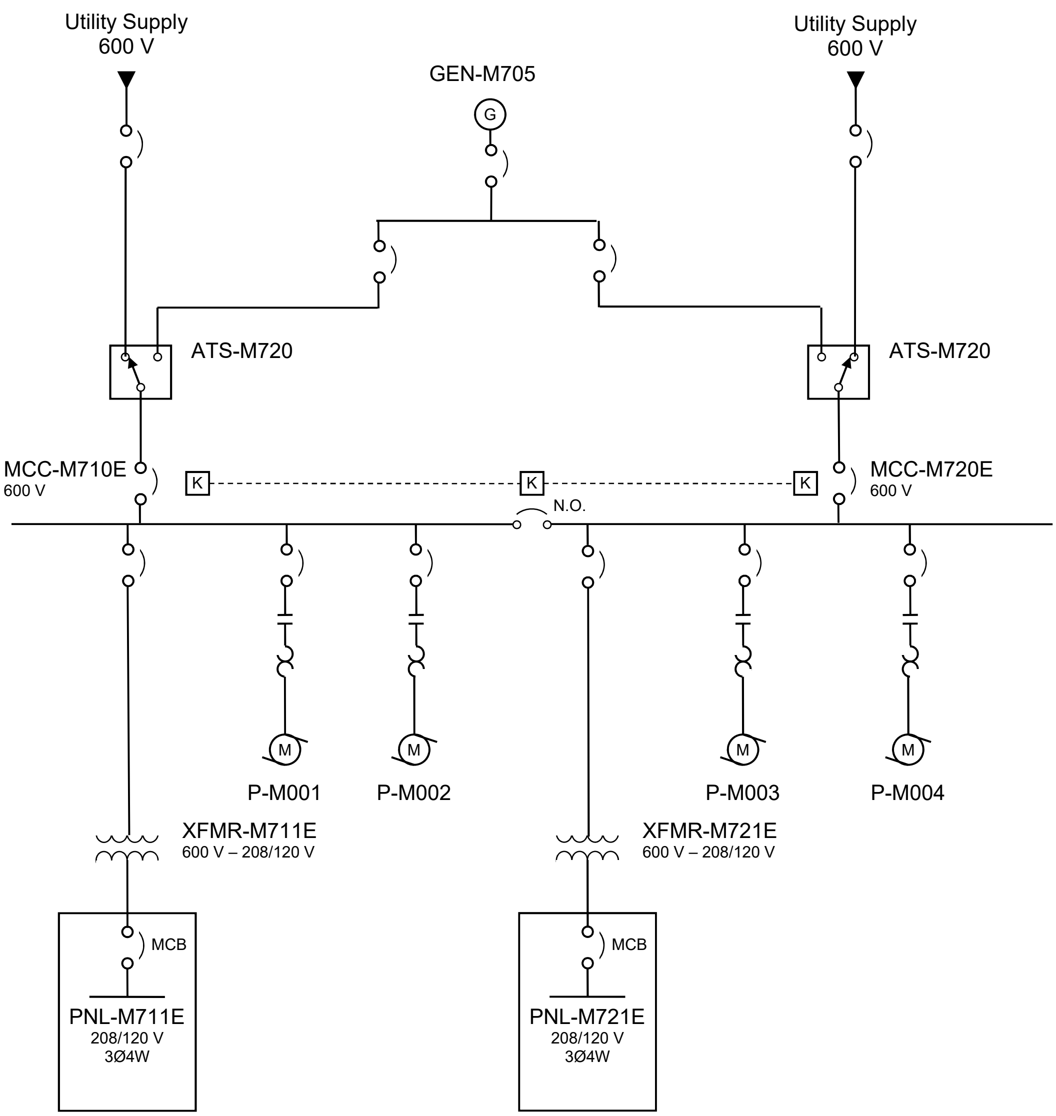

Figure 3-6: Configuration F - 600 V Redundant with Standby Generator

3.3.7 Configuration G - MV Distribution

Configuration G is a radial system with a medium voltage supply from the utility. Typically, transformation and utilization at 600 V and 208/120 V would also be provided. A sample single line diagram is shown in Figure 3-7.

Internal distribution within the facility is typically at medium voltage, and the system may or may not have motors or other loads fed directly via medium voltage. No redundancy, or standby generation, is provided by this configuration. While any utility power failure or equipment failure will result in an outage, operation is simple and the capital cost is relatively low. Figure 3-7 shows a utility owned transformer configuration, however a City owned supply transformer is also a potential configuration. With a City owned transformer configuration, a customer owned disconnect is required on the primary side of the transformer.

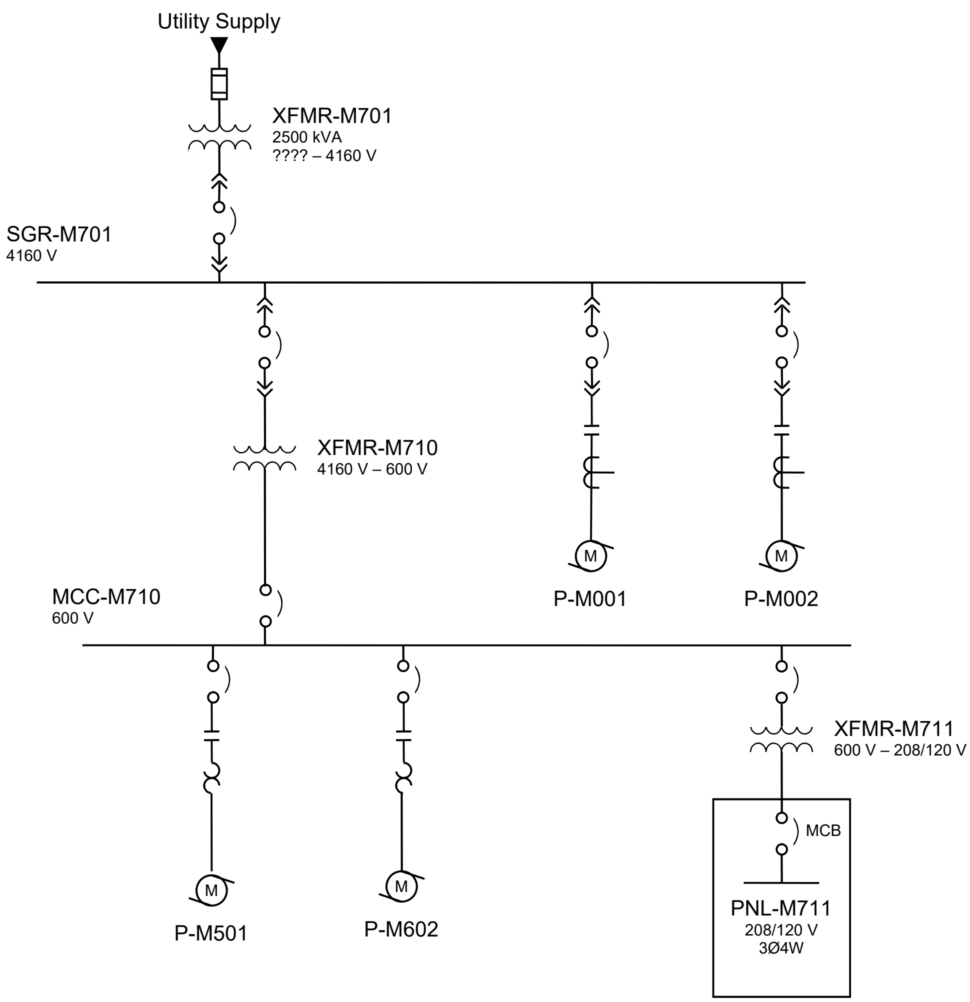

Figure 3-7: Configuration G - MV Distribution

3.3.8 Configuration H - MV Distribution with Essential Bus

Configuration H, MV Distribution with Essential Bus, is similar to Configuration E, 600 V Distribution with Essential Bus, except that medium voltage distribution is utilized in addition to 600 V distribution. The standby generator only services critical loads, allowing the standby generator rating to be less than the total facility load. This configuration would typically be considered when the service size exceeds 2 MVA or medium voltage motors are utilized. See Figure 3-8 for an example simplified single line diagram. Note that a utility owned transformer configuration is shown, however a City owned supply transformer is also a potential configuration. With a City-owned transformer configuration, a City-owned disconnect is required on the primary side of the transformer.

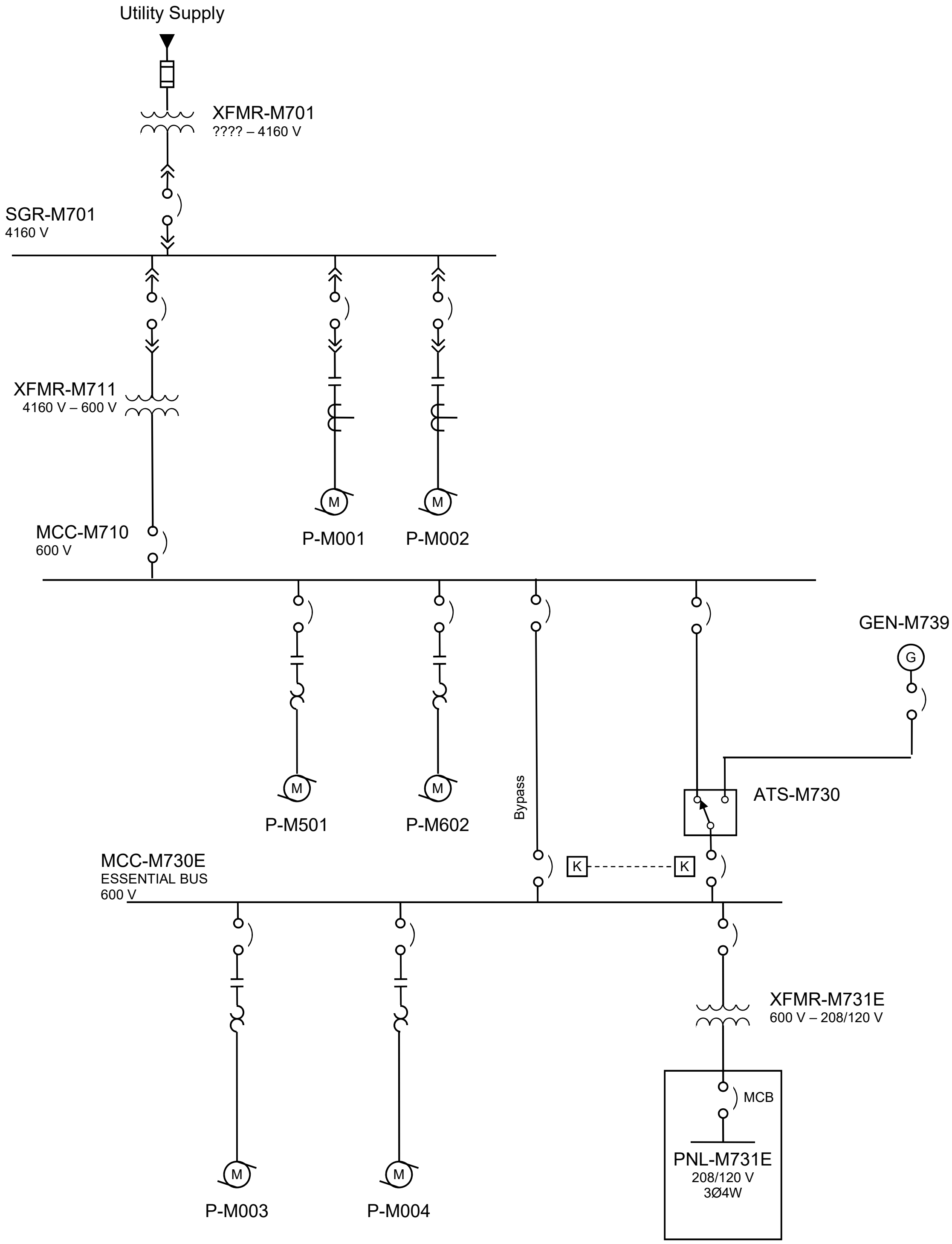

Figure 3-8: Configuration H - MV Distribution with Essential Bus

3.3.9 Configuration I - MV Redundant with Essential Bus

Configuration I, MV Redundant with Essential Bus, utilizes medium voltage for distribution and large motor loads. Most of the load is not protected by standby generation, but tie breakers are provided to allow for operation with a single feeder out of service. The services are typically rated such that the entire facility can be fed from a single service. This configuration would typically be considered when the service size exceeds 2 MVA or medium voltage motors are utilized. See Figure 3-9 for an example simplified single line diagram. Note that utility owned transformer configurations are shown; however City-owned supply transformers are also a potential configuration. With a City-owned transformer configuration, a City-owned disconnect is required on the primary side of each transformer.

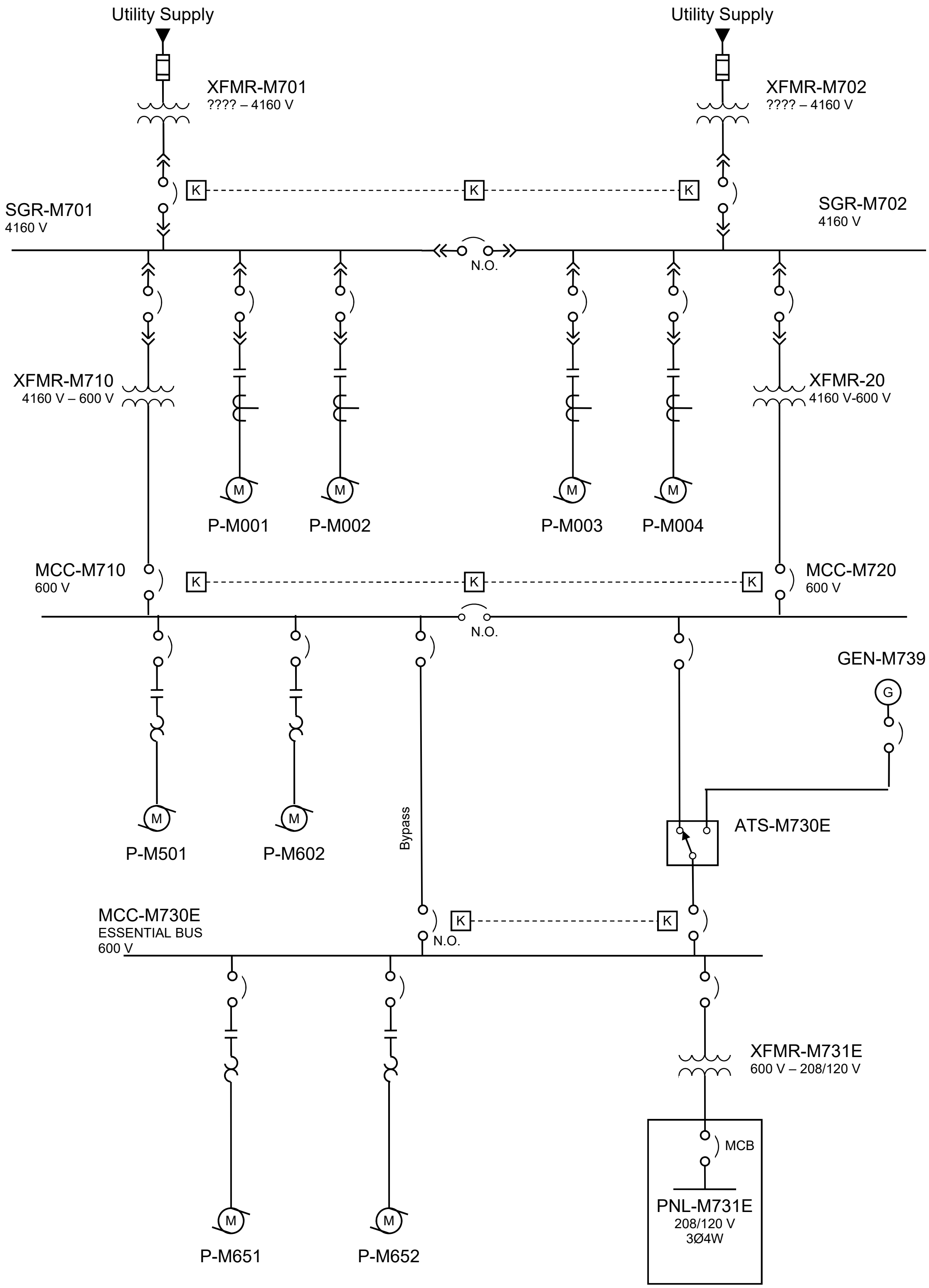

Figure 3-9: Configuration I - MV Redundant with Essential Bus

3.3.10 Configuration J - MV Redundant with Integrated Generation

Configuration J, MV Distribution with Integrated Generation, utilizes medium voltage for distribution and potentially motor loads. Generation is provided, with generator switchgear to allow for paralleling of generators and with synchronizing switchgear, to allow for seamless transitions between utility and generator power for testing purposes. Load shedding would be an option under this configuration as well. This configuration would typically be considered when the service size exceeds 2 MVA or medium voltage motors are utilized, and a high level of availability is required. See Figure 3-10 for an example simplified single line diagram.

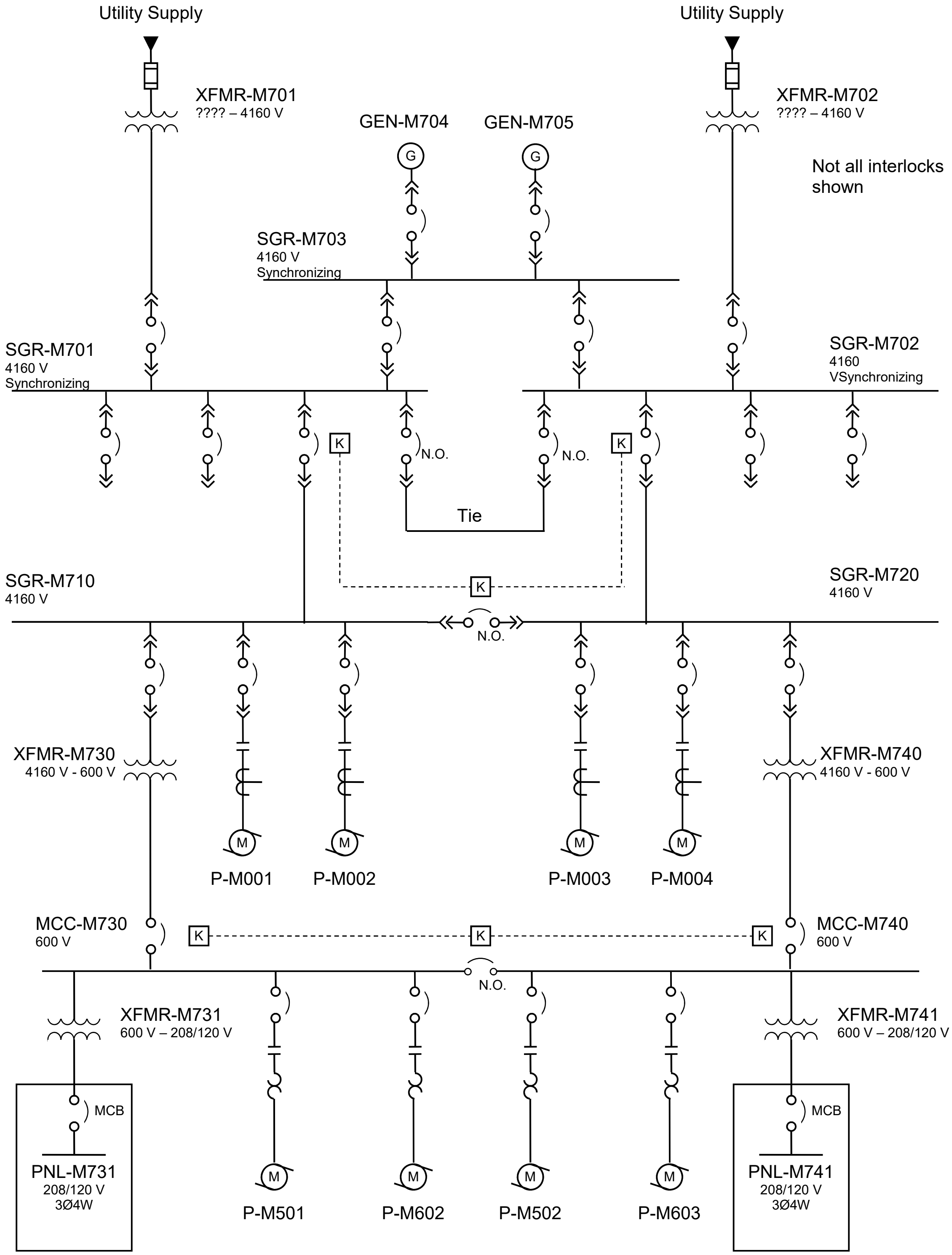

Figure 3-10: Configuration J - MV Redundant with Integrated Generation

3.3.11 System Configuration Selection

The selection of the appropriate system configuration for each application is an engineering decision that must be made, with consideration to the specific requirements of the application. The preferred system configurations, shown in Table 3-2, are deemed to be general guidance regarding system configurations that are generally acceptable to the City. However, in some cases, the application requirements or reliability requirements are not necessarily clear and detailed discussion with the City is required. Where selection of an appropriate system configuration is not clear, a reliability analysis shall be performed to aid in system selection.

Table 3-2 : Preferred System Configurations

Application	Risk	Preferred Configurations
Land Drainage Pumping Station	Low	(B) 600 V Distribution
	Medium	(C) 600 V Distribution with Portable Generator Provision
	High (4)	(D) 600 V Distribution with Standby Generator
Wastewater Flood Pumping Station	Low	(B) 600 V Distribution
	Medium (5)	(B) 600 V Distribution (C) 600 V Distribution with Portable Generator Provision
	High	(D) 600 V Distribution with Standby Generator
Wastewater Lift Station - Small	Low	(A) 208/120 V (*) (C) 600 V Distribution with Portable Generator Provision
	Medium	(D) 600 V Distribution with Standby Generator (E) 600 V Distribution with Essential Bus
	High	(D) 600 V Distribution with Standby Generator (E) 600 V Distribution with Essential Bus (F) 600 V Redundant with Standby Generation
Wastewater Lift Station – Large (6)	Low	(D) 600 V Distribution with Standby Generator (E) 600 V Distribution with Essential Bus (H) MV Distribution with Essential Bus
	Medium	(E) 600 V Distribution with Essential Bus (*) (F) 600 V Redundant with Standby Generation (I) MV Redundant with Essential Bus
	High	(F) 600 V Redundant with Standby Generation (I) MV Redundant with Essential Bus
Wastewater Treatment Facility	-	(F) 600 V Redundant with Standby Generation (*) (I) MV Redundant with Essential Bus (J) MV Redundant with Integrated Generation
Regional Water Pumping Station	-	(I) MV Redundant with Essential Bus (J) MV Redundant with Integrated Generation

See Notes next page.

Notes:

1. The existing City facilities do not necessarily conform to the preferred system configurations.
2. It is recommended that the City provide further definition of the risk classification.
3. Configurations marked with a (*) require specific City acceptance.
4. An underpass pumping station on a major route is considered a high risk installation.
5. Currently, most/all flood pumping stations in the City are not provided with standby power. It is recommended to prioritize provision of standby power to lift stations over flood stations in combined sewer areas.
6. A large lift station is deemed to be one with more than 200 kVA of demand load. This size is based upon the capacity of the portable generator that the City intends to purchase.
7. The use of engine based backup drives could, with approval of the City, affect the requirement for standby generation or redundancy in a Land Draining Pumping Station or Wastewater Lift Station.

3.4 Redundancy Requirements

3.4.1 Wastewater Treatment Facilities

1. All electrical systems in a wastewater treatment facility shall be configured in a redundant manner such that the failure of a single piece of major equipment or major conductor will not impair the operation of the wastewater treatment facility. Without reducing the general requirement specified above, specific redundancy requirements are itemized in Table 3-3.

Table 3-3 : Wastewater Treatment Process Redundancy Requirements

Process	**Capacity**	**Redundant Mandatory**	**Notes**
Incoming Electrical Service	All	Yes	
Raw Sewage Pumping Station	All	Yes	
Preliminary Treatment	All	Yes	
Primary Treatment	All	Yes	
Wet Weather Treatment	>= 100 MLD	Yes	
	< 100 MLD	No	
Secondary Treatment	Yes	Yes	
Tertiary Treatment	Yes	Yes	
Effluent Disinfection	>= 100 MLD	Yes	
	< 100 MLD	No	
Effluent Sampling	All	No	
Sludge/Biosolids	All	Yes	
Hauled Liquid Waste	All	No	

2. The feeders to each redundantly configured piece of equipment shall be arranged in a manner to not defeat the redundancy of the arrangement.
3. Two-bank redundancy shall be utilized for medium voltage equipment.
4. Two-bank redundancy shall be utilized for low-voltage (< 750 V) equipment, except redundancy utilizing multiple banks will be permitted where the design capacity exceeds typical equipment ratings or the resulting arc flash energy of a two bank scenario is greater than desired/specified.
5. The capacity of two-bank and multi-bank redundancy schemes shall be such that the minimum capacity of each bank is the sum of any two bank loads that can be tied together, or 2xC/N, (where C is the Total Design Capacity (including spare) and N is the number of banks), whichever is greater. For clarity, with a two-bank scenario, if the total design capacity of a building is 1 MVA, then each redundant bank must have a capacity of 1 MVA.
6. Where multiple electrical rooms are utilized for a given process, given the distributed nature of the process, each electrical room shall be fed by a minimum of two banks of power complete with the appropriate interlocks (kirk key or similar), unless the electrical room has less than 100 kVA of load and there would be no consequences to the facility operation in the event of the electrical bank being out of service. An example of an electrical distribution for a distributed process is shown in Figure 3-11.

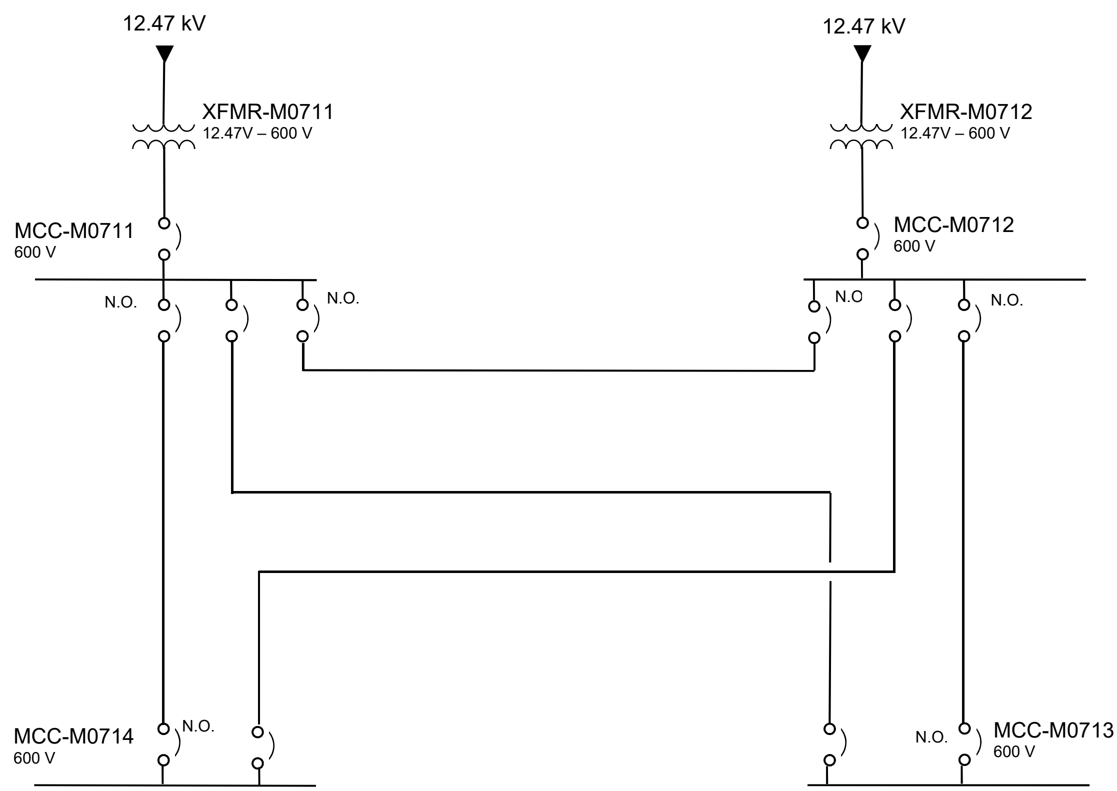

Figure 3-11: Example of Distributed Process Redundancy

3.5 Electrical Service

Electrical service sizing for new applications should be as shown in Table 3-4. Review potential future loads with the City and ensure that they are accommodated in the design. Deviations in the sizing of the electrical service are to be approved by the City.

Table 3-4 : Minimum Electrical Service Sizing

Application	Redundant Service	Minimum Size
Land Drainage Pumping Station	No	Design load + 25% spare
Wastewater Flood Pumping Station	No	Design load + 25% spare
Wastewater Lift Station	No	Design load + 25% spare
	Yes	Total design load + 15% spare on each service (See Note 1)
Wastewater Treatment Facility	Yes	Total design load + 25% spare on each service
Regional Water Pumping Station	No	Design load + 25% spare
	Yes	Total design load + 10% spare on each service (See Note 2)

Notes:

1. Each of the redundant services would be sized to carry the full design load of the facility + 15%. Thus, under normal operation with two services, the total loading of the total capacity should not exceed 42.5%.
2. Each of the redundant services would be sized to carry the full design load of the facility + 10%. Thus, under normal operation with two services, the total loading of the total capacity should not exceed 45%.

Coordinate the service details including voltage, size and point of delivery with the supply utility (Manitoba Hydro). Provide the utility with data indicating connected load, demand load, the associated load factors and a list of large motors (greater than 150 hp) that are included in the total load requirements for the plant.

Where technically and economically feasible (based on the total lifecycle costs), it is the City's preference to locate the point of delivery downstream of high and medium voltage transformation.

The design of the configuration and location for the service should consider the following factors:

- Location of the principal loads on the site;
- Redundancy requirements;
- Management of electrical system parameters including short circuit levels and associated coordination, arc flash levels, harmonics and power factor;
- Essential power requirements; and
- Future growth.

3.6 Classification of Loads

3.6.1 Wastewater Treatment Facilities

Priority	Description	Examples	Standby Power
1 – Emergency	Life safety systems mandated by codes and regulations. (See Note 1)	Fire alarm and emergency voice communications systems; Firefighters' elevators and elevators serving storeys above the first storey in a high building; Fire protection water supply pumps that depend on electrical power supplied to the building; Smoke control systems; Fans required for smoke control; Emergency lighting; and Exit signs.	Yes
2 – Critical	Loads that are critical for health and safety of facility occupants	Ventilation systems for electrically classified areas, hazardous gas detection systems	Yes
3 – Essential	Essential loads required for process operation or infrastructure protection that cannot be interrupted.	Sump pumps, Raw sewage pumps	Yes
4 – Essential Intermittent	Essential loads required for process operation, but may be interrupted for intervals during significant power events.	BNR aeration blowers	Yes
5 – Normal A	Loads required for process operation that should not normally be interrupted, but may be under power failures and other extreme events.	BNR mixers	Not required
6 - Normal B	Process loads that may be interrupted for significant abnormal events	Secondary clarifier mechanisms	Not required
7 – Non-Essential A	Loads that may be interrupted with no significant impact on process, but may inconvenience personnel	General lighting, lunch room microwaves, general ventilation in non-hazardous areas.	Not required
8 – Non-Essential B	Loads that may be interrupted with only minor inconvenience to	Task lighting, convenience receptacles	Not required

	personnel		

Notes:

1. The use of batteries in a life safety load does not change the load priority of the source. For example, a fire alarm system is a critical load.

2: From a load shedding perspective, additional levels are for adjustment of set-points and operating conditions prior to dropping a load.

3.7 Distribution Capacity

1. The size and capacity for new electrical distribution equipment and interconnections shall be as shown in Table 3-45. Review potential future loads with the City and ensure that they are accommodated in the design. Deviations in the sizing of the electrical distribution are to be reviewed and accepted by the City in writing.

2. Distribution systems may be considered dedicated (Dedicated Distribution Equipment) where:

   2.1 UNDER DEVELOPEMENT

Reference Transformer Section 6.11 in this Design Guide for additional information.

Table 3-5 : Minimum Electrical Distribution Sizing

Application	**Application**	**Current Design Load**	**Future Design Load** (See Note a)	**Spare Capacity**
Medium Voltage	General	Required	Required	25%
	Dedicated (See Note b)		No (See Note c)	10%
600 V Switchgear	General		Yes	Total design load + 25% spare on each service
600 V MCCs	General		Yes	Total design load + 25% spare on each service
	Dedicated (See Note b)			
Low Voltage Process Panelboards			No	Design load + 25% spare
			Yes	Total design load + 10% spare on each service (See Note b)
Low Voltage Building Panelboards				

Notes:

1. The Future Design Load is the planned future load that is anticipated to be planned for within the scope of the project. This typically includes planned future upgrades.
2. Despite the fact that Dedicated Distribution Equipment does not require future spare capacity, the building space, including electrical rooms, shall provide space as required to install future general and Dedicated Distribution Equipment.
   a) Each of the redundant services would be sized to carry the full design load of the facility + 15%. Thus, under normal operation with two services, the total loading of the total capacity should not exceed 42.5%.
   b) Each of the redundant services would be sized to carry the full design load of the facility + 10%. Thus, under normal operation with two services, the total loading of the total capacity should not exceed 45%.

3 Coordinate the service details including voltage, size and point of delivery with the supply utility (Manitoba Hydro). Provide the utility with data indicating connected load, demand load, the associated load factors and a list of large motors (greater than 150 hp) that are included in the total load requirements for the plant.

4 Where technically and economically feasible (the total lifecycle costs are not significantly higher), it is the City's preference to locate the point of delivery downstream of high and medium voltage transformation.

3.8 System Grounding

Historically, most systems within the City of Winnipeg have been solidly grounded. However, the use of neutral grounding resistors has significant benefits in certain applications. Some typical benefits of a neutral grounding resistor are:

- Minimizes the risk of arc flash and arc blast on the first ground fault;
- Reduces electric-shock hazards to personnel caused by stray ground-fault currents in the ground return path;
- Reduces the arc blast or flash hazard of a line-to ground arc fault;
- Reduces burning and melting effects in faulted electrical equipment, such as switchgear, transformers, cables, and motors;
- Limits energy available to a ground fault;
- To reduce the momentary line-voltage dip occasioned by the occurrence and clearing of a ground fault; and
- Can improve availability by allowing equipment to continue to operate during a single line-to-ground fault, provided a continuously rated neutral grounding resistor is provided.

Some disadvantages of neutral grounding resistors are:

- Transformer neutral bushings must be rated for the full secondary voltage;
- Transformer secondary windings must be fully insulated for the full secondary voltage at the neutral end;
- System neutral is no longer at zero volts during a fault;
- Additional costs and complexities; and
- Additional monitoring, protection and coordination requirements.

System Applications:

1. 208/120 V Systems
   1.1 Solid grounding is mandatory.

2. 600 V (and 480 V if applicable) Systems:
   - 2.1 Systems < 1000 kVA would typically be solidly grounded, however high-resistance grounding (HRG) should be utilized for cases where continuity of service is required in the event of a ground fault or reduction of the potential arc flash risk in the event of an L-G fault is desired.
   - 2.2 Systems >= 1000 kVA shall be provided with high-resistance grounding unless otherwise approved by the City.
3. 4160 V Systems
   - 3.1 High-resistance or low-resistance grounding is mandatory, except where:
     - a) The power supply from the utility is a 4160 V solidly grounded system; or
     - b) Express written permission is received from the City.
4. Medium Voltage Systems > 4160 V
   - 4.1 Low resistance grounding is mandatory for all medium voltage systems > 4160 V on the secondary of a City-owned transformer.
   - 4.2 Solid grounding is acceptable where no motor loads are utilized at the voltage and the power directly comes from the utility without City-owned transformation. That is, it is acceptable to distribute medium voltage power around a site, provided the power supply is from the utility at that voltage. However, specific engineering review is required to justify the proposed installation.

3.9 Short Circuit Current Rating

Short Circuit Current Rating (SCCR) is the maximum prospective symmetrical fault current that a device, panel or a system can safely withstand for a short specified time. The SCCR is usually expressed in kA at a specified voltage, and in some cases may be linked to specific upstream overcurrent protection devices, which will clear a fault within a specified time. The SCCR is also sometimes known as fault current *withstand rating.*

The SCCR is also closely related to the *interrupting rating* for protective circuit devices. The interrupting rating is the highest current at a specific voltage that the device can interrupt.

The SCCR rating shall exceed the available fault current of the system, at the point of application of the device, panel or system and shall allow for future expansion of the system including replacement of transformers. For example, if a bus has a 23 kA SCCR requirements based upon an upstream 5.75% impedance transformer, but it is reasonably possible that the impedance of a replacement transformer could be 5%, size the SCCR of the bus based upon calculations using the 5% impedance. At a minimum the SCCR will be sized based on a +10% margin.

A short circuit current study shall be completed to determine the fault currents for the equipment being designed with the results being used to determine the appropriate SCCR for the equipment.

Refer to the minimum transformer impedance values outlined in the City of Winnipeg Electrical Bylaw when determining the fault current available from utility supply transformers. All systems with a service voltage of 600 V or less shall assume an infinite bus on the primary of the utility transformers in SCCR calculations. Note that the actual utility fault currents must always be obtained for performance of the coordination and arc flash studies.

Maximum assumed SCCR values for unmarked components (i.e. with no SCCR rating) that may be assumed for calculations are as follows:

Table 3-6 : Maximum Assumed Short Circuit Current Rating (SCCR) for Unmarked Components

System/ Component	SCCR [kA]
Bus-bars	10
Circuit Breaker (including GFCI)	5
Current shunt	10
Fuse Holder	10
Industrial Control Equipment:	
Auxiliary devices (overloads)	5
Switches	5
Motor Controllers	
0 - 37.3 kW (0 - 50 hp)	5
38 - 149.2 kW (51 - 200 hp)	10
149.9 kW - 298.4 kW (201 - 400 hp)	18
299.1 kW - 447.6 kW (401 - 600 hp)	30
448.3 - 671.4 kW (601 - 900 hp)	42
672.1 - 1118 kW (901 - 1500 hp)	85
Meter Socket Base	10
Miniature fuse (maximum use at 1250 V)	10
Receptacle (GFCI type)	2
Receptacle other	10
Supplementary protector	0.2
Switch Unit	5
Terminal Block	10

3.10 Harmonics

1. The electrical design should ensure that harmonics are within IEEE 519 requirements at all major points in the electrical distribution, and not just at the utility service. Major points shall include but not be limited to:
   1.1 The main switchgear or electrical distribution in a building or process area of that voltage; and
   1.2 Switchgear / electrical distribution equipment rated greater than 3 MVA.
2. Voltage harmonics shall be limited as follows at all panelboards, MCCs, switchboards, switchgear, and other electrical busses:
   2.1 Individual frequency harmonics < 3%; and
   2.2 Total Harmonic Distortion (THD) < 5% as defied by IEC 61000-4-7.
3. Ensure current harmonics at major points in the electrical distribution are within IEEE 519 Table 10-3.
4. Harmonic studies are required for facilities with significant harmonic sources, as discussed in Section 19.4.
5. Refer to Section 15 regarding additional power quality requirements.
6. Comply with the latest version of the Manitoba Hydro's Power Quality Specification.

3.11 Environmental

Design / specify all electrical equipment, enclosures, etc. located outdoors for ambient temperatures of +/- 40^{0}C. Ensure additional prevailing conditions, including humidity, accumulation and infiltration of snow and any environmental contaminants or conditions that could affect equipment performance and longevity are addressed in the design.

Electrical equipment below 1,000 volts shall conform to the NEMA classifications detailed below. For electrical equipment above 1,000 volts, the enclosure ratings shall be utilized as a guideline to achieve the ratings described. Enclosure utilization will generally conform to the following guidelines:

Indoor, clean areas (electrical rooms, etc.) – NEMA 1.
Plant process areas that are neither hazardous nor corrosive – NEMA 12 or NEMA 4 (based on sound engineering judgement).
Outdoors – NEMA 4.

Plant process areas that are corrosive (typical wastewater environment containing hydrogen sulfide) – NEMA 4X minimum. Other corrosion resistant materials may be required depending upon the nature of the chemicals present.

Hazardous rated plant process areas require appropriate enclosures. This may require NEMA 7 enclosures, however alternate enclosure types are also appropriate for certain installations. Refer to Section 12 for further details.

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4 WIRING AND CABLING

4.1 Type Identification

To provide consistency between drawings, all wire and cables types shall be designated utilizing the following format.

4.1.1 Power Conductors

A	-	N	C	+ BND	, Size	, Type	, Volt	, Other
Number of cables (Optional)	-	Number of Cond.		Bonding Conductor (Optional)	Conductor Size	Conductor Type	Voltage Rating	Other

Where,

A	is the number of cables in parallel. For many applications, this is one (1) and therefore is omitted.
N	is the number of individual conductors in the cable or conduit. Include neutral conductors as applicable, unless the neutral conductor is a different size.
C	is the letter C, to indicate “Conductors”.
+ BND	is an optional indication to include a bonding conductor of the same size and type as the power conductors. This would not be utilized for cable assemblies where the bonding conductor is an inherent part of the cable, but could be utilized for conduit applications. If the bonding conductor is a different size of type, refer to Section 4.1.2.
Size	is the conductor size in AWG or kcmil.
Type	is the cable / wire type. Utilize CSA standard type references where applicable. The conductor shall always be copper, unless otherwise indicated.
Volt	is the voltage rating of the cable / wires (Not the applied system voltage).
Other	is an optional field for other special characteristics of the cable, such as “Shielded” or insulation class for medium voltage cabling

Notes:

1. Where individual wires are in conduit, they are expressed as parallel conductors, not parallel cables.
2. Do not utilize the “#” symbol to represent AWG.
3. Do not indicate the bonding conductor if it is part of a standard cable assembly, such as Teck90 cable.
4. Large AWG sizes shall be expressed as follows: 1/0, 2/0, 3/0, and 4/0 AWG and not 0, 00, 000, and 0000 AWG.

4.1.2 Bonding Conductors

Where bonding conductors are a different size or construction from the phase conductors, they shall be designated in the following format. Note that bonding conductors in a conduit, of the same size and type as the phase conductors may be designated as shown in Section 4.1.1.

N	-	BND	, Size	, Type	, Volt	, Other
Number of Cond. (Optional)	-		Conductor Size	Conductor Type	Voltage Rating	Other

Where,

N	is the number of individual conductors in the cable or conduit. Include neutral conductors as applicable, unless the neutral conductor is a different size.
BND	is the shortened designation for bonding conductors.
Size	is the conductor size in AWG or kcmil.
Type	is the cable / wire type. Utilize CSA standard type references where applicable. The conductor shall always be copper, unless otherwise indicated.
Volt	is the voltage rating of the cable / wires (Not the applied system voltage).
Other	is an optional field for other special characteristics of the cable

4.1.3 Neutral Conductors

Where neutral conductors are a different size or construction from the phase conductors, they shall be designated in the following format. Note that neutral conductors of the same size and construction as phase conductors may be identified as per Section 4.1.1.

N	-	NEU	, Size	, Type	, Volt	, Other
Number of Cond. (Optional)	-		Conductor Size	Conductor Type	Voltage Rating	Other

Where,

N	is the number of individual conductors in the cable or conduit. Include neutral conductors as applicable, unless the neutral conductor is a different size.
NEU	is the shortened designation for neutral conductors.
Size	is the conductor size in AWG or kcmil.
Type	is the cable / wire type. Utilize CSA standard type references where applicable.
Volt	is the voltage rating of the cable / wires (Not the applied system voltage).

Other — is an optional field for other special characteristics of the cable, such as “Shielded”

4.1.4 Examples

3C, 250 kcmil, TECK90, 1000 V	Three conductor TECK cable in cable tray.
4C, 1 AWG, RW90, 600 V	Four, 1 AWG RW90 wires in conduit.
6-1C, 500 kcmil, RA90, 1000 V	Six parallel 1-conductor cables.
2-3C, 750 kcmil, TECK90, 1000 V	Two 3-conductor cables in parallel.
4C, 10 AWG, RW90, 600 V BND, 12 AWG, RW90, 300 V	Four 10 AWG plus one 12 AWG ground wire.
6C, 250 kcmil, RW90, 600 V 2C, NEU, 3/0 AWG, RW90, 600 V 2C, BND, 4 AWG, RW90, 300 V	Six 250 kcmil plus two 3/0 AWG neutrals plus two 4 AWG bonding wires.
2-3C, 250 kcmil, HVTECK AL, 15 kV, Shielded, 133%	Two three-conductor shielded 15 kV cables, aluminum conductors.

4.2 Conductor Material

1. All conductors shall be copper, except as follows:
   - 1.1 Aluminum conductors may be utilized if and only if:
     - 1.1.1 The load is an MCC, transformer, switchgear, or distribution panel or other similar equipment. Aluminum conductors are not permitted for end loads such as motor loads;
     - 1.1.2 The aluminum conductor is sized a minimum of 250 kcmil; and
     - 1.1.3 All terminations are appropriately rated for aluminum conductors.
2. Ensure the project specifications are clear regarding the conductor material requirements. All aluminum conductors shall be clearly shown on the single line drawings.
3. Ensure all project construction specifications are clear and complete regarding the installation requirements of aluminum conductors.

4.3 Insulation Ratings

1. Provide wire and cable insulation ratings that are consistent with the minimum insulation ratings indicated in Table 4-1.

Table 4-1 : Minimum Wire Insulation Ratings

Nominal 3Ø Voltage	System Grounding	Application	Minimum Insulation Rating
12.47 kV	Low Resistance [1]	Any	15 kV 133%
	Solid	Any	15 kV 100%
4.16 kV	Low Resistance [1]	Any	5 kV 133% or 8 kV 100%
	High Resistance [1]	Any	
	Solid	Any	
600 V	High Resistance	Any	1000 V
	Solid	VFD and other high harmonic loads	1000 V
		Buried Wire / Cables	1000 V
		All Teck90 cables	1000 V
		Indoor RW90 applications– no VFD	600 V
480 V	High Resistance	Buried Wire / Cables	1000 V
		Other	600 V
	Solid	Any	600 V
120/208 V	Solid	Any	600 V

Note:

1. Low Resistance grounding is to be set-up to clear faults within one hour. Higher insulation ratings may be required for systems that allow longer duration faults.

4.4 Power Distribution

4.4.1 Conduits vs. Cables

1. Cables and conduits shall be selected based upon the requirements of Table 4-2.
   1.1 Where not identified in Table 4-2, the decision to use conduits or cables for interior power distribution should be based on the specific details of the application. In general, cables in cable tray is preferred for new installations; however there are cases were the use of conduits is appropriate.
2. Conduits should be considered in the following applications:
   2.1 Where the existing installation is conduit based.
   2.2 Where aesthetics are a concern.
   2.3 Where there is potential for physical abuse or damage.
      2.3.1 For example, rigid aluminum conduits are preferred in lift stations that have limited space such that the removal of a pump could result in physical damage to the electrical system.
   2.4 Where the specific cables required do not have a FT4 rating.
3. It is acceptable for a facility to have a mixture of conduits and cables.

Table 4-2 : Conduit / Cable Applications

Application	Voltage	Cable	Conduit	Notes
Distribution	Medium Voltage	A	NA	1
	< 750 V	A	NA	1
Motor Loads	Medium Voltage	A	NA	
	600 V	P	A	
	208/120 V	A	A	
Heating Loads	600 V	P	A	
	208/120 V	A	A	
Other Equipment Loads	600 V	P	A	
	208/120 V	A	A	
Fire Alarm	< 750 V	A	A	
Lighting	< 750 V	A	P	
Receptacles	< =208 V	A	P	
	> 208 V	A	P	
Legend: P Preferred A Acceptable NA Not Acceptable				

Notes:

1. Cable Bus is acceptable for distribution application.
2. Duct bus is acceptable only in clean, non-corrosive environments.

4.5 Cable Types and Ratings

In general, cable with galvanized steel armour covered with PVC outer sheath is acceptable. In very corrosive areas, aluminum armour with PVC outer sheath should be used subject to verifying the suitability of aluminum for the corrosive compounds present.

4.5.1 Cable Requirements

12.47 kV (15 kV Class) Distribution system:

CSA TECK cable, Tree-Resistant XLPE RW90, 15 kV, semi-conductive shielded with insulation as per Table 4-1.

Phase marking/colour codes - Phase A - Red, Phase B – Black, Phase C - Blue.

Outer jacket – Orange/Red PVC jacket rated FT-4.

4.16 kV Distribution system:

CSA TECK cable, Tree-Resistant XLPE RW90, 5kV, semi-conductive shielded with insulation as per Table 4-1.

Phase marking/colour codes - Phase A - Red, Phase B – Black, Phase C - Blue.

Outer Jacket – Orange/Red PVC jacket rated FT-4.

600 V, 208/120 V, 120/240 V Low Voltage Distribution system:

CSA TECK cable, XLPE RW90, 600 V/1000 V, with insulation as per Table 4-1.

Phase marking/colour codes - Phase A - Red, Phase B – Black, Phase C - Blue.

Jacket – Black PVC jacket rated FT-4 and low acid gas emitting. The jacket will be UV, moisture and oil resistant.

Control and Instrumentation cables:

CIC or ACIC, XLPE RW90, 600/300 V, with 100% insulation.

- 600 V cable is to be utilized for any cable termination in an enclosure containing voltages above 300 V.

Phase/polarity numbering marking/colour codes – Standard numbering and colour coding.

Jacket – Black PVC jacket rated FT-4 and low acid gas emitting. The jacket will be UV, moisture and oil resistant.

Fire Alarm Cable

- Cabling conforms to CAN/CSA-C22.2 No. 208 Fire Alarm and Signal Cable
- Low energy, 300 V, FAS 105 twisted stranded coper shielded cable: minimum 16AWG, with PVC insulation
- Overall aluminum/polyester foil shield, with tinned copper drain wire
- Notification circuit conductors shall be stranded copper, minimum 12 AWG
- All fire alarm cables shall be installed in a separate, dedicated conduit system
- All cables with be FT4 rated

4.6 Conductor Sizes

1. Select conductor size based upon conductor ampacity and voltage drop requirements.
   1.1 Voltage drop calculations shall be made utilizing worst case operating scenarios, including utilization of spare distribution capacity.
2. Ensure spare capacity allowed for in equipment is also provided in associated feeder conductor sizing.
3. Ensure conductors are appropriately derated as per the Canadian Electrical Code. Derating to include factors for maximum termination temperature, ambient conductor temperature, and the number of conductors in the conduit or cable tray.
   3.1 Unless specifically designated as a feeder cable tray, with a cable tray section layout clearly indicated on the drawings, all cable trays shall be assumed to have numerous cables added in the future and be de-rated appropriately.
   3.2 It is preferred to designate certain cable trays for large feeder cables, where spacing can be maintained.
4. Do not necessarily size cables as per the minimum ampacity. Utilize good engineering judgement to ensure each cable ampacity will be sufficient for the life of the cable.
   4.1 For example, if a motor feeder cable ampacity is calculated, based on a specific actual motor FLA, to be 258 A, do not select a cable with an ampacity of 260 A. In the event the motor is replaced with one that has a slightly higher FLA, the cable with an ampacity of 260 A would no longer be technically acceptable.
5. Ensure that the conductor sizes selected are appropriate for the maximum acceptable conductor termination temperature. For example, many circuit breaker terminations are only rated at 75°C and cannot utilize a conductor ampacity rating for a temperature rating of 90°C.
6. Minimum wire size to be as per Table 4-3.

Table 4-3 : Minimum Conductor Sizes

Application	Minimum Size
Medium Voltage Power (> 1000 V)	2 AWG
Low Voltage Power (120 – 750 V)	12 AWG
Control	16 AWG
Instrumentation	18 AWG
Voltage Signal (PT)	14 AWG
CT Signal	12 AWG

Note:

1. The minimum conductor sizes only apply to electrical power cables. See the Automation Design Guide for automation cable sizes.

4.7 Conduit Materials and Sizes

1. Conduit to be CSA, cUL listed.
2. Use rigid conduit, except where flexible conduits are required for maintenance of equipment or in areas where the equipment is subject to vibrations during operation (compressors, motors, etc.), to reduce the effect on connections. EMT may be utilized within office areas if there are no environmental issues.
3. Rigid galvanized steel conduit is not acceptable for use within wastewater facilities. See Table 4-4.
4. The minimum conduit size is 21 mm (3/4 “).
5. Conduit boxes to be aluminum with cast covers. Use spring door covers for areas with circulating dust and contamination.
6. Liquid tight flexible conduit c/w correct watertight fittings shall be used in short lengths for application areas where vibration will be an issue.
   6.1 Flexible conduit to be CSA, cUL listed.
   6.2 Maintain fill factors as stipulated in Code.
   6.3 All motors and connected equipment shall be considered to be a source of vibration.
7. For areas where conduit is installed and there is a risk of migration of gases and vapour, the conduits are to be sealed with suitable conduit seals to prevent entry of moisture, vapour and gases into another area, panel enclosure, etc.
8. Where EMT and PVC conduit is used, provide a separate green insulated ground wire in each conduit.
9. Ensure fittings allow cable/conductor bending radius to be maintained.
10. Wire pulling calculations shall be performed for all cables in conduits or ducts sized 2 AWG or larger. Modify the design as required to limit forces and sidewall pressure. Document all cable pulling calculations as per Section 19.4.

Table 4-4 : Facility Conduit Application

Facility Type	Application	Type
All	In poured concrete walls and floors	PVC
	Underground	PVC
Wastewater Collections Facilities (Lift, Flood, CSO)	General Use – Where prone to potential mechanical damage or acceptable support spans exceed PVC capabilities.	Rigid Aluminum
	General Use – Where not prone to potential mechanical damage	PVC
	Hazardous Locations	Rigid Aluminum
Wastewater	General Use	Rigid Aluminum
	Corrosive locations not suitable for aluminum	PVC
	Exterior	Rigid Aluminum
	Hazardous Locations	Rigid Aluminum
	Office and similar locations, without environmental contamination.	EMT
Water	Corrosive Locations (Category 2)	PVC
	Exterior	Rigid Galvanized Steel
	General Use	Rigid Galvanized Steel
	Hazardous Locations	Rigid Galvanized Steel
	Office and similar locations	EMT

4.8 Conduit Colour Coding

Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 5 m intervals based on the system, per Table 4-5. The widths of the prime and auxiliary bands are to be 38 mm and 19 mm, respectively.

Table 4-5 : Conduit Colour Bands

System	Prime Band	Aux. Band
Medium Voltage (> 750 V)	Orange	
347/600 V	Yellow	
208/120/240 V Power	Black	
UPS 208/120/240 V Power	Black	Green
Control Wiring (120 V)	Black	Orange
Fire Alarm	Red	
Low Voltage Communication/General	Blue	
Low Voltage Control Wiring (< 50 V)	Blue	Orange
Intrinsically Safe	Blue	White
Grounding	Green	
Fibre Optic Cable	Purple	

4.9 Device and Pull Boxes

1. Joints and splices are not acceptable in conduits. All joints shall be in conduit bodies or junction boxes.
2. Only connections for lighting and receptacles shall be made in device boxes. All other connections shall be made in boxes with numbered terminals and the conductors shall be identified with wire labels.
3. Pull boxes should be sized as per the Canadian Electrical Code (Rule 12-3036).

4.10 Cable Trays

4.10.1 General

1. Arrangement
   1.1 Design cable trays in a manner to provide ease of access, capacity for expansion and change.
   1.2 Ensure headroom is not impeded by cable trays.
   1.3 Do not install cables for redundant systems in the same cable tray.
   1.4 Provide a minimum of 1 m separation (edge to edge) between cable trays carrying redundant cables or cables for redundant systems.
   1.5 Ensure cable tray routing does not impede equipment operation, maintenance or cable replacement;
   1.6 Locate cable tray in a manner and location to ensure the full life and reliability of the cables is maintained;
   1.7 Route such that the cable tray is not subjected to temperatures higher than ambient space temperatures; and
   1.8 Do not route cable trays above any combustible material storage.

2. Size:
   2.1 A side rail height of 152 mm (6”) is preferred. Utilize 102 mm (4”) side rail height where vertical space is limited.
   2.2 Size cable tray to meet current and future cable requirements. Minimum tray width is 152 mm (6”).
3. Tray to be CSA, cUL listed.
4. The rungs of the ladder shall typically be at 305 mm (12”) spacing. However for single conductor 1/0 to 4/0 AWG the rung spacing shall not exceed 229 mm (9”).
5. Tray load ratings:
   5.1 Cable tray load ratings are to be sufficient for the cables installed and any additional loads such as snow, ice and wind, where applicable.
   5.2 Allow for spare cables in cable tray loading calculations. For trays where cables may be installed with no spacing, assume the tray will be filled in the future.
   5.3 Minimum load rating for indoor tray: CSA Class C1
   5.4 Minimum load rating for outdoor tray: CSA Class D
6. The tray shall be installed in accordance with manufacturer’s instructions.
7. Use tray covers in dusty areas, outdoors, for aesthetic reasons and for trays passing under walkways or where there is a risk of falling debris.
8. Use stainless steel SS316 bolting and fixing hardware.
9. Select cable tray material as per Table 4-6.
   9.1 Utilize fibreglass cable tray in corrosive locations where fibreglass will outperform the alternatives. Fibreglass tray shall not be exposed to sunlight unless confirmed by the manufacturer that it is sunlight/UV resistant.

Table 4-6 : Standard Cable Tray Material

Application	Standard Material	Alternates
Wastewater Collection / Treatment	Aluminum	Fibreglass Stainless Steel
Water Treatment Plant	Aluminum	Fibreglass Stainless Steel
Regional Water Pumping Stations	Rigid Galvanized Steel	Aluminum Fibreglass Stainless Steel

4.11 Buried Installation Requirements

1. All buried cables and conduits shall be protected by treated planks or concrete blocks. Concrete blocks or cast-in place red-dyed concrete shall be utilized in applications with a high reliability requirement.
2. Bright orange vinyl warning tape shall be installed above all buried cable installations, including above duct banks.
3. Buried cable installations shall be based upon the requirements of CSA standard C22.3 No. 7 for underground systems.
4. Where buried cable installations terminate into indoor equipment, bottom equipment entry is required to avoid potential water migration issues. Where top entry of equipment is required ensure that potential water migration through cables is addressed.
5. Direct buried cables:
   - 5.1 Provide a minimum of 100mm of sand cover on all sides of the cable. Provide additional depth below cables for critical applications.
   - 5.2 Provide cable slack loops as required to address ground movement.
   - 5.3 Provide water-tight seals at the building entry.
6. PVC conduit:
   - 6.1 The use of PVC DB2 conduit for buried applications is only permitted for certain applications, as indicated in Table 4-7.
   - 6.2 Arrange PVC conduit such that drainage is provided to a suitable location.
   - 6.3 Transition from underground to above ground shall use PVC rigid conduit. Expansion fittings shall be provided where required.
   - 6.4 Provide water-tight seals at the building entry.
   - 6.5 Provide a minimum of 100mm of sand cover on all sides of the conduit. Provide additional depth below conduits for critical applications.
7. Concrete duct banks (and utilidors):
   - 7.1 Underground duct banks will be PVC DB2 ducts, sized 50mm or larger, encased in concrete.
   - 7.2 A minimum spacing of 50mm between ducts, and outer covering of 75 mm of concrete must be maintained.
   - 7.3 Duct runs will be sloped to drain any water entering the system, towards manholes provided with a sump pit.
   - 7.4 Pull boxes will be drained individually or use a connected network of drainage pipes. Pull boxes will be drained using:
     - 7.4.1 Connection to the land drainage infrastructure;
     - 7.4.2 Connection to a building's sump pump system; or
     - 7.4.3 Connection to a pump station.
   - 7.5 All duct banks shall have a minimum of one duct allocated for fibre optic systems.
   - 7.6 Provide a minimum of 20% spare ducts.
   - 7.7 Ensure that the pull boxes are sized to account for minimum bending radius as per the Canadian Electric Code for both installation and long term use.
   - 7.8 All penetrations required in the pull boxes for cable entry/exits and pull box connections shall be included in the design.

7.9 The duct bank system shall be designed with a grade on each section of duct bank to prevent water from ponding in the ducts.

7.10 Pull boxes shall be watertight.

7.11 Pull boxes shall be mounted on appropriate foundations as required to prevent movement.

7.12 Pull tape shall be installed in all the ducts and shall be suitable for the highest applicable pull tensions.

Table 4-7 : Buried Installation Requirements

Application	Acceptable Installations	Notes
Control / Communications – Std. Reliability Requirement	Buried armoured cable	
	PVC Conduit	
Control / Communications – High. Reliability Requirement	Concrete Duct Bank	
	Buried armoured cable	Cables to be protected by concrete blocks / concrete.
Low Voltage Power < 750 V – Std. Reliability Requirement	Buried TECK Cable	
Low Voltage Power < 750 V – High Reliability Requirement	Concrete Duct Bank	
	Buried TECK Cable	Cables to be protected by concrete blocks / concrete.
Medium Voltage – Std. Reliability Requirement	Concrete Duct Bank	
	Buried TECK Cable	Cables to be protected by concrete blocks / concrete.
Medium Voltage – High Reliability Requirement	Concrete Duct Bank	

4.12 Terminations

4.12.1 Power Wiring – Medium Voltage

1. Lugs
   1.1 Two-hole long barrel (double crimp) lugs shall be utilized wherever possible.
   1.2 Belleville washers shall be used on all bolts.
2. Medium voltage terminations shall be heat shrink type, CSA, cUL listed and tested to IEEE standards.
3. For 1/C cable – single (1/C) terminations are required with grounding kits.
4. For 3/C cable – one three conductor (3/C) termination kit is required with grounding kit.

4.1 A breakout boot is required for outdoor installations or those where any possibility of moisture or debris is present.

5. Shielded cables are to be grounded at both ends for three conductor cables, or three single conductors in one duct or conduit. Shielded cables <= 250 kcmil installed in separate ducts must also be grounded at both ends. Ensure that the cable ampacity accounts for shield heating due to circulating currents. Cable ampacity adjustments are a requirement > 250 kcmil where the phase conductors are in separate ducts.

6. All shielded cables proposed to be bonded at one end only require approval of the City, along with supporting calculations of the safety of the installation.

7. Use in-line terminations for motor terminations.

8. Generally for medium and high voltage, *creepage extending sheds* are not required to be used for Indoor areas. However if the termination is installed in an indoor area where there is a presence of high humidity, saturated water vapour or presence of free droplets then these sheds shall be used. Sheds shall always be installed with the open end of the cone down irrespective of whether the termination is installed "up" or "down". Creepage extending sheds are required on outdoor terminations.

4.12.2 Power Wiring – Low Voltage (< 750 V)

1. Lugs

   1.1 Two-hole long barrel (double crimp) lugs are preferred over mechanical connectors for high ampacity and critical applications.

   1.2 Belleville washers shall be used on all bolts.

4.12.3 Control Wiring – Low Voltage

1. Wire barrel ferrules shall be used for all stranded wiring connections to terminals.

2. Wire labels shall be used wherever a wire is terminated.

4.13 Framing and Support Systems

1. Utilize strut framing and support systems from a single manufacturer for each project.

2. Materials shall be as per Table 4-8.

Table 4-8 : Framing and Support Materials

Application	Application	Preferred Material	Alternate Material	Hardware
Wastewater Collections and Treatment	All	Aluminum	Stainless Steel	Stainless Steel
Water Treatment	All	Aluminum	Stainless Steel	Stainless Steel
Regional Water Pumping Stations	All	Galvanized Steel	Stainless Steel	Stainless Steel

4.14 Segregation of Systems

1. Segregation of cable systems shall be as per Table 4-9. Note that typical good design practice would be to allocate a separate cable tray for power cables vs. instrumentation cables.

Table 4-9 : Segregation of Cable Systems

Cable	Other Cable	Minimum Segregation	Notes
Communication - Fibre	Communication	None	
	Instrumentation / Control < 50 V	None	
	Other	Separate Raceway	To reduce risk of physical damage to fibre cable.
Communication - Copper	Instrumentation / Control < 50 V	50 mm	
	120 VAC, 8 AWG or smaller	100 mm	
	120 VAC, > 8 AWG	300 mm	
	600 VAC Power	300 mm	
	VFD or other high harmonic cable	300 mm	Metallic Conduit
		600 mm	Other raceway
	Medium Voltage – 3C armoured and shielded	300 mm	May be in metallic conduit instead of armoured.
	Medium Voltage – 1C or 3C unshielded	450 mm	
Instrumentation (Analog)	Control < 50 V	None	
	120 VAC, 8 AWG or smaller	100 mm	
	120 VAC, > 8 AWG	300 mm	
	600 VAC Power	300 mm	
	VFD or other high harmonic cable	300 mm	Metallic Conduit
		600 mm	Other raceway
	Medium Voltage – 3C armoured and shielded	300 mm	May be in metallic conduit instead of armoured.
	Medium Voltage – 1C or 3C unshielded	450 mm	

Cable	Other Cable	Minimum Segregation	Notes
Control < 50 V	120 VAC, 8 AWG or smaller	50 mm	
	120 VAC, > 8 AWG	300 mm	
	600 VAC Power	300 mm	
	VFD or other high harmonic cable	300 mm	Metallic Conduit
		450 mm	Other raceway
	Medium Voltage – 3C armoured and shielded	300 mm	May be in metallic conduit instead of armoured.
	Medium Voltage – 1C or 3C unshielded	450 mm	
120 VAC Control	120 VAC, 8 AWG or smaller	none	
	120 VAC, > 8 AWG	Metal barrier or 150 mm	
	600 VAC Power	Metal barrier or 150 mm	
	VFD or other high harmonic cable	150 mm	Metallic Conduit
		300 mm	Other raceway
	Medium Voltage – 3C armoured and shielded	300 mm	May be in metallic conduit instead of armoured.
	Medium Voltage – 1C or 3C unshielded	450 mm	
120 VAC Power	600 VAC Power	Metal barrier	Cable Armour is acceptable
	VFD or other high harmonic cable	100 mm	Metallic Conduit
		150 mm	Other raceway
	Medium Voltage – 3C armoured and shielded	300 mm	May be in metallic conduit instead of armoured.
	Medium Voltage – 1C or 3C unshielded	450 mm	
600 VAC Power	VFD or other high harmonic cable	100 mm	Metallic Conduit or both armoured cables
		150 mm	Other raceway
	Medium Voltage – 3C armoured and shielded	150 mm	May be in metallic conduit instead of armoured.
	Medium Voltage – 1C or 3C unshielded	300 mm	

4.15 Redundant Cables

1. Redundant cables are two or more cables serving the same system, or parallel systems serving the same objective, where the failure of one cable does not compromise the operation of the load.
2. Redundant cables should be physically and electrically separated to the greatest extent possible. The goal shall be that no single event would prevent the ultimate operation of the load.
3. Routing of redundant wires / cables within the same conduit or cable tray is not acceptable.
4. Redundant medium voltage cables shall not be closer than 1 m at any point along the length of the cables.

5 LIGHTING

5.1 Fixture Type Selection

1. The types of lighting fixtures and their mounting methods shall be selected to satisfy the various project requirements and conditions. Particular attention to colour renditions, light distribution and stroboscopic effects is needed when choosing the type of lamps, starting system, controls and reflection accessories. Due consideration shall also be given to the provision of proper re-lamping facilities. Specifically, care shall be taken to avoid the need for scaffolding or the need to drain tanks or to shut down processes in order to re-lamp or repair light fixtures safely.
2. Utilize industrial grade fixtures and components in process areas.
3. Refer to Table 5-1 for a general comparison of various fixture types.
4. Fluorescent or LED fixtures are preferred for most indoor applications as they provide instant on capability.
5. Light fixtures must be selected for the correct environment and installed (mounted) to facilitate lamp replacement and maintenance. Where corrosive gasses may be present, utilize sealed fixtures which are resistant to the specific corrosive atmosphere. Selection of accessories and other related materials must also bear the same degree of protection and be properly installed.
6. Refer to Table 5-2 for fixture selection for various applications. Note that the specific requirements of each application must be considered prior to final selection. Where an alternate type of lighting is proposed, review the proposed selection with the City.
   6.1 Lifecycle costs of original price, lamp replacement, and energy use will guide the choice of lighting fixtures employed.
7. The final number and array of fixtures used in the final required design must be supported by calculation using recognised methods; the use of vendor software is acceptable. The final design must ensure that the illumination levels will be met and maintained for the specified maintenance requirements and re-lamping intervals.
8. Select light fixtures to require minimal cleaning and permit practical and easy access and disassembly.

Table 5-1 : Fixture Type Comparison

Type	Efficacy	L70 Lamp Life (hrs)	Colour Rendering Index (CRI)	Instant On	Cost	Notes
Fluorescent	80 – 100	24K – 40K	80 – 90	Yes	$	Not suitable for outdoor
High Pressure Sodium (HPS)	100 – 130	24K – 30K	22	No	$	Not recommended for indoor.
Induction	60 – 75	100K	80	Yes	$$	
LED	70 – 140	50K – 70K	65 – 85	Yes	$$	
Metal Halide (MH)	70 - 120	12K – 20K	65 - 90	No	$	

Note:

1. Cost is the construction cost, not the operating cost.

Table 5-2 : Lighting Fixture Types

Facility Type	Area	Fixture Type	Notes
All	Mechanical Rooms	LED or F32T8	
	Electrical Rooms	LED or F32T8	
	Control Rooms	LED or F32T8	
	Offices	LED or F32T8	
	Washrooms	LED or F32T8	
	Stairways - switched	LED or F32T8	
	Stairways – always on	LED	
	Corridors	LED or F32T8	
	Bright Locations such as Instrument Shop	LED or F54T5HO	
	High-Bay Applications	MH, Induction or F32T8	
	Emergency Lighting	LED	
	Exterior - Building Entrances	HPS or LED	
	Exterior - Driveways	HPS or LED	
Wastewater Lift Station	All interior spaces	LED or F32T8	
Flood Pumping Station	All interior spaces	LED or F32T8	
Water Pumping Stations	All interior spaces	LED or F32T8	

5.2 Lighting Control

1. Lighting controls shall be provided to reduce the energy consumption of the facility while minimizing impact on personnel.
   1.1 Requirements of the Manitoba Energy Code for Buildings may exceed requirements herein.
2. Design lighting control to permit simple and integrated control of lighting.
   2.1 Ensure lighting controls can be easily operated.
   2.2 Ensure lighting controls are conveniently located for each area and function.
   2.3 Provide capability to control lighting at each entrance to the space. Doors utilized exclusively as emergency exits are not required to have lighting controls.
3. Provide highly controllable lighting in control rooms with multiple lighting schemes to support day and night monitoring of HMI screens, meetings, cleaning and other functions without eye-strain to personnel. Scenes shall include but not be limited to:
   3.1 Full lighting on;
   3.2 Dimmed (50%);
   3.3 Dimmed + task lighting, zoned by working areas.
4. Provide highly controllable lighting in conference and meeting rooms with multiple lighting schemes to support meetings, A/V presentations, and video conferencing. Control of lighting will be integrated with the equipment controls and control stations in the room so as to permit the attendees to vary the ambient and task lighting as required for different activities. All conference and meeting rooms shall be provided with dimming down to 5%. Lighting will have minimum of four levels of control.
5. Where lighting controls are required to be located in areas accessible to the public, protect the controls from unauthorized operation.
6. Provide capability of overriding the night setback control.
7. All lighting controls shall be appropriate and appropriately rated for the area in which they are located. Commercial grade lighting controls are not acceptable within process areas.
8. In large open process areas, arrange and zone lighting controls to permit energy management control and variation of light levels. However, provide consideration to operational and maintenance requirements and ensure that the lighting control scheme does not negatively impact personnel.
9. Controls for lighting will be controlled utilizing a zone control of lighting. Zoning control to provide automatic night setback with sweep ‘off’ per programmable time (i.e. two hours) throughout the night to turn off lights that may have been manually turned on by staff via a local light control. Ensure safety considerations are addressed to avoid leaving staff in the dark through the use of warning or other appropriate mechanisms.
10. Lighting control system will be interfaced to the PCS to permit override ‘100% on’. Lighting program will be established to address different conditions such as power outage and fire alarm.
11. Where significant glazing is provided, utilize daylighting controls for all lighting in areas adjacent to exterior glazing and provide dimming to 10% of lamp output.
12. Occupancy sensors and, where provided, daylighting controls, will be integrated into the lighting controls.

13. Where always on and delayed off lighting is applied, more than one luminaire and more than one lighting circuit shall be used in each area to implement this strategy.
14. Refer to Table 5-3 for potential methods of lighting control. Note that the list is not exhaustive.
15. Refer to Table 5-4 for typical lighting control application requirements. Note that this table is not deemed to be mandatory, and each application should be reviewed with the City.

Table 5-3 : Lighting Control Methods

Legend	Method	Description
AO	Always On	Lighting is always on.
D	Dimmable	
MS	Master Switch	Contactors are utilized to switch multiple circuits from one switch.
MSPDO	Master Switch Partial Delay Off	A master switch is utilized, but upon turning the lighting off, a portion of the lighting remains on for a time delay. In the event that someone is still in the building, this provides the occupants opportunity to exit.
OS	Occupancy Sensor	An occupancy sensor is utilized to control lighting in the room. Timers will turn off the lighting after occupancy is not detected for a set period of time.
OSM	Occupancy Sensor with Manual On-Off Switch	An occupancy sensor with a timer and a manual On-Off switch to override the occupancy switch.
PC	Photocell Control	The lighting is controlled by ambient light.
S	Switch	Standard switches are utilized for each lighting circuit. The switches may be a 3-way/4-way circuit as required.
S/AO	Switched / Always On	Combination switched lighting and partial always on. Also known as a night-lighting arrangement.
T	Timer	The lighting turns on and off via a timer.
TO	Timer with Override	The lighting turns on and off via a timer, but an override system is present to allow personnel to turn the lighting on during typical off hours.
TO/AO	Timer with Override and partial lighting always on	Same as TO, except that a night-lighting circuit is present to provide a low level of base lighting.

5.3 Illumination Levels

1. Illumination levels must meet or exceed requirements of building codes and fire safety norms for exit lighting and the requirements of this document, whichever is greater.
2. Refer to Table 5-4 and Table 5-5 for required illumination levels for various applications.
3. Use the following criteria as maximum factors for calculation of illumination levels:
   3.1 Luminaire dirt depreciation: 0.80
   3.2 Luminaire lumen depreciation: 0.85
4. Where light fixtures may be subject to significant accumulating dust or splatter, utilize a lower luminaire dirt depreciation factor.

Table 5-4 : Illumination Requirements - General

Area	Minimum / Average Illumination (lux)	Control (See Table 5-3)	Notes
Control Rooms	400 / 450	D + OSM	
Corridors – High or Public Use	200 / 250	AO TO/AO	
Corridors – Low Use	100 / 150	S TO/AO	
Electrical Rooms	450 / 500	S S/AO	
Electrical Shop	500 / 550	S	
Instrument Shop	750 / 850	S	
Janitor Rooms	200 / 250		
Laboratory	–700 / 800	D + OSM	
Locker Rooms	150 / 200	OS	Utilize ultrasonic or other appropriate technology to avoid lights turning off while in shower.
Mechanical (HVAC) Rooms	200 / 250	S S/AO	
Offices	450 / 500	OSM	
Outdoor - Building Entrances	75 / 100	Photocell	
Outdoor Electrical Substations	10 / 20	Photocell	Base lighting
	250 / 300	S	.
Outdoor - Sidewalks and Walkways	10 / 15	Photocell	
Meeting Rooms	450 / 500	D + OSM	
Parking Lots	20 / 25	Photocell	
Process Areas - Indoor	300	S/AO TO/AO	
Process Areas - Outdoor	25 / 35	Photocell	Walkways
	150 / 200	S	Or higher as required to operate and maintain the process
Roads	–10 / 15	Photocell	
Server Rooms	450 / 500	OSM	
Stairways – High or Public Use	200 / 250	AO TO/AO	

Area	Minimum / Average Illumination (lux)	Control (See Table 5-3)	Notes
Stairways – Low Use	100 / 150	AO TO/AO	
Storage Rooms	125 / 150	OSM	
Washrooms	150 / 200	OS	
Workshop - Mechanical Maintenance	500 / 550	S TO/AO	
General – Not Specified	250 / 300	TBD	May discuss with City

Table 5-5 : Illumination Requirements - Specific

Facility Type	Area	Recommended Illumination (lux)	Control (See Table 5-3)	Notes
Wastewater Lift Station	Main Level – Electrical Area	300 - 350	S MS	
	Main Level – Non Electrical	250 - 300	MSPDO	
	Lower Levels including Pump Room	150 – 250	MSPDO	
	Areas not accessed for regular maintenance	100	S	
	Exterior equipment such as valve actuator.	50	S	
Flood Pumping Station	Main Level – Electrical Area	300-350	S	
	Main Level – Non Electrical	250 - 300	S	
	Lower Levels including Pump Room	150 – 250	S MSPDO	Select control as appropriate.
	Areas not accessed for regular maintenance	100	S	
	Exterior equipment such as valve actuator.	50	S	
Other Facilities	Areas with Small / Delicate Equipment.	500+	TBD	Select control as appropriate.
	Areas Requiring Frequent Inspection / Maintenance	300	TBD	
	Areas Requiring Routine Inspection / Maintenance	250	TBD	
	Areas Requiring Minimal Inspection / Maintenance	100 - 200	TBD	
	Areas Requiring Infrequent Inspection / Maintenance, but performance of visual tasks of small size is required.	300	TBD	

5.4 Fixture Location Requirements

1. Locate fixtures to avoid interference with ductwork, piping, cable trays, and other items which may block the light or impede fixture access.
2. Where practical, lighting should not require scaffolding, fall arrest equipment, the drainage of tanks or the disruption of operations for it to be serviced safely and in accordance with safety legislation. Fixtures that are accessible via the use of a small motorized scissor lift are satisfactory, provided that the facility has ready access to a scissor lift, and the scissor lift can easily be brought to the applicable space.
   - 2.1 LED fixtures shall be accessible. Despite longer intervals between service, access is still required for lamp/lens cleaning and other maintenance.
3. Locate fixtures to avoid the accumulation of dust and spatter so far as practical.

5.5 Emergency Lighting and Associated Power Source

1. Emergency lighting must be installed in all facilities.
2. The emergency lighting power supply shall be one or more of the following:
   - 2.1 Unit based battery back-up units.
   - 2.2 Centralized UPS power, dedicated for lighting and separate from the control system UPS.
   - 2.3 An emergency generator.
3. Utilize an emergency generator set to power emergency lighting, or a combination of battery supported emergency lighting with a standby generator, for mid to large sized facilities, where the facility may require occupancy during a power failure.
4. Where an emergency generator is utilized for emergency lighting:
   - 4.1 The generator installation shall comply with CSA C282.
   - 4.2 The emergency power system shall be separated from any non-life-safety loads via a separate transfer switch.
5. Where battery-based emergency lighting is utilized:
   - 5.1 Minimize the number of batteries utilized for unit-based emergency lighting.
   - 5.2 All batteries used in the unit shall be sealed maintenance free type, 10-year rated. Ensure the recommended date for first battery replacement is provided to the City project manager, to allow the required work to be added to City maintenance schedules.
   - 5.3 The units shall have auto-test capability.
   - 5.4 The size of circuit conductors to remote lamp heads shall be such that the voltage drop does not exceed 5% of the marked output voltage of the unit equipment, or such other voltage drop for which the performance of the unit is certified when connected to remote lamp.
   - 5.5 Unit emergency lighting equipment and lighting control units, other than remote lamp heads shall not be installed in wet or corrosive locations.
6. Emergency power supply shall have adequate capacity and rating to ensure that all connected equipment can be operated safely when the normal power source fails.
7. Emergency lights shall be arranged so that the failure of any one lamp will not leave the area in total darkness. Use double lamp heads.

8. No other appliance or equipment other than for emergency purpose shall be supplied by the emergency power circuit.
9. In the event an emergency generator is utilized to provide emergency lighting, provide additional battery based unit emergency lighting in the following locations:
   9.1 Generator room
   9.2 Major electrical rooms
   9.3 Major control rooms.
10. Typical emergency lighting application requirements are indicated in Table 5-6.

Table 5-6 : Typical Emergency Lighting Requirements

Facility Type	Area	Recommended Emergency Illumination (lux)	Min. Duration (hours)	Notes
All	Below-Grade Walkways	> 10	0.5	
	Control Rooms	> 50	2	
	Corridors – High Use	> 20	0.5	
	Corridors – Low Use	> 10	0.5	
	Electrical Room	>10	1	Illumination should be above 50 lux on the front of all critical equipment.
	Electrical Substation – Outdoor	See Note 2	See Note 2	
	Exits	> 10	0.5	
	Generator Rooms	> 50	3	
	Laboratory	> 10	0.5	
	Mechanical Rooms	> 10	0.5	Along egress path.
	Offices	Not Req.	-	Required for corridors
	Process Areas	> 10	0.5	On major walkway / exit path
	Stairways – High Use	> 20	0.5	
	Stairways – Low Use	> 10	0.5	
	Washrooms – One Person	Not Req.	-	
	Washrooms – Multiple People	> 10	0.5	
	Workshop	> 10	0.5	On major walkway through area.
Wastewater Lift Station	Main Level	> 10	1	
	Lower Levels including Pump Room	> 10	0.5	
	Areas not required for regular maintenance	Not Req.	-	

Notes:

1. There will be exceptions to the above table. Exceptions are to be reviewed and approved on a case-by-case basis.
2. The requirement for emergency lighting in an outdoor electrical substation shall be determined on a case-by-case basis.
3. Minimum code requirements shall be adhered to.

5.6 Requirements for Exit Signs

1. Exit signs shall be provided for all facilities, where required by code or egress would not be clear under all circumstances.
2. LED exit signs are the standard of acceptance. All alternatives must be approved by the City.
3. Exit signs shall comply with requirements of the City of Winnipeg Electrical Bylaw, the National Building Code of Canada with Manitoba Amendments and the National Fire Code.
4. Exit signs shall be installed such that they are visible and point towards the direction of building exit.
5. Preferably exit signs shall indicate a running person pictogram figure with arrow sign indicating direction of exit. In existing facilities, exit signs shall match the type of sign used elsewhere in the facility.
6. Where an emergency generator is available, avoid the use of battery based systems if possible, except as noted herein.
7. Where batteries are utilized, all batteries used in the unit shall be sealed 10-year rated maintenance-free type.

6 EQUIPMENT DESIGN REQUIREMENTS

6.1 DC Power Supply

6.1.1 125 VDC Power Supplies

1. DC power supplies may be utilized for switchgear control power, as per Section 6.10.
2. The voltage for switchgear DC power supplies shall be 125 VDC, ungrounded.
3. Provide ground fault detection with alarming on all ungrounded conductors.
4. As a minimum this system or any individual unit, shall consist of a battery bank, a battery charger and a DC distribution board.
5. Batteries shall be Valve Regulated Lead Acid (VRLA). Battery sizing to be based upon the application requirements per IEEE Standard 485 “Recommended Practice to Size Lead Acid Batteries for Stationary Applications”, but at minimum shall be sized to allow:
    - 5.1 Ten hours of continuous standby current, plus
    - 5.2 One operation for all momentary loads (e.g., one breaker trip and close for all breakers).
6. Preferred input voltage is 600 V, 3-phase. Alternately, 208 V, 3-phase may be utilized with approval of the City.
7. The battery charger shall have the following features:
    - 7.1 Provide input AC voltmeter for each phase (or utilize voltage selector switch).
    - 7.2 Provide a rectifier output DC voltmeter.
    - 7.3 Provide minimum of two 2-pole DC rated output load circuit breakers (2-pole, 250 V DC) for 125 V DC load circuits. One breaker is to be utilized for the DC distribution panelboard. The second breaker is for connection to a second panelboard, if required, or utilized as a future spare.
    - 7.4 Provide one DC Battery circuit breaker (2-pole, 250 V DC) for connecting the 125 V DC battery bank.
    - 7.5 Provide a load DC ammeter.
    - 7.6 Provide an auxiliary contact relay output and alarm for AC power failure.
    - 7.7 Provide a low DC battery voltage alarm to indicate battery over discharge.
    - 7.8 Provide high DC output voltage alarm and high DC output voltage automatic shutdown.
    - 7.9 Provide “no-charge” alarm to indicate charger has no DC output.
    - 7.10 Provide DC ground detector relay and alarm (+ve and –ve).
    - 7.11 Provide local indication and annunciation, as well as relay contacts for PLC/DCS/SCADA monitoring of all alarms including: failure of AC power, low DC voltage, high DC voltage, no rectifier output.
    - 7.12 Provide an equalize timer, automatic reset type with charge time compatible with battery type. Equalize interval shall be settable from 0-28 days.

6.1.2 24 VDC Power Supplies

1. The common conductor, in many cases labelled as the negative terminal, from 24VDC power supplies shall be grounded at the DC power supply.

6.2 Electric Heating

6.2.1 General

1. Tubular heating coils are required.
2. Ensure a high temperature cut-out is provided for electric heaters.
3. Ensure an airflow proving switch is provided for all forced air electric heaters.
4. SCR systems should be utilized for applications requiring proportional control. Zero-crossing SCR systems are preferred to reduce harmonics.
5. For heaters > 50 kW where proportional control is required, consider utilizing staging in addition to SCR control.

6.2.2 Heater Voltage Levels

1. Heater voltages should be selected based upon the nominal system voltage. For example, the heater voltage rating should be 600 V on a 600 V rated system, and not 575 V.
2. The preferred voltage levels for various electric heater sizes are shown in Table 6-1.

Table 6-1 : Acceptable Heater Voltage Levels

Heater Rating	Voltage Levels	Acceptable	Notes
< 1.5 kW	120 V, 1Ø	Yes	
	208 V, 1Ø 240 V, 1Ø	Yes	
	208 V, 3Ø	Yes	
1.5 kW – 4.9 kW	24 , 1Ø	Specific Cases	Only where three phase power is not available
	208 V, 3Ø	Yes	
	600 V, 3Ø	Yes	
5.0 kW – 9.9 kW	208 V, 1Ø 240 V, 1Ø	No	Except with City approval due to extenuating circumstances
	208 V, 3Ø	No	Except with City approval due to extenuating circumstances
	600 V, 3Ø	Yes	
> 10 kW	600 V, 3Ø	Yes	

6.3 Motor Control Centres

6.3.1 Low Voltage MCC (600 V)

1. Typically, MCCs will be 3-phase, 3-wire. The use of 4-wire MCCs should not be typical, and should only be utilized where accepted by the City.
2. Enclosure Type: NEMA 1 with gaskets or better if the application requires.
3. Wiring Type: Class 1, Type B-D or B-T.
4. Busbars: Tin-plated copper.
5. Short circuit withstand rating is based on fault level calculations at the point of connections.
6. Provide thermographic inspection windows in MCCs (or compartments as applicable) with an arc flash rating of 8 cal/cm2 or greater.
7. Use surge arrestors at line terminals if MCC BIL rating is inadequate to meet system BIL requirements.
8. Provide a Transient Voltage Surge Suppressor (TVSS) at each MCC where there is possibility of transient voltages. Connect the TVSS to the control system for monitoring.
9. Utilize active harmonic filters or other harmonic mitigation means on MCC's that have VFD's or other harmonic sources as required to achieve a bus and incoming feeder harmonic level in accordance with Section 3.10.
10. Provide clearances around the MCC in accordance with Code requirements and the following, whichever is greater:
    10.1 Front of MCC: 1.5 m
11. As per Section 9.2 Table 9-2, equip MCCs with a power meter complete with a Modbus TCP communication interface to provide real-time measurements of voltage, current, power, power factor, and energy consumption.
    11.1 Power meters may be omitted for small applications, where approved by the City.
    11.2 Provide meter with harmonic voltage and current measurement capabilities where significant harmonics are present.
12. As required by Table 6-2, and Section 9.3, provide a voltage monitoring relay with dry alarm contacts for connection to the control system.
    12.1 Voltage relay to alarm on any phase loss or voltage imbalance > 10%.
    12.2 Voltage relay to automatically reset upon restoration of power.
    12.3 Standard of acceptance to be ABB SSAC WVM011AL.
    12.4 The voltage monitoring relay functionality may be combined with the power meter, provided all power failure modes are accounted for in the design.
13. All components shall be CSA approved or cUL listed.
14. Motor control circuits shall be 120 VAC and powered by a dedicated control power transformer within each motor starter.
    14.1 Size control power transformers with a minimum of 50 VA capacity above that required for starter components.
    14.2 Protect CPTs with two fuses on the primary winding and one fuse on the secondary. The secondary neutral shall be connected to ground.

15. Where space permits, provide a total of four individual and reversible auxiliary contacts from the contactor (3 NO & 1 NC). The contacts shall be wired to an isolated section of the starter's terminal block

16. Ensure motor protection and control is consistent with Section 7

17. All motor overloads are to be of electronic type, to allow for improved protection, easier adjustment of settings, and better phase-loss protection.

    17.1 It is preferred to connect overload contacts on the line-side of the contactor coil, to ensure that overload protection is not lost in the event of a contactor coil ground fault.

18. Smart / Intelligent MCCs have integrated communications capability to allow the control system to directly monitor and control the motor starters via a network. Smart / Intelligent MCCs are required for many new MCC installations.

    18.1 Apply smart/intelligent MCCs as per Table 6-2.

    18.2 Coordinate with the City to determine if the City has a current standard regarding manufacturer and/or communication protocol.

19. Drawing Requirements

    19.1 Provide a MCC Layout Drawing as per Section 19.2.10.

    19.2 Provide a MCC Schedule as per Section 19.2.11.

Table 6-2 : MCC Application Requirements

Facility Type	Voltage Monitoring Relay	Smart MCC	Notes
Wastewater Flood Station	Yes	No	
Wastewater Lift Station	Yes	No	
Wastewater Treatment Facility	See Note 1	Yes	
Water Pumping Station	Yes	Yes	
Other	See Note 1	TBD	Review on a case-by-case basis.

Note:

1. Refer to Section 9.3.

6.3.2 Medium Voltage MCC

1. Short circuit withstand rating is based on fault level calculations at the point of connections.

2. Use surge arrestors at line terminals if MCC BIL rating is inadequate to meet system BIL requirements.

3. The motor controllers shall be rated and designed for starting method to be compatible with motor starting characteristics.

4. The motor controllers shall be equipped with a motor protection relay having a Modbus/TCP communication interface to convey status monitoring and control commands from external Control system.

5. The MCC busbar and connections shall be designed to withstand electromechanical stresses of across the line motor starting.
6. The Main MCC busbar shall be designed to withstand and carry rated fault current.
7. MCC shall be equipped with a power meter complete with a Modbus/TCP communication interface to provide real-time measurements of Voltage, Current, Power, Power Factor, and Energy consumption.
8. All MCC components shall be motor horsepower rated. All components shall be CSA approved or cUL listed. IEC components are not acceptable.
9. Motor control circuits shall be 120 VAC or 125 VDC.
10. Provide thermographic inspection windows in all medium voltage MCCs.
11. Apply other design requirements from Section 6.3.1, as applicable.

6.4 Moulded Case Circuit Breakers

1. Protection Requirements:
   - 1.1 Provide electronic trip units with appropriate protection capabilities where required to meet protection, selective coordination and arc flash reduction requirements.
   - 1.2 All moulded case circuit breaker selection shall be based upon the Short Circuit, Coordination and Arc Flash Study as identified in Section 19.4.2.

6.5 Neutral Grounding Resistors

1. General Requirements
   - 1.1 All NGRs shall have an appropriate protection relay and be monitored locally (ammeter) and by the control system.
2. High Resistance Grounding
   - 2.1 The NGR shall be designed to be placed outdoors and use wire wound resistance elements.
   - 2.2 The NGR shall be rated for continuous duty.
3. Low Resistance Grounding
   - 3.1 The NGR shall be designed to be placed outdoors and use edge wound stainless steel resistance elements. It shall be designed to trip within 1 second on sensing a Ground fault.
   - 3.2 All downstream ground fault protection relays shall be coordinated to trip faster than NGR protection relay.
   - 3.3 NGR time ratings shall be appropriate for the application.
4. Refer to Section 10.5 for ground fault detection system requirements.

6.6 Panelboards

1. All breakers are to be bolt-on type.
2. Surface mounted panelboards are preferred over flush mounted panelboards in industrial style occupancies.

3. Except as noted in Subclause 3.1 below, utilize separate process panelboards from panelboards dedicated for building systems, each powered by separate transformers.

   3.1 Common process and building system panelboards may be utilized where the number of building circuits or process circuits will be less than eight, and there will be no operational or maintenance issues associated with the circuits being on a common panelboard.

4. Segregate loads such as those that generate high harmonics on a separate panelboard fed from a dedicated transformer.

5. Where 347V lighting is utilized, provide a dedicated 347/600 V panelboard powered by a transformer to generate the required neutral.

6. Provide a minimum of 20% spare 15A breakers (or 5 breakers, whichever is less).

7. DC panelboard shall be suitable for 125 V DC power and shall be rated either 125 V/250 V DC, 12/24 way distribution with individual DC rated circuit breakers. AC circuit breakers with equivalent DC rating are also acceptable.

6.7 Receptacles

6.7.1 General

1. Arrange receptacles in accessible locations, considering operational and maintenance requirements.

2. Ensure that the voltage drop is minimized such the maximum voltage drop at the receptacle utilization point is 3% below nominal voltage, under system full load.

3. Receptacles shall be coloured as per **Error! Reference source not found.**

Table 6-3 : Receptacle Colours

Color	Application
White	General use – Offices, control rooms, and similar spaces
Grey	General use – Process areas, maintenance / shop areas
Orange	Powered by Process UPS
Blue	
Yellow	Powered by Lighting UPS
Red	Dedicated branch backed up by a generator and not load-shed. See Note 1.

Note:

1. Where standby generator can power the main power distribution, only the receptacles always designated to be powered by the generators should be colored red.

6.7.2 Welding Receptacles

1. Provide 600 V, three-phase welding receptacles in areas where mechanical equipment will be maintained and where welding may be required. Welding receptacles will be 600 V, 3 Ø, 60 A with integral disconnect switch.
2. Supply a maximum of two welding receptacles from each feeder breaker.
3. Coordinate to ensure only a single receptacle type is provided for each facility.
4. Mount welding receptacles at 1.2 m.

6.7.3 Convenience Receptacles

1. Convenience receptacles are those allocated for undefined, general purpose use of facility occupants.
2. Convenience receptacles will be duplex 5-15 R, 120 V, 1-phase. Appropriate rated receptacles will be utilized in hazardous locations.
3. Locate convenience receptacles to include at minimum:
   - 3.1 Automation rooms: Every 3 m of wall space not completely blocked by equipment and on columns as required such that the entire space can be reached via a 3 m extension cord.
   - 3.2 Electrical rooms: Every 3 m of wall space not completely blocked by equipment and on columns as required such that the entire space can be reached via a 3 m extension cord.
   - 3.3 Control rooms: Every 2 m of wall space and at every workstation, desk, or other location where a convenience load may be required.
   - 3.4 Janitor rooms: Every 3 m of wall space.
   - 3.5 Mechanical rooms: Every 4 m of wall space and on columns as required such that the entire space can be reached via a 4 m extension cord.
   - 3.6 Server room: Every 2 m of wall space.
   - 3.7 Process areas (indoor and outdoor): Every 30 m of wall or walkway space.
   - 3.8 Other spaces: Every 6 m of wall space
   - 3.9 Areas within 7.5m of equipment requiring maintenance;
4. Limit the number of convenience receptacles on each circuit to a maximum of six duplex receptacles; however, ensure that receptacles that are likely to be simultaneously loaded are on separate circuits.
5. GFCI receptacles shall be provided for:
   - 5.1 All locations where required by the Canadian Electrical Code.
   - 5.2 All outdoor locations.
   - 5.3 All wet locations.
   - 5.4 All receptacles located below grade in a wastewater lift, flood station or wastewater treatment process area.

6.7.4 Maintenance Receptacles

1. Maintenance receptacles are those allocated for maintenance (and possible housekeeping) use.
2. Maintenance receptacles will be duplex 5-20R, 120 V, 1-phase and GFCI protected, except appropriate rated receptacles will be utilized in hazardous locations.
3. Locate maintenance receptacles in all indoor locations such that all floor areas can be reached with a 30 m extension cord.
4. Limit the number of maintenance receptacles on each circuit to a maximum of ten duplex receptacles; however ensure that receptacles that are likely to be simultaneously loaded are on separate circuits.
5.

6.7.5 Dedicated Purpose Receptacles

2. Utilize locking-type receptacles where:
   2.1 the receptacle or the connected device is subject to vibration; or
   2.2 the load is of high importance, including UPS, sump pumps, control equipment and emergency lighting.
3. Ensure dedicated purpose receptacles are on independent circuits, unless it can be clearly demonstrated that the loads are similar, and there will be no operational or maintenance impact through the use of a common circuit.

6.8 Soft Starters

6.8.1 Design Requirements

1. Short circuit withstand rating based on fault level calculations at the point of connections. In some cases, upstream fuses may be required to address the expected short circuits.
2. The 600 V soft starter shall be rated and designed for starting method to be compatible with motor starting characteristics. It shall be verified that the maximum torque developed by the soft starter exceeds the starting torque required by the load at standstill.
3. The soft starter shall be equipped with all the required motor protection functions.
4. Where installed in an intelligent MCC, the starter shall be equipped with a communication interface compatible with the intelligent MCC communications.
5. The soft starter shall be equipped with a programming and display keypad unit, which shall be front door mounted.
6. Adequate cooling shall be provided by integral fans or enclosure mounted fans to transfer the heat from soft starter to outside. A heat loading calculation shall be performed for all custom enclosures.
7. Under no condition may the SCRs be utilized for continuous operation of a motor, regardless of manufacturer’s claims. Internal bypass contactors however are acceptable under certain applications, as per Table 6-4.

8. Where external contactors are utilized, IEC contactors shall only be acceptable in applications where internal bypass contactors are acceptable, as per Table 6-4. All other applications shall utilize appropriately rated NEMA contactors. An exemption may be granted in certain applications, with approval by the City, where the available space does not allow for installation of a NEMA contactor.

9. Where an External Bypass Starter is required, as per Table 6-4, the overload shall be on the bypass line, and of an electronic type. The bypass starter shall be utilized when the motor is up to speed. Provide a "Soft Start / Bypass selector" switch on the front of the starter, and monitor the switch from the control system. The external bypass starter must be capable of performing a full voltage, across the line start if the soft starter fails.

10. Several models of soft starters are available with an internal bypass contactor that closes once the motor is up to speed. Use of the internal bypass contactor is only permitted for applications as indicated in Table 6-4.

Table 6-4 : Soft Starter Application Requirements

Facility Type	**Application**	**Internal Bypass Acceptable**	**External Bypass Starter Required**	**Line Isolation Contactors Required**	**Load Isolation Contactors Required**	**Notes**
Wastewater Flood Station	Flood Pump	Yes	No	Yes (1)	No	
Wastewater Lift Station	Lift Pump	No	Yes	Yes (1)	No (2)	
Wastewater Treatment Facility	Raw Sewage Pump	No	TBD	TBD	TBD	Review on a case-by-case basis.
	Process Pump	TBD	TBD	No	No	Review on a case-by-case basis.
	Ventilation / HVAC	Yes	No	No	No	
	Misc. Other	Yes	No	No	No	
Water Pumping Station	HVAC	Yes	No	No	No	
Other	Other	TBD	TBD	TBD	TBD	Review on a case-by-case basis.

Notes:

1. In certain applications where space does not permit, the City may grant an exemption to the requirement for isolation contactors.

2. For wastewater lift stations, a load contactor shall be provided where it is required in order to implement the automatic bypass starter.

6.8.2 Bypass Starters

1. Bypass across-the-line (ATL) motor starting method to be used for very critical pumping loads required to be kept in operation upon a failure of the soft starter.
2. Ensure that the mechanical equipment and power system can handle the hard across the line start method via the bypass starter. If this is not technically feasible then a redundant soft starter may be required.
3. The bypass starter shall be designed for continuous operation with motor loads when its associated soft starter is unavailable.
4. The bypass starter components shall be NEMA rated. IEC components are not acceptable.
5. Bypass mode is to be selected via a door-mounted two-position selector switch.
6. The bypass starter must be operable with the soft-starter removed. Ideally this would require no re-wiring; however for Schneider ATS48 installation it is acceptable to require minor power re-wiring to effect the removal of the soft starter.
   - 6.1 Where re-wiring is required to allow the bypass starter to operate without the soft starter in place, provide permanent diagrams and clear warnings on the starter door interior guiding maintenance personnel on the wiring for each configuration. Ensure that the motor starter schematics also provide a clear wiring diagram for each mode.
   - 6.2 With the soft starter in place, the bypass starter shall be operable by simply switching the *Soft Start/Bypass* switch on the door exterior into the *Bypass* position, without any rewiring.

6.8.3 Supervisory Monitoring and Control

1. Soft starter operating modes and status signals are to be monitored by the automation system and displayed on the SCADA HMI. Typical monitored points include:
   - 1.1 Ready Status
   - 1.2 Running Status
   - 1.3 Soft Starter Fault Status
   - 1.4 Bypass Starter O/L Trip Status
   - 1.5 Soft Starter/Bypass Mode, monitored directly from the selector switch
   - 1.6 Remote/Local Mode, monitored directly from the selector switch
   - 1.7 Motor Current
2. Fault signals should be wired to a non-fail safe contact (normally open, closed upon a fault condition) to avoid fault alarms from appearing on the HMI when the soft starter is disconnected from the power source for maintenance purposes.

6.9 Switchgear – Low Voltage

1. Switchgear connected directly to utility services must be service entrance rated.
2. Instrument Transformers
   - 2.1 Instrument transformers shall have a thermal rating of 2.0 and include all the current transformers (CT's) and potential transformers (PT's) required for both metering and protection purposes.
   - 2.2 Current transformers shall be mounted in the breaker compartment around the stationary main contacts and shall have their thermal and mechanical rating capable

of withstanding the short circuit rating of the associated circuit breakers. They shall be accessible from the front of the switchgear assembly. There shall be one CT per phase.

2.3 The metering accuracy of the CT's shall be 0.3 B-0.2 as a minimum. Burden factor of 0.2 Ω shall be increased to higher values as needed for the application. For protection duty, sensors' accuracy class shall not be less than C100, and shall be increased as required by the application to comply with Class C. CT's used for metering and protection shall fulfill the accuracy requirements for both duties.

2.4 Potential transformers with their primary and secondary fuses shall be mounted inside the switchgear's instrument compartment. Accuracy shall be 0.3WX0.6Y1.2Z, as a minimum. The fuses shall be of the pull out type.

2.5 Potential transformers shall be connected in open delta with their secondaries at 120 V.

2.6 Current and potential transformers shall be wired to test blocks. Whenever an instrument transformer is connected to more than one device, there shall be one test block for every device. Potential transformers shall be grounded at the input side of the test block.

3. Controls

3.1 Control potential transformer with pull-out type primary (two fuses) and secondary fuse shall be mounted inside the switchgear instrument compartment.

3.2 Control and timing relays shall be of the plug-in type. Timing relays shall be solid state.

4. Communication

4.1 Review the requirement for Ethernet communication of relays and metering devices on a case-by-case basis.

5. Power Connections

5.1 Two-hole, long barrel, tin-plated, copper, NEMA standard spacing compression type lugs and cable support brackets for the incoming and outgoing cables.

5.2 Where an incoming bus duct is specified, suitable flanges shall be provided.

5.3 Provide removable conductive gland plate (non-magnetic and non-conductive for single conductors).

6. Control Wiring

6.1 Control wiring shall be 14 AWG minimum, single conductor, stranded copper having 600 volt, flame retardant insulation, SIS switchboard type.

6.2 Current transformer wiring shall be 10 AWG minimum, single conductor, stranded copper having 600 volt, flame retardant insulation, SIS switchboard type wiring.

6.3 All external connections shall be via terminal blocks. Provide a minimum of 15% spare terminals.

7. Provide closed-door racking for all low-voltage switchgear.

8. Provide arc-resistant switchgear or remote racking for switchgear with arc flash ratings exceeding 25 cal/cm^2 to limit the potential exposure of maintenance personnel performing racking operations.

9. Provide thermographic inspection windows in low voltage switchgear with an arc flash rating greater than 8 cal/cm^2.

10. Clearances

10.1 Provide sufficient working space in front of medium voltage switchgear to allow for all draw-out racking operations to be comfortably carried out by maintenance personnel. At a minimum provide 1.5m front clearance, in addition to space required for drawout equipment in the full disconnect position.

6.10 Switchgear – Medium Voltage

1. Switchgear connected directly to utility services must be service entrance rated.
2. The main incoming service for facilities requiring medium voltage switchgear shall be metal-clad circuit breaker switchgear.
3. Fuse-based medium voltage switchgear is only acceptable in the following scenarios:
   - 3.1 Systems without neutral-grounding resistors;
   - 3.2 Capacity is less than 2 MVA;
   - 3.3 Arc flash hazards are not increased by the use of a fuse based installation;
   - 3.4 Protection is provided to prevent the occurrence of a loss of a phase to loads; and
   - 3.5 Selective coordination is not lost.
4. Circuit breakers shall be vacuum circuit breakers.
5. Utilize 125 VDC switchgear control power for all installations, except as follows:
   - 5.1 AC control power may be utilized for installations less than 4 MVA, and requires provision of a dedicated UPS or capacitor trip supply.
6. At minimum, provide arc-resistant switchgear where the arc flash category level for the switchgear is above Category 2. Under no circumstances shall protection settings be set in a manner to reduce arc flash energies for the purpose of bypassing this requirement, if the reduced protection settings impact selective coordination or in any other way impact operation or maintenance.
7. Where arc resistant switchgear is provided:
   - 7.1 The standard of acceptance shall be ANSI/IEEE C37.20.7 Type 2B; and
   - 7.2 Ensure that the maximum fault clearing time is within the switchgear design limits (typically 0.5 second).
8. Protection and metering shall be microprocessor based with integrated digital metering and display, as well as communications capability for remote display via the control system.
9. See Section 10.4 for protection requirements.
10. Provide at minimum the following signals to the control system for monitoring and alarming:
    - 10.1 Closed / open status of main and tie breakers.
    - 10.2 Breaker / Relay fail status.
    - 10.3 Metering signals as per Section 9.2.
11. Provide closed-door racking for all medium-voltage switchgear.
12. Consider the use of light-based arc detection protection relays to reduce arc flash energies.
13. Utilize remote racking for switchgear with arc flash ratings exceeding Category 3, where maintenance personnel are not otherwise protected by arc-resistant switchgear.
14. Ensure viewing windows are provided to visually monitor the position of disconnect blades in switch style switchgear.

15. Provide thermographic inspection windows in all medium voltage switchgear.

16. Clearances

    16.1 Provide sufficient working space in front of medium voltage switchgear to allow for all draw-out racking operations to be comfortably carried out by maintenance personnel. At a minimum provide 1.5m front clearance, in addition to space required for drawout equipment in the full disconnect position.

    16.2 Provide a minimum of 1 m clearance at the rear of the switchgear. Increase clearance in accordance with CSA 22.1 Table 56 as necessary.

    16.3 Provide a minimum of 1 m of clearance on the sides with radius around corners expanding to required clearances in the front and rear of the switchgear.

6.11 Transformers

1. General

    1.1 Provide 25% spare capacity for future use, except as follows:

        a) Where a dedicated electrical distribution is provided to power selected process loads in accordance with Section 3.7; or

        b) Where future loads are not expected and the City has approved the reduction of the spare capacity in writing.

    1.2 Percent Impedance (%Z) in accordance with CSA and design requirements.

    1.3 Copper windings only.

    1.4 All three phase transformers to be delta-wye unless otherwise approved by the City.

    1.5 Specify the relevant CSA standards for each transformer installation.

2. Sizing

    2.1 Ensure sizing is in accordance with Section 3.7.

    2.2 Ensure all transformer sizing is coordinated with generator sizing to allow the generator(s) to energize the transformer (considering maximum inrush current) without complicated start-up schemes.

    2.3 Limit the size of transformers in accordance with Table 6-5. Utilize separate transformers and secondary distribution systems where the size of the transformer is exceeded.

Table 6-5 : Maximum Transformer Size

Secondary Voltage	Maximum Size (KVA)		
	Distribution		Service
	Recommended	Absolute	Recommended
240/120 V, 1Ø	50	75	30
208/120 V, 3Ø	75	150	50
480 V, 3Ø	1500	2000	2000
600 V, 3Ø	2000	2500	2500
4160 V, 3Ø	5000	5000	5000
12.47 kV, 3Ø	Note 1	Note 1	Note 1

Notes:

1. TBD

3. Outdoor, liquid-filled transformers

3.1 Efficiency in accordance with:

3.1.1 CAN/CSA C802.1 – Minimum Efficiency Values for Liquid-Filled Distribution Transformers

3.1.2 CAN/CSA C802.3 - Maximum Losses for Power Transformers

3.2 Secondary neutral terminal bushing is required. The neutral must be fully rated for all neutral grounding resistor applications.

3.3 Provide surge arrestors on the primary side of the transformer.

3.4 The NGR enclosure shall be stainless steel and NEMA 3-R rated.

3.5 Primary terminal bushings shall be suitable for cable connections.

3.6 Secondary terminals for connecting secondary cables or cable bus duct / bus way shall be tinned copper bus bars.

3.7 Utilize PCB free transformer oil suitable for Arctic conditions (extreme cold climate).

3.8 The transformer core shall be cold rolled grain oriented steel laminations.

3.9 Transformer shall withstand thermally and mechanically a two second short circuit at its secondary terminals.

3.10 Transformer shall be equipped with all standard metering, pressure relief and CTs as required by CSA.

3.11 Transformer shall be provided with stainless steel grounding pads at two diagonally opposite ends.

3.12 Transformer shall be equipped with oil fill, drain and sample valves.

3.13 Transformer shall be equipped with an oil level monitoring gauge with alarm contacts.

3.14 Transformer shall be equipped with a de-energized tap changer on the primary winding. The tap changer should be functional to -40°C ambient temperature operation. At minimum two taps above and two taps below at 2.5% increments shall be provided. All taps shall be full capacity.

3.15 Where Transformer connections are enclosed in junction boxes provide window for infrared thermography. Not applicable to pad-mount transformers.

3.16 Protection Requirements – Provide at minimum:

3.16.1 Primary and secondary overcurrent protection.

3.16.2 Winding temperature indicator with alarm and trip contacts.

3.16.3 Sudden pressure relay for sealed-tank design transformers.

3.16.4 Vacuum/pressure gauge for sealed-tank design transformers.

3.16.5 Provide differential protection for transformers as per Section 10.4.

3.17 Power transformers, >= 35 kV or >= 10 MVA:

3.17.1 Windings shall be disc type and not layer type.

3.17.2 Provide transformer demising partition walls between liquid-filled transformers that are in proximity to each other such as to affect the other during extreme events.

3.18 Provide a load-tap changer (LTC) where specified or required to provide acceptable voltage regulation.

3.19 Additional transformer protection is appropriate for many applications, especially for larger transformers. Apply protection in accordance with good engineering design practice.

4. Dry-Type Transformers

4.1 All indoor transformers shall be dry type unless otherwise specified or approved by the City.

4.2 Enclosure: NEMA 1 is typical. Specify NEMA 2 drip-proof or sprinkler-proof enclosure or NEMA 3R where required.

4.3 Efficiency in accordance with:

4.3.1 CSA C802.2 – Minimum Efficiency Values for Dry-Type Distribution Transformers

4.4 Ensure adequate space for ventilation is provided.

4.5 Provide at minimum two taps above and two taps below at 2.5% increments, full capacity.

4.6 Protection Requirements – Provide at minimum:

4.6.1 Primary and secondary overcurrent protection.

4.6.2 Winding temperature indicator with one probe in the center winding, with alarm and trip contacts for transformers >= 150 kVA.

4.6.3 For transformers >= 1000 kVA, provide a digital temperature monitoring unit with one probe in each winding, giving instantaneous temperature readings for each winding, average readings and maximum reading recorded. Unit shall provide three 120 Vac, 10 A, SPDT dry contacts for alarm and trip outputs. All contacts shall have an adjustable temperature setpoint.

4.7 Review the requirement for surge arrestors on the transformer primary terminals. Where applied, they shall comply with the requirements of Appendix B of CSA C9.

4.8 Review the requirement for K-rated transformers in harmonic environments.

4.9 Electrostatic shield between high voltage and low voltage windings, connected to the enclosure ground bar, except that the use of electrostatic shields shall be reviewed in high harmonic environments.

4.10 Ensure lifting hooks for lifting complete transformer assembly are provided.

4.11 Where required, neutral grounding resistors shall be made of stainless steel, completely protected by a hot dip galvanized enclosure, and mounted on top of the transformers.

4.12 The grounding resistors shall be insulated for the full line to line voltage and hot spot temperature rise, above 30°C ambient, shall be limited to 385°C for continuous rating, and 760°C for 1 minute rating, as per IEEE Standard No. 32.

4.13 Neutral connection shall be made with 2/0 AWG copper conductors (minimum), insulated for the transformer secondary line to line voltage. Colour of insulation shall be green.

4.14 Provision shall be made for field installation of NGR current transformer on live side of NGR.

4.15 Protection for three-phase delta-wye transformers:

4.15.1 Provide secondary overcurrent protection for all delta-wye transformer installations with a secondary breaker sized at 125% or less of the transformer full-load current. Note that secondary overload protection provides better delta-wye transformer protection than primary overload protection.

4.15.2 For primary voltages > 750 V, protection may be either by fuse or circuit breaker, as appropriate for the application.

a) Ensure appropriate protection is provided to address transformer inrush and potential short circuit currents.

b) Ensure selective coordination is provided.

c) Refer to Section 10.4 for other protection requirements.

4.15.3 For primary voltages < 750 V, provide primary overcurrent protection for all delta-wye transformer installations with a primary breaker sized between 150% and 300% of the transformer full-load current, taking into account:

4.15.3.1 Transformer inrush current

4.15.3.2 Selective coordination between upstream and downstream breakers.

4.15.3.3 Transformer short circuit protection.

6.12 Transient Voltage Surge Suppressors

1. Provide TVSS at each major point in the distribution connecting to load equipment. For example, all major MCCs should be equipped with a TVSS.
2. If TVSS units are utilized on resistance grounded systems, ensure that they are appropriately rated for potential overvoltages during a ground fault.

6.13 Unit Substations

1. The term “Unit Substation” shall be used to refer to a fully co-ordinated and pre-assembled power supply unit consisting of:

1.1 Primary switchgear; or feed through device with interrupting and isolating devices

1.2 Step-down transformer

1.3 Low voltage switchgear or cable termination compartment

1.4 All necessary instrument transformers, ground fault detection and protection devices, locally mounted.

2. All components of a unit substation shall be directly coupled and suitable for indoor use.

3. A feed through type switchgear or proper cable connection arrangement will be required if more than one unit substation will be connected from the same primary supply circuit (in daisy chain or loop configuration)
4. The low voltage section may be equipped for use as a single load feed or as a distribution board for multiple loads. Alternatively the low voltage switchgear required may be mounted within a short distance, in which case, a fully rated cable or bus-duct termination box shall be mounted directly on the secondary side of the transformer section.
5. The transformer section shall be fully enclosed and shall include all required instrument transformers, and monitoring devices pre-wired to the corresponding switchgear section or terminated in a separate junction box if external wiring is required.

6.14 Uninterruptible Power Supplies

There are many critical loads within water and wastewater facilities that require their power supply to remain available in the event of a utility power failure. Typically, an Uninterruptible Power Supply (UPS) is used to accomplish this.

6.14.1 Application Requirements

1. Uninterruptible power supplies are to be provided for process controls for all facilities. This shall be a dedicated UPS that does not serve other applications within the facility.
2. Uninterruptible power supplies may be utilized for provision of emergency lighting power where an emergency generator is not available or where no interruption of lighting is deemed to be acceptable, during the start of the generator.

6.14.2 Design Requirements

1. UPS Selection
   - 1.1 All AC UPS units shall be of the double-conversion (on-line) type.
   - 1.2 DC UPS units are acceptable for small loads, such as a single control panel. Required voltage is 24 VDC.
   - 1.3 In larger facilities, the UPS will be designed to be multiple standalone units. In these cases, UPS loads are distributed around the facility or process area and the UPS shall feed a standard panelboard for distribution of the UPS power.
2. Load Distribution
   - 2.1 Do not route UPS load cabling over long distances. Do not route parallel to other electrical cabling that could radiate harmonics or noise.
   - 2.2 Limit voltage drop from the UPS to the load to 3%.
   - 2.3 Provide selective coordination of the load breakers to the greatest extent possible. In some cases, this may require over-sizing the UPS.
   - 2.4 All load distribution wiring to be hard cabled. Where a UPS with hardwired connections is not available, a UPS with locking receptacles may be utilized. UPS units with non-locking receptacles are not permitted.
3. Bypass Requirements
   - 3.1 All 208/120 V UPS units shall be provided with an external maintenance bypass switch to allow for removal of the UPS unit.

6.14.3 Redundancy

1. UPS redundancy is typically only required for only the most critical loads. Note that paralleling UPS units to achieve a larger capacity does provide a level of redundancy.
2. Use of paralleled UPS units with a synchronized common distribution system is not a preferred redundancy solution, due to the following considerations:
   - 2.1 There are still single points of failure in the UPS load distribution system.
   - 2.2 Maintenance or modifications to the UPS load distribution system requires all UPS powered loads to be de-energized.
   - 2.3 If a common power source is provided to both UPS units, any maintenance or extended downtime on the upstream power supply for durations longer than the battery backup time would require that the UPS powered loads be de-energized.
3. If UPS redundancy is required, preferred solutions include:
   - 3.1 Distribution of critical loads across multiple UPS units such that a single UPS failure will not affect all critical loads. This is typically a good solution where parallel process trains are utilized.
   - 3.2 Utilizing load equipment that support multiple power supplies (dual corded equipment), such that each power supply can be connected to a different UPS.

6.14.4 Sizing Factors

1. The inverter must be capable of supplying power to the load under typical and peak conditions. Peak load inrush conditions are typical during equipment start-up, and can be significantly higher than the measured loads.
2. Other factors to be considered in sizing the UPS units are:
   - 2.1 Crest factor of the load. This accounts for the fact that switching mode power supplies may not draw current in a typical sinusoidal fashion, and that the peak cycle current may be significantly higher than the normal crest factor of 1.414 of a clean alternating current cycle. Utilize a crest factor of 2.4 in sizing of UPS units that primarily feed switching mode power supplies.
   - 2.2 Inrush of load transformers (on initial power-up). This inrush can be very high, and can potentially be addressed by starting the UPS up in bypass mode.
   - 2.3 Fault clearing capability of the UPS and its internal bypass line.
   - 2.4 Selective coordination of the upstream UPS protection and load circuit breakers.
   - 2.5 Whether the load is connected single or three-phase, and whether there is an isolation transformer present.
3. Include the following in battery runtime calculations:
   - 3.1 Age derating of the batteries. IEEE standards recommend replacing batteries when the measured capacity drops below 80%. Thus, it is recommended that the batteries are derated by 80% when determining the runtime of batteries, to account for end of life capacity.
   - 3.2 Include any losses in any isolation transformers that may be present.
   - 3.3 If there is potential for the UPS environment to become cold in the event of a power failure, it is recommended to de-rate the batteries by 80% to account for a reduced building temperature.
   - 3.4 Ensure that the rate of discharge is accounted for in the runtime calculations. Lead-acid battery capacity is dependent upon the discharge rate.

3.5 Provide a minimum of 20% spare capacity.

6.14.5 Battery Runtimes

Battery runtimes for each application shall be discussed with the City and documented. Minimum requirements are shown in Table 6-6.

Table 6-6 : Minimum UPS Runtime Requirements

Facility Type	Application	Standby Generator	Minimum Runtime (min)	Notes
Wastewater Lift Station	Control System	N	60	
		S	30	
		R	15	
Wastewater Flood Station	Control System	N	60	
Wastewater Treatment Facility	Control System	N	120	
		S	60	
		R	30	
Regional Water Pumping Stations	Control System	R	120	
Secondary Water Pumping Stations (Tache/Deacon)	Control System	N	600	
		S	60	
Water Treatment Plant	Control System	R	30	
Shoal Lake Aqueduct	Control System	S	720	Due to remote nature of facility.
Legend for Standby Generator Column: N No Standby Generation S Single Standby Generator or Generator System with No Redundancy R Standby Generation with Generator Redundancy				

6.14.6 Other Design Requirements

1. Power Supply
   1.1 Where a standby generator is available, the UPS power supply shall be powered from the standby generator.
   1.2 Address the potential harmonics associated with the UPS input current, and the associated effect on standby generators.
2. Location
   2.1 Locate all UPS units above grade.
3. Environmental
   3.1 The optimum temperature for UPS batteries is 22°C + /- 5°C, and it should be noted that the temperature inside the UPS battery module/cabinet, may be higher than the

typical room temperature. This is not expected to be a significant issue for the installations present. The optimum relative humidity is 35 to 55%.

4. Ventilation

4.1 Lead-acid batteries produce hydrogen gas. Valve Regulated Lead Acid (VRLA) batteries are sealed, such that the hydrogen gas recombines into water inside the battery. However, under certain fault conditions, the hydrogen gas may build up faster than it can be recombined, and a safety valve opens to vent the excess hydrogen. For most UPS installations with VRLA batteries, normal building ventilation rates are typically above that required to disperse the hydrogen gas of VRLA batteries. However, if the UPS batteries are contained within a small room or enclosure, review of the required ventilation is required.

6.15 Variable Frequency Drives

6.15.1 General

1. Voltage of VFD drives shall be as per Table 6-7.

Table 6-7 : VFD Voltage and Type Requirements

Motor Power	**Maximum Motor / VFD Voltage**	**Minimum VFD Pulse** (See Note 1)	**Notes**
< 224 kW (300 hp)	600 V 3Ø	6	Small motors < 0.37 kW may be 120 V 1Ø
>= 224 kW (300 hp) and < 261 kW (350 hp)	600 V 3Ø or 4160 V 3Ø	12	Dependant on application
> 261 kW (350 hp)	4160 V 3Ø	24	

Notes:

1. The minimum VFD pulse does not eliminate the requirement to meet Section 3.10 regarding harmonics, which may require a higher pulse count VFD.
2. Limit the length of VFD driven motor cables in accordance with Table 6-8.

Table 6-8 : Maximum VFD Motor Cable Length

Motor Power	Maximum Motor / VFD Voltage	Maximum Length		
		Normal Cases	Abnormal Cases (See Note 2)	Special Case With City Approval (See Note 3)
< 224 kW (300 hp)	600 V 3Ø	100 m	150 m	200 m
>= 224 kW (300 hp) and < 261 kW (350 hp)	600 V 3Ø or 4160 V 3Ø	80 m	100 m	125 m
> 261 kW (350 hp)	4160 V 3Ø	75 m	100 m	125 m

Notes:

1. Do not assume that no harmonic or voltage mitigation is required for VFD motor cables less than or up to the indicated maximum length.
2. The length indicated for abnormal cases shall only be utilized for a limited number of motors where other practical alternatives do not exist. For example, a single VFD driven motor in a remote location could be classified as an abnormal case; however, a set of six 200 hp process pumps 145 m away from an electrical room would not be an abnormal case.
3. Special City approval shall only be utilized where it is demonstrated and clear that alternatives are not economically viable from a lifecycle cost alternative, and all appropriate filtering and other mitigation to address the long length is implemented.

6.15.2 Medium Voltage (4160 V) VFD Requirements

1. The VFD rated output current should exceed the motor nameplate current, irrespective of the motor power and VFD power ratings not being matched.
2. Short circuit withstand rating based on fault level calculations at the point of connections.
3. Use surge arrestors at line terminals if VFD BIL rating is inadequate to meet system BIL requirements.
4. The VFD shall be minimum 24 pulse or optionally utilize an active front end.
5. The VFD controller shall be rated and designed for starting method to be compatible with motor starting characteristics. Motor RPM encoder is not required.
6. VFD shall be programmable for V/F as well as sensorless vector control in the field. User can choose either based on field conditions.
7. The VFD shall comply with IEEE-519 harmonic requirements at its Line terminals.
8. The VFD shall be equipped with a network communication interface to convey status monitoring and control commands from external Control system.
9. All VFD power control components shall be CSA approved or cUL listed. IEC components are not acceptable.

10. Use integral primary isolation transformer to reduce short circuit fault levels on the VFD side, and also to reduce the Common Mode Voltages developed in the Inverter Bridge.

11. The VFD inverter shall be minimum three levels, and shall use Pulse width modulation (PWM) technique for voltage synthesis.

12. The system designer in coordination with the manufacturer is to review potential resonance effects and address any issues at design time.

6.15.3 Low Voltage (600 V) VFD Requirements

2. Select the VFD manufacturer based upon the City's standard, for motors rated less than 75 kW (< 100 hp). Specialized applications may deviate from this standard.

3. Adequate cooling shall be provided by integral fans or enclosure mounted fans to transfer the heat from the VFD to outside. A heat loading calculation shall be performed for all custom panels.

1. Confirm that the building ventilation and cooling is adequate for the VFD heat loading.

2. Ensure that corrosive gases are not present in the VFD cooling air.

3. The system designer must review the harmonic impact of the VFD on the power supply.

4. At a minimum, utilize a line reactor on the line side of all VFDs to reduce inrush currents and the level of harmonics. Line reactors can also protect the VFD against some power line disturbances. The selection of the appropriate reactor is to be based upon harmonics and voltage analysis.

    4.1 Line reactors shall be provided for all VFDs, regardless of size, unless it can be clearly demonstrated that they do not provide a benefit and approval of the City is provided.

5. Load reactors are utilized to protect the motor if the wiring distance between the VFD and motor is long.

    5.1 The appropriate selection of an appropriate load reactor is beyond the scope of this guide, and the application details should be reviewed in each case, however the following is provided as "rule-of-thumb" general guidance:

        a) Load reactors are recommended for motors greater than 37 kW (50 hp) to reduce motor temperatures and increase motor life.

        b) Load reactors are recommended when motor leads exceed 30m.

        c) Load reactors are mandatory when motor leads exceed 100m.

        d) Filters (dv/dt) are required when motor leads exceed 150m.

6. Utilize inverter rated cabling for all six-pulse VFD load cabling, with three copper grounding conductors, 1000 V rated insulation, continuous copper tape shield with 50% overlap or continuous (non-interlocked) aluminum armour, and approved for six-pulse VFD use.

6.15.4 Bypass Starters

1. 60Hz AC operation with Across the Line (ATL) motor starting method to be used for very critical pumping loads required to be kept in operation upon a failure of the main motor controller.

2. Ensure that the mechanical equipment and power system can handle the hard across the line start method via the bypass starter. If this is not technically feasible then a Reduced Voltage bypass starter or a soft-start bypass starter may be utilized instead of the conventional ATL bypass starter.

3. The bypass starter shall be equipped with its own motor protection relay as the motor protections inside VFD would be unavailable.
4. The bypass starter components shall be NEMA rated. IEC components are not acceptable.
5. The bypass starter shall be interlocked with the VFD such that at any time only one can operate.
6. A zero speed switch or a suitable time delay relay will be used to prevent a bypass starter from closing power on a rotating motor.
7. Provide isolation disconnects / and contactors on VFD load side to prevent power back-feed into the VFD inverter module when the VFD is not running.
8. Bypass mode is to be selected via a door-mounted two-position selector switch.

6.15.5 Supervisory Monitoring and Control

1. VFD operating modes and status signals are to be monitored by the automation system and displayed on the HMI. Typical monitored points include:
   - 1.1 Ready Status
   - 1.2 Running Status
   - 1.3 VFD Fault Status
   - 1.4 Bypass Starter O/L Trip Status (if applicable)
   - 1.5 VFD/Bypass Mode, monitored directly from the selector switch (if applicable)
   - 1.6 Auto/Manual Mode, monitored directly from the selector switch
   - 1.7 Motor Current
2. The VFD/Bypass mode is typically controlled via a door-mounted selector switch on the VFD panel. However, for critical applications where maintenance personnel are not able to reach the facility in a reasonable amount of time, selection of the Bypass mode may be made from the HMI system.
3. Fault signals should be wired to a non-fail safe contact (normally open, closed upon a fault condition) to avoid fault alarms from appearing on the HMI when the VFD is disconnected from the power source for maintenance purposes.

6.15.6 Functional Requirements

1. Wastewater Pumping (Lift) Stations
   - 1.1 VFDs used in wastewater pumping (lift) stations should operate such that upon a start command, the VFD ramps up from zero speed to a minimum operating speed, which corresponds with the minimum scouring velocity of the force main. After reaching minimum speed, the speed command to the VFD can be PID controlled to maintain the setpoint level in the wet well. The VFD shall not be allowed to operate below the minimum operating speed; otherwise solids will settle out of the wastewater, which may plug the force main over time. Upon receiving a stop signal, the VFD shall ramp down in speed, rather than coast, to reduce equipment and pipe stresses.
   - 1.2 Typical lift stations contain multiple pumps that discharge to a common header or force main. When multiple VFD driven pumps are in operation at one time, the commanded speed to all of the pumps is to be identical, provided the pumps are matched. If one of several pumps is operating in bypass mode (and therefore running at full speed) then the other VFDs shall be commanded to run at full speed when they are called to start.

1.3 Provide local manual speed control by means of a door-mounted potentiometer on the VFD panel.

7 MOTORS

7.1 General Requirements

1. General Requirements for all motors
   1.1 All motors are to have a service factor of 1.15 under normal full voltage operation.
   1.2 Operating Temp Class B (130°C)
   1.3 Insulation Class F
   1.4 Terminal boxes rated NEMA 4.
   1.5 Motors must meet or exceed the efficiencies outlined in either Table 2 (energy efficient) or Table 3 (premium efficiency) of CAN/CSA C390-10, depending on their design.
2. General Duty motors for non-process equipment are to have the following requirements:
   2.1 TEFC enclosures.
3. Process motor requirements include:
   3.1 TEFC enclosures.
   3.2 Suitable for moist and corrosive locations.
4. Motors for use with a variable frequency drive:
   4.1 TEFC enclosures.
   4.2 Suitable for moist and corrosive locations.
   4.3 Inverter duty rated, in conformance with NEMA MG1.
   4.4 Ensure that the driven load is not rated at more than 85% of the motor's effective service rating.
   4.5 Ensure motors have adequate cooling over the operating speed range.
   4.6 Motors larger than 150 kW (200 hp) shall have an insulated bearing on the non-driven end (NDE) when driven by VFD.
5. Explosion-proof motor requirements include:
   5.1 Rated for Class I, Zone 1 (or Div. 1) as applicable.
   5.2 Provide an approved breather / drain device at the motor drain hole.

7.2 Motor Voltage Levels

1. The acceptable motor power for each voltage level is shown in Table 7-1.

Table 7-1 : Acceptable Motor Voltage Levels

System Voltage Level	Motor Voltage Level	Minimum	Preferred Low	Preferred High	Maximum
120 V 1Ø	115 V 1Ø	-	-	0.37 kW (½ hp)	3.7 kW (5 hp)
240 V 1Ø	230 V 1Ø	-	-	0.37 kW (½ hp)	7.5 kW (10 hp)
208 V 3Ø	200 V 3Ø	-	-	0.75 kW (1 hp)	37 kW (50 hp)
600 V 3Ø	575 V 3Ø	-	0.37 kW (½ hp)	261 kW (350 hp)	556 kW (750 hp)
4160 V 3Ø	4000 V 3Ø	75 kW (100 hp)	261 kW (350 hp)	1492 kW (2000 hp)	5595 kW (7500 hp)

Notes:

1. For motor sizes outside of the preferred ranges the designer shall submit to the City a clear rationale, with analysis as appropriate, justifying the deviation from the preferred range.
2. Motor sizes outside of the preferred ranges require specific acceptance by the City.
2. Three-phase motors are preferred over single-phase motors.
3. Utilize higher voltage motors where the higher voltage is available.

7.3 Special Requirements

1. The use of oversized terminal boxes is desirable. Size of power cable will have an influence on the size of the terminal box and must be taken into account. Terminal boxes must be accessible for the connection and disconnection of motors without dismantling or removing nearby equipment.
2. Motor winding temperature protection should generally be provided for motors 75 kW (100 hp) and above. Provide RTD Winding Temperature Detectors embedded in the stator for motors above 150 kW (200 hp). Provide a dedicated terminal box separate from the motor box for termination of the RTD leads. Motors less than 150 kW (200 hp) may utilize thermistors.
3. Specify motors equipped with anti-condensation heaters in the following cases:
   3.1 Medium voltage motors
   3.2 Low voltage motor above 37 kW (50 hp), where the motors could potentially not be operating for a significant period of time in an area with high humidity.

7.4 Acceptable Methods of Control

1. The following methods of control are deemed to be acceptable, as per application requirements. Other methods of control require specific approval of the City.
   - 1.1 Full Voltage Direct On Line (DOL) - Fixed speed
   - 1.2 Soft Start – Fixed speed
   - 1.3 Variable Frequency Drive (VFD) – Variable speed
   - 1.4 DC Electrically Commutated.
2. The use of magnetic couplings or eddy current drives may be acceptable for certain applications where the variable speed requirements are limited (~85% - 100% speed). Review would be required on a case-by-case basis.
3. Contactors
   - 3.1 All full voltage motor starter contactors shall be NEMA rated contactors.
   - 3.2 NEMA labelled IEC style contactors are acceptable for most applications.
   - 3.3 IEC style contactors are permitted for the following applications:
     - a) Soft starter isolation contactors.
     - b) Soft starter bypass contactors provided the bypass contactor is not utilized for full voltage starting.
   - 3.4 For applications in wastewater collections, wastewater flood pumping, or land drainage, where IEC contactors are utilized for bypass or isolation purposes, they shall, at minimum, be sized as follows:
     - a) One size larger than required, or
     - b) 125% of FLA.
4. Typical special motor control requirements are as per Table 7-2; however the control of each motor shall be reviewed in light of the specific application requirements.
5. Most wastewater flood pumping stations have a special requirement in that the motors cannot be tested at full speed during a non-flood event as this would pump wastewater to the river. Thus, all applications where full speed testing cannot be performed must have a slow speed jog capability. The Allen-Bradley SMC-Flex series of soft starter is known to have this capability.

Table 7-2 : Typical Special Motor Control Requirements

Facility Type	Equipment	Rating	Motor Control
Underpass Pumping Station	Lift Pump – Single Speed	>= 18.7 kW (25 hp)	Soft Starter
Wastewater Lift Pumping Stations	Wastewater Lift Pumps – Single Speed	< 18.7 kW (25 hp)	Full Voltage Starter
		>= 18.7 kW (25 hp)	Soft Starter with isolation contactors and bypass starter
	Wastewater Lift Pumps – Variable Speed	Any	VFD with isolation contactors and bypass starter
Wastewater Flood Pumping Stations	Flood Pumps – Single Speed	>= 18.7 kW (25 hp)	Soft starter with bypass contactor (internal or external) and upstream isolation contactor.

7.5 Control Circuits

7.5.1 Motor Restart Control

Motor control circuits are to be designed to have anti-restart prevention, to prevent or delay automatic immediate restart after a stop or power failure situation. The purpose is to prevent restart of the motor while residual voltage could still be present in the motor. For motors 75 kW (100 hp) or greater, provide motor restart prevention. As per NEMA MG1 guidelines, motor restart shall be prevented until 1.5x the motor open circuit time constant. The delay could potentially be accomplished via a three-wire control (stop/start) control arrangement, timers to delay restart, or potentially an undervoltage relay with a restart time.

7.6 General Protection Requirements

1. The typical protection requirements for various applications are identified in Table 7-3. Note that the below is a general guide, and additional protection requirements may be required for specific applications. See Section 7.7 for some special protection requirements.

Table 7-3 : Typical Motor Protection Requirements

Application	Rating	Protection
600 V motors, single speed, general service	< 75 kW (100 hp)	Electronic Overload
	>= 75 kW (100 hp) < 187 kW (250 hp)	Overload Overcurrent Locked Rotor Ground Fault (zero-sequence CT) Winding Temperature (Thermistor or RTD)
	> 187 kW (250 hp)	Overload Overcurrent Locked Rotor Ground Fault (zero-sequence CT) Winding Temperature (RTD)
600 V motors, single speed, critical service	< 37 kW (50 hp)	Electronic Overload
	>= 37 kW (50 hp) < 75 kW (100 hp)	Electronic Overload Winding Temperature (Thermistor or RTD) Ground Fault (zero-sequence CT)
	>= 75 kW (100 hp) < 187 kW (250 hp)	Overload Overcurrent Locked Rotor Ground Fault (zero-sequence CT) Winding Temperature (RTD)
	>= 187 kW (250 hp)	Overload Overcurrent Locked Rotor Ground Fault (zero-sequence CT) Winding Temperature (RTD) Bearing Temperature
600 V motors, VFD driven	< 37 kW (50 hp)	Standard VFD protection
	>= 37 kW (50 hp) < 75 kW (100 hp)	Standard VFD protection Winding Temperature (Thermistor - PTC)
	>= 75 kW (100 hp) < 187 kW (250 hp)	Standard VFD protection Winding Temperature (RTD)
	>= 187 kW (250 hp)	Standard VFD protection Winding Temperature (RTD) Bearing Temperature

Application	Rating	Protection
Medium Voltage Motor	<= 746 kW (1000 hp) See Note 1	Overload Overcurrent Locked Rotor Ground Fault (zero-sequence CT) Phase Balance Undervoltage Winding Temperature (RTD) Bearing Vibration Bearing Temperature

Notes:

1. Medium Voltage motors greater than 746 kW will require, at minimum, the protection indicated, but in addition, shall be provided with additional protection as appropriate and in accordance with good industry practice.
2. Where bearing vibration and temperature sensors are required, they are required for each bearing.
3. Where PTC winding temperature is required, one detector shall be provided per phase.
4. Where RTD winding temperature is required, two RTDs are to be provided per phase.

7.7 Special Protection Requirements

Special motor protection requirements for specific applications are identified in Table 7-4. Note that the table is not comprehensive and a review of the protection requirements for special applications is required on a case by case basis. Special protection requirements are in addition to standard protection requirements discussed in Section 7.6.

Table 7-4 : Special Motor Protection Requirements (Minimum)

Application	Rating	Protection
Submersible Pumps – Process Applications	> 2.2 kW (3 hp)	Humidity / leak
	> 7.5 kW (10 hp)	Humidity / leak Winding Temperature (switch)
	>= 75 kW (100 hp)	Humidity / leak (in applicable compartments such as connection housing / stator / oil) Winding Temperature (RTD) Bearing Temperature
	>= 186 kW (250 hp)	Humidity / leak (in applicable compartments such as connection housing / stator / oil) Winding Temperature (RTD) Bearing Temperature Bearing vibration

7.8 Local Controls

The following are standard minimum requirements, and shall be augmented as required by the application.

7.8.1 Wastewater Collections & Land Drainage Facilities

1. Motor Driven Equipment – Single Speed
   1.1 Small motors (Not pumps)
      a) Install a *Hand-Off-Auto* (HOA) or *On-Off* switch and a green *Running* pilot light at the MCC/Starter, as appropriate.
   1.2 Pump motors (< 37 kW (50 hp))
      a) At the MCC/Starter, provide:
         i. A *Hand-Off-Auto* (HOA) switch
         ii. A blue *Ready* pilot light to indicate the motor is ready to run.
         iii. A green Running pilot light to indicate the motor is running.
      b) Install an E-Stop mushroom pushbutton at the starter, pump and motor levels. Provide a Reset pushbutton to allow the pump to restart.
   1.3 Pump motors (>= 37 kW (50 hp))
      a) At the MCC/Starter, provide:
         i. A Manual-Auto (M-A) and Start-Stop buttons
         ii. A blue Ready pilot light to indicate the motor is ready to run.
         iii. A green Running pilot light to indicate the motor is running.
      b) Install an *E-Stop* mushroom pushbutton at the starter, pump and motor levels. Provide a *Reset* pushbutton to allow the pump to restart.
   1.4 In addition, if a soft starter and bypass starter are provided
      a) Install a *Soft Start / Bypass* switch at the starter.
2. Motor Driven Equipment - VFD Drive
   2.1 Pump motors (< 37 kW (50 hp))
      a) At the VFD starter, provide:
         i. A HOA switch.
         ii. A manual speed potentiometer to be utilized in Hand mode.
         iii. A blue Ready pilot light to indicate the motor is ready to run.
         iv. A green Running pilot light to indicate the motor is running.
      b) Install an *E-Stop* mushroom pushbutton at the starter, pump and motor levels. Provide a *Reset* pushbutton to allow the pump to restart.
   2.2 Pump motors (>= 37 kW (50 hp))
      a) At the VFD starter, provide:
         i. A *Manual-Auto* (M-A) and *Start-Stop* buttons
         ii. Install a manual speed potentiometer to be utilized in *Manual* mode.
         iii. A blue *Ready* pilot light to indicate the motor is ready to run.
         iv. A green *Running* pilot light to indicate the motor is running.
      b) Install an *E-Stop* mushroom pushbutton at the starter, pump and motor levels. Provide a *Reset* pushbutton to allow the pump to restart.
   2.3 In addition, if a bypass starter is provided:

a) Install a *VFD / Bypass* switch at the VFD starter.

Notes:

1. For motors > 50 hp, momentary start / stop is provided to ensure motor does not restart after brief power interruption, as is possible if a Hand position is provided.
2. Use of Lock-Off-Stop switches will not be permitted as they imply lock-off capability for the equipment, but are not suitable for use as a disconnecting means.
3. Additional safety controls may be required for equipment with safety requirements. An emergency-stop switch shall be a minimum requirement when there is a potential safety risk.

7.8.2 Wastewater Treatment Plants

1. Small motors (<= 19 kW (25 hp))
   1.1 At the MCC/Starter/VFD, provide:
      a) A *Hand-Off-Remote* (HOR) switch.
      b) A green *Running* pilot light to indicate the motor is running.
2. Motors (>19 kW (25 hp) and < 37 kW (50 hp)), standby operation
   2.1 At the MCC/Starter/VFD, provide:
      a) A *Local-Off-Remote* (LOR) switch and *Start-Stop* pushbuttons.
      b) A green *Running* pilot light to indicate the motor is running.
3. Medium size and larger motors (>= 37 kW (50 hp))
   3.1 At the MCC/Starter/VFD, provide:
      a) A *Local/Off/Remote* (LOR) and *Start-Stop* pushbuttons.
      b) A green *Running* pilot light to indicate the motor is running.
   3.2 Provide a dedicated local e-stop near the equipment.

Notes:

1. For motors >= 19 kW (25 hp), momentary Start / Stop provided to ensure motor does not restart after brief power interruption, as is possible if a Hand position is provided. This is both for motor protection in the event of a very brief interruption and for reduction of potential load on a centralized standby generator.
2. Use of Lock-Off-Stop switches shall not be permitted as they imply lock-off capability for the equipment, but are not suitable for use as a disconnecting means. Existing Lock-Off-Stop switches can be maintained, provided that no significant modifications are made to the motor control circuit.
3. Additional safety controls may be required for equipment with safety requirements. An emergency-stop switch shall be a minimum requirement for equipment with a safety risk.
4. Where an Emergency Stop pushbutton is provided together with local control, the equipment shall utilize a Local / Off / Remote set of control modes, with separate Start and Stop pushbuttons. Equipment shall not restart automatically upon the Emergency Stop pushbutton being released, but rather require a separate restart action from either a local Start/Reset pushbutton or a start or reset action from the HMI.

7.9 Local Disconnect Switches

The following are standard minimum requirements, and shall be augmented as required by the application.

7.9.1 Wastewater Collections & Land Drainage Facilities

Local disconnect switches are not typically required within these facilities, due to the limited number of loads and small size of the facilities. However, local disconnect switches should be provided where the upstream equipment lockout procedure would expose personnel to a significant arc flash hazard.

7.9.2 Wastewater Treatment Plants

1. Small motors (< 37 kW (50 hp))
   - 1.1 Non-hazardous / non-corrosive location:
     - a) Install a local disconnect switch at the motor.
   - 1.2 Hazardous / corrosive location:
     - a) Local disconnect switches will not typically be provided unless maintenance disconnect requirements are very frequent (more than weekly). See Note 2.
2. Medium size and larger motors (>= 37 kW (50 hp))
   - 2.1 Local disconnect switches will not typically be provided unless maintenance disconnect requirements are very frequent (more than weekly)
3. Where a local disconnect switch is installed, provide an early-break auxiliary contact from the disconnect switch to provide indication when the motor disconnect is open for the following cases:
   - 3.1 VFD driven equipment; or
   - 3.2 Equipment that is utilized for standby operation and is critical to start when required.
4. Where a motor starter is local to the motor the disconnect may be included as part of the motor starter.
5. Hasps on 120 V panelboard breakers are not acceptable disconnecting means for motors.

Notes:

1. For all disconnect switch applications, ensure that the disconnect SCCR is appropriate for the application. Where the SCCR is higher than the typical disconnect switch capability, a case may be made for omission of the disconnect switch provided that the maintenance requirements are not excessive. Fuse-based disconnects to obtain a higher SCCR may only be utilized where deemed absolutely necessary.
2. Local disconnect switches should also be provided where the upstream equipment lockout procedure would expose personnel to a significant arc flash hazard.

7.10 Emergency Stop Systems

Where emergency stop systems are implemented, they shall comply with CSA Z432 Clause 6.2.5.2.2 which states:

6.2.5.2.2 Effects of emergency stop and reset commands

> *Once active operation of the emergency stop device has ceased following an emergency stop command, the effect of this command shall be sustained until the device is reset. This reset shall be possible only at that location where the emergency stop command has been initiated. The reset of the command shall not restart the machinery but shall only permit restarting.*

This requires a *Reset* or *Power On* pushbutton to allow the restarting of equipment after an e-stop has been reset. Within the Water and Waste Department, most equipment runs unattended 24 hours a day, with automatic controls. Thus, typical implementation requirements of an e-stop system include the following:

1. Provide a reset button on the motor starter (or control panel) to latch in a ready coil after an e-stop. Alternately, the function could be written in PLC logic, if appropriate for the application.
2. Ensure that systems where continuous unattended operation is required will appropriately restart after a power failure. This may require an automatic reset of the e-stop system after a power failure.

Some e-stop applications require a higher level of safety reliability as per the ISA-84 series of standards. Applications where equipment is not fully guarded, such as open conveyors, are one example where additional requirements apply.

8 EQUIPMENT APPLICATION REQUIREMENTS

8.1 HVAC Equipment

1. Air Handling Units

1.1 Natural Gas Fired Air Handlers:

1.1.1 On-Off (non-variable speed) applications may have the motor starter included as part of the natural gas-fired package system.

1.1.2 Variable speed applications:

1.1.2.1 AHU's located on the roof shall have the VFD located in the electrical room.

1.1.2.2 AHU's located in a location with potential corrosive or explosive gases shall have the VFD located in the electrical room.

1.1.2.3 Where the AHU is not on the roof and it is not in a location with potential explosive or corrosive gases, the VFD may be located in the electrical room, adjacent to the AHU in a separate enclosure, or as part of the AHU cabinet. The VFD may be packaged with the AHU; however, all other requirements associated with VFDs still apply. Ensure that the VFD display is easily accessible.

1.2 Hydronic or Electric Heater Air Handlers:

1.2.1.1 AHU's located on the roof shall have the VFD / motor starter located in the electrical room.

1.2.1.2 AHU's located in a location with potential corrosive or explosive gases shall have the VFD / motor starter located in the electrical room.

1.2.1.3 Where the AHU is not on the roof and it is not in a location with potential explosive or corrosive gases, the VFD / motor starter may be located in either the electrical room or in an enclosure adjacent to the AHU. Packaging of the AHU motor control with the AHU is not acceptable.

2. Exhaust Fans

2.1 Motor starters and VFDs for process exhaust fans shall always be located in electrical rooms.

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9 POWER SYSTEM MONITORING

9.1 Pilot Lights

1. Where pilot lights are utilized, the colour convention shall be as per Table 9-1.

Table 9-1 : Pilot Light Colors

Function	Wastewater	Water	Notes
Alarm / Warning – Priority 1 - Process	Red	Amber	
Alarm / Warning – Priority 1 - Electrical System	Amber	Amber	See Note 3
Alarm / Warning – Not Priority 1	Amber	Amber	
Circuit De-energized	Red	Green	
Circuit Energized	Green	Red	
Miscellaneous Status	Blue	Blue	
Motor Not Running	Blue	Green	Not Normally Provided
Motor Running	Green	Red	
Switch / Breaker Closed	Green	Red	
Switch / Breaker Open	Red	Green	
Warning	Amber	Amber	

Notes:

1. The colours for the wastewater system have been selected from an operations perspective. The colour red indicates an abnormal situation that requires attention, while the colour green indicates that equipment / power is in a normal condition. It is noted that these colors are different than much of the electrical industry and thus appropriate labelling and training is required.
2. Many existing systems within the wastewater facilities currently are based upon the colors indicated in the Water column.
3. The alarm / warning – Priority 1 color for electrical systems in wastewater facilities has been selected to be amber to avoid conflict with the switch / breaker closed status indication.

9.2 Power Meter Requirements

1. Multifunction power meters shall be provided as per Table 9-2.
2. Enhanced power meter requirements shall include:
    - 2.1 Local display for all measurements.
    - 2.2 Functional Requirements:
        - a) Volts, Amps, kW, kVAR, PF, kVA (per phase)
        - b) Frequency, kWh, kVAh, kVARh
        - c) Minimum 17 μs transient detection
        - d) Sampling rate of 1024 samples/cycle or better

2.3 Measurement Accuracy:

a) Power Class A monitor conforming to IEC 61000-4-30

b) 0.2% energy

c) 0.1% current

d) 0.1% voltage

e) Voltage and current harmonics measurement, individual, even, and odd, up to 63rd, %THD (Total Harmonic Distortion) Monitoring for voltage and current per phase.

f) Min / Max recording capability

2.4 The meter shall have an accuracy of +/- 0.5% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (class 0.5%) and ANSI C12.20 (Class 0.2%).

2.5 The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.

2.6 Ethernet Modbus TCP Communication capability, interconnected with the Ethernet Control Network, for communicating with the control system.

3. Basic power meter requirements shall include:

3.1 Local display for all measurements.

3.2 Functional Requirements:

a) Volts, Amps, kW, kVAR, PF, kVA

b) Frequency, kWh, kVAh, kVARh

c) % THD (Total Harmonic Distortion) Monitoring for voltage

d) Min / Max recording capability

3.3 The meter shall have an accuracy of +/- 0.5% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (class 0.5%) and ANSI C12.20 (Class 0.2%).

3.4 The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.

4. All power meters in wastewater treatment facilities shall be Schneider Electric.

5. Ensure the metering system is not dependent on power from the metered circuit for its operation. The power supply for the power meter shall be powered by a battery-backed power source, which ensures operation when the metered circuit is de-energized.

Table 9-2 : Power Meter Requirements

Facility Type	Equipment	Advanced	Intermediate	Basic	Enhanced
All	Medium voltage main breakers - utility service	X			
	Medium voltage main breakers - not utility service		X		X
	Medium voltage feeder breakers.		X		X
	Medium voltage main switches of fused gear, unless the equivalent current reading can be provided by upstream feeders.		X		
	600 V switchgear main breakers.		X		X
	600 V switchgear feeder breakers rated 500 A or greater, where there is no downstream power meter. Note that power meters at the load are preferred in this case for accurate load voltage measurements.			X	X
	600 V distribution panelboards rated 1000 A or greater.				X
	600 V distribution panelboards rated 400 A – 800 A or less than 400 A, but fed from a utility transformer or a transformer with a medium voltage primary.			X	
	MCCs with a connected load of 600 A or greater.				X
	MCCs with a connected load of 250 A – 599 A or less than 250 A, but fed from a utility transformer or a transformer with a medium voltage primary.			X	
	Essential Power System – Main breaker / Distribution rated >= 500 kW				X
	Essential Power System – Main breaker / Distribution rated >= 100 kW and < 500 kW			X	

Facility Type	Equipment	Advanced	Intermediate	Basic	Enhanced
	Essential Power System – 600 V distribution panelboards with a demand load of 200 A or greater.			X	
	Essential Power System – MCC with demand load of 100 A – 599 A			X	
	Generator – Medium Voltage	X			
	Generator – 600 V		X		

9.3 HMI / SCADA Monitoring and Control Requirements

1. All enhanced power meters, as per Section 9.2 shall be connected to the HMI / SCADA system via a network connection.

   1.1 All key values including phase voltages, phase currents, kW, kVAR, PF, kVA and THD shall be available from the HMI, logged to the historian, and made available via trending.

2. Additional HMI / SCADA monitoring and control requirements of the electrical distribution system shall be provided as per Table 9-3.

3. The PLC / DCS shall have one or more power fail status inputs from the power distribution system.

   3.1 Ensure appropriate power fail status inputs are provided to allow for effective implementation of required control strategies.

   3.2 Network power meter connections shall not be relied upon for power fail status in control systems, where real-time control associated with the power status is required. Power meter response time of the network has in the past been demonstrated to cause issues in control logic applications.

   3.3 Sufficient power fail status input shall be provided to allow a reasonable representation of power availability to controlled motor loads.

Table 9-3 : Electrical Power System Monitoring and Control Minimum Requirements

Item	Monitoring	Control
Automatic Transfer Switch	Normal Position Emergency Position Common Fault	N/A
Breaker – High Voltage	Closed Status Open Status Breaker / Relay Fail Status Local Status (Local/Remote) Remote Status (Local/Remote)	Close Command Open Command
Disconnect Switch – High Voltage, non-motorized	Closed Status Open Status	
Breaker – Medium Voltage	Closed Status Open Status Breaker Rack Position Status Breaker / Relay Fail Status Control Power Fail (may be included in Fail status) Local Status (Local/Remote) Remote Status (Local/Remote)	Close Command Open Command
Disconnect Switch – Medium Voltage	Closed Status Open Status	
Breaker – 600 V >= 2000A	Breaker Closed Status Breaker Open Status	Close Command Open Command
Breaker – 600 V >= 600 A	Breaker Closed Status Breaker Open Status	As required for load shedding strategy implementation.
Breaker – 600 V < 600 A	As required for load shedding strategy implementation.	As required for load shedding strategy implementation.
Capacitor / Power Factor Correction Bank	Alarm / Trouble	N/A
Neutral Grounding Resistor	Ground Fault Alarm	N/A
Motor Control Centre – General (specific requirements apply to MCC components)	Power Fail Status	N/A
Protection Relay – Medium Voltage	Alarm Trip Fail	N/A
Standby Generator	Auto / Manual Status or Local / Remote Status as applicable Run Trouble Failure	Full Control

Item	Monitoring	Control
Switchgear Battery System	AC Power Fail DC Power Fail Charging System Fail High VDC Low VDC Positive Ground Fault Negative Ground Fault	N/A
Transformers >= 1000 kVA	Temperature Alarm Requirements of Section 6.11	
Transformers >= 300 kVA	Temperature Alarm Requirements of Section 6.11	
TVSS	Status/Fault	
UPS	Battery Low Fault	

9.3.2 Additional Requirements for Wastewater Lift Stations

1. Provide voltage and phase loss monitoring for all incoming power distribution (600 V).
2. Provide 120 VAC power failure monitoring for all 120 VAC distribution systems.

9.3.3 Additional Requirements for Wastewater Flood Stations

1. Provide voltage and phase loss monitoring for all incoming power distribution (600 V).
2. Provide 120 VAC power failure monitoring for all 120 VAC distribution systems.

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10 PROTECTION

10.1 General

1. Design protection equipment so that the initial electrical installation, and future additions and modifications to the installation will be protected and fully coordinated, meaning that in the event of a fault or overload, protective devices will act to isolate only the faulty portion of the system and areas downstream, leaving all other portions of the system fully operational.
2. Ensure protection adequately protect against injury to persons and damage to property.

10.2 Instrument Transformers

1. Current transformer circuits shall be grounded on the secondary side.
2. Provide test blocks for all CT circuits.
3. Test blocks are not required on PT circuits. Potential transformer circuits shall be grounded on the secondary side.
4. Current transformer calculations shall be based on IEEE C.37.110 “Guide for the Application of Current Transformers Used for Protective Relaying Purposes” and take into account expected loading, short circuit levels, X/R values, and protective relaying burdens with a minimum thermal rating of 2.0..

~~5.~~ Current transformers for medium voltage switchgear feeders shall be multi-ratio CTs.

10.3 Protection for Distribution <= 600 V

10.3.1 Circuit Breakers

1. Circuit breakers are required for 600 V distribution and below.
2. Ensure that circuit breakers are rated for the design SCCR at the specific point in the distribution.
3. Series breaker ratings are not permitted for the purpose of reducing the SCCR of downstream circuit breakers. All exceptions shall be accepted by the City~~,~~ Ensure that the breakers selected provide selective coordination to the greatest extent possible. LS, LSI, and LSIG breakers shall be specified where required to achieve selective coordination. This may require the use of larger frame circuit breakers to achieve the required coordination.
4. Without limiting other requirements of this section, at a minimum:
   - 4.1 For breakers rated 600 A or greater, provide LSI or LSIG breakers;
5. Breaker and Protection Relay Settings Datasheets:
   - 5.1 For installations where the service rating is < 1000 kVA, indicate all breaker and protection relay settings on the drawings.
   - 5.2 For installations where the service rating is >= 1000 kVA, provide protection settings datasheets, divided by area code and equipment, that comprehensively indicate all breaker and protection relay settings.

10.3.2 Fuses

1. Fuses are acceptable in 600 V distribution and below in the following situations:
   1.1 For protection of VFDs to meet manufacturer's requirements.
   1.2 For protection of capacitors.
   1.3 For protection of staged electric heaters.
   1.4 For protection of control power transformers or voltage instrument transformers.
2. Class J fuses are preferred for general purpose power use in new installations.

10.3.3 Ground Fault Protection

1. Provide ground fault protection for systems as follows:
   1.1 For systems rated 1000 A or more, ground fault protection is mandatory to de-energize all circuits.
   1.2 For systems rated less than 1000 A, ground fault protection at the main breaker is subject to City acceptance. However, the following should be noted:
      a) Ground fault protection should be provided where additional protection is required to reduce damage in the event of a ground fault.
      b) Ground fault protection may be provided for individual loads and feeders.
2. The delay associated with ground fault protection must not exceed 1 second.
3. Ground fault protection applied solely to the facility main breaker is not acceptable.
4. Where ground fault protection is provided, selective coordination of the ground fault protection shall be provided as follows.
   4.1 For essential power systems and systems feeding critical loads with ground fault protection, the selective coordination of the ground fault protection system must limit the affected outage to the area of the ground fault. All exceptions are to be accepted by the City.
   4.2 For all systems not addressed under 4.1 above, appropriate coordination shall be provided to limit the affected zone in the event of a ground fault trip
5. The ground fault setting of main breakers and feeders would be limited to 30% of the circuit breaker rating; however, the selective coordination of the application must be reviewed by the City. There are applications where selective coordination is deemed to be a higher requirement than a low ground fault protection setting.
6. For systems that have their neutral grounded through a Neutral Grounding Resistor (NGR), main ground fault detection can be provided using either voltage detection method (59N) and/or zero sequence current detection method (50/51G). A Startco SE-330 relay is capable of both these functions.
7. Ground fault detection may utilize a residual CT connection if the ground fault trip current is 10% or higher of the CT current rating.
   7.1 Residual CT ground fault measurement is not applicable to high resistance grounded systems.
8. Ground fault detection on high-resistance grounded systems must utilize a zero-sequence CT.

10.4 Protection for Medium Voltage Distribution

1. Circuit breakers are required in all medium voltage applications, except as follows:
    1.1 Protection of individual loads or transformers <= 2 MVA;
    1.2 Appropriate protection is provided to address potential single phase issues; and
    1.3 The resulting downstream arc flash energies are limited to Category 2 or lower.
2. The protection relays shall be provided with the following protection elements, at minimum:
    2.1 Short circuit protection at all levels (IEEE 50)
    2.2 Overload protection at all levels (IEEE 51)
    2.3 Ground fault protection (IEEE 51G)
3. The following protection shall be provided for all medium-voltage service applications:
    3.1 Phase loss/unbalance protection (IEEE 46) shall be provided in any case where upstream fusing is provided.
    3.2 Frequency protection (IEEE 81)
    3.3 Overvoltage protection (IEEE 59)
    3.4 Negative Sequence (IEEE 47N)
4. The requirement for under voltage protection (IEEE 27) shall be evaluated on a case-by-case basis. It is noted that it is not acceptable to trip a facility main breaker on temporary power failure, whereby a manual reset of the breaker is required to restore power.
    4.1 All installations of Undervoltage protection on main breakers shall be approved by the City.
5. Provide reverse power protection (IEEE 32) when generators are synchronized with the utility service.
6. Provide transformer differential protection (IEEE 87T) for:
    6.1 Transformers rated 5 MVA and above, for installations with no redundancy;
    6.2 Transformers rated 7.5 MVA and above, for critical installations, with or without redundancy; and
    6.3 For all transformers rated 10 MVA and above.
    6.4 Differential protection for smaller transformers shall be evaluated on a case-by-case basis and reviewed with the City.
7. Provide zone/bus (IEEE 87Z or IEEE 87B) differential protection for indoor switchgear in a clean environment with a capacity of 10 MVA or greater and on outdoor switchgear or indoor switchgear not in a clean environment with a capacity of 7.5 MVA or greater.
    7.1 Zone/bus protection may be utilized to reduce the available arc flash energy to meet the requirements of Section 13.
8. Provide optical protection relays in switchgear where required to reduce arc flash ratings below 8cal/cm^2. Refer to Arc Flash Section in Appendix A

10.4.2 Ground Fault Protection

1. As discussed in Section 3.8, resistance grounding is recommended for medium voltage systems.
2. All medium voltage loads, such as motors, must be provided with dedicated ground fault protection.

3. All feeders must be provided with ground fault protection, unless it can be demonstrated that ground fault protection of the feeder is adequately provided via alternate protection, without impacting selective coordination and accepted by the City.

10.5 Resistance Grounding Ground Fault Detection Systems

10.5.1 Low Voltage/High Resistance Grounding

1. During the 1st phase to ground fault, the NGR system will:
   1.1 Alarm with both a local pilot light and an alarm to the PCS, allowing personnel to correct the problem or allow for an orderly shutdown of the process.
2. During the 2nd phase to ground fault, the protection system will:
   2.1 Trip the main breaker to de-energize the system.
3. Design the system to provide continuity of power upon a single ground fault event.
4. Provide a pulser-based system along with all required tools to allow maintenance personnel to diagnose and troubleshoot the location of the ground fault.

10.5.2 Low Resistance Grounding

1. Ensure all medium voltage ground faults trip the circuit breaker closest to the fault.

11 STANDBY AND EMERGENCY GENERATION

11.1 General Requirements

1. Generator ratings shall be selected based upon the ISO 8528 standard. ISO 8528 ratings are summarized as follows:
   1.1 Continuous Power
      a) The rated output is available continuously, with average power output within 70% to 100% of the rating.
   1.2 Prime Power
      a) The generator may run continuously, with an average power output of up to 70% of the rating over 24 hours.
   1.3 Limited Time Running Power
      a) The rated output is available for up to 500 hours per year, with average power output up to 100% of the rating.
   1.4 Emergency Standby Power
      a) The generator may run up to 200 hours per year, with an average power output of 70% of the rating over 24 hours.
2. Engine exhaust system:
   2.1 Exhaust gas piping to be insulated
   2.2 Piping designed to prevent vibration isolation from generator set to piping and therefore to building.
   2.3 Piping to be equipped with drain valves at the lowest point to drain condensation.
   2.4 Piping to be designed in such a way that exhaust is away from building ventilation air intakes.
   2.5 Piping to be designed in such ways that it is above the building perimeter to allow for easy dispersal of exhaust gases.
   2.6 Allow for expansion due to high temperature without affecting building supports.
   2.7 Provide piping of suitable size and length to prevent exceeding the backpressure on engine.
3. Generator cooling system:
   3.1 Provide the required ambient air temperature range for the generator room.
   3.2 Provide radiator based cooling/ or remote radiator cooling depending on engineering analysis of generator room temperature rises.
   3.3 Provide fresh air intake (combustion air + cooling air) and generator room ambient air exhaust fans as required to maintain the required operating ambient temperature.
4. Fuel supply system:
   4.1 Considerations to include when evaluating natural gas vs diesel fuel:
      a) The energy density of natural gas is lower than diesel fuel, which may require larger engines for large generator sets (typically in excess of 1 MW capacity), This will have an impact on initial purchase costs for the unit as well as the associated support infrastructure including building space and must be weighed against the cost of providing diesel fuel storage and the associated diesel fuel ongoing supply and maintenance issues.

b) In instances where the generator application would require extended periods of operation, the frequency of overhaul for natural gas engines is typically higher than for diesel engines.

4.2 Natural gas is the preferred fuel for City installations where:

- Natural gas is available;
- The availability, cost, and size differential of the natural gas generator compared to the diesel generator are acceptable.

4.2.1 If the generator is an emergency generator, ensure that natural gas is acceptable as per CSA C282 and the AHJ.

4.3 Where diesel fuel is selected:

4.3.1 Provide a day tank for fuel within the generator room.

4.3.2 Comply with CSA C282 for fuel and piping requirements.

5. Generator set control panel

5.1 Provide automatic remote start ability.

5.2 Provide a “Hand-Off- Auto” selector for manual operation or Auto operation.

5.3 Provide local alarm indications.

5.4 Provide connections for remote alarms.

5.5 Provide remote connections using discrete relays and communication ports for monitoring of generator set status, alarms

5.6 Provide automatic controls for auxiliary heating, block and space heating.

5.7 Provide generator paralleling controls if required for the application.

6. Engine starting systems:

6.1 Provide storage battery/battery charger to power starting system.

6.2 Batteries shall be as recommended by the manufacturer and designed for the required cold cranking cycles.

6.3 Cold cranking cycles to comply with CSA C282.

6.4 Provide monitoring of battery voltage and automatic alarm to warn of low battery.

6.5 Battery system shall be designed to operate in extreme temperature range that may occur inside the generator room.

7. Alternators:

7.1 For smaller generators, provide alternator winding with 2/3rd pitch. For larger generators > 1 MW, consider the use of higher pitch windings.

7.2 Comply with CSA C22.2 No. 100 for construction.

7.3 Windings shall be copper.

7.4 Provide suitable exciter in static or direct connected type.

7.5 Automatic voltage regulator shall be permanent magnet, quick voltage build up type.

7.6 Provide complete alternator datasheet, and parameters.

7.7 Alternator shall be designed to be able to withstand, electrically and mechanically, 300% of its full load current for 1 second with its terminals shorted.

8. Neutral Grounding Resistors:

8.1 Provide generator neutral grounding resistors as required to incorporate into the electrical design, but at minimum, should be provided for all generators rated 1 MW and over.

9. Automatic transfer switches:

9.1 Provide ATS in compliance with CSA C22.2 No. 178.

9.2 Transfer equipment should be designed, installed and maintained in such a way that it will never allow inadvertent interconnection of the standby power source with the normal power source.

9.3 Most applications will utilize open transition transfer (break before make) for simplicity.

a) Ensure that the open delay is sufficient for residual voltage of motor loads to dissipate.

9.4 Closed transition transfer switches shall be provided when the facility cannot accept temporary power interruptions when transferring from the standby to utility source.

9.5 Where closed transition transfer switches are required, selection is typically between three major types:

a) Momentary Passive:

i. The transfer switch waits for the generator to passively synchronize with the utility source and then closes the utility switch. The generator switch is opened within 100ms of the utility switch closing.

ii. The transfer switch must be CSA approved.

iii. Under-voltage protection and an automatic synchronization check are required.

b) Momentary Active:

i. This type of transfer is the same as momentary passive discussed above, except that the generator is actively controlled by an automatic synchronizer.

c) Soft Transition:

i. In a soft transition transfer scheme, the synchronization is controlled by an automatic synchronizer, but the generator is paralleled with the utility source for longer than 100 ms. This allows the loads to be gradually transferred from the generator to the utility source over a short period of time, typically 2 to 10 seconds.

ii. This type of transition requires additional protection and coordination with the utility.

9.6 Ensure that separate, interlocked bypass feeders are provided around automatic transfer switches to allow for maintenance on transfer switches without interrupting critical loads.

10. Load bank connection

10.1 If the generator is classified as an emergency generator, the system must be operated under a minimum of 30% load monthly, and 100% load annually.

a) Unless the City has a portable load bank of the appropriate size, provide a permanent load bank for testing purposes.

10.2 If not classified as an emergency generator, at minimum provide provision for connection of a temporary load bank subject to acceptance by the City.

11. Provide at minimum the following signals to the control system for each standby generator:

11.1 Generator running

11.2 Generator fail

11.2 Emergency Loads

Reference Section 3.6of this Design Guide

1. In accordance with the National Building Code, a generator shall be classified as an emergency generator if it feeds life safety equipment, such as:
   - 1.1 Fire alarm and emergency voice communications systems;
   - 1.2 Firefighters' elevators and elevators serving storeys above the first storey in a high building;
   - 1.3 Fire protection water supply pumps that depend on electrical power supplied to the building;
   - 1.4 Smoke control systems;
   - 1.5 Fans required for smoke control;
   - 1.6 Emergency lighting; and
   - 1.7 Exit signs.
2. An emergency generator may power other essential (non-emergency) loads, provided that they are switched via an independent transfer switch and arranged in a manner to not compromise the emergency power system.
3. Certain other critical loads should be considered for connection to the emergency generator via the emergency power branch; however these loads are not acknowledged in current codes as emergency loads. Thus, it is recommended to perform a review of the criticality of the loads, provide a recommendation based upon good engineering practice, and discuss with the AHJ for approval.
   - 3.1 Other loads for potential connection to the emergency power distribution include:
     - a) Aircraft warning lights,
     - b) Critical ventilation where a combustible or toxic atmosphere could be created within a short amount of time.
   - 3.2 While not applicable in Canada, it is recommended to review NFPA 70 requirements associated with Critical Operating Power Systems (COPS) as a reference.
4. Auxiliary systems associated with emergency generation must also be powered from the emergency power distribution system. An example is generator room ventilation equipment.
5. Emergency generators must meet the requirements of CSA C282.
6. Emergency loads must be provided with a separate transfer switch and distribution from the non-emergency essential power loads.

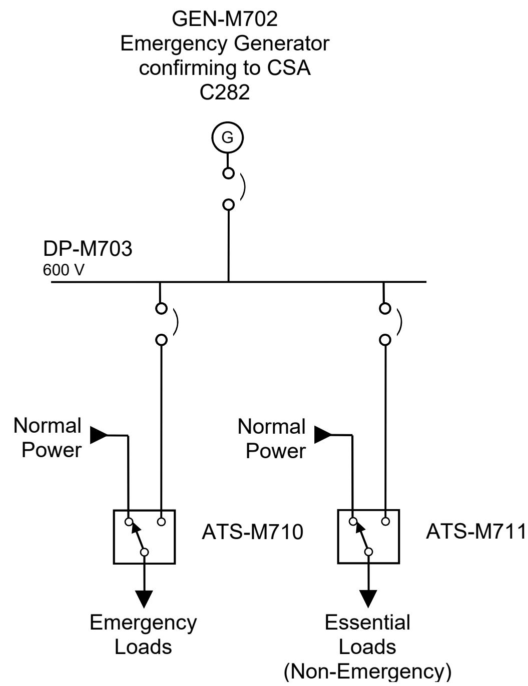

Figure 11-1: Emergency Generator utilized for both Emergency and Essential Loads

11.3 Essential Loads

Reference Section 3.6 of this Design Guide

1. Essential (non-emergency) loads should be powered via a standby generator, or the standby power branch of an emergency generator system (as shown in Figure 11-1).
2. The following loads should typically be designated as Essential Loads:
   - 2.1 Essential process motor loads, including critical motor operated valves.
   - 2.2 UPS systems
   - 2.3 Switchgear DC control power supplies
   - 2.4 Plant security/CCTV systems
   - 2.5 Ventilation systems that must remain operable during a power failure.
3. The requirement for standby power for process systems shall be decided on a case-by-case basis. Consider risks to the process and operating licence conformance.

11.4 Generator Set Sizing

1. It is recommended that the generator sizing be confirmed by the manufacturer based on load profile provided by the responsible engineer and subject to acceptance by the City.
2. A standby/emergency generator should be sized in such a manner that on average the running load will not be below 30% of its rated kVA capacity. Permanent load banks may be required to be operated in parallel with plant loads less than 30%, in order to protect the generator from engine related reliability issues. If loads less than 30% are expected, review the application with generator manufacturers.
3. Maximum allowable Step Loading: The maximum allowed single step loading will cause a voltage dip that should stay within the operating voltage range of all live loads, which indirectly will decide the generator kVA rating. Generators may be sized based on picking all load up in a single step or alternatively designing the single step to pick up a maximum load step in a sequential loading plan.
4. Maximum allowable single step frequency dip: The maximum allowed single step loading will also cause a single step frequency drip which in turn will have a bearing on the generator kVA rating.
5. Increased ambient temperatures will require higher kVA rating.
6. All generators are to be designed with a minimum of 10% spare (reserve) capacity.
   - 6.1 Where the generator is classified as an emergency generator, the 10% spare (reserve) capacity shall be retained throughout the life of the generator, as per CSA C282.
   - 6.2 Where the generator is not classified as an emergency generator, the 10% spare (reserve) capacity may be utilized for expansion, if accepted by the City.
7. Single Phase Loads versus Three Phase loads: Each load that is being analyzed must be converted into current loadings and power factor. Each phase must be summarized individually to arrive at the highest phase loading and power factor which will decide the generator kVA ratings, operability and stability.
8. Transformer inrush: Ensure that upstream distribution transformers and generator sets are sized to handle transformer inrush 100% of the time without any issues, trips or alarms. Special generator start sequences, such as online reduced voltage generator starting, to reduce transformer inrush shall not be required. Where parallel generators are installed, ensure that transformer inrush can be met by 50% or N-2 of the generators running, whichever is greater. Provided that automatic, PLC controlled switching systems are installed to control the sequencing of loads on generator power, the generator installation may be designed to address the inrush of one transformer at a time. For any loads that do not have automatic sequencing, the transformer inrush loads shall be considered in parallel.
9. Design Load Calculations:
   - 9.1 Conduct a thorough study to identify each and every type and size of emergency/essential loads that the emergency/standby generator will power after the normal power has failed. Note the individual load power factors as they will be required to establish the distribution of real power and reactive power in the alternator.
     - a) Three phase generators are rated for 0.8 PF. Lower power factors at rated kVA will require larger alternators.
     - b) Generators that will be supplying only leading power factor loads should be treated with extreme caution, as these can cause the generator set to lose

control of its voltage. An example is UPS loads, or data servers which may exhibit leading PF load characteristics.

9.2 Determine the maximum time delay that can be suffered by each load before each load is transferred to generator power. The time delay with the least value will be the deciding factor for adjusting the start-up delay of the generator.

9.3 Determine all motor loads and calculate the starting kVA of each motor load. Based on diversity of all motor loads, calculate the total motor starting kVA which must be supported by the generator.

9.4 Identify VFDs and non-liner loads with harmonic contribution to the generator voltage and current. Ensure that appropriate generation capacity is provided to address the harmonics present.

9.5 Review UPS loads to ensure sufficient generation capability is provided for charging current and harmonics.

9.6 After totalling all loads, add 10-25% to allow for future kVA capacity increase.

10. Regenerative loads:

10.1 Regenerative loads are typically elevators, cranes, hoists and sometimes pumps. These loads when braking or decelerating will feed energy back to the generator leading to over-speeding and consequent tripping of the generator. This situation may require keeping some non-critical loads powered on the generator set so that they can absorb extra energy and prevent a mechanical overspeed of the engine.

11.5 Temporary Generator Connection

1. Temporary generator connections shall be utilized at critical facilities that do not have permanent emergency/standby generators.
2. Consult with the City to determine if a standard for a plug / receptacle system exists, which would allow for fast, straightforward hook-ups without errors.
3. Supply a junction box with terminals for temporary generator connection. The breaker connected to the junction box shall be interlocked with the utility breaker.
4. Connect temporary (grounded wye) generators for 3Ø3W installations as shown in Figure 11-2. Note that 3Ø3W installations are preferred for systems interconnecting with generators.
5. Connect temporary (grounded wye) generators for 3Ø4W installations as shown in Figure 11-3.
6. The generator frame must be bonded.

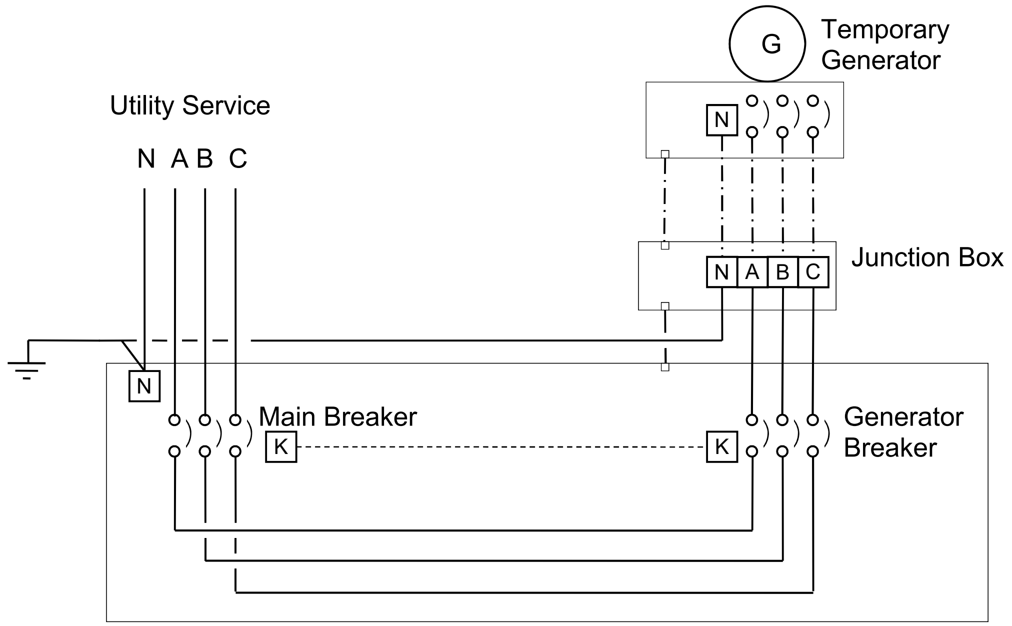

Figure 11-2: Temporary Generator Connection - 3Ø3W

Note: The above assumes a grounded wye connected generator.

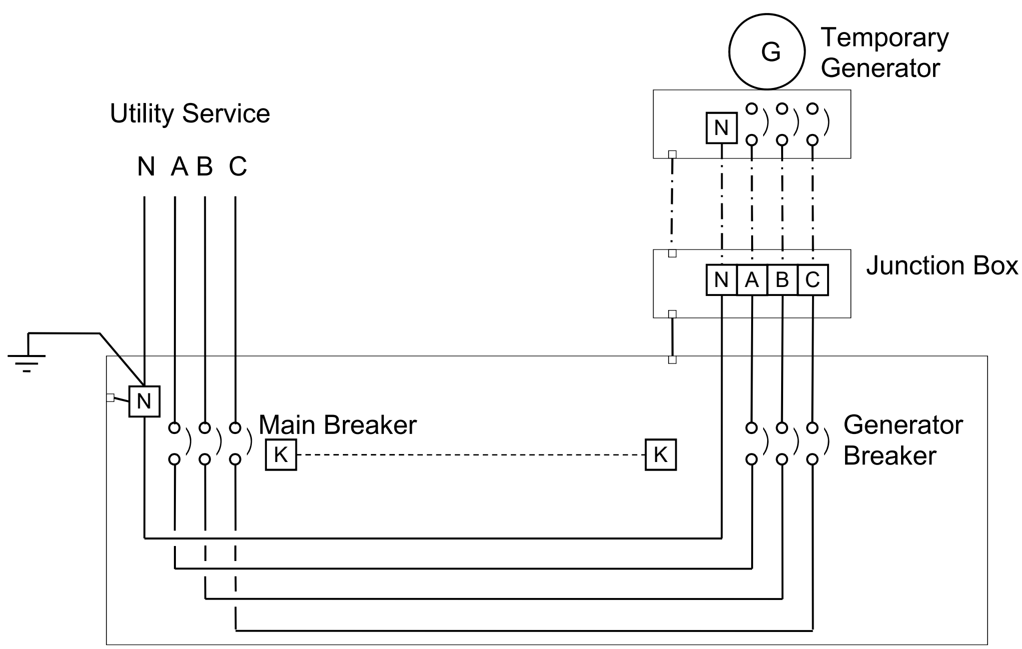

Figure 11-3: Temporary Generator Connection - 3Ø4W

Note: The above assumes a grounded wye connected generator.

12 HAZARDOUS LOCATIONS

12.1 General

1. Prepare comprehensive hazardous location drawings for all facilities containing a hazardous area, in accordance with Section 19.2.7.
2. Design, installation, selection of equipment and materials, shall be based on the Hazardous Location Drawings produced for the facility.
3. Hazardous locations should be selected based on the requirements of:
    - 3.1 Winnipeg Electrical Bylaw
    - 3.2 Canadian Electrical Code (CSA 22.1)
    - 3.3 NFPA 820
4. It is recommended that API Standard 505 be utilized as a reference document.

12.2 Wastewater Facilities

All wastewater facilities will typically have hazardous locations. Utilize NFPA 820, along with appropriate engineering analysis to determine appropriate area classifications. Plan drawings that clearly indicate the hazardous locations shall be created for all facilities.

12.3 Design Requirements

12.3.1 Class I, Zone 0 Locations

1. Hazard:
    - 1.1 An explosive gas mixture is present continuously or for long periods of time, at a level above the Lower explosive limit (LEL).
    - 1.2 Common areas are spaces inside vessels or chambers containing flammable mixtures, liquids, or spaces around vents from such sources.
2. Zone 0 Installation Requirements:
    - 2.1 Where possible, electrical equipment shall not be installed in Zone 0 locations.
    - 2.2 Where required, electrical equipment that can be used in Class I, Zone 0 locations shall be:
        - a) Approved for equipment protection level Ga (IEC);
        - b) Approved as being intrinsically safe, type i, or ia;
    - 2.3 Ensure code requirements for Zone 0 locations are met.

12.3.2 Class I, Zone 1 Locations

1. Hazard:
    - 1.1 An explosive gas mixture is likely to occur in normal operation.
    - 1.2 Common areas are locations adjacent to Class I Zone 0 locations, from which explosive gas mixtures could be dispersed.

2. Zone 1 Installation Requirements:

2.1 Transformers and capacitors shall be installed in electrical equipment vaults with no doorway between the room and the Zone 1 classified area. Provide adequate ventilation in vault. Vents shall be provided to contain electrical explosions and convey the pressure and gases safely outside the building.

2.2 Cable glands shall be of sealing type, and suitable for Class I, Division 1, or Zone 1

2.3 Wiring method shall be threaded rigid metal conduit or cables approved for the hazardous location with associated cable glands.

2.4 All boxes, enclosures, fittings shall be threaded type for connection to conduit and cable glands.

2.5 All fittings between the conduit seal and the explosion proof rated enclosures must be explosion proof type to contain any explosion and withstand the same pressures built up in the enclosure.

2.6 Splices and taps shall not be located in fittings which are only compound filled (non-pressure withstand).

2.7 The use of single conductor metallic armoured cable in Zone 1 locations is not permitted. Armoured single conductor cables with high currents are a possible ignition source due to high magnetic field and consequent energy available in the cable.

2.8 It is preferred to use three-conductor power cables with balanced loadings on all three conductors to cancel out the magnetic effect on armour.

2.9 Cable trays can be used in Zone 1 locations, however they should be bonded to prevent occurrence of circulating currents.

2.10 Conduits shall be sealed when crossing Zone 1 boundaries to prevent migration of gas vapours into other areas.

2.11 Explore the possibility of reducing the hazard by incorporating ventilation in Zone 1 along with failure protections, which may lead to modification of the hazardous location to less severe Zone 2, thereby enabling use of lower rated and classified equipment. It should also be noted that electrical maintenance in Zone 2 locations is more straightforward.

2.12 Electrical equipment that can be used in Class I, Zone 1 locations shall be:

a) Approved for Class I or Class I, Div. 1 locations;

b) Approved for equipment protection level Ga or Gb (IEC);

c) Approved as being intrinsically safe, type i, ia, or ib;

d) Approved as being flameproof (marking “EEx d”);

e) Approved as being increased safety (marking “EEx e”);

f) Approved as being oil immersed (marking “EEx o”);

g) Approved as being pressurized (marking “EEx p”);

h) Approved as being powder filled (marking “EEx q”); or

i) Approved as being encapsulated (marking “EEx m”).

2.13 Ensure equipment temperature code classification is appropriate for the installation. See Table 12-1.

2.14 Ensure that equipment is suitable for the applicable gas group.

2.15 Increased safety e motors shall incorporate thermal protection.

2.16 Lighting fixtures shall be provided with guards to prevent damage or shall be built of break resistant construction.

Table 12-1 : Hazardous Area Temperature Codes

Temperature Code	Maximum Surface Temperature
T1	450°C
T2	300°C
T2A	280°C
T2B	260°C
T2C	230°C
T2D	215°C
T3	200°C
T3A	180°C
T3B	165°C
T3C	160°C
T4	135°C
T4A	120°C
T5	100°C
T6	85°C

Notes:

1. If the equipment is installed in a higher ambient than the rated ambient, then the actual surface temperature will be higher than the above marked ratings for the full load operating condition. The designer must ensure that this does not compromise the safety.
2. The minimum ignition temperature of the gas should be greater than the Temperature Code rating.

12.3.3 Class I, Zone 2 Locations

1. Hazard:
    - 1.1 An explosive gas mixture is not likely to occur in normal operation, and if they do occur, they will exist for a short time only.
    - 1.2 Common areas are locations adjacent to Class I Zone 1 locations from which explosive gas mixtures could be communicated.
2. Zone 2 Installation Requirements:
    - 2.1 Transformers, capacitors, solenoids and other winding type equipment that do not incorporate sliding or make and break type contacts, heat producing resistance elements and arcing or spark producing elements are permitted for use in Zone 2 locations.
    - 2.2 Non-classified enclosures are permitted for use in Zone 2 provided they contain:
        - a) Non-arcing connections and connecting devices like joints, splices, etc. (non-sparking type)
        - b) Load break isolating switches interlocked to load break contactor or breaker.

c) Not more than ten sets of approved fuses; or

d) Not more than 10 lighting circuit breakers that are not used as switches.

2.3 Cable glands shall be of sealing type, and suitable for Class I Division 1, Division 2 or Zone 0, 1, or 2.

2.4 Wiring method shall be threaded rigid metal conduit or cables approved for hazardous location with associated cable glands.

2.5 Type TC cables, installed in cable tray is acceptable.

2.6 Armoured cables types TECK 90, ACWU90, ACIC, and copper sheathed RC90 with PVC overall jacket are acceptable.

2.7 All boxes, enclosures, fittings shall be threaded type for connection to conduit and cable glands.

2.8 All fittings between the conduit seal and the explosion proof rated enclosures must be explosion proof type only to contain any explosion and withstand same pressures built up in the enclosure.

2.9 Splices and taps shall not be located in fittings which are only compound filled (non-pressure withstand).

a) Any single conductor metallic armoured cable in Zone 2, carrying > 400 A is a possible ignition source due to high magnetic field and consequent energy available in the cable:

i. Bond metallic armour of single conductor cables every 1.8 m, so as to equalize the field (sheath voltage) between them and prevent any sparks due to sheath voltage difference between the cables.

ii. PVC jacketed single conductor armoured cable should be bonded only in the hazardous area and not at the other end. However there will be a sheath voltage present at the non-bonded end which may be a shock hazard. Bonding at both ends will lead to presence of circulating currents which is an incendive source for ignition.

iii. A separate bonding conductor in parallel with the cable is required to bond both ends of the cable route, at the two enclosures.

2.10 It is preferred to use 3 conductor power cables with balanced loadings on all three conductors to cancel out the magnetic effect on armour.

2.11 Cable trays can be used in Zone 2 locations, however they should be bonded to prevent occurrence of circulating currents.

2.12 Conduits shall be sealed when crossing Zone 2 boundaries to prevent migration of gas vapours into other areas.

2.13 Electrical equipment that can be used in Zone 2 shall be:

a) approved for Class I, Division 2 locations;

b) approved as non-incendive;

c) approved as providing equipment protection level Ga, Gb, or Gc;

d) approved as providing a method of protection “n”; or

e) equipment permitted in Zone 1.

2.14 Ensure equipment temperature code classification is appropriate for the installation. See Table 12-1.

2.15 Ensure that equipment is suitable for the applicable gas group.

2.16 Increased safety e motors shall incorporate thermal protection.

2.17 Lighting fixtures shall be provided with guards to prevent breakage damage or be break resistant construction.

13 ARC FLASH HAZARD STUDY

13.1 General

Refer to Appendix A - Arc Flash Hazard Study and Electrical System Modeling Requirements

The purpose of an Arc Flash Hazard Study is to identify and quantify potential arc flash hazards associated with electrical distribution equipment, and establish safe working guidelines for personnel. The safe working guidelines consist of identifying arc flash protection boundaries and the personnel protective equipment (PPE) required for each piece of electrical equipment. The available arc flash energy information is identified on a label, which is to be applied to each piece of electrical equipment. Safe working guidelines and PPE requirements are referenced to these labels.

The Arc Flash Hazard Study is to be performed in association with a short circuit study and protection device coordination study. Results of the short circuit study are used to determine the available fault current levels at each piece of equipment and to specify equipment interrupting and withstand capacities. Results from the coordination study determine the time required for the electrical circuit protective devices to clear the fault condition. The results of these two studies are combined to calculate the incident energy at assigned working positions from the electrical equipment and categorize the arc flash hazard to determine the required PPE to provide adequate protection. These studies should be completed and accepted by the City at design time so as to identify and mitigate any potential issues.

The City has standardized on Power*Tools software provided by SKM Systems Analysis, Inc. (also known as SKM PTW). A model of the electrical distribution should be created using this software that includes any equipment that may need to be accessed by City personnel. Tag equipment within the model using the City of Winnipeg WWD Identification Standard. The SKM PTW project and library files shall be supplied to the City, in native electronic format, upon completion of the Arc Flash Hazard Study.

13.2 Design Requirements

1. All new and modified electrical designs shall ensure that arc flash energies are within the ratings specified in Table 13-1.
2. The electrical designer shall model the arc flash energies during design time and specify equipment as required to ensure that the design arc flash ratings are maintained.

Table 13-1 : Arc Flash Design Requirements

Equipment	Arc Flash Hazard / Risk Rating		Notes
	Recommended Maximum	Absolute Maximum (See Note 1)	
Control Panels, <= 600 V	0	1	
Distribution Panel, <= 600 V	2	3	
Distribution Panel, <= 600 V, Main Breaker	3	4	2
Motor Control Centre, 600 V	2	3	
Motor Control Centre, 600 V, Main Breaker	3	4	2
Panelboard, 208/120 V	0	2	
Panelboard, 347/600 V	1	2	
Switchgear, <= 600 V	3	4	
Switchgear, <= 600 V, Main Breaker	4	4	
Switchgear, Medium Voltage	3	4	
Switchgear, Medium Voltage, Main Breaker	4	4	
Transformers	4	-	3

Notes:

1. The City must approve all cases where the arc flash energies exceed recommended maximum values.
2. The main breaker must be in a separate compartment to permit a separate rating.
3. It is not typical to require live work on energized transformers.

13.3 Typical Arc Flash Labels

1. Arc flash labels are to utilize metric units.
2. Certain types of equipment, such as transformers, contain multiple voltage levels. The arc flash incident energy needs to be evaluated at all voltage levels present and the highest incident energy computed will need to be shown on the arc flash label. The approach distances on the labels must always reflect the highest voltage level present within the equipment, regardless of which voltage level generates the highest incident energy.

The arc flash label format used for equipment rated Category 0 through Category 4 is shown in Appendix A Figure 2.9-1 and Figure 2.9-2.

14 GROUNDING

14.1 General

1. See Section 3.8 for system grounding requirements.
2. Reference IEEE-142 and IEEE-399 for grounding system design practices.
3. All grounding and bonding are to utilize stranded copper conductors.
4. All ground rods to be copper-clad steel, 19mm diameter, and minimum 3m long. Where six meter long ground rods are required, utilize two 3m long rods with a threadless connector.
5. Minimum grounding conductor size for grounding electrode and buried conductors:
   - 5.1 600 V systems: 2/0 AWG
   - 5.2 Medium Voltage systems: 4/0 AWG
   - 5.3 Grounding conductor sizing for connection of transformers, generators, etc. should not be less than required for the equivalent bonding conductor, and never less than 6 AWG.
6. Burial depth of grounding conductors:
   - 6.1 600 V systems: 300 mm – 500 mm
   - 6.2 Medium voltage systems: 500 mm below rough grade

14.2 Equipment Bonding and Grounding

This refers to the bonding and grounding of non-current carrying metal parts like panel enclosures, motor frames, switchgear, and switchyard structures, etc.

14.2.1 General

1. All non-current-carrying metal equipment parts shall be bonded to station ground grid.
2. All metal building columns shall be bonded and connected to ground using 2/0 AWG copper conductors.
3. All tanks, vessels and piping shall be bonded to ground.
4. A grounding system consisting of a grid or network of buried soft drawn bare copper conductors and electrodes will be provided for each facility. The individual ground grid will be tied together with interconnecting ground cables. The grounding system will be designed to limit the overall resistance to earth to a level satisfactory for the safe operation of the equipment and for the safety of the personnel.

14.2.2 Low Voltage Systems (< 750 V)

1. All major electrical equipment rated 1200 A and above, such as transformers, switchgear, large motors, motor controllers, etc., must be connected to the ground, at minimum through two paths.

14.2.3 Medium Voltage System

The following are applicable to medium voltage systems.

1. Prior to detail design execution, the design team must locate and obtain sufficient site soil data, as it is required for calculations and design development. Soil characteristics and seasonal changes must be fully documented. If such data is not available or is insufficient; the project design team shall commission an appropriate soil resistivity survey with a competent and qualified specialized enterprise (SES CDEGS software is preferred).
2. The design of the grounding system shall be based on calculated requirements to maintain safe *touch* and *step* potentials required by the Canadian Electrical Code.
3. Provide a switchyard ground grid in accordance with requirements of IEEE-80 to achieve required touch voltage and step voltage limitations.
4. The minimum grounding conductor size for connection of grounding electrodes and ground grids is 2/0 AWG. The use of 4/0 AWG or larger conductors is recommended to be utilized for applications with transformers rated 1 MVA or greater.
5. All electrical equipment frames shall be connected to ground grid using 2/0 AWG or larger copper conductors.
6. All metal columns, pedestals, supports shall be bonded and connected to ground using 2/0 AWG copper conductor.
7. Provide ground grid conductor around the building perimeter, to reduce touch and step potentials, unless it can be demonstrated with study/analysis that this will not be an issue.
8. The type of power system grounding selected must be in accordance with the Manitoba Hydro and CEC requirements. Values of resistivity to ground must be carefully measured and recorded to provide the most suitable equipment protection.
9. All medium voltage electrical equipment will be connected to the ground, at minimum through two paths.
10. All metallic fencing; property perimeter, outdoor substations and any other, required to protect property, equipment or to restrict access to designated plant facilities will be connected to an appropriate grounding system.
11. Metal fencing around medium voltage stations:
    - 11.1 Locate fence at least 1m inside the periphery of the station ground grid conductor.
    - 11.2 Connect the fence to station ground grid in accordance with CEC.
    - 11.3 Where there is an external metal boundary fence, in proximity to the station fence, the touch voltages within 1m of all parts of the metal boundary fence shall not exceed the tolerable step voltage limits given in CEC Table 52.

14.3 Lightning Protection

Perform a risk analysis as per NFPA 780 for all new facilities. Review acceptable risks with the City. Where required, install appropriate lightning protection.

A minimum level of lightning protection, as required by local codes, shall be allowed for to protect property, personnel and equipment. Subject to the results of an evaluation, the complexity of the design required shall depend on the severity or level of incidence of lightning strokes in the area of the project plant; as well as the type of plant and risks in the event of lightning strokes. Statistical or statutory meteorological data must be consulted to make a proper determination of the degree of protection required.

Buildings and structures will be adequately grounded to prevent damage from a lightning stroke or discharge. In the absence of project specific standards, the design will follow NFPA 780 and CSA B72.

Ensure that the grounding system for the lightning protection is segregated from the electrical safety ground system and only interconnected as required in the codes and standards.

14.4 Grounding Study

1. As per Canadian Electrical Code requirements, appropriate review and calculation of the ground resistance is required for medium voltage systems. However, for certain applications with high voltages, more formal, documented analysis in the form of a grounding study is required to identify grounding system safety hazards and provide for a safe grounding system design.
2. A grounding study report shall be provided for all systems where line-to-line voltages exceed 7500 V within the City's electrical distribution system. A grounding study shall include the following:
   - 2.1 Identify the existing and proposed electrical grounding and bonding.
   - 2.2 Testing of the soil resistivity.
   - 2.3 Test results of any fall-of-potential testing performed on any existing ground electrodes. The requirement for testing existing electrodes shall be determined on a case-by-case basis.
   - 2.4 Coordinate with the utility to obtain relevant utility supply information.
   - 2.5 Determine the available fault currents at various points within the electrical distribution. This information may be obtained from a short circuit study.
   - 2.6 Create a model of the grounding system in specialized grounding software (SES CDEGS is the preferred software). Alternately, manual calculations may be utilized for small systems.
   - 2.7 Perform a safety analysis utilizing the software model (or manual calculations for small systems).
   - 2.8 Fully document the results of the safety analysis in the report.

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15 POWER QUALITY

15.1 General

1. All designs and installations shall include equipment specifically designed to control and remove all adverse power quality conditions that could damage or impair function of any of the electrical or electronic equipment, which will be in use in the facilities. Adverse power quality conditions to be addressed include but are not limited to:
   - 1.1 Voltage surges;
   - 1.2 Voltage sags;
   - 1.3 Voltage transients;
   - 1.4 Harmonics;
   - 1.5 Power factor;
   - 1.6 Radio frequency interference; and
   - 1.7 Manitoba Hydro Power Quality Standard PQM-2000.

15.2 Power Factor Correction

1. Unless otherwise specified, it is generally recommended that the electrical power factor for each facility be corrected to 0.95 or better. However, the economic payback for power factor correction should be calculated for all cases where the requirement for power factor correction is not clear.
2. Correction of the power factor to past 0.95 leading shall not be permitted under any circumstance.
3. For small facilities with a limited number of loads, power factor correction connected to the individual motor loads is preferred. For example, connection of capacitors to motor loads is appropriate in most wastewater lift stations.
4. For facilities supplied at 600 V, with numerous motor loads and potential harmonics, connection of one or more automatic power factor correction banks is preferred. Perform a harmonic review of the existing and potential future installation, and install detuning capacitors if potentially damaging harmonics are present.
5. Ensure that capacitors do not create a resonance condition.
6. Where any point in the electrical distribution has non-linear loads exceeding 15% of the upstream transformer capacity, a harmonic study must be performed to determine the appropriate application of power factor correction.
7. Capacitors connected directly to the bus without an upstream contactor require special permission from the City.
8. For facilities supplied at medium voltage, the appropriate configuration of power factor correction shall be based upon Table 15-1.
9. Switching and control of power factor correction equipment shall be given special attention. The transient and dynamic behaviour of this equipment under various operating conditions must be supported by calculations and studies documented with reports provided and incorporated into O&M information. The design adopted shall ensure safe operation and protection of associated equipment.

15.3 Application Requirements and Configurations

1. The configuration of power factor correction is classified into three types:
   1.1 Load Power Factor Correct (See Section 15.3.2)
   1.2 Decentralized Bulk Power Factor Correction (See Section 15.3.3)
   1.3 Centralized Bulk Power Factor Correction (See Section 15.3.4)
2. Typical configurations for power factor correction are identified in Table 15-1. However, determination the appropriate configuration shall be reviewed for each facility.

Table 15-1 : Power Factor Correction Application Requirements

Application	Requirement	Typical Configuration	Notes
Land Drainage / Underpass Pumping Station	Based upon Economic Evaluation	Load Power Factor Correction	
Regional Water Pumping Station	Required	Load Power Factor Correction (MV) Decentralized Bulk Power Factor Correction (600 V)	
Flood Pumping Station	Based upon Economic Evaluation	Load Power Factor Correction	Review the economic benefit considering occasional use.
Wastewater Lift Station	Based upon Economic Evaluation	Load Power Factor Correction	
Flood and Wastewater Lift Station (combined)	Based upon Economic Evaluation	Load Power Factor Correction	
Wastewater Treatment Facility	Required	Decentralized Bulk Power Factor Correction (preferred) or Centralized Bulk Power Factor Correction	
Water Treatment Plant	Required	Decentralized Bulk Power Factor Correction (preferred) or Centralized Bulk Power Factor Correction	

3. Wastewater treatment plants shall be designed to have a power factor target of 0.95. The design shall ensure that the average power factor over the worst load day shall never be less than 0.92 lagging.

15.3.2 Load Power Factor Correction

The power factor correction equipment may be installed close to the load equipment exhibiting poor power factor, to improve the power factor, reduce load cable currents and losses, and provide for starting kVAR for heavy loads which require heavy inductive kVAR at start.

1. Before applying power factor correction, the power factor, actual load current, individual harmonic components of individual loads and the power supply source need to be reviewed.
2. Power factor correction capacitors may be installed and switched in line with motors ensuring that such a design is in compliance with Canadian Electrical Code.
3. Capacitors should not be installed at the terminals with larger size AC induction motors with high inertia loads due to risk of self-excitation, after the motor is switched off. Self-excitation may lead to presence of over-voltages at motor/capacitor terminals. The capacitor rated current should be less than the no-load magnetizing current of the induction motor.
4. Individual Motor Power Factor Correction
   - 4.1 Connection Type A1 – Motor Terminals
     - a) Connection of power factor correction capacitors at the motor terminals is acceptable for full voltage started motors only.
     - b) Do not apply to motors started by soft starters or VFDs.
     - c) Do not apply to motors which are subject to plugging, jogging, high-inertia, reversing, or open transient compound starting.
     - d) Maximum capacitor size as per motor nameplate or such that capacitor current <= motor no-load current.
     - e) The overload setting must be adjusted to account for the reduced motor current. This reduced overload setting must be clearly documented on the drawings.
   - 4.2 Connection Type A2 – Overload Load Terminals
     - a) Same as Connection Type A1, except the capacitors may be located at the motor starter instead of the motor.
   - 4.3 Connection Type B1 – After Contactor and Before Overload
     - a) Connection of power factor correction capacitors in this manner is acceptable for full voltage started motors only.
     - b) Do not apply to motors started by soft starters or VFDs.
     - c) Do not apply to motors which are subject to plugging, jogging, high-inertia, reversing, or open transient compound starting.
     - d) Maximum capacitor size as per motor nameplate or such that capacitor current <= motor no-load current.
   - 4.4 Connection Type B2 – Overload Cancelled
     - a) Same as Connection Type B1, except the power factor correction conductors are routed back through the overload CTs to cancel the PFC current and allow the overload setting to match the motor FLA.
   - 4.5 Connection Type C – Separate Contactor
     - a) Connection of power factor correction capacitors in this manner is acceptable for most motors.
     - b) Do not apply to motors started by VFDs.
     - c) Capacitor size should be less than the motor kVAR rating. Note that the capacitors in this configuration may be slightly larger than the previous connection types.

d) When configured with a soft start, the capacitor contactor should only close after the motor is up to speed.

5. VFDs

   5.1 Capacitors are not typically required to provide displacement power factor correction, but rather to filter harmonics.

   5.2 Capacitors should never be applied to VFDs without appropriately designed filtering reactors.

6. For smaller facilities, such as wastewater lift stations and flood stations, where harmonics are present install detuning reactors on individual capacitors.

15.3.3 Decentralized Bulk Power Factor Correction

The power factor correction equipment may be installed in various locations in a facility on busses such as motor control centers and switchgear. The primary advantage of this arrangement compared to centralized bulk power factor correction is that the power factor correction can reduce feeder currents and associated losses within the facility.

1. Before applying power factor correction, the power factor, actual load current, individual harmonic components of individual loads and the power supply source needs to be reviewed.
2. Provide detuned power factor correction banks whenever harmonic currents are present or may arise in the future.
3. Capacitor banks shall be designed in steps to prevent electrical resonance. Each step will be controlled based on desired power factor setting.
4. Provide a programmable PF/VAR controller with adjustable/programmable settings so as to control the centralized capacitor bank.
5. All components in each automatic power factor correction cabinet will be designed to accommodate an additional 20% of the initial kVAR capacity in the future.

15.3.4 Centralized Bulk Power Factor Correction

The Centralized Bulk Power Factor Correction utilizes capacitor banks that are installed close to the power source. Its primary aim is to improve overall facility power factor. Reduction in the facility power factor provides for reduced demand billing, release of capacity from a loaded supply transformer, and reduction in upstream transformer and cable losses. Power factor correction can also assist with voltage stabilization.

1. Before applying centralized bulk power factor correction, a proper electrical study shall-be carried out to study the kVA, kVAR, power factor, actual load current, individual harmonic components at the given power source.
2. Calculate the maximum kVA capacity that can be released by using centralized PF capacitor banks instead.
3. Provide detuned power factor correction banks to prevent providing a low impedance path for harmonic currents that are present or may arise in the future. Detuned power factor correction banks shall be considered as standard and justification, with approval of the City, shall be required for elimination of this requirement.
4. Capacitor banks shall be designed in steps to prevent electrical resonance. Each step will be controlled based on desired power factor setting.
5. Provide a programmable PF/VAR controller with adjustable/programmable settings so as to control the centralized capacitor bank.

15.4 Capacitor Units

1. Oil-filled capacitors are not acceptable. Provide metalized polypropylene dielectric thin film impregnated self-healing capacitors.
2. Capacitance tolerances to be within -5% to +10%.
3. Ampacity of feeders supplying capacitors shall be 135% of the rated capacitor current.
4. Rated voltage of the capacitors shall be 110% of the system nominal voltage.
5. Rated over-current capability of capacitors shall be 135% of the nominal.
6. Capacitors shall be provided with integral discharge devices complying with Code requirements for residual voltage decay. Decay time shall be marked as a warning label on a cover protecting the terminals.
7. Capacitors shall be provided with integral fuses, coordinated to prevent the capacitor case from bursting on a short circuit fault inside the capacitor case.
8. The capacitive power overload of a capacitor due to overload in voltage or current must not exceed 135% of its nominal rated kVAR.
9. Provide capacitor units with low dielectric losses.

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16 OTHER SYSTEMS

16.1 Fire Alarm System

16.1.1 General Requirements

1. The requirement for a fire alarm system is dependent upon the type of facility and applicable code requirements. Where a fire alarm system is required as part of mandatory code requirements or good design practice, advise the City early in the design process.
2. Fire alarm systems are presently required for (but not necessarily limited to):
   2.1 The South End Water Pollution Control Centre
   2.2 The Water Treatment Plant
   2.3 Regional Water Pumping Stations.
3. Where fire alarm systems are to be installed, install in accordance with the National Building Code of Canada, the Canadian Electrical Code, and CAN/ULC-S524 – *Installation of Fire Alarm Systems*.
4. All fire alarm wiring shall be entirely independent from all other wiring. Each breaker feeding fire alarm equipment shall be coloured red and lockable in the “on” position.
5. The environmental conditions in some process areas are too harsh for commercial grade components to have sufficient operating life. In general, components in process areas should be industrial grade. However, the areas where industrial grade components will be necessary should be determined during the fire alarm design.
6. Each fire alarm device shall have a lamacoid adjacent to the device indicating the device ID as specified in the City’s Identification Guidelines.
7. At minimum, an alarm and trouble signal shall be sent from the fire alarm panel to the main facility control system.
8. The requirement for central monitoring is to be determined on a case-by case basis. Where provided, it shall be installed in accordance with CAN/ULC-S561.

16.1.2 Drawing Requirements

1. Prepare fire alarm plan drawings in accordance with Section 19.2.4.
2. Prepare fire alarm riser diagrams in accordance with Section 19.2.5.

16.2 Voice Communications

The specific requirements for communications systems are dependent upon the scope of work for each project. At minimum, the electrical design shall include provision of space, conduits and/or cabling for the communication systems.

16.2.1 Telephone

1. Hardwired telephone communication infrastructure shall be provided for all facilities that are occupied on a routine basis.
2. Utilize analog telephone systems for small to medium sized facilities.
3. Utilize IP based telephony for all large facilities, including wastewater treatment facilities.
4. Allocate space for the central telephone backboard in a clean, conditioned space. For large facilities, this will ideally be in a server room or similar environment. For smaller / medium sized facilities, preference would be to typically locate in an electrical room, but at least 1m away from electrical equipment.
5. Provide boxes and wallplates with jacks for all telephone connections.
6. All cabling is to be as per Data Communications requirements in Section 16.3. No “Cat-3” or telephone-grade cabling is permitted.

16.2.2 Public Address (PA) System

1. The requirement for a PA system will be made on a case-by-case by the City, however it is expected that only large facilities will typically require a PA system.

16.3 Data Communications

16.3.1 Cabling

1. Copper data cabling in wastewater lift stations, regional water pumping stations, and other small to medium sized facilities may utilize Cat-5e wiring systems. Utilize Cat-6 wiring systems for larger facilities, such as wastewater treatment facilities.
2. Utilize multi-mode fibre-optic cabling where required due to distance or potential electrical interference
   - 2.1 Fibre optic cables shall be indoor/outdoor direct burial rated loose tube, rodent protected and constructed with 50/125 multi-mode glass fibres, spiral interlocked armour, and outer polyethylene jacket.
   - 2.2 All fibre cables are to meet TIA 492-AAAC (OM3) designation at minimum. Where required for distance and bandwidth, TIA 492-AAAD (OM4) fibres may be required.
   - 2.3 All fibre terminations are to include buffer tube fan out kits, connectors, termination/distribution panels, and wall mount enclosures.
   - 2.4 Where possible, standardize on LC fibre connectors.
3. Utilize single-mode fibre for long distance communication requirements.
4. All communication cables shall be supported at intervals not exceeding 1.0 m.

16.3.2 Raceways

1. Communication conductors shall be installed in separate raceways and cable trays from power conductors.
2. Where communication conductors cross power conductors, they shall cross perpendicularly.
3. Segregation of cable systems shall be as per Table 4-9.

16.4 Security Systems

16.4.1 Basic Requirements

1. Each facility shall, at minimum, be provided with basic security monitoring; however additional requirements may apply. Coordinate with the City to determine the specific requirements for each facility.

16.4.2 Wastewater Treatment Facilities

1. The basic security system for all process areas, consisting of door, window and motion sensors as applicable, will typically be connected with the process control system rather than a commercial-style security system. Video systems will be treated independently of the security systems connected to the process control system. Refer to the Automation Design Guide for additional information.
2. Basic requirements include:
   - 2.1 Intrusion monitoring for all exterior plant doors.
   - 2.2 Intrusion monitoring for all exterior windows that are not within the plant perimeter fence (if any).
   - 2.3 Motion detectors for critical areas only.
3. Video surveillance systems for security purposes are not typically required unless indicated by the City; however video monitoring of specific processes and operations may be required.
4. For NEWWPCC, please refer to WSTP NEWPCC Access Control Guideline

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17 PACKAGED SYSTEMS

17.1 General Requirements

Various process and mechanical equipment may be appropriate for packaging, where the equipment vendor provides a complete package, including electrical and automation equipment. For automation system packaging requirements, please refer to the Automation Design Guideline.

1. Vendor packaging of electrical equipment with the process equipment is permitted where:
   - 1.1 The equipment operation is complex or the technology is proprietary. Vendors of these packaging systems must be able to provide a complete proven system that can be fully tested at the factory. The vendors of these systems must provide assistance with the integration of the City's PCS system and the vendors control system, such that from the City Control Room the operator has visibility and control of the vendors packaged equipment.
   - 1.2 Where vendors are providing packaged equipment, should try and utilize City standardized equipment.
2. Vendor packaging of general building HVAC systems is permitted where:
   - 2.1 The packaged unit is dedicated to a non-process area such as a laboratory or Administration Building
   - 2.2 Vendor does not have to adhere to City standardized equipment
   - 2.3 Vendor must provide a suitable communication between the packaged unit and the PCS system to allow City Operations to monitor the unit's performance, adjust temperature and humidity set points, start/stop the unit, reset the unit on a fault and provide detailed alarms to the PCS on unit failure.
3. This section is still under development

Table 17-1 : Wastewater Treatment Equipment Vendor Packaging

Equipment	**Permitted Packaging Type**				**Comments**
	1	**2**	**3**	**NP**	
Air Handling Unit - General	Y	Y	Y		Application dependant
Air Handling Unit with Fan Wall		Y	Y		Application dependant
Air Handling Unit – NG Fired	-	Y	Y		Application dependant
Blowers - Turbo	Y	Y	Y	-	Application dependant
Blowers – conventional					
Clarifier Mechanism - Rotary	-	Y	Y		
Compressor, Air, <= 3.7 kW	Y	Y	Y		
Compressor, Air, > 3.7 kW	-	Y	Y		
Compressor, Digester Gas	-	-	Y		
Grit Classifier	-	-			
Fan - General	-	-	-		
Mixers, Tank	-	-	-		
Pump – Chemical Feed Pump					
Pump - General					
Rotary Drum Thickener		Y			
Screens – Perforated Plate					
UV System	Y				
Legend					
Packaging Type 1		Black Box			
Packaging Type 2		Standards except standardized equipment vendors			
Packaging Type 3		All standards including standardized equipment vendors			
Packaging Type NP		Not Permitted			

Note:

1. Packaging of equipment may be in accordance with Table 17-2 where the equipment is part of a system.

Table 17-2 : Wastewater Treatment System Vendor Packaging

Equipment	Permitted Packaging Type				Comments
	1	2	3	NP	
Biofilter / Odour control system	-	-	Y		
High Rate Clarifier - Actiflo®	-	-	Y		
Polymer Mixing System	-	-	-		TBD
Thermal Hydrolysis Process - Cambi®	-	-	-		TBD
Legend					
Packaging Type 1		Black Box			
Packaging Type 2		Standards except standardized equipment vendors			
Packaging Type 3		All standards including standardized equipment vendors			
Packaging Type NP		Not Permitted			

18 ELECTRICAL ROOMS

18.1 General Requirements

Requirements of electrical rooms include the following:

1. Ensure bare concrete floors are covered, painted, or sealed to reduce the build-up of concrete dust on electrical equipment. Use of conductive surface hardeners for concrete floors is not permissible.
2. Locate electrical rooms a minimum of 150mm above outdoor grade level.
3. Where electrical rooms are subject to potential flood risk from a nearby process upset, locate the electrical room a minimum of 100 to 150 mm above the process floor level, or higher as required, to prevent a process flood incident from flowing into the electrical room.
4. Locate electrical rooms to allow for access of cables and conduits from all sides.
5. No process piping shall run through the electrical room.
6. No washroom or kitchen facilities shall be allowed directly above an electrical room.
7. Hot water or glycol heating pipes or heaters shall not be located above electrical rooms or anywhere such that a leak of liquid or steam could conceivably enter an electrical room.
8. Evaporating coils for air handling units will be located and arranged to prevent condensation from running onto electrical equipment in the event of a plugged drain.

9. Housekeeping pads:

   9.1 It is generally preferred that electrical equipment be installed on housekeeping pads. Housekeeping pads are required in any application where there is potential for water leakage on the floor.

      a) Housekeeping pads may be omitted where not compatible with certain types of draw-out switchgear.

   9.2 Size housekeeping pads to extend 50mm past the equipment.

   9.3 Housekeeping pads to be between 110 and 152 mm high.

   9.4 Provide rebar as structurally required.

18.2 Space and Location Requirements

1. Design new electrical rooms to provide a minimum of 25% usable floor space not allocated to installed equipment, O & M information, tools, spare parts, related safety equipment at the end of the project. In addition, a minimum of 10% of usable wall space shall be spare after all associated electrical single line drawings (D sized) are mounted on the walls. This space provision shall not be utilized for equipment that only becomes defined as the project progresses.

Note: A common issue is that not all the electrical and automation equipment are known at the time of electrical room sizing. Electrical room sizing at the preliminary design stage may need to be 150 – 200% of the size required for the equipment known at this stage. Consider undefined requirements at the time of electrical room sizing.

2. Design new electrical rooms to be sufficiently close to loads to prevent excessive feeder lengths. This may require the provision of multiple or additional electrical rooms.

   2.1 Ensure VFD motor lead length limits in this document and manufacturer's recommendations are adhered to.

18.3 Redundancy Requirements

1. Where electrical distribution redundancy is required, separate each bank of the electrical distribution, with a minimum of a 2-hour rated fire separation for:

   1.1 All medium voltage distribution systems with a bus rating of 10 MVA or greater.

18.4 Ventilation Requirements

1. Design ventilation and mechanical cooling as required to keep electrical rooms cool. Minimum requirements are as per the Mechanical Design Guide.

Table 18-1 : Electrical Room Temperature Requirements

Type	Heating		Cooling	
	Occupied	Unoccupied	Occupied	Unoccupied
Standard	18°C	10°C	26°C	26°C
Small & Non-Critical	18°C	10°C	35°C	35°C

Note: 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.

2. Perform a heat load calculation for electrical rooms to ensure the ventilation system is adequately sized to reject the heat.
3. Where air quality is a concern, ensure that the electrical room is positively pressurized relative to surrounding areas. Pressurization is required in any area containing hazardous locations.
4. Ensure that electrical rooms maintain a G1 – Mild classification as per ISA 71.04. Where required, install a scrubber to address corrosive gases.
5. Ensure sufficient ventilation is provided to exhaust any potential hydrogen off-gas from batteries.
6. Filters are required on the air intake of all electrical rooms.
7. Humidity control may be required if electrical equipment within the room is sensitive to this or if environmental conditions warrant it.

19 ENGINEERING DESIGN TEAM RESPONSIBILITIES

19.1 General

1. Responsibility for deliverables
   1.1 All drawings and other deliverables related to a design are the responsibility of the design engineer.
2. All electrical deliverables are to be sealed by a qualified professional engineer registered in the Province of Manitoba.
3. Completeness of drawings:
   3.1 All drawings shall be comprehensive in nature to allow for effective use in construction and maintenance. For example: partial single line drawings are not permitted.
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.
      a) Single line drawings must always be updated, such that a complete set of single line diagrams is provided for the facility.
      b) Panel schedule drawings must always be updated, such that a complete set of panel schedules is provided for the facility.
      c) Update of existing motor starter schematics and loop diagrams is required, wherever changes are being made to the content of the specific drawings.
      d) The update of existing electrical plan drawings to reflect new work is not typical, and is not required unless specifically identified by the City.
      e) The update of other existing electrical drawings is dependent upon the design engineer’s scope of work, as agreed to with the City.
5. As-Built Drawings:
   5.1 All electrical 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.
   5.2 Unless otherwise specified by the City, as-built drawings will not be sealed (Otherwise known as record drawings).
6. External, 3rd Party Consultants:
   6.1 Expertise and assistance may be required, from external 3rd party specialized consultants, outside of the primary electrical design team.
   6.2 Areas where an external 3rd party consultant may be utilized, with permission from the City, are:
      a) Analysis and design of grounding system.
      b) Design of project specific specialized systems and equipment.
      c) Medium-voltage protection systems.
      d) Fire detection, protection and alarm systems.
      e) Corrosion protection systems.
      f) Area classification.

6.3 The design team shall be responsible for monitoring the activities and progress of each 3rd party consultant.

6.4 It is the responsibility of the design engineer to ensure that the deliverables follow all City standards and guidelines.

7. Site Visits:

7.1 The electrical 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 equipment.

8. Demolition Requirements

8.1 It is generally required that the design 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. Specific requirements include:

8.2 Where demolition requirements are significant, create dedicated demolition drawings.

8.3 Generally, abandoned equipment, wiring, etc. shall be removed unless specifically requested by the City that the equipment/wiring be retained, or removal is not practical.

9. Acceptance Testing

9.1 Acceptance testing requirements shall be defined for every project. Acceptance tests shall utilize NETA standards as a reference.

9.2 Acceptance testing forms shall be completed for every project and included with the O&M manuals.

9.3 The Design Team is responsible for reviewing the completed acceptance test forms to ensure that the installation complies with the specifications.

19.2 Drawings

The drawing requirements in this section are not exhaustive, but indicate general requirements for all projects, as applicable to the scope of work in the project. The electrical drawings produced shall be comprehensive to cover the scope of the project, and shall be detailed to an “industrial” level of detail. “Commercial-grade” drawings that have excessive use of “typical” and a general lack of detail are not acceptable.

19.2.1 Cable Tray Layouts

1. Requirement

1.1 Cable tray layouts are required for all work that includes cable trays.

2. Content:

2.1 All new and existing cable trays shall be shown, to scale, on the layout.

2.2 All potentially interfering mechanical equipment, if applicable, shall be shown with a lighter line weight.

2.3 All relevant equipment identifiers are to be shown on the drawing.

2.4 Provide sections and elevations where sufficient detail cannot be provided in plan.

2.5 Provide 3 dimensional views of the cable tray layouts where required to clarify the layout.

2.6 The requirement to produce cable tray layouts in a 3D model, together with mechanical equipment, shall be evaluated and established on a per project basis.

3. Format:

3.1 All cable tray layout drawings are to be produced on a standard A1 size drawing.

3.2 Drawing Scale:

a) Recommended: 1:30 or 1:50

b) Maximum: 1:75

19.2.2 Electrical Room Layouts

1. Requirement

1.1 Electrical Room Layouts shall be prepared for every project.

2. Content:

2.1 All new and existing equipment shall be shown, to scale, on the layout.

2.2 All mechanical equipment, if applicable, shall be shown with a lighter lineweight.

2.3 All equipment identifiers are to be shown on the drawing.

2.4 Provide sections and elevations where sufficient detail cannot be provided in plan.

3. Format:

3.1 All equipment plan layout drawings are to be produced on a standard A1 size drawing.

3.2 Drawing Scale:

a) Recommended: 1:30

b) Maximum: 1:50

19.2.3 Equipment Plan Layout Drawings

1. Requirement:

1.1 Equipment Plan Layout Drawings shall be prepared for every project.

2. Content:

2.1 All new and existing equipment shall be shown, to scale, on the equipment plan layout.

2.2 All mechanical equipment shall be shown with a lighter lineweight.

2.3 All equipment identifiers are to be shown on the drawing.

2.4 Provide sections and elevations where sufficient detail cannot be provided in plan.

2.5 Show all convenience and welding receptacles with circuiting indicated.

2.6 Show all Public Address (PA) system components.

3. Format:

3.1 All equipment plan layout drawings are to be produced on a standard A1 size drawing.

3.2 Drawing Scale:

a) Recommended: 1:50

b) Maximum: 1:100

19.2.4 Fire Alarm and Security Plan

1. Requirement

   1.1 Fire Alarm and Security Plan Drawings are required for all facilities with a fire alarm and/or security system.

2. Content

   2.1 Prepare plan drawings that show the detailed location and type of each detector, isolator, horn, strobe, pull station, etc.

   2.2 Provide the equipment identifier adjacent to each device. Where the room number is clearly shown on the drawing, the room number portion of the identifier may be implied.

   2.3 All fire alarm spacing shall be designed per CAN/ULC-S524 by the design engineer. Indication of general detection requirements for detailed design by the Contractor is not acceptable.

   2.4 Where flat ceilings are not provided, provide sections or other details to clarify the installation requirements, including installations in beam pockets.

   2.5 Show all security access control systems.

   2.6 Show the routing of major conduits on the plan drawing.

   2.7 Show all isolators.

3. Format:

   3.1 All fire alarm and security drawings are to be prepared on a standard A1 size drawing.

   3.2 Drawing Scale:

   a) Recommended: 1:50 – 1:100

   b) Maximum: 1:150

19.2.5 Fire Alarm Riser Diagram

1. Requirement

   1.1 Fire Alarm Riser Diagrams are required for all facilities with a fire alarm.

2. Content

   2.1 Provide a riser diagram for both the detection system and the notification system. For small systems this may be on a common drawing, but for large systems, these systems should be on separate drawings.

   2.2 Provide the equipment identifier adjacent to each device. Where the room number is clearly shown on the drawing, the room number may be implied.

   2.3 Clearly show all zone, devices, and wiring interconnections between devices.

   2.4 Show all booster power supplies.

3. Format:

   3.1 All fire alarm drawings are to be prepared on a standard A1 size drawing.

19.2.6 Grounding Diagrams

1. Requirement
   1.1 Grounding Diagrams are required for all facilities.
2. Content:
   2.1 Provide plan and elevation drawings as required to indicate the routing and connection of grounding conductors.
   2.2 The drawings are to clearly represent the grounding conductors within the building(s) and the exterior ground electrode layout, as well as interconnections.
   2.3 Clearly show the location of all ground electrodes.
   2.4 Clearly show conductor material type and size requirements.
   2.5
3. Format:
   3.1 All grounding diagrams are to be produced on a standard A1 size drawing.
   3.2 Drawing Scale - Interior:
      a) Recommended: 1:50
      b) Maximum: 1:100
   3.3 Drawing Scale - Exterior:
      a) Recommended: 1:50 - 1:100
      b) Maximum: 1:150
   3.4 Provide details and sections at a lower scale as required to clarify grounding requirements.

19.2.7 Hazardous Location Plan Drawings

1. Requirement
   1.1 Hazardous location plan drawings are required for all wastewater facilities, and should cover all floor areas.
   1.2 Hazardous location plan drawings are also required for any other facility where a hazardous location is present.
2. Content:
   2.1 Plan drawings of the facilities clearly showing the hazardous locations via hatching.
   2.2 It is recommended to also show Canadian Electrical Code Category 1 (wet) and Category 2 (corrosive) locations on the same plans via hatching.
   2.3 Show temperature codes for hazardous locations.
   2.4 For indoor locations where the hazardous classification is related to ventilation, clearly indicate the design ventilation rate on the drawings.
3. Format:
   3.1 All hazardous location plan drawings are to be produced on a standard A1 size drawing.
   3.2 Drawing Scale:
      a) Recommended: 1:50
      b) Maximum: 1:100

3.3 Provide details and sections at a lower scale as required to clarify hazardous locations around equipment.

19.2.8 Lighting Plan Drawings

1. Requirement:
   1.1 Lighting Plan Drawings are to be prepared for every project.
   1.2 Do not combine the Lighting Plan Drawings with the Equipment Plan Layout Drawings unless specifically approved by the City.
2. Content:
   2.1 Include all primary and emergency lighting.
   2.2 Include all exit lighting.
   2.3 Indicate circuit numbers beside each fixture.
   2.4 Indicate all lighting control.
   2.5 All lighting plan drawings shall reference a luminaire schedule. Where an existing luminaire schedule exists for a building or building area being modified, the existing luminaire schedule shall be updated and utilized. Avoid multiple luminaire schedules for the same area.
3. Format:
   3.1 All lighting plan drawings are to be produced on a standard A1 size drawing.
   3.2 Drawing Scale – Interior Drawings:
      a) Recommended: 1:50
      b) Maximum: 1:100
   3.3 Drawing Scale: - Exterior Drawings:
      a) Maximum: 1:100

19.2.9 Lightning Protection Drawings

1. Requirement:
   1.1 Lightning Protection Drawings are to be prepared for every project with lightning protection.
   1.2 Lighting protection drawings may be integrated into the overall grounding diagrams, but shall not be combined with other general rood arrangement drawings unless specifically approved by the City.
2. Content:
   2.1 Air terminals height and locations;
   2.2 Arrangement of main and down conductors;
   2.3 Grounding points and spacing;
   2.4 Bonding of roof drawings
   2.5 Sizing of conductors;
   2.6 Protection of conductors;
   2.7 Testing requirements of grounds; and
   2.8 Standard details.

3. Format:
   3.1 All lightning plan drawings are to be produced on a standard A1 size drawing.
   3.2 Drawing Scale (other than standard details):
      a) Recommended: 1:50
      b) Maximum: 1:100

19.2.10 MCC Layout Drawing

1. Requirement:
   1.1 A MCC layout drawing is required for every MCC.
2. Content:
   2.1 The primary content of the drawing is a front elevation of the MCC structure.
   2.2 Label all vertical sections with a number starting at 1. Label all horizontal rows with a letter, as per manufacturer identification.
   2.3 Each bucket / wrapper shall be sized appropriately and identified with the load equipment identifier and description.
   2.4 Label spare units as SPARE and space available for future starters/feeders as SPACE.
   2.5 Provide a table with the following MCC design requirements clearly identified:
      a) Equipment Identifier
      b) Enclosure Type
      c) Mounting
      d) Depth
      e) Supply voltage, phase, frequency
      f) Incoming neutral termination
      g) Control voltage
      h) Wiring Class
      i) Minimum bus rating (amps) for horizontal and vertical bus.
      j) Suitable for service entrance
      k) Neutral Bus
      l) Bus Bracing
      m) SCCR
      n) Series SCCR Permitted
      o) Bus Material
      p) Manufacturer / Model (To be completed at As-Built stage if competitive procurement)
3. Format:
   3.1 All MCC Layout Drawings are to be produced on a standard A1 size drawing.
   3.2 Drawing Scale:
      a) Recommended: 1:10

19.2.11 MCC Schedule

1. Requirement:
   1.1 A MCC Schedule is required for every MCC.
2. Content:
   2.1 Identify in tabular format:
   b) MCC Identifier
   c) Description
   d) Location
   e) Volts
   f) Amp Rating
   g) Phases
   h) Wires
   i) Main Breaker
      i. Rating
      ii. Type
      iii. Settings
   j) Total Connected Load
   k) Total Demand Load
   l) Legend

   2.2 For each unit within the MCC, provide a row within the table with the following clearly identified:
   a) Unit Location
   b) Load Identifier
   c) Load Description
   d) Motor Load (kW/hp/FLA)
   e) Non-Motor Load (kW)
   f) Starter
      i. NEMA Size
      ii. Type
      iii. Overload
   g) Circuit Protection
      i. Rating
      ii. Type
   h) Notes
3. Format:
   3.1 All MCC Schedules are to be produced on a standard A1 size drawing.

19.2.12 Motor Connection Diagram

1. Requirement:
   1.1 A dedicated motor connection diagram shall be prepared for every motor starter.
2. Content:
   2.1 The connection diagram will include all power and control field wiring external to the motor starter or control panels. The cables and conductors will be individually labelled along with all the terminations.
   2.2 All cable identifiers and sizes / types will be shown on the connection diagram.
3. Format:
   3.1 All motor connection diagrams are to be produced on a standard A1 size drawing.
   3.2 Space permitting, the Motor Connection Diagrams will be located together with the Motor Starter Schematics, occupying the right side of the drawing.

19.2.13 Motor Starter Schematics

1. Requirement:
   1.1 A dedicated motor schematic shall be prepared for every motor starter.
2. Content:
   2.1 The schematic will include the power distribution for the motor as well as the complete control circuit including terminal and wiring identification.
3. Format:
   3.1 All motor starter schematics are to be produced on a standard A1 size drawing.
   3.2 For typical 600 V motors, with minor to medium complexity, it is typical that the motor connection diagram is integrated with the schematic on the same drawing.

19.2.14 PA Riser Diagram

1. Requirement
   1.1 Public Address (PA) Riser Diagrams are required for all facilities with a PA system.
2. Content
   2.1 Provide a riser diagram that shows the complete details (not typical) for all PA system components.
   2.2 Provide the equipment identifier adjacent to each device. Where the room number is clearly shown on the drawing, the room number may be implied.
   2.3 Clearly show all zone, devices, and wiring interconnections between devices.
   2.4 Show all amplifiers and connections to telecom / network systems.
3. Format:
   3.1 All PA Riser Diagrams are to be prepared on a standard A1 size drawing.

19.2.15 Panel Schedules

1. Requirement:

   1.1 A dedicated panel schedule shall be prepared for every panelboard and distribution panel.

2. Content:

   2.1 The information provided for each panel shall include in tabular format:

   a) Panel identifier
   b) Amp rating, volts, phases, wires
   c) Surface / flush mount
   d) Top / bottom feed
   e) Description
   f) Location
   g) Manufacturer / Model
   h) Interrupting Rating
   i) Main Breaker
   j) Main Breaker Settings

   2.2 Show for each circuit:

   a) Circuit number
   b) Load description
   c) Notes
   d) Wire size
   e) Breaker rating
   f) Load (VA)
   g) Phase

   2.3 Total Connected Load (kVA)

   2.4 Total Connected Load per Phase (kVA & Amperes)

   2.5 Reference the applicable single line diagram feeding each panel on the drawing.

3. Format:

   3.1 All panel schedules are to be produced on a standard A1 size drawing in tabular format.

19.2.16 Power Distribution Switching Diagrams

1. Requirement:
   1.1 Power Distribution Switching Diagrams are required for all facilities where the electrical distribution cannot fit on one or two single line drawings.
2. Content
   2.1 A Power Distribution Switching Diagram is utilized to represent the overall power distribution of a larger facility on a single diagram, with less detail than a Single Line Diagram. Multiple switching diagrams should be avoided if possible.
   2.2 The level of detail on the drawings shall be reduced to a level to allow the entire electrical distribution to be shown. A primary purpose of the drawing shall be to allow electrical maintenance personnel to perform switching. All relevant equipment identifiers associated with switching shall be shown. Include all:
   2.3 Switching devices including disconnects fuses, breakers, interlocks, etc.
   2.4 Key Interlocks including identification numbers.
   2.5 Equipment including transformers, generators, major pumping units, feeders, buses, etc.
   2.6 For facilities with medium voltage distribution, it is acceptable to limit the scope of the facility switching diagram to the medium voltage distribution system. Additional switching diagrams may be required for the low voltage distribution systems.
3. Format:
   3.1 All switching diagrams are to be produced on a standard A1 or A0 size drawing.
   3.2 Orient power flow vertically from top to bottom.
   3.3 Where possible without adding complexity to the drawing, orient loads to reflect the physical orientation as seen by someone viewing the equipment from the front.

19.2.17 Security Riser Diagram

1. Requirement
   1.1 Security Riser Diagrams are required for all facilities with a security and/or access control system.
2. Content
   2.1 Provide a riser diagram for both the detection system and the notification system.
   2.2 Provide the equipment identifier adjacent to each device. Where the room number is clearly shown on the drawing, the room number may be implied.
   2.3 Clearly show all zone, devices, and wiring interconnections between devices.
3. Format:
   3.1 All security riser diagrams are to be prepared on a standard A1 size drawing.

19.2.18 Single Line Diagrams

1. Requirement:
   1.1 Single Line Diagrams are critical and shall be prepared for every facility.
   1.2 Single line diagrams shall be fully detailed and indicate the full electrical distribution from the source to the load.

2. Content

2.1 Each piece of equipment shall have the equipment identifier shown, as well as major equipment ratings.

a) Equipment ratings to include, but not be limited to voltage and ampere ratings

b) Show short circuit current ratings.

2.2 All medium voltage, 600 V, and 480 V loads shall be shown in detail on the single line diagrams.

a) Underneath each load indicate, in order from top to bottom, Equipment Identifier, description, load ratings

b) Indicate Full Load Amps for motor loads.

i. Utilize reasonable assumed full load currents until actual motor full load amps are known.

c) Update all load ratings (including full load amps) on the as-built drawings.

2.3 Show all mechanical, Kirk key and electrical interlocks.

2.4 Show connected and demand loads at each distribution point.

2.5 Show service and transformer grounding including details and protections associated with neutral grounding resistors.

2.6 Each cable shall have an identifier and cable size/type shown.

2.7 Show calculated arc flash incident energies at all points in the electrical distribution.

2.8 Show all electrical equipment interface connections to a PLC or any other equipment within the Process Control System.

2.9 Any notes or reference drawing information shall be noted on the drawing.

2.10

3. Format:

3.1 All single line drawings are to be produced on a standard A1 size drawing. If a facility cannot fit on a single drawing, utilize multiple drawings, preferably split per process area. See Single Line Overview Drawings for overview drawings

3.2 Orient power flow vertically from top to bottom.

3.3 Where possible without adding complexity to the drawing, orient loads to reflect the physical orientation as seen by someone viewing the equipment from the front. For MCC single line drawings, group loads from the same vertical section of a MCC.

3.4 Partial single line diagrams for renovations are not acceptable.

3.5 All text shall be 2.5mm high unless otherwise specified.

3.6 Arc flash incident energies shall be shown in an octagon, with two lines of text:

3.6.1 The first line: “I.E.” representing incident energy (2.0 mm high text); and

3.6.2 The second line “12.3” where 12.3 is the calculated incident energy in cal/cm^2 in 2.5 mm high text.

3.7 Show all electrical equipment interface connections to the PCS as a dashed line to a diamond, 10 mm wide by 10 mm high, with “PCS” in the diamond. The dashed line may represent multiple signals. The text may be 2.0 mm or 2.5 mm high as appropriate.

19.2.19 Switchgear Three-Line Diagram

1. Requirement:
   1.1 A switchgear three-line diagram shall be prepared for any switchgear containing PTs or CTs and associated protection or metering.
2. Content:
   2.1 A Switchgear Three-Line Diagram is utilized to represent the power distribution and associated protection and metering for power distribution switchgear.
   2.2 The appearance of a Three-Line Diagram is similar to a single Line Diagram, except each phase conductor is shown, along with all CTs, PTs, CPTs, and other protection and metering devices.
3. Format:
   3.1 All three-line diagrams are to be produced on a standard A1 size drawing.
   3.2 It is useful to contain some level of correlation in the arrangement to the actual physical orientation of the switchgear and the single line diagram.

19.3 Other Documents

19.3.1 Cable Schedule

1. Requirement:
   1.1 A cable schedule is required for every project.
2. Content:
   2.1 All power and control cables shall be uniquely identified on the cable schedule. Cables shall not be entered as typical.
   2.2 Where individual wires are routed in conduit, the wires shall be identified as an item in the cable schedule. This is not applicable for minor circuits, such as lighting, receptacles, etc.
   2.3 The cable schedule shall include the following fields:
      2.3.1 Cable Identifier
      2.3.2 Cable Type (e.g. 3C, 250 kcmil, TECK90, 1000 V)
      2.3.3 From
      2.3.4 To
      2.3.5 Spacing (0 – 100% applicable to cables in tray)
      2.3.6 Length (Estimate)
      2.3.7 Routing (Brief description)
      2.3.8 Notes
   2.4 The length for each cable shall be estimated at design time to within ~10% accuracy for purposes of pre-bid cost estimating and electrical system modelling.
3. Format:
   3.1 A cable schedule will typically be prepared in Microsoft Excel, but other formats may be accepted by the City with approval.

19.3.2 Lamacoid Schedule

1. Requirement:
   1.1 A lamacoid schedule is required for every project.
   1.2 It has been noted that the creation of a lamacoid schedule at design time greatly assists the Contractor, helps provide a higher quality of identification lamacoids for maintenance personnel, and can be created for a minimal effort above that required to thoroughly review a Contractor produced lamacoid schedule.
2. Content:
   2.1 All electrical lamacoids shall be uniquely identified on the lamacoid schedule, except as follows:
      a) Lamacoids for cables may reference the cable schedule.
   2.2 The lamacoid schedule shall at minimum include the following fields:
      a) Item
      b) Line 1
      c) Line 2
      d) Line 3
      e) Text Size
      f) Notes
3. Format:
   3.1 A lamacoid schedule will typically be prepared in Microsoft Excel, but other formats may be accepted by the City with approval.

19.3.3 Protection Settings Datasheets

1. Requirement:
   1.1 Protection Settings Datasheets are required for all projects with service equipment rated >= 1000 kVA. For projects with lower capacity, protection settings shall be shown on the drawings.
   1.2 Provide a protection settings datasheets for all equipment with configurable electrical protection settings, including but not limited to:
      a) Breakers with L, LI, LSI, and LSIG settings;
      b) Protection Relays;
      c) Variable Frequency Drives;
      d) Soft Starters; and
      e) Intelligent Motor Starters.
2. Content:
   2.1 Indicate all applicable settings for the device along with the setting.
   2.2 The datasheets schedule shall at minimum include the following fields:
      a) Device name and location
      b) Setting name;
      c) Setting value; and
      d) A revision code next to each setting so that it is clear which revision of a document changed a setting.

3. Format:

   3.1 Provide datasheets in editable Microsoft Word format, with settings in form format.

19.4 Design Calculations and Studies

19.4.1 General

1. All design decisions, leading to important design activities, must be supported by an appropriate calculation, which may be required for verification and justification. The Design Engineer shall prepare design calculations as required. It shall be the responsibility of the Design Team, to collect, verify and file all such calculations.
2. Methods and calculation formulae used shall be that permitted by company approved procedures and manuals or as specifically approved for the project. The software tools or vendor packages, utilized for the required calculations must be approved by the Lead Engineer for each specific project.
3. The general requirements for design calculations and studies are identified in Table 19-1.
4. Calculations done by subcontractors, contractors or vendors will be permitted if the calculation requires specialized knowledge or experience that a typical electrical design engineer would not possess. In these cases, it is the responsibility of the design engineer to ensure that the calculations follow all City standards and guidelines.
5. The calculations and studies shall only be deferred to the Contractor after review and agreement with the City.

19.4.2 Voltage Stability Study

1. Without limiting the general requirements to meet voltage drop requirements for all facilities with a service size greater than 1 MVA perform a voltage stability study to ensure that under all facility and utility operating scenarios that the power supply to the facility remains acceptable, avoiding any impact to operations or degrading the service life of the equipment.

19.4.3 Short Circuit, Coordination and Arc Flash Study

1. For all facilities, provide a comprehensive study and report which includes:
   - 1.1 Short circuit analysis including protective device evaluation
   - 1.2 Protective device coordination study
   - 1.3 Arc flash analysis
2. The Short Circuit, Coordination and Arc Flash Study shall be iteratively performed as part of the design process to ensure that the design is optimal, including short circuit, selective coordination and arc flash considerations.
3. Provide comprehensive arc flash labelling of all equipment:
   - 3.1 Type and style of label shall be submitted to and approved by the City prior to generating final labels.
   - 3.2 Detailed electrical hazard warning shall be compliant with part Q.4 of Annex Q of standard Z462-15 and produced and installed per ANSI Z535.4.
4. Refer to Appendix A – Arc Flash Study and Electrical System Modeling Requirements for detailed requirements.

19.4.4 Harmonic Studies

1. Harmonic studies are required to be performed prior to the installation of new non-linear loads at a facility. Manitoba Hydro mandates that the total voltage distortion (i.e. THD) must not exceed 3.5% and any individual harmonic or inter-harmonic voltage distortion must not exceed 2% at the point of common coupling and for supply voltages of 69kV and less. A harmonic study should be performed if 20% or more of the facility load consists of harmonic producing sources.
2. The harmonic study is the responsibility of the design engineer; however, the design engineer may utilize services provided by third party consultants and/or contractors with specialization in this area. In these cases, it is the responsibility of the design engineer to ensure that the calculations and recommendations meet local codes and requirements as well as all City standards and guidelines.

19.4.5 Instrument Transformer Sizing Calculations

1. Provide instrument transformer sizing calculations to justify selection of current and potential transformer ratings, including ratios, accuracy, and burdens, etc.
2. Current transformer calculations shall be based on IEEE C 37.110 “Guide for the application of Current Transformers Used for Protective Relaying Purposes” and take into account expected loading, short circuit levels, X/R values, protective relaying burdines, etc.

Table 19-1 : Design Calculations and Studies

Deliverable	Notes
Arc Flash Study	Required for all new work and the scope of the work must address the entire facility.
Cable Ampacity Calculations – Tray and Conduit	
Cable Ampacity Calculations – Underground	
Cable Pulling Calculations	Only required by the design engineer for major feeders. Contractor may be required to calculate for other cable pulls.
Cable Tray Loading Calculations	Not required for minor trays if load is self-evident.
Coordination Study	
Electrical Rooms Heating and Cooling Loading	Utilized for ventilation design.
Grounding Resistance Calculations	
Grounding Study	Typically only required for medium voltage systems. See Section 14.4.
Harmonic Study	Only required for systems with significant harmonic sources. See Section 19.4.2
Heat Tracing Calculations	
Lighting Illumination Calculations	
Load Tabulation	
Load Flow Study	Determine power flows and voltages in a power system. Ensure power flows are within equipment ratings. Ensure voltages are within acceptable operating limits.
Motor Starting Analysis	Typically only required for larger motors.
Power Factor Correction Calculations / Study	A formal study would only be provided for larger installations, where identified by the City as a deliverable.
Short Circuit Calculations / Study	
Soil Resistivity Survey	Typical for medium voltage systems.
Voltage Drop Calculations	Formal calculations would only be typical for major feeders. May be part of the Load Flow Study.

19.5 Example - Typical Deliverables for a Lift Station

Typical electrical deliverables for a wastewater lift station are shown in Table 19-2.

Table 19-2 : Wastewater Lift Station Electrical Typical Deliverables

Deliverable	Preliminary	Detailed Design	Notes
Single Line Diagram(s)	Y	Y	
Electrical Room Layout	Y	Y	
Cable Trench Layout		Y	
Demolition Drawings (as required)		Y	
Hazardous Location Plan		Y	
Electrical Equipment Plans (all levels)		Y	Show all equipment and convenience receptacles.
Lighting Plan (all levels)		Y	
Emergency Lighting Riser Diagram		Y	May be on lighting plans.
Distribution Panel Elevation		Y	
Motor Control Center Elevation		Y	
Motor Control Center Schedule		Y	
Panelboard Schedules		Y	
Luminaire Schedule		Y	
Emergency Lighting Battery Schedule		Y	May be on schedules drawing
Lift Pump Motor Starter Schematic		Y	Typical drawings not permitted.
Lift Pump Motor Starter Connection Diagram		Y	Typical drawings not permitted.
Panel Layout – Lift Pump Motor Starters		Y	
Motor Starter Schematics and Connection Diagrams (Other motors)		Y	Typical drawings not permitted.
Electrical Details		Y	
Telephone Network Details		Y	
Grounding Diagram and Details		Y	
Short Circuit, Coordination, and Arc Flash Study		Y	

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20 SAMPLE DRAWINGS

SK-101	Single Line Diagram, MCC-M710
SK-102	Single Line Diagram, 4160 V Electrical Distribution
SK-201	Motor Starter Schematic, P-L01, Wastewater Lift Pump
SK-202	Connection Diagram, P-L01, Wastewater Lift Pump
SK-203	Motor Starter Schematic, P-M541, Sump Pump

Appendix A

TABLE OF CONTENTS

PAGE

APPENDIX A

ARC FLASH HAZARD STUDY AND ELECTRICAL SYSTEM MODELING REQUIREMENTS

1. DEFINITIONS

1.1.1 In this document, in addition to the definitions set out in the Electrical Design Guide, the following expressions have the following meanings (and, where applicable, their plurals have corresponding meanings):

(a) Arc Flash Hazard – a source of possible injury or damage to health associated with the release of energy caused by an electric arc.

(b) “Arc Flash Labels” has the meaning indicated in Annex Q of CSA Standard Z462 current edition.

(c) “Arc Flash, Short Circuit and Coordination Study Report” means the report indicated in Section xx.

(d) “HRC” means Hazard Risk Category as used in relation to Arc Flash Hazards.

(e) “MCC” means Motor Control Centre.

(f) “TCC” has the meaning time-current characteristic curves.

(g) “SKM Power*Tools for Windows” (SKM) has the meaning indicated in Section xx.

(h) “Work” or “Works” means the carrying out and the doing of all things, whether of a temporary or permanent nature, that are to be done by the contractor pursuant to this contract and, without limiting the generality of the foregoing, includes the furnishing of all plant, material, labour and services necessary for or incidental to the fulfilment of the requirements of this contract, including all Changes in Work.

2. ARC FLASH STUDY AND ELECTRICAL SYSTEM MODEL

2.1 Arc Flash Hazard Study and Associated Work

2.1.1 The consultant will complete the Arc Flash Hazard Study and all associated work outlined below using an SKM model and turn over the model and associated libraries to the City for its use at the end of the Work.

2.1.2 The systems shall be designed with Arc Flash restrictions as a consideration and, where possible with new systems, the Arc Flash restrictions shall be maintained at a Hazard Risk Category (HRC) of two (2) or lower as defined within CSA Z462.

2.1.3 The consultant shall ensure that all calculations, analyses, and recommendations for the Work meet the requirements of the latest edition of the following industry standards.

CSA C22.1	Canadian Electrical Code, Part I – Safety Standard for Electrical Installations (CEC)
CSA Z462	Workplace electrical safety (Z462)

IEEE 1584	IEEE Guide for Performing Arc–Flash Hazard Calculations (IEEE 1584)
IEEE 141	IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE 141, or the Red Book)
IEEE 241	IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (IEEE 241, or the Grey Book)
IEEE 242	IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE 242, or the Buff Book)
IEEE 399	IEEE Recommended Practice for Industrial and Commercial Power System Analysis (IEEE 339, or the Brown Book)
IEEE 551	Recommended Practice for Calculating AC Short–Circuit Currents in Industrial & Commercial Power Systems (IEEE 551, or the Violet Book)
IEEE 1015	IEEE Recommended Practice For Applying Low Voltage Circuit Breakers Used in Industrial and Commercial Power Systems (IEEE 1015, or the Blue Book)
ANSI / IEEE C37.010	IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (IEEE C37.10)
ANSI / IEEE C37.13	IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures (IEEE C37.13)
	The Manitoba Electrical Code and the Winnipeg Electrical By-law

2.2 Scope of Study

2.2.1 The scope of the study shall be based on the Works including the complete facility in its existing condition, and all transitional stages up to the final configuration.

2.2.2 The City will supply to the consultant:

(a) the anticipated Services required, if they deviate from those outlined in this section;

(b) any available single line diagrams showing the modes of operation and the configurations to be studied;

(c) any existing arc flash models for the facility. The existing model is supplied as is and the consultant shall validate and update the model with the Works as required;

(d) Manitoba Hydro supplied utility information regarding fault levels and supply transformer(s);

(e) other available information as required by the consultant for completion of the analysis; and

(f) site access for data collection and verification.

2.2.3 The consultant shall be responsible for removing existing Arc Flash Labels.

2.2.4 The consultant shall provide and install Arc Flash Labels for the entire facility in a manner such that equipment is always labelled with current arc flash values.

2.3 Design Requirements

2.3.1 All new and modified electrical designs shall ensure that arc flash energies are within the ratings specified in Table 2.3-1.

2.3.2 The electrical designer shall model the arc flash energies during design time and specify equipment as required to ensure that the design arc flash ratings are maintained.

Table 2.3-1 : Arc Flash Design Requirements

Equipment	Arc Flash Hazard / Risk Rating		Notes
	Recommended Maximum	Absolute Maximum (See Note 1)	
Control Panels, <= 600 V	0	1	
Distribution Panel, <= 600 V	2	3	
Distribution Panel, <= 600 V, Main Breaker	3	4	2
Motor Control Centre, 600 V	2	3	
Motor Control Centre, 600 V, Main Breaker	3	4	2
Panelboard, 208/120 V	0	2	
Panelboard, 347/600 V	1	2	
Switchgear, <= 600 V	3	4	
Switchgear, <= 600 V, Main Breaker	4	4	
Switchgear, Medium Voltage	3	4	
Switchgear, Medium Voltage, Main Breaker	4	4	
Transformers	4	-	3

Notes:

1. The City must approve all cases where the arc flash energies exceed recommended maximum values.
2. The main breaker must be in a separate compartment to permit a separate rating.
3. It is not typical to require live work on energized transformers.

2.4 General Requirements

2.4.1 As part of any Arc Flash Hazard Study assignment, the consultant shall include:

(a) a short circuit analysis with protective device evaluation;

(b) a protective device coordination study; and

(c) a single-line diagram of the system showing results of the analysis. The single line diagram will done following current City drafting standards on current City drawing title blocks and will be signed by the engineer referenced in Item.

(d) Upon completion, the consultant shall submit a draft and final report detailing the findings.

2.4.2 The consultant shall conduct the Arc Flash Hazard Study under the supervision and approval of an EGM registered professional electrical engineer with a minimum of five (5) years' experience in performing and interpreting power system studies including Arc Flash Hazard.

2.4.3 The consultant shall utilize the most current version of the SKM Power*Tools for Windows software package to perform all modelling and analysis.

2.4.4 Where the City has existing studies in its records using SKM software, the consultant shall incorporate and consolidate these SKM models into its model. The consultant shall be responsible for verification of any existing models provided by the City. The consultant may rely on the existing models for the purpose of arc flash modelling, however, no reliance on the models may be utilized for any other purpose associated with the design

2.4.5 The consultant shall coordinate with the City to acquire details required to complete the analysis. The consultant shall perform a document review of available documents and drawings prior to formally verifying all documentation on site.

2.4.6 The consultant shall arrange, with the Contract Administrator, travel to each site to acquire the necessary data required to complete the study.

2.4.7 The Consultant shall be made aware of and shall follow all site safety requirements.

2.4.8 Data collection, verification and analysis shall begin at the Utility point of service and include all downstream AC electrical equipment, including but not limited to:

(a) Switchgear, distribution switchboards, panelboards and MCCs rated 120/208 volts and higher. (This criterion is more stringent than the Standards covering Arc Flash Hazard Study and shall be used by the consultant to define the Scope of Study;

(b) disconnect switches;

(c) neutral grounding resistors;

(d) standby generators;

(e) manual transfer switches;

(f) automatic transfer switches;

(g) busway and splitters;

(h) motor starters;

(i) power factor correction equipment;

(j) adjustable speed drives;

(k) all medium voltage equipment;

(l) primary and secondary transformer connection cubicles; and

(m) other significant locations throughout the system as identified by the City.

2.4.9 The consultant shall also carry out the analysis of any DC equipment using DC incident energy calculations found in CSA Z462 Annex D Section D.5.

2.4.10 For existing distributions, the consultant shall verify all equipment nameplates and ratings; protective device manufacturers, types, sizes and settings; cable sizes, types, lengths, raceways and configurations; and other relevant details on–site to confirm the accuracy of the City's drawings and previous Arc Flash Hazard Study studies.

2.4.11 Transformer design impedances shall be used when actual test impedances are not available. The consultant shall consider the full range of impedances for transformers equipped with on-load tap changers to determine the worst case scenario.

2.4.12 Motor contributions shall be incorporated in determining fault levels as follows:

(a) all Medium voltage motors shall be individually modelled;

(b) all 600V motors equal to or greater than 50 HP shall be individually modelled; and

(c) all smaller motors shall be lumped into groups, with each grouping not to exceed 50HP, feeding their nearest panelboard, MCC or distribution switchgear.

2.4.13 The consultant shall use actual conductor impedances and configurations if known. If actual values are not known, typical impedance values shall be obtained from manufacturer for the given configuration or calculated from the given materials, geometry and configuration used.

2.4.14 Any information from manufacturers and any calculated or assumed values shall be supplied, in an appendix with clear reference to report sections, as information in the final report.

2.5 Short Circuit Analysis with Protective Device Evaluation

2.5.1 The consultant shall perform a short circuit analysis with a protective device evaluation based on this section and the General Requirements section.

2.5.2 Four operating scenarios are to be evaluated:

(a) Scenario 1 will represent an “Infinite Bus” scenario per Winnipeg Electrical By-law (By-law No. 86/2018) Rule 14-012:

(i) The calculation will assume an infinite primary bus.

(ii) The percent impedance for transformers will be the percent impedance of the installed transformer or the value provided by Manitoba Hydro for a utility-owned transformer.

(b) Scenario 2 and Scenario 3 will be based on the Manitoba Hydro provided normal and expected maximum available fault levels at the point of utility interconnection.

(c) Scenario 4 will represent a very low short-circuit current that can be reached at the point of interconnection.

2.5.3 Calculations shall be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the system contribution is at a minimum with minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the system and will assume the maximum amount of motors is operating.

2.5.4 Calculations shall be based upon all configuration scenarios including extreme supply conditions from the utility.

2.5.5 The analysis calculation methodology shall be in accordance with the listed IEEE and ANSI C37 standards. Short circuit calculations shall be prepared in SKM Systems Analysis software.

2.5.6 Calculate the short circuit momentary and interrupting duties for a three-phase bolted fault and single-line-to-ground faults at each location in Item 2.3.7. Include any planned future standby generation.

2.5.7 Evaluate all electrical equipment’s short circuit withstand rating within the Works at calculated short circuit levels.

2.5.8 Evaluate all protective devices’ interrupting capacities at the calculated short circuit level of their associated switchboard, MCC or panelboard, etc.

2.5.9 Results of the equipment and protective device evaluation shall be presented in tabulated form within the short circuit evaluation analysis comparing the highest calculated fault level to the device withstand/interrupting ratings.

2.5.10 Include the following information in the tabulation:

(a) Bus identifier.

(b) Device name.

(c) Manufacturer and description of equipment.

(d) Voltage.

(e) Device withstand or interrupting rating.

(f) Suitability of device interrupting rating.

(g) Calculated short circuit current for each Scenario identified in Item 2.4.2.

(h) Example table:

Bus ID	Device Name	Manufacturer/ Description	Voltage	Device Rating	Suitability	Calculated Current			
						Scenario 1	Scenario 2	Scenario 3	Scenario 4

2.5.11 For the equipment within the facility, the consultant shall notify the City, in writing, of circuit protective devices and any system component inadequately rated for the calculated available fault current.

2.5.12 Inadequate rating of any equipment supplied or modified under the Work is not acceptable.

2.6 Protective Device Coordination Study

2.6.1 The consultant shall perform a protective device coordination study based on the requirements outlined in this section and in the General Requirements section.

2.6.2 The consultant shall verify any built-in SKM device models used in the software model against device manufacturer’s documentation. Any device that is not present within the SKM library shall be modelled as a custom device as per the manufacturers most current product information for the specific device installed.

2.6.3 The consultant shall prepare and present time-current characteristic curves (TCC), displayed on log-log scale graphs. All curve sheets shall be multi-colored for improved clarity. Include on each TCC graph:

(a) a complete title and one-line diagram with legend identifying the specific portion of the system covered and the configuration used;

(b) voltage at which curves are plotted;

(c) current multiplier; and

(d) ANSI frequent fault damage curves.

2.6.4 The equipment modeled shall include:

(a) fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands;

(b) low voltage circuit breaker trip devices, including manufacturer's tolerance bands;

(c) transformer full-load current, magnetizing in-rush current, and ANSI through-fault protection curves for both bolted and single line to ground fault conditions;

(d) conductor damage curves;

(e) pertinent motor starting characteristics and motor damage points where applicable;

(f) the largest feeder circuit breaker in each MCC and applicable panelboards; and

(g) ground fault protective devices, as applicable. To increase clarity of TCCs multiple ground fault devices in a circuit shall be shown on a separate TCC.

2.6.5 The TCC shall be used to determine the required sizes and settings of the protective devices to optimize selectivity and meet Canadian Electrical Code requirements.

(a) Provide adequate time margins between device characteristic curves such that selective operation is provided, while providing proper protection.

(b) For each device, show the as-found settings. Identify the device associated with each curve by device name, manufacturer, device type, function, and, if applicable, tap, time delay, and pick-up settings.

(c) Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

(d) Where applicable, the incoming Manitoba Hydro protective devices shall be the most upstream device analyzed in a coordination study. The consultant shall coordinate Manitoba Hydro protection TCC with the rest of the system. If necessary, a Manitoba Hydro contact will be provided to the consultant by the City.

(e) Where devices are existing, changes to settings are to be shown on a separate TCC with associated devices demonstrating the improved coordination. The revised setting shall be recommended to the City and presented in the report as final only when the City has agreed to allow the changes. Where changes are required, they shall be clearly identified in a separate table with their corresponding device names to ensure that changes are made as the labels are applied. The consultant shall implement the proposed changes.

2.6.6 A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection in explicit detail. Areas lacking complete coordination shall be highlighted, and the consultant shall provide reasons for allowing the condition to remain as-is or provide recommendations to resolve the situation.

2.6.7 The consultant shall provide all final protective device settings in a table, including all enabled elements (overcurrent, ground overcurrent, differential, restricted earth, etc.), as well as supporting calculations justifying selected settings.

2.7 Arc Flash Hazard Study

2.7.1 The consultant shall perform an Arc Flash Hazard Study based on the guidelines outlined in this section and in the General Requirements section.

2.7.2 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system as outlined in CSA Z462 and Annex D - IEEE 1584 calculation method where work could be performed on energized parts.

(a) Separate calculations shall be made for different compartments within the same overall equipment where the arc flash energies will be different.

(i) For example, the main incoming breaker compartments and feeder breaker compartments in medium voltage switchgear shall have independent arc flash calculations performed.

(b) For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall be provided for both the line and load side of the main breaker.

(i) When performing incident energy calculations on the line side of a main breaker the line side and load side contributions shall be included in the fault calculation.

(c) The calculations at tie-breakers or other locations where two sources may contribute to an arcing fault at a common piece of equipment or switchgear cell, the arc flash energy shall be calculated based on combined contributions from both sources, regardless of the normal operating state of the device.

(d) Safe working distances shall be based upon the calculated arc flash boundary as per CSA Z462. Safe working distances shall be determined for both the circumstance of the conductors exposed and the circumstance of covers closed and fully latched and bolted.

(e) Arc flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at two (2) seconds based on IEEE 1584 section B.1.2: Where it is not physically possible to move outside of the arc flash protection boundary in less than two (2) seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

(f) Arc Flash Hazard results table summary, which shall include:

(i) Location & equipment designation;

(ii) Nominal voltage;

(iii) Flash protection boundary;

(iv) Incident energy; and

(v) Working distance.

2.7.3 The short circuit calculations and the clearing times of the phase overcurrent devices will be determined from the City's provided drawings and information, and equipment model numbers verified by the consultant.

(a) The short circuit calculations and the corresponding incident energy calculations for multiple system scenarios shall be compared, and the greatest incident energy shall be uniquely reported for each equipment location.

(b) The incident energy calculations shall consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should not be considered beyond 3-5 cycles.

2.7.4 Mis-coordination should be checked amongst all devices. The calculation shall utilize the fastest device to compute the incident energy for the corresponding location.

2.7.5 The consultant shall review existing protection settings/devices for proper coordination. The consultant shall recommend mitigation measures to reduce the arc flash hazard as appropriate. These recommendations may include but are not limited to either equipment protection and/or improving arc flash incident energy levels by adjusting existing protection settings/devices. The corresponding incident energy levels shall be provided where improvements can be made.

2.8 Final Report

2.8.1 All final reports and drawings shall be sealed by a Professional Electrical Engineer registered and in good standing with EGM.

2.8.2 The Arc Flash, Short Circuit and Coordination Study Report shall include the following sections:

(a) Executive summary.

(b) Descriptions, purpose, basis and scope of the study.

(c) Modes of operation studied.

(d) List of assumptions made where specific information was not available.

(e) List of all study input data, including but not limited to: Utility information; motor data; transformer data; cable sizes, types and lengths; protective device types and settings; etc.

(f) Short Circuit Study

(i) Tabulation of distribution equipment, circuit breaker, fuse and other protective device withstand and interrupting ratings versus calculated short circuit duties as per Items 2.4.9 and 2.4.10.

(ii) Results of short circuit study listing equipment that is applied above short circuit current rating and recommendations if appropriate.

(g) Protective Device Coordination Study

(i) TCC curves demonstrating protective coordination for all segments of the Work including all interfaces to the facility distribution.

(ii) Explanatory descriptions to any curves or graphs shall be provided to aid with interpretation.

(iii) Tabulation of all protective device settings and fuse selections.

(iv) Recommendations to improve coordination and/or reduce arc flash energies.

(v) Tabulation of all recommended settings.

(h) Arc Flash

(i) Fault current calculations including a definition of terms and a guide for interpretation of the results.

(ii) Details of the incident energy and flash protection boundary calculations for each scenario analyzed.

(iii) Design methodology employed to reduce arc flash energies and provide for selective coordination.

(i) Single-line diagram of the Work, which shall include:

(i) transformer rating, voltage ratio, impedance, and winding connection;

(ii) feeder cable phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type where applicable;

(iii) switchgear, switchboards, panelboards, MCCs, fuses, circuit breakers and switches continuous ratings and interrupting capabilities or withstand capacities, as applicable;

(iv) protective relays with appropriate device numbers, CTs and PTs with associated ratios;

(v) detailed legend indicating device type identification and other significant details; and

(vi) incident arc flash energies.

2.8.3 The consultant shall provide the City with a copy of the final SKM Systems Analysis model generated for each stage of the Works. The final update will include all work performed to date by the consultant for each facility.

2.9 Final Deliverables

2.9.1 Prior to Total Performance, the consultant shall submit:

(a) electronic Word and pdf copies of the Arc Flash, Short Circuit and Coordination Study Report;

(b) three (3) bound, color, paper copies of the final Arc Flash, Short Circuit and Coordination Study Report, with drawings and TCCs formatted as 11x17 pages and folded into the report;

(c) native SKM Power Tools model and library files, including all scenarios assessed; and

(d) single line drawings shall be submitted as AutoCAD dwg files, pdf files and oversize ISO A1 drawings printed on Mylar.

2.10 Labelling

2.10.1 The consultant shall remove existing Arc Flash Labels prior to installing new labels.

2.10.2 Arc flash labels shall utilize metric units.

2.10.3 The consultant shall provide and install detailed Arc Flash Labels on all electrical equipment encompassed by the Arc Flash Hazard Study.

2.10.4 Certain types of equipment, such as transformers, contain multiple voltage levels. The arc flash incident energy needs to be evaluated at all voltage levels present and the highest incident energy computed will need to be shown on the arc flash label. The approach distances on the labels must always reflect the highest voltage level present within the equipment, regardless of which voltage level generates the highest incident energy.

2.10.5 The arc flash label format used for equipment rated Category 0 through Category 4 is shown in Figure 2.9-1 and Figure 2.9-2.

(a) Warning labels are to utilize an orange heading with the word “Warning”.

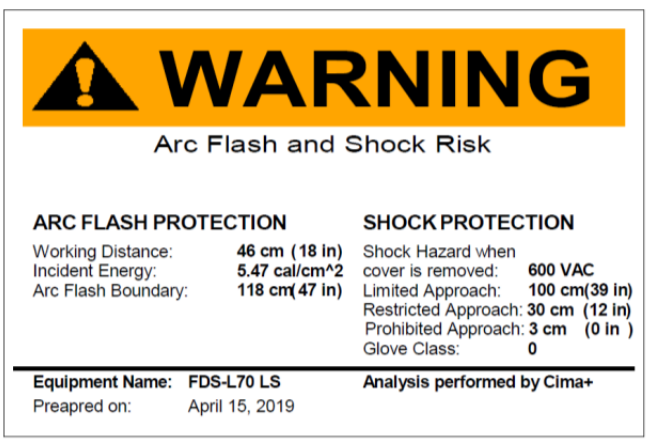

Figure 2.9-1

(b) For equipment that is given a Dangerous category rating, the arc flash labels are to utilize a red heading with the word "Danger".

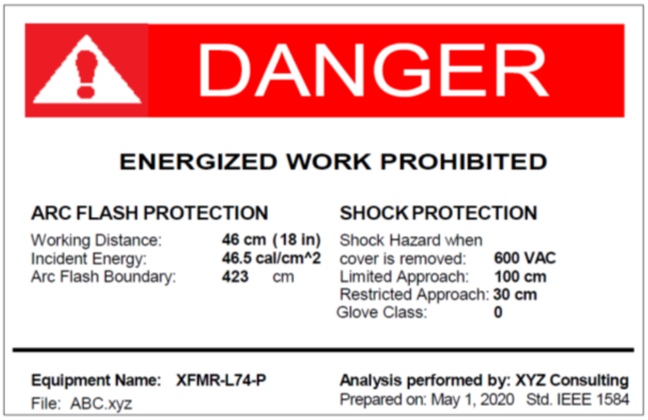

Figure 2.9-2

2.10.6 The consultant shall coordinate with the City to provide an Arc Flash Label format and size acceptable to the City. Type and style of label shall be submitted to the City and endorsed as "Reviewed" prior to final printing and application of labels.

2.10.7 Detailed electrical hazard warning shall be compliant with CSA Z462 Annex Q Section Q.4 and produced and installed per ANSI Z535.4. Labels shall be vinyl, waterproof with UV Resistance and a five (5) year rated life.

APPENDIX O – WSTP ELECTRICAL AND INSTRUMENTATION STANDARDIZATION SUMMARY - R05

Winnipeg Sewage Treatment Program

Capital Development

Electrical and Instrumentation Standardization Summary

Document Number:	**-**
Number of Pages:	9
Revision:	**05**
Date:	**2020-01-23**
Prepared By:	**Kurt Schimke**
Checked By:	**J. Veilleux (R05)**
Approved By:	**J. Veilleux (R05)**

1 Introduction

The City of Winnipeg has standardized on specific electrical and automation manufacturers. This document provides a summary of the standards.

It is intended that the manufacturer selected by the standardization process may be considered the standard for the City of Winnipeg wastewater treatment facilities. The goods to be purchased under the standardization contracts are intended to be utilized at the SEWPCC, NEWPCC, and WEWPCC facilities. However, the City of Winnipeg reserves the right to procure goods under the standardization contracts for other City of Winnipeg facilities, without initiating a separate Bid Opportunity process.

2 Control System and Motor Control Equipment

Associated RFP	756-2013
Award Date	2014-11-07
Contract Expires	2024-06-30
Contract Extensions	Optional four (4) five-year extensions, ultimately to 2039-06-30
Contract Administrator	Kurt Schimke CET 1199 Pacific Ave Winnipeg, MB, R3E 3S8 kschimke@winnipeg.ca tel. 204-986-5310
Vendor	**Schneider Electric Canada Inc.**
Primary Contact (Schneider)	Garth Eastman 21 Omands Creek Blvd Winnipeg, MB, R2R 2V2 204-631-0670 garth.eastman@ca.schneider-electric.com
Example Items included in the Standardization (The list is not comprehensive but provides a general indication of the scope)	Motor Control Centers (intelligent & standard) Loose motor starters Loose VFDs PLCs Pre-manufactured terminal assemblies designed to interconnect with the PLCs (Telefast blocks) Industrial HMI hardware HMI software systems Ethernet network switches for the control system
Example Items not under the Standardization	Electrical Transformers not in a MCC or motor starter Disconnect / Safety Switches not in a MCC or motor starter Panelboards not integrated in a MCC Switchboards / Switchgear not integrated in a MCC System Integration Services Control Panels to house PLCs Windows-based Computer Hardware Instrumentation Power supplies not integrated with the PLC / HMI systems Terminal blocks not integrated with the PLC / HMI systems
General Procurement Details	See Section 7

Distributor Contact	Eecol Electric Trevor Hambleton 1760 Wellington Avenue Winnipeg, MB, R3H 0E9 Telephone: 204-774-2800 E-mail: hambletont@eecol.com
Goods to be procured from Distributor (Other goods from Schneider)	• Programmable Controllers (PLCs) including all associated components, hardware and software • Programmable Controller Programming Software • HMI System software • Touchscreen HMI systems such as Magellis HMIs • Touchscreen HMI Programming Software • Motor Control Centers including all components • Loose VFDs, motor starters, soft starters, and associated components • Industrial Ethernet Switches
Goods to be procured directly from Schneider	• PLC to Infi90 Termination Unit migration cables • Process Simulator Software • Historian Server and Client Software • Version Management Software • Information Server Software • Annual update and support services • Training sessions • Field services

3 Electric Valve Actuators

Associated RFP	331-2014
Award Date	2015-01-27
Contract Expires	2024-09-30
Contract Extensions	Optional four (4) five-year extensions, ultimately to 2039-09-30
Contract Administrator	Kurt Schimke CET 1199 Pacific Ave Winnipeg, MB, R3E 3S8 kschimke@winnipeg.ca tel. 204-986-5310
Vendor	**Rotork Controls Canada Ltd.**
Contact	Mr. Henry Zenteno #6, 820 - 28th Street North East Street Calgary, Alberta, T2A 6K1 1-403-813-5850 Henry.Zenteno@rotork.com
Example Items included in the Standardization (The list is not comprehensive but provides a general indication of the scope)	Multi-turn electric valve actuators and quarter-turn electric valve actuators with an approximate torque requirement of On/off torques > 250 Nm Modulating torques > 150 Nm
Example Items not under the Standardization	Solenoid valve actuators Small HVAC damper actuators Electric valve actuators with a power supply < 120 VAC
Procurement Details	See Section 7

4 Gas Detection Systems

Associated RFP	123-2014
Award Date	2015-01-23
Contract Expires	2024-06-30
Contract Extensions	Optional four (4) five-year extensions, ultimately to 2039-06-30
Contract Administrator	Kurt Schimke CET 1199 Pacific Ave Winnipeg, MB, R3E 3S8 kschimke@winnipeg.ca tel. 204-986-5310
Vendor	**Tundra Process Solutions Ltd.**
Contact	Sheldon Bradley Senior Inside technical Sales 3200-118Ave S.E. Calgary, AB T2Z 3X1 Telephone: 1-800-265-1166 Mobile: 403-510-2011 E-mail: sbradley@tundrasolutions.ca
Example Items included in the Standardization (The list is not comprehensive but provides a general indication of the scope)	Gas detection sensors Gas detection transmitters Gas detection controllers Gas detection consumables
Example Items not under the Standardization	Analytic sensors for online process measurement
Procurement Details	See Section 7

5 Instrumentation

Associated RFP	449-2014
Award Date	2015-04-28
Contract Expires	2024-09-30
Contract Extensions	Optional four (4) five-year extensions, ultimately to 2039-09-30
Contract Administrator	Kurt Schimke CET 1199 Pacific Ave Winnipeg, MB, R3E 3S8 kschimke@winnipeg.ca tel. 204-986-5310
Vendor	**Trans-West Supply Company Inc.**
Contact	Amurthan Abimanan Branch Manager 126 Bannister Road Winnipeg, MB, R3R 0S3 Telephone: 204-783-0100 Mobile: 204-782-1864 E-mail: amu@transwest-mb.com
Example Items included in the Standardization (The list is not comprehensive but provides a general indication of the scope)	Flowmeters – electromagnetic Flowmeters – Differential pressure based Pressure Transmitters Temperature Transmitters Ultrasonic Level Transmitters
Example Items not under the Standardization	Flowmeters – ultrasonic, coriolis Flow switches Pressure switches Temperature switches Radar Level Transmitters Level Switches (non-ultrasonic based)
Procurement Details	See Section 7

6 Uninterruptible Power Supplies

Associated RFP	341-2013
Award Date	2014-02-10
Contract Expired	2015-08-31

This contract has expired. The WSTP does not currently have a standard for Uninterruptible Power Supplies.

7 General Procurement Details

The procurement details associated with all standardization initiatives in this document summarized below. For specific contract requirements, refer to the appropriate standardization RFP.

Procurement Format	Procurement of Goods under this Contract may be directly by the City, or indirectly via an Installation Contractor engaged by the City. "Installation Contractor" means the person undertaking construction or implementation work under a separate contract with the City, who will utilize the pricing, terms, and conditions of this Contract to procure equipment for performing the work under the separate contract. The Installation Contractor may be a subcontractor to a contractor engaged by the City. The Vendor shall allow Installation Contractors to procure equipment on behalf of the City, based upon the pricing, technical specifications and delivery requirements of the corresponding contract.
Quotation	Upon request by the City or a potential Installation Contractor for installation work on behalf of the City, the Vendor shall provide an itemized quotation for the Goods, consistent with the terms of the contract.
Pricing	The Vendor is responsible for providing pricing to either the City or Installation Contractors, consistent to that provided in the contract with the City. The Installation Contractor may mark-up the associated goods, within the terms of their specific contract with the City. The vendor shall provide an equal quotation to all potential Installation Contractors
Payment	Payment to the Vendor is the responsibility of the party ordering the goods. Where an Installation Contractor purchases the goods, the Installation Contractor is responsible for payment.
Auditing	An auditing mechanism between the Vendor and the City of Winnipeg provides the means for the City to verify that the supply of goods and associated pricing is as per the contract.
Reference	In each quotation, purchase order, proposal, and invoice reference: • The specific Bid Opportunity the purchase is associated with. • A statement indicating: "This request / purchase order is subject to the Terms and Conditions of City of Winnipeg Request for Proposal RFP XXX-YYYY." Where XXX-YYYY is the specific RFP number of the standardization contract.

APPENDIX P – WSTP ELECTRICAL AND INSTRUMENTATION STANDARDIZATION CLAUSES - R04

THE CITY OF WINNIPEG

BID OPPORTUNITY

BID OPPORTUNITY NO. ^

^

REFERENCE CLAUSES FOR USE OF WSTP STANDARDIZATION CONTRACTS

Instructions:

1. *The clauses in this document should be added to the relevant Bid Opportunity. The clause numbering in this document will not be correct, and it is the responsibility of the Bid Opportunity author to ensure that the clauses are incorporated into the correct section.*
2. *If a section is not applicable to the work, for example, if there is no instrumentation under the contract, then delete the applicable section(s).*

TABLE OF CONTENTS

FORM B: PRICES
(See B3)

^

UNIT PRICES

ITEM NO.	DESCRIPTION	SPEC. REF.	UNIT	APPROX. QUANTITY	UNIT PRICE	AMOUNT
1.						
2.						
3.						
4.						
5.						
Standardized Goods. Indicate base costs for material supply under the following standardization agreements. Any material mark-up or installation costs, as applicable, shall be included in other line items above.						
6.	Standardized Control System and Motor Control Equipment – Base Cost	E2				
7.	Standardized Gas Detection Equipment – Base Cost	E3				
8.	Standardized Electric Valve Actuators – Base Cost	E4				
9.	Standardized Instrumentation – Base Cost	E5				
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						

TOTAL BID PRICE (GST extra) (in figures) $ ____

____

____

FORM B: PRICES
(See B3)

^

UNIT PRICES

ITEM NO.	DESCRIPTION	SPEC. REF.	UNIT	APPROX. QUANTITY	UNIT PRICE	AMOUNT

Name of Bidder

PART B - BIDDING PROCEDURES

B1. CONFIDENTIALITY

B1.1 Information provided to a Bidder by the City or acquired by a Bidder by way of further enquiries or through investigation is confidential. Such information shall not be used or disclosed in any way without the prior written authorization of the Contract Administrator. The use and disclosure of the confidential information shall not apply to information which:

(a) was known to the Bidder before receipt hereof; or

(b) becomes publicly known other than through the Bidder; or

(c) is disclosed pursuant to the requirements of a governmental authority or judicial order.

B1.2 The Bidder shall not make any statement of fact or opinion regarding any aspect of the Bid Opportunity to the media or any member of the public without the prior written authorization of the Contract Administrator.

B1.3 Notwithstanding B1.1, all quotations, invoices and other pricing related information associated with the Standardized Goods and acquired by a Bidder or its Subcontractors through enquiries, investigation or any other means is confidential. Such information shall not be used or disclosed in any way, other than meeting the requirements of this Bid Opportunity.

B2. SUBSTITUTES

B2.1 Substitutes to the City's Standardized Goods, as identified in E2, will not be accepted.

B3. PRICES

Spec Note: MRST treatment for the below needs to be reviewed and is dependent upon the PST treatment of the overall construction bid opportunity.

B3.1 Form B, Item 6: The Bidder shall enter the cost of the Standardized Goods to be supplied from Schneider Electric Canada Ltd. (Schneider) as part of the Standardized Control System and Motor Control Equipment agreement identified in E2. The cost shall be the base cost received from Schneider, without any mark-up or taxes applied.

B3.1.1 Any mark-up to the supply of the Standardized Goods shall be deemed to be included in other applicable Form B lines.

B3.2 Form B, Item 7: The Bidder shall enter the cost of the Standardized Goods to be supplied from Rotork Control Canada Ltd. (Rotork) as part of the Standardized Electric Valve Actuators agreement identified in E3. The cost shall be the base cost received from Rotork, without any mark-up or taxes applied.

B3.2.1 Any mark-up to the supply of the Standardized Goods shall be deemed to be included in other applicable Form B lines.

B3.3 Form B, Item 8: The Bidder shall enter the cost of the Standardized Goods to be supplied from Mine Safety Appliances Company, LLC (MSA) as part of the Standardized Gas Detection Systems agreement identified in E4. The cost shall be the base cost received from MSA, without any mark-up or taxes applied.

B3.3.1 Any mark-up to the supply of the Standardized Goods shall be deemed to be included in other applicable Form B lines.

B3.4 Form B, Item 9: The Bidder shall enter the cost of the Standardized Goods to be supplied from Trans-West Supply Company Inc. (Trans-West) as part of the Standardized Instrumentation agreement identified in E5. The cost shall be the base cost received from Trans-West, without any mark-up or taxes applied.

B3.4.1 Any mark-up to the supply of the Standardized Goods shall be deemed to be included in other applicable Form B lines.

PART C - GENERAL CONDITIONS

PART D - SUPPLEMENTAL CONDITIONS

GENERAL

D1. DEFINITIONS

D1.1 When used in this Bid Opportunity:

(a) "**Standardized Goods**" means the respective goods identified in D2 that have been standardized by the City.

(b) "**Standardization Vendor**" means a contractor or supplier of Standardized Goods, as identified in D2.

STANDARDIZATION

D2. STANDARDIZED GOODS

D2.1 The following goods have been standardized by the City and will be supplied by the Contractor:

(a) Standardized Control System and Motor Control Equipment as per E2.

(b) Standardized Electric Valve Actuators as per E3.

(c) Standardized Gas Detection Systems as per E4.

(d) Standardized Instrumentation as per E5.

D3. CONTRACTUAL ARRANGEMENT

D3.1 Each Standardization Vendor shall be a Subcontractor of the Contractor.

D3.2 The City's contract with each of the Standardization Vendors defines the prices and general terms of supply to the Contractor. Each Standardization Vendor is obligated to enter into a contract with the Contractor, based upon such prices and general terms of supply.

D3.2.1 The City is not a party to any contract between a Standardization Vendor and the Contractor, or any Subcontractor.

D3.3 In the event that a potential dispute arises between the Contractor and a Standardization Vendor, the Contract Administrator shall be notified.

D4. PAYMENT OF STANDARDIZATION VENDORS

D4.1 The Contractor is obligated to pay the Standardization Vendors in accordance with general terms of supply applicable to such Standardization Vendor.

D4.2 The Contractor's payment terms to the Standardization Vendor, in respect of Standardized Control System and Motor Control Equipment identified in E2, include the following:

D4.2.1 Except as indicated in D4.2.2, payment shall be in Canadian funds net thirty (30) Calendar Days after shipment.

D4.2.2 Payment for motor control centres shall be in Canadian funds net thirty (30) Calendar Days and initiated based upon the following schedule:

(a) Upon approval of the shop drawings or forty (40) Calendar days after the last comprehensive submittal, in the event that a response is not made to the submittal: 25% of the total value.

(b) Upon delivery of the complete MCC along with all associated as-manufactured documentation: 60% of the total value; or

(c) In the event that the delivery is intentionally delayed, upon request by the Contractor, the following payment schedule would replace the 60% payment:

(i) Upon completion of the FAT and delivery of all as-manufactured documentation to the Contractor – 30% of the total value.

(ii) Forty (40) Calendar days after delivery of the as-manufactured documentation to the Contractor, or upon delivery, whichever comes sooner – 30% of the total value.

(d) Upon successful commissioning and delivery of documentation or six (6) months after delivery, whichever comes first: 15% of the total value.

D4.3 The Contractor's payment terms to the Standardization Vendor, in respect of Standardized Electric Valve Actuators identified in E3, include the following:

D4.3.1 Payment shall be in Canadian funds net thirty (30) Calendar Days after receipt and approval of the Standardization Vendor's invoice.

D4.4 The Contractor's payment terms to the Standardization Vendor, in respect of Standardized Gas Detection Systems identified in E4, include the following:

D4.4.1 Payment shall be in Canadian funds net thirty (30) Calendar Days after receipt and approval of the Standardization Vendor's invoice.

D4.5 The Contractor's payment terms to the Standardization Vendor, in respect of Standardized Instrumentation identified in E5, include the following:

D4.5.1 Payment shall be in Canadian funds net thirty (30) Calendar Days after receipt and approval of the Standardization Vendor's invoice.

SUBMISSIONS

D5. ESTIMATES

D5.1 The Contractor shall provide the Contract Administrator with copies of the estimates provided by Standardized Equipment Suppliers identified in E2, E3, E4 and E5.

Work with the Standardized Equipment Project Manager to check the estimates and ensure the vendors provided the appropriate City pricing.

MEASUREMENT AND PAYMENT

D6. PAYMENT SCHEDULE

D6.1 The City's payment to the Contractor, associated with Standardized Goods, will be in accordance with C12.

PART E - SPECIFICATIONS

CONTRACTOR SUPPLIED STANDARDIZED GOODS

E1. GENERAL REQUIREMENTS

E1.1 Comply with the general requirements of E1 for all Standardized Goods supplied by the Contractor.

E1.2 Comply with the following Standardization Goods requirements:

E1.2.1 Control System and Motor Control Equipment in accordance with E2.

E1.2.2 Electric Valve Actuators in accordance with E3.

E1.2.3 Gas Detection Systems in accordance with E4.

E1.2.4 Instrumentation in accordance with E5.

E1.3 Contact the Contract Administrator regarding any potential uncertainty as to whether a good is covered under a standardization agreement.

E1.4 The Contractor may utilize a Standardization Vendor to provide other goods required under the Contract, in addition to Standardized Goods.

E1.5 The Contractor shall separately track all goods supplied under each standardization agreement.

E1.5.1 In the event that one or more Standardization Vendors are utilized to procure goods not covered under a standardization agreement, the Contractor shall ensure such goods are quoted, ordered, tracked and accounted in a separate manner.

E1.6 Pricing:

E1.6.1 The City has obtained discounted pricing for Standardized Goods. Each Standardization Vendor is obligated to sell Standardized Goods to all prospective Contractors at the discounted price, provided the goods are for the City of Winnipeg.

E1.6.2 The Standardization Vendors may at their option provide lump sum pricing for goods packages. The Standardization Vendor is not required to provide breakout pricing details to the Contractor.

E1.6.3 The Contractor and Subcontractors shall not utilize the City's agreements with the Standardization Vendors for any purpose other than City work.

E1.6.4 The City may audit the goods purchased from the Standardization Vendors under the standardization agreements and may identify to the Standardization Vendors any goods procured that are not associated with the Contract.

E1.7 The Contractor is responsible for ensuring that the Material supplied by the Standardization Vendors meets the requirement of the Contract. The Contractor shall review and confirm quotations supplied by the Standardization Vendors to ensure that all required Material is supplied.

E1.8 Without limiting or otherwise affecting any other term or condition of the Contract, including (non-exhaustive) D3.2.1:

E1.8.1 The supply of goods through a Standardization Vendor shall not relieve the Contractor of their obligations.

E1.8.2 Errors or omissions by a Standardization Vendor shall not be a cause for a Change in Work.

E1.8.3 Delays by a Standardization Vendor shall not be a cause for a Change in Work where the delay could have been avoided through reasonable planning, contingency allocation, or communication by the Contractor.

E1.8.4 The Contractor shall engage directly with the persons listed as the Standardized Vendor contact in the following sections E2.7, E3.9, E 4.5 and E 5.6 unless otherwise directed by the Contract Administrator.

E1.9 Submittals

E1.9.1 Submittals shall be provided for Standardized Goods in accordance with the Specifications and typical industry practice. Submittals shall not be bypassed for Standardized Goods.

E2. STANDARDIZED CONTROL SYSTEM AND MOTOR CONTROL EQUIPMENT

E2.1 The City has standardized on a specific vendor for the supply and delivery of control system and motor control equipment. The Standardization Vendor was selected via RFP 756-2013 and was awarded to Schneider Electric Canada Inc. (Schneider).

(a) Refer to E2.7 for contact information.

(b) Copies of the tender documents are available from City of Winnipeg Material Management's website.

E2.2 Goods to be procured via this standardization agreement includes but is not limited to:

(a) Programmable Controllers (PLCs) including all associated components, hardware and software.

(b) PLC to Infi90 Termination Unit migration cables.

(c) Programmable Controller Programming Software.

(d) Dynsim Process Simulator Software.

(e) HMI System software.

(f) Historian Server and Client Software.

(g) Touchscreen HMI systems such as Magellis HMIs.

(h) Touchscreen HMI Programming Software.

(i) Motor Control Centers including all components

(j) Loose VFDs, motor starters, soft starters, and associated components.

(k) Industrial Ethernet Switches as per design. Note that some Ethernet switches may be specified to be from other vendors due to application requirements. Refer to drawings and specifications.

(l) Version Management Software.

(m) Information Server Software.

(n) Training sessions.

Ensure that the appropriate specifications are provided to fully detail the equipment that the vendor needs to supply. Do not assume that the vendor understands the project requirements.

E2.3 For clarity, this standardization agreement does not include:

(a) Computer workstation hardware including operating systems;

(b) Computer server hardware, including operating systems and general terminal server / client software;

(c) Thin client terminals;

(d) Fused and un-fused disconnect switches not incorporated into a MCC or other motor starter;

(e) Control stations and pendants not incorporated into a MCC or other motor starter;

(f) Electrical Transformers not in a MCC or motor starter;
(g) Panelboards not integrated in a MCC;
(h) Switchboards / Switchgear not integrated in a MCC;
(i) System Integration Services (including programming and configuration);
(j) Control Panels to house PLCs;
(k) Instrumentation;
(l) Power supplies not integrated with the PLC / HMI systems; and
(m) Terminal blocks not integrated with the PLC / HMI systems

E2.4 The following model series shall be utilized unless otherwise indicated in the Specifications, Drawings or otherwise approved by the Contract Administrator:

(a) M580, and M340 PLCs;
(b) X80 PLC I/O;
(c) EcoStruxure programming software;
(d) Citect Scada HMI systems;
(e) Wonderware Historian;
(f) Local HMI – Harmony HMIGTO or HMIGTU series;
(g) Model 6 MCC – NEMA rated starters, Intelligent Ethernet (unless otherwise specified);
(h) Altivar Process 600 series VFDs for variable torque applications; and
(i) Altivar Process 900 series VFDs for more demanding applications.

E2.5 Commissioning and start-up:

E2.5.1 Except as identified in E2.5.2, commissioning and start-up of all goods purchased under this standardization agreement shall be performed by the Contractor.

E2.5.2 Schneider shall provide MCC start-up services, but not commissioning services. Coordinate with Schneider as required to understand the limitations of Schneider's MCC start-up services and provide all remaining testing, commissioning and start-up services to provide a complete commissioning and start-up.

Ensure that complete start-up and commissioning requirements are identified in the specifications.

E2.6 Training

E2.6.1 Programmable Controller Local Training

(a) Overview
   (i) Provide instruction to designated City personnel in the operation and maintenance of the Schneider programmable controller control system components and associated Schneider tools and equipment.
   (ii) This training shall be provided by Schneider.
   (iii) This training does not relieve the Contractor of other training requirements associated with the control system.
(b) Location
   (i) The location of the training will be in the City of Winnipeg, in a facility provided by the City.
   (ii) The room will be classroom style.
(c) Submittals
   (i) Submit the names and qualifications of the proposed instructors.

(ii) Submit training proposal complete with hour by hour schedule including brief overview of content of each training segment a minimum of 30 Working Days prior to the anticipated date of beginning of training.

(d) Quality Assurance

(i) Provide competent instructors thoroughly familiar with all aspects of the programmable controller control system.

(ii) The Contract Administrator may reject instructors it deems to not be qualified.

(iii) In the event that the training provided is not satisfactory, reduction of payment may be applied.

(e) Duration

(i) The training shall be a minimum of one (1) day in duration.

(f) Materials

(i) Provide equipment, visual and audio aids, and materials.

(ii) Supply manual for each trainee, describing in detail the information included in each training program.

(g) Attendees

(i) The attendees are expected to include, but not be limited to: electrical and instrumentation maintenance personnel and programmable controller support specialists.

(h) Content

(i) Overview of the equipment.

(ii) Equipment maintenance training including:

- ♦ Installation
- ♦ Troubleshooting
- ♦ Preventative maintenance
- ♦ Replacement of modules
- ♦ Network communication troubleshooting and diagnostics.
- ♦ Fieldbus troubleshooting and diagnostics
- ♦ Programmable controller redundancy strategies and operation.

(iii) Maintenance use of programmable controller programming software, including:

- ♦ Basic operation of the software
- ♦ Connecting to programmable controllers
- ♦ Download and upload of software configuration.
- ♦ Diagnostics and troubleshooting.

(i) Number of Sessions:

(i) Provide a minimum of two (2) sessions.

E2.6.2 MCC and VFD Local Training Session

(a) Overview

(i) Provide instruction to designated City personnel in the operation and maintenance of the motor control centres and variable frequency drives.

(ii) This training shall be provided by Schneider.

(iii) This training does not relieve the Contractor of other training requirements associated with the control system.

(b) Location

(i) The location of the training will be in the City of Winnipeg, in a facility provided by the City.

(c) Submittals

(i) Submit the names and qualifications of the proposed instructors.

(ii) Submit training proposal complete with hour by hour schedule including brief overview of content of each training segment a minimum of 30 Working Days prior to the anticipated date of beginning of training.

(d) Quality Assurance

(i) Provide competent instructors thoroughly familiar with all aspects of the MCC and VFD systems.

(ii) The Contract Administrator may reject instructors it deems to not be qualified.

(iii) In the event that the training provided is not satisfactory, reduction of payment may be applied.

(e) Duration

(i) The training shall be a minimum of six (6) hours in duration, excluding coffee and lunch breaks.

(f) Materials

(i) Provide equipment, visual and audio aids, and materials.

(ii) Supply manual for each trainee, describing in detail the information included in each training program.

(g) Attendees

(i) The attendees are expected to include, but not be limited to:

- Electrical and instrumentation maintenance personnel.
- Programmable controller support specialists.

(h) Content

(i) Overview of the equipment.

(ii) Equipment maintenance training including:

- Installation
- Troubleshooting
- Preventative maintenance
- Replacement of modules
- Fieldbus diagnostics
- Configuration of equipment parameters.

(iii) Maintenance use of equipment configuration software, including:

- Basic operation of the software
- Connecting to intelligent starts and VFDs.
- Download and upload of software configuration.
- Diagnostics and troubleshooting.

(i) Number of Sessions:

(i) Provide a minimum of two (2) sessions.

E2.7 The contact information for all quotations and purchases from Schneider is:

Garth Eastman
21 Omands Creek Blvd
Winnipeg, MB, R2R 2V2
Telephone: 204-228-7807
E-mail: garth.eastman@se.com

E2.7.1 Goods to be procured directly from Schneider using the Schneider contact:

(a) Further to E2.2, goods to be procured via Schneider includes but is not limited to:

(i) PLC to Infi90 Termination Unit migration cables;

(ii) Process Simulator Software;

(iii) Historian Server and Client Software;
(iv) Version Management Software; and
(v) Training sessions.

E2.7.2 Goods to be procured via Eecol Electric (Eecol), as Schneider's High Tech Automation Distributor (HTAD):

(a) Further to E2.2, goods to be procured via Eecol includes but is not limited to:
(i) Programmable Controllers (PLCs) including all associated components hardware and software;
(ii) Programmable Controller Programming Software;
(iii) HMI System software;
(iv) Touchscreen HMI systems such as Magellis HMIs;
(v) Touchscreen HMI Programming Software;
(vi) Motor Control Centers including all components;
(vii) Loose VFDs, motor starters, soft starters, and associated components; and
(viii) Industrial Ethernet Switches as per design. Note that some Ethernet switches may be specified to be from other vendors due to application requirements. Refer to drawings and specifications.

(b) The Eecol contact:
Theodore James Howe
Regional Industrial Manager
1760 Welllington Avenue
Winnipeg, MB, R3H 0E9
Telephone: 204-784-6952
E-mail: howetj@eecol.com

(c) All correspondence related to requests-for-quotations to Eecol for goods listed under E2.7.2(a) shall be copied to the Schneider contact listed under E2.7.

(d) For whatever reason, if Eecol is unable to receive or respond to request-for-quotations for goods listed under E2.7.2(a), request-for-quotations may be issued directly to the Schneider contact listed under E2.7.

E2.8 Quotations and orders:

E2.8.1 Reference the following in all quotation requests and purchase orders:

(a) This Bid Opportunity number; and

(b) A statement indicating:
"This request / purchase order is subject to the Terms and Conditions of City of Winnipeg Request for Proposal RFP 756-2013."

E3. STANDARDIZED ELECTRIC VALVE ACTUATORS

E3.1 The City has standardized on a specific vendor for the supply and delivery of electric valve actuators. The Standardization Vendor was selected via RFP 331-2014 and was awarded to Rotork Control Canada Ltd. (Rotork).

(a) Copies of the tender documents are available from City of Winnipeg Material Management's website.

E3.2 Goods to be procured via this standardization agreement include but are not limited to:

(a) Multi-turn electric valve actuators and quarter-turn electric valve actuators with approximate torque requirements of:
(i) On/off torques > 250 Nm
(ii) Modulating torques > 150 Nm

(b) Associated accessories are also included in the agreement.

Ensure that the appropriate specifications are provided to fully detail the equipment that the vendor needs to supply. Do not assume that the vendor understands the project requirements.

E3.3 For clarity, this standardization agreement does not include:

(a) Solenoid valve actuators;

(b) Small HVAC damper actuators; and

(c) Electric valve actuators with a power supply < 120 VAC.

E3.4 The use of gearboxes shall not be utilized to reduce actuator torque requirements for the purpose of bypassing this standardization agreement.

E3.5 The following model series shall be utilized unless otherwise indicated in the Specifications, Drawings or otherwise approved by the Contract Administrator:

(a) IQ3 Range – (IQ, IQM, IQS, IQT, IQTM)

E3.6 Valve Integration Assistance

E3.6.1 Coordinate with Rotork to review the integration of valves with the valve actuators. Comply with guidance provided by Rotork.

E3.6.2 The review provided by Rotork shall be for the purpose of ascertaining conformance of the actuator application with the given valve. The responsibility for integration of the valve with the valve actuator shall remain with the Contractor.

E3.6.3 Rotork will make all applicable actuator shop drawings and datasheets available to the Contractor to allow for integration of the valve with the valve actuator.

E3.6.4 In the event that the valve cannot directly attach to a standard base available for the electric actuator, supply and installation of valve adaptors between the actuator base and the valve will be the responsibility of the Contractor.

E3.6.5 Costs

(a) Rotork is obligated to provide valve integration assistance services at no additional cost above the supply of the actuator.

E3.7 Valve Integration Services

E3.7.1 The Contractor may engage Rotork to provide valve integration services in addition to that required in E3.6; however, this additional work would be outside of the Standardization Agreement.

(a) The Contractor is encouraged to provide the best value for services provided.

E3.8 Field setup and commissioning:

E3.8.1 Field setup and commissioning of the actuators shall be performed by Rotork under the standardization agreement for the following:

(a) The first actuator of each type installed on site; and

(b) A minimum of two actuators additional of each type, or 5% of the actuators of that type, whichever is greater.

E3.8.2 Coordinate with Rotork as required to understand the limitations of Rotork’s field setup and commissioning services and provide all remaining services to provide a complete commissioning and start-up.

E3.8.3 Field setup and commissioning of the remaining actuators may be performed by Rotork, or by a representative of the valve manufacturer.

E3.8.4 Rotork’s presence to setup and commission the actuator in no way limits the valve or gate vendor’s responsibility for setup and commissioning.

E3.8.5 Responsibility of the Contractor:

(a) It is the responsibility of the Contractor to ensure that the installation of the actuator is complete and that the valve is ready to commission, as per Rotork's documented pre-commissioning checklist.

E3.8.6 Field setup and commissioning servers shall include all standard manufacturer recommended start-up and commissioning procedures, as well as the following:

(a) Visual Inspection
  (i) Inspect equipment for signs of damage.
  (ii) Verify mechanical installation per drawings.
  (iii) Inspect electrical terminal compartment for foreign objects.

(b) Mechanical Inspection
  (i) Check all bolts for tightness and to the correct torque.
  (ii) Check for alignment.
  (iii) Ensure appropriate clearances for all connecting bushings and connecting faces.

(c) Electrical Inspection
  (i) Check all power wiring connections for tightness.
  (ii) Check all fuses for continuity.
  (iii) Confirm input voltage and phase rotation is correct.
  (iv) Confirm that the control / fieldbus connections are correct.

(d) Start-up Services
  (i) Coordinate turning on power to the actuator.
  (ii) Perform functional tests.
  (iii) Coordinate with City personnel and designated representatives to confirm and finalize the application requirements.
  (iv) Configure and document all settings, as appropriate for the application.
  (v) Perform test runs.
  (vi) Verify that all configuration values are in the correct state.
  (vii) Transfer the configuration settings to on-site personnel.

Ensure that complete start-up and commissioning requirements are identified in the specifications.

E3.9 On-Site Training Session

E3.9.1 Operation and Basic Maintenance

(a) Overview
  (i) Provide instruction to designated City personnel in the operation and basic maintenance of the electric actuators.

(b) Location
  (i) The location of the training will be in the City of Winnipeg, in a facility provided by the City.

(c) Travel
  (i) Provide all travel and accommodations at no additional cost.

(d) Submittals
  (i) Submit the names and qualifications of the proposed instructors.
  (ii) Submit training proposal complete with hour by hour schedule including brief overview of content of each training segment a minimum of 30 Calendar Days prior to the anticipated date of beginning of training.

(e) Quality Assurance

(i) Provide competent instructors thoroughly familiar with all aspects of the electric actuators.
(ii) The Contract Administrator may reject instructors it deems to not be qualified.
(iii) In the event that the training provided is not satisfactory, reduction of payment may be applied.

(f) Duration
(i) The training shall consist of two (2) three and a half (3.5) hours periods, excluding coffee breaks. Both sessions shall be in one day.
(ii) Each day shall be assumed to be independent of other training days, and not necessarily aligned with other on-site work or training.

(g) Materials
(i) Provide equipment, visual and audio aids, and materials.
(ii) Supply manual for each trainee, describing in detail the information included in each training program.

(h) Attendees
(i) The attendees are expected to include, but not be limited to:
- Operations personnel.
- Mechanical maintenance personnel.
- Electrical and instrumentation maintenance personnel.

(i) Content
(i) Overview of the equipment.
(ii) Internal operation of the actuators.
(iii) Equipment operating training including:
- Local operation of the actuator,
- Manual / handwheel operation,
- Remote operation, and
- Operation via the remote configuration tool.

(j) Basic equipment maintenance training including:
(i) Basic diagnostics,
(ii) Basic troubleshooting,
(iii) Access to historical information and torque values, and
(iv) Preventative maintenance

(k) Number of Sessions:
(i) Provide a minimum of three (3) sessions.

E3.9.2 Detailed Configuration and Service

(a) Overview
(i) Provide instruction to designated City personnel in the detailed setup, configuration, and service of the electric actuators.

(b) Location
(i) The location of the training will be in the City of Winnipeg, in a facility provided by the City.

(c) Travel
(i) Provide all travel, meals and accommodations at no additional cost.

(d) Submittals
(i) Submit the names and qualifications of the proposed instructors.

(ii) Submit training proposal complete with hour by hour schedule including brief overview of content of each training segment a minimum of 30 Calendar Days prior to the anticipated date of beginning of training.

(e) Quality Assurance

(i) Provide competent instructors thoroughly familiar with all aspects of the electric actuators.

(ii) The Contract Administrator may reject instructors it deems to not be qualified.

(iii) In the event that the training provided is not satisfactory, reduction of payment may be applied.

(f) Duration

(i) The training shall consist of two days, each seven (7) hour sessions, excluding lunch and coffee breaks. The session days shall be back-to-back.

(ii) Each session (2-days) shall be assumed to be independent of other training sessions, and not necessarily aligned with other on-site work or training.

(g) Materials

(i) Provide equipment, visual and audio aids, and materials.

(ii) Supply manual for each trainee, describing in detail the information included in each training program.

(h) Attendees

(i) The attendees are expected to include, but not be limited to:

- Mechanical maintenance personnel.
- Electrical and instrumentation maintenance personnel.

(i) Content

(i) Detailed overview of the equipment and its internal construction.

(ii) Equipment configuration training, including:

- Setup of the actuator parameters,
- Establishing communications, and
- Setting torque limits and end limits.

(j) Equipment maintenance training including:

(i) Detailed diagnostics,

(ii) Detailed troubleshooting,

(iii) Preventative maintenance,

(iv) Disassembly,

(v) Replacement of modules, and

(vi) Fieldbus diagnostics

(k) Maintenance use of equipment configuration software, including:

(i) Basic operation of the software,

(ii) Connecting to electric actuators,

(iii) Download and upload of the actuator configuration, and

(iv) Diagnostics and troubleshooting.

(l) Number of Sessions:

(i) Provide a minimum of two (2) sessions.

E3.10 The contact for all quotations and purchases:

Mr. Henry Zenteno
#6, 820 - 28th Street North East Street
Calgary, Alberta, T2A 6K1
Telephone: 403-569-9455

Mobile: 403-813-5850
E-mail: Henry.Zenteno@rotork.com

E3.11 Quotations and orders:

E3.11.1 Reference the following in all quotation requests, quotations \ proposals, purchase orders, and invoices:

(a) This Bid Opportunity number; and

(b) A statement indicating:

“This request / purchase order is subject to the Terms and Conditions of City of Winnipeg Request for Proposal RFP 331-2014.”

E4. STANDARDIZED GAS DETECTION SYSTEMS

E4.1 The City has standardized on a specific vendor for the supply and delivery of gas detection systems. The Standardization Vendor was selected via RFP 123-2014 and was awarded to Mine Safety Appliances Company, LLC (MSA) c/o Tundra Process Solutions Ltd.

(a) Copies of the tender documents are available from City of Winnipeg Material Management’s website.

E4.2 Goods to be procured via this standardization agreement include but are not limited to:

(a) Gas detection sensors;

(b) Gas detection transmitters;

(c) Gas detection controllers;

(d) Gas detection sensor consumables; and

(e) Associated accessories.

Ensure that the appropriate specifications are provided to fully detail the equipment that the vendor needs to supply. Do not assume that the vendor understands the project requirements.

E4.3 The following model series shall be utilized unless otherwise indicated in the Specifications, Drawings or otherwise approved by the Contract Administrator:

(a) UltimaX gas detection systems.

(b) GasGard XL controllers.

E4.4 Field setup and commissioning:

E4.4.1 Field setup and commissioning of the gas detection systems may be performed by MSA under the Standardization Agreement. Coordinate with MSA as required to understand the capabilities and limitations of MSA’s field setup and commissioning services and provide all remaining services to provide a complete commissioning and start-up.

Ensure that complete start-up and commissioning requirements are identified in the specifications.

E4.4.2 The Contractor may provide field setup and commissioning services for the gas detection system via alternate means, provided that this does not result in a reduction of the services or quality of work.

E4.4.3 Where MSA is utilized to provide field setup and commissioning, their scope of work has been standardized as follows:

(a) Provide the services for a factory-trained instrument technician to setup and commission the gas detection instruments and controllers, as requested by the City. It is expected that setup and commissioning will be required for some, but not all, of the equipment.

(b) Qualification

(i) The personnel provided shall be a factory trained and certified technologist, with a minimum of one year of experience working with the products proposed.

(c) Services

(i) Provide a full eight hours of on-site labour, for each allocated day, to setup and commission the gas detection systems.

(ii) Provide all travel and tools required.

E4.5 Training

E4.5.1 Local Training Session

(a) Overview

(i) Provide instruction to designated City personnel in the operation and maintenance of the gas detection equipment.

(b) Location

(i) The location of the training will be in the City of Winnipeg, in a facility provided by the City.

(c) Travel

(i) Provide all travel, meals and accommodations at no additional cost.

(d) Submittals

(i) Submit the names and qualifications of the proposed instructors.

(ii) Submit training proposal complete with hour by hour schedule including brief overview of content of each training segment a minimum of 30 Working Days prior to the anticipated date of beginning of training.

(e) Quality Assurance

(i) Provide competent instructors thoroughly familiar with all aspects of the gas detection equipment.

(ii) The Contract Administrator may reject instructors it determines to not be qualified.

(iii) In the event that the training provided is not satisfactory, reduction of payment may be applied.

(f) Duration

(i) The training shall be a minimum of eight (8) hours in duration, excluding coffee and lunch breaks.

(ii) Each session shall be assumed to be independent of other training sessions, and not necessarily aligned with other on-site work or training.

(g) Materials

(i) Provide equipment, visual and audio aids, and materials.

(ii) Supply manual for each trainee, describing in detail the information included in each training program.

(h) Attendees

(i) The attendees are expected to include, but not be limited to:

- ♦ Electrical and instrumentation maintenance personnel and
- ♦ Operations personnel.

(i) Content

(i) Overview of the equipment.

(ii) Equipment maintenance training including:

- ♦ Installation,
- ♦ Configuration,
- ♦ Troubleshooting, and

- ♦ Preventative maintenance

(j) Number of Sessions:

(i) Provide a minimum of two (2) sessions.

E4.6 The contact for all quotations and purchases:

Sheldon Bradley
Senior Inside Technical Sales
3200-118Ave S.E.
Calgary, AB
T2Z 3X1
Telephone: 1-800-265-1166
Mobile: 1-403-510-2011
E-mail: sbradley@tundrasolutions.ca

E4.7 Quotations and orders:

E4.7.1 Reference the following in all quotation requests, quotations \ proposals, purchase orders, and invoices:

(a) This Bid Opportunity number; and

(b) A statement indicating:

“This request / purchase order is subject to the Terms and Conditions of City of Winnipeg Request for Proposal RFP 123-2014.”

E5. STANDARDIZED INSTRUMENTATION

E5.1 The City has standardized on a specific vendor for the supply and delivery of specific instrumentation. The Standardization Vendor was selected via RFP 449-2014 and was awarded to Trans-West Supply Company Inc. (Trans-West).

(a) Copies of the tender documents are available from City of Winnipeg Material Management’s website.

E5.2 Goods to be procured via this standardization agreement include but are not limited to:

(a) Flowmeters – Electromagnetic;

(b) Flowmeters – Differential pressure based;

(c) Pressure Transmitters including manifold assemblies;

(d) Temperature Transmitters including temperature elements and thermowells;

(e) Ultrasonic Level Transmitters; and

(f) Associated accessories.

Ensure that the appropriate specifications are provided to fully detail the equipment that the vendor needs to supply. Do not assume that the vendor understands the project requirements.

E5.3 For clarity, this standardization agreement does not include:

(a) Flowmeters - Coriolis;

(b) Flowmeters – Thermal Dispersion;

(c) Flowmeters – Ultrasonic;

(d) Flow switches (i.e. mechanical);

(e) Pressure switches;

(f) Temperature switches;

(g) Radar Level Transmitters; and

(h) Level Switches (non-ultrasonic based).

E5.4 The following model series shall be utilized unless otherwise indicated in the Specifications, Drawings or otherwise approved by the Contract Administrator:

(a) Magnetic Flowmeter Flowtubes – SITRANS F M MAG 5100W series.
   (i) SITRANS F M MAG 3100W series may be utilized where specified.
(b) Magnetic Flowmeter Transmitters - SITRANS F M MAG 6000 series.
(c) Pressure Transmitters - SITRANS P DS III.
(d) Temperature Transmitters
   (i) SITRANS TF (Process Applications)
   (ii) SITRANS TH400 (HVAC applications)
(e) Ultrasonic Level Transmitters
   (i) Integrated applications: SITRANS Probe LU
   (ii) Separate controller applications: Multiranger 100/200 with EchoMax transducers.

E5.5 Field setup and commissioning:

E5.5.1 Field setup and commissioning of the gas detection systems may be performed by Trans-West under the Standardization Agreement. Coordinate with Trans-West as required to understand the capabilities and limitations of Trans-West's field setup and commissioning services and provide all remaining services to provide a complete commissioning and start-up.

E5.5.2 Field setup and commissioning of the standardized instrumentation shall be performed by Trans-West under the standardization agreement for the following:

(a) The first instrument of each type installed on site; and
(b) A minimum of five additional instruments of each type, or 10% of the actuators of that type, whichever is greater.

E5.5.3 The Contractor may provide field setup and commissioning services for the remaining instrumentation via alternate means, provided that this does not result in a reduction of the services or quality of work.

E5.5.4 The services provided are to include at all standard manufacturer recommended start-up and commissioning procedures, as well as the following:

(a) Visual Inspection
   (i) Inspect instrument for signs of damage,
   (ii) Verify mechanical and piping installation per drawings and manufacturer requirements,
   (iii) Verify wiring installation per drawings and manufacturer requirements, and
   (iv) Inspect electrical terminal compartment for foreign objects.
(b) Mechanical Inspection
   (i) Check all connections and bolts for tightness and to the correct torque,
   (ii) Check for alignment, and
   (iii) Ensure appropriate clearances for all connecting bushings and connecting faces.
(c) Electrical Inspection
   (i) Check all power wiring connections for tightness,
   (ii) Check all fuses in the instrument for continuity,
   (iii) Confirm input voltage is correct, and
   (iv) Confirm that the signal / fieldbus connections are correct.
(d) Start-up Services
   (i) Coordinate turning on power to the instrument,

(ii) Configure all applicable settings and parameters that could not be configured prior to installation,

(iii) Perform functional tests,

(iv) Coordinate with City personnel and designated representatives to confirm and finalize the application requirements,

(v) Configure and document all settings, as appropriate for the application,

(vi) Coordinate to perform test demonstrations to verify instrument performance,

(vii) Verify that all configuration values are in the correct state, and

(viii) Transfer the configuration settings to on-site personnel.

(e) Documentation

(i) Provide a signed documented commissioning form for each instrument, in a format acceptable to the Contract Administrator.

(f) Travel

(i) Provide all travel and accommodations at no additional cost.

(g) Personnel:

(i) Personnel shall be factory trained in the maintenance, configuration, and service of the proposed instrumentation.

E5.5.5 Responsibility of the Contractor:

(a) It is the responsibility of the Contractor to ensure that the installation of the instrumentation is complete and that the instrument is ready to commission prior to engaging Trans-West to commission any instrumentation.

E5.6 Training

E5.6.1 Local Training Session – General Requirements

(a) Overview:

(i) Provide instruction to designated City personnel in the operation, configuration, and maintenance of the proposed instruments and associated components.

(b) Location:

(i) The location of the training will be in the City of Winnipeg, in a facility provided by the City.

(ii) The room will be classroom style.

(c) Submittals:

(i) Submit the names and qualifications of the proposed instructors.

(ii) Submit training proposal complete with hour by hour schedule including brief overview of content of each training segment a minimum of 30 Calendar Days prior to the anticipated date of beginning of training.

(d) Quality Assurance:

(i) Provide competent instructors thoroughly familiar with all aspects of the instruments.

(ii) The Contract Administrator may reject instructors it deems to not be qualified.

(iii) In the event that the training provided is not satisfactory, reduction in payment may be applied.

(e) Materials:

(i) Provide equipment, visual and audio aids, and materials.

(ii) Sample instruments of each type shall be provided, along with all equipment required to power and configure the instruments.

(iii) Supply manual for each trainee, describing in detail the information included in each training program.

(f) Attendees:
  (i) The attendees are expected to include, but not be limited to:
    - Electrical and instrumentation maintenance personnel.

E5.6.2 Local Training Session – Electromagnetic Flowmeter, Pressure, Temperature

(a) Provide local training sessions, in accordance with E8.6.1:

(b) Duration:
  (i) Each training session shall be a minimum of six (6) hours in duration, excluding coffee and lunch breaks.
  (ii) Each day shall be assumed to be independent of other training days, and not necessarily aligned with other on-site work or training.

(c) Scope:
  (i) Each training session shall address the complete scope of all products proposed.

(d) For each instrument type, provide the following training content:
  (i) Overview of the instrument,
  (ii) Equipment maintenance training, including:
    - Installation,
    - Troubleshooting,
    - Preventative maintenance,
    - Replacement of components,
    - Fieldbus network troubleshooting and diagnostics, and
    - Calibration procedures.
  (iii) Maintenance use of associated software and HART/PROFIBUS parameters, including:
    - Basic operation of software,
    - Connecting to instruments,
    - Configuration of parameters,
    - Download and upload software configuration, and
  (iv) Diagnostics and troubleshooting.

(e) Number of Sessions:
  (i) Provide a minimum of two (2) sessions for each instrument type.

E5.6.3 Local Training Session – Ultrasonic Level

(a) Provide local training sessions, in accordance with E5.6.1:

(b) Duration:
  (i) Each training session shall be a minimum of three (3) hours in duration, excluding coffee and lunch breaks.
  (ii) Each day shall be assumed to be independent of other training days, and not necessarily aligned with other on-site work or training.

(c) Scope:
  (i) Each training session shall address the complete scope of all products proposed.

(d) For each instrument, provide the following training content:
  (i) Overview of the instrument,
  (ii) Equipment maintenance training, including:
    - Installation,
    - Troubleshooting,

- ♦ Preventative maintenance,
- ♦ Replacement of components,
- ♦ Fieldbus network troubleshooting and diagnostics, and
- ♦ Calibration procedures.

(iii) Maintenance use of associated software and HART/PROFIBUS parameters, including:

- ♦ Basic operation of software,
- ♦ Connecting to instruments,
- ♦ Configuration of parameters,
- ♦ Download and upload software configuration, and
- ♦ Diagnostics and troubleshooting.

(e) Number of Sessions:

(i) Provide a minimum of two (2) sessions for each instrument type.

E5.6.4 Electromagnetic Flowmeter Calibration Verification Tool Training

(a) Provide local training sessions, in accordance with E5.6.1:

(b) Provide one training session per unit supplied, to instruct designated City personnel in the operation, configuration, and maintenance of the proposed instruments and associated components.

(c) The location of the training will be in the City of Winnipeg, in a facility provided by the City.

(d) Provide competent instructors thoroughly familiar with all aspects of the verification tool.

(i) The Contract Administrator may reject instructors it deems to not be qualified.

E5.6.5 Each training session shall be a minimum of four (4) hours in duration, excluding coffee and lunch breaks, or longer as required to instruct personnel in the required operation.

Ensure that complete start-up and commissioning requirements are identified in the specifications.

E5.7 The contact for all quotations and purchases:

Amurthan (Amu) Abimanan Branch Manager
126 Bannister Road
Winnipeg, MB, R3R 0S3
Telephone: 204-783-0100
Mobile: 204-782-1864
E-mail: amu@transwest-mb.com

E5.8 Quotations and orders:

E5.8.1 Reference the following in all quotation requests, quotations \ proposals, purchase orders, and invoices:

(a) This Bid Opportunity number; and

(b) A statement indicating:

"This request / purchase order is subject to the Terms and Conditions of City of Winnipeg Request for Proposal RFP 449-2014."

APPENDIX Q – WSTP SEWAGE TREATMENT PLANT TAG NAMING STANDARD - R00

Winnipeg

The City of Winnipeg

Water & Waste Department

Sewage Treatment Plant
Tag Naming Standard

Document Code: 612620-0014-40ER-0001

Revision: 00

Approved By:	D. Griffin Duane Griffin, Branch Head – WW Planning & Project Delivery	Sept 25, 2015 Date

REVISION REGISTER					
Rev.	**Description**	**Date**	**By**	**Checked**	**Approved**
00	Issued for City Use	2015-09-23	B. Cleven	T. Church	T. Church

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TABLE OF CONTENTS

LIST OF TABLES

1 INTRODUCTION

This Water and Waste Department Sewage Treatment Plant Tag Naming Standard is to be referenced for consistent naming of software tags within the PLC (I/O, variables, and control system functions) and HMI. This standard is an extension of the Identification Standard, document 510276-0000-40ER-0002, and it follows the same rules. Where there are discrepancies between these two standards, this standard shall take precedence for PLC and HMI programming.

1.1 Scope of the Standard

This identification standard, document 510276-0000-40ER-0002, applies to all PLC, HMI, and SCADA systems in City-owned sewage treatment plants, which includes the following facilities:

1. North End Sewage Treatment Plant (NEWPCC)
2. South End Sewage Treatment Plant (SEWPCC)
3. West End Sewage Treatment Plant (WEWPCC)

These design requirements will also be applied to the collection system where relevant and useful.

1.2 Application

This Standard is meant as a guideline for control system developers to provide consistent tag naming across all City sewage treatment plants. Although every conceivable tag naming scenario cannot be covered in this document, developers are expected to follow the general intent and guidelines provided herein.

Existing facilities do not necessarily comply with this standard. The expectations regarding application of this standard to existing facilities must be decided on a case-by-case basis with consideration of the future arrangement of the facility, however general guidelines for application are presented as follows:

1. All new custom process control system applications developed for the City shall follow this standard. It is not expected that pre-developed PLC or HMI applications from packaged equipment vendors follow these rules, but where pre-developed PLC or HMI applications from a vendor allows customizable options by the vendor before delivery, the intent of this standard should be followed as reasonably practicable.
2. All new facilities must comply with this standard.
3. All upgrades to a facility that require the installation of a PLC or HMI must comply with this standard.
4. All minor upgrades to an existing control system should utilize this standard as far as practicable, however in some cases compromise with the existing control system identification practice may be required. For example, addition of new tags to the Bailey Infi90 control system.

1.3 Definitions

Class	A template definition of the PLC and HMI logic, variables, and graphic symbols associated with a particular type of equipment. Within the Schneider Electric software, this is typically implemented as a Derived Function Block in the Unity Pro PLC programming software and a Genie or Super-Genie in the Vijeo Citect HMI software.

Control System Function	Functions within a PLC program related to the control and monitoring of equipment/instruments. Control System Functions shown on the P&IDs are typically in the form of a square-enclosed circle. These can be implemented either as an instance of a Derived Function Block or a grouping of Elementary Function Blocks.
Derived Function Block	A user-defined PLC function block containing custom logic and that has been added to the function block library. These are defined once and are instantiated for use in the PLC program.
Elementary Function Block	Predefined PLC function blocks in the function block library that typically cannot be modified by users.
Equipment.Item	Within the Vijeo Citect HMI software, this is a field for a Variable Tag. It is generated within the software by combining the *Equipment* and *Item Name* fields that are defined by the developer. When this term is used within this document it will be italicized.
FDT/DTM	Field Device Tool / Device Type Manger. A tool for configuring the communication interface between field devices and the PLC system. The Schneider Electric Unity Pro PLC programming software incorporates an FDT frame for loading device DTMs from the device manufacturers.
Instance	A specific realization of a class. Within the Schneider Unity Pro software, each time a Derived Function Block is used within a PLC program it is an instance of a class.
Parameter	An attribute (input, output, or internal variable) of a class or function block. This portion of the tag provides a name of the signal.
Tag	A variable utilized within a PLC or HMI program. 'Tag' is synonymous with 'Variable'.
Tag Name	The actual identifier assigned to a specific tag. When this term is used within this document it will be italicized.
Variable	Data used by a PLC or HMI that is stored at a unique memory address. 'Variable' is synonymous with 'Tag'.
Variable Tag	A term used in the Vijeo Citect HMI software that refers to an HMI tag that is linked to a PLC tag. It can be referenced within the HMI program by either the associated Tag Name or *Equipment.Item*. When this term is used within this document it will be italicized.

1.4 Notes on Naming Conventions

In the following sections, the naming convention for tags and classes are defined in tables. The following notes offer an explanation of the conventions utilized within the tables:

1. A number of letters in succession represents a parameter that must have the same number of characters as the number of letters. For example, **NNN** in Section 4.2.1.1 indicates three digits must be used for the equipment number.
2. A letter with a star indicates a variable number of characters. For example, **X*** in Section 4.2.1.1 could represent between two and four characters.

1.5 References

The following City of Winnipeg standards may be referenced where applicable:

1. Water and Waste Department Identification Standard, document 510276-0000-40ER-0002,
2. Wastewater Treatment Electrical Design Guide, document 510276-0000-40ER-0002,
3. Wastewater Treatment Automation Design Guide, document 612620-0013-40ER-0001,
4. HMI Layout and Animation Plan, document 612620-0015-40ER-0001,
5. Historical Data Retention Standard, document 612620-0016-40ER-0001.

The following industry standards and guidelines may be referenced where applicable:

1. ANSI/ISA-5.1-2009, Instrument Symbols and Identification.

The following Schneider Electric help system documents may be referenced where applicable:

1. Unity Pro Help » Unity Pro Software » Languages Reference » Data Description » Syntax Rules for Type\Instance Names
2. Unity Pro Help » Unity Pro Software » Data Description » Data References » Data Naming Rules
3. Vijeo Citect Online Help – Tagging Process Variables, http://www.citect.schneider-electric.com/webhelp/vijeo2015/Content/Tagging_Process_Variables.html
4. Vijeo Citect Online Help – Tag Name Syntax, http://www.citect.schneider-electric.com/webhelp/vijeo2015/Content/Tag_name_syntax.html

2 BASIC RULES

2.1 General

In general, all tags utilized within the Process Control System (PCS) should be named in a manner that is consistent with how they are shown on the P&IDs. PCS tag names will include the identifier of the equipment or control system function they are associated with (e.g. P-P217.Run).

The City of Winnipeg Identification Standard, document 510276-0000-40ER-0002, uses hyphens and periods as separation characters within identifiers (e.g. VFD-G101.Flt). For PLC variables, Schneider Electric's Unity Pro software does not allow the use of hyphens in variable names and therefore hyphens must be replaced with underscores in PLC programs. Unity Pro only supports the use of periods in variable structures but not in regular variables. As such, it is required to replace periods with underscores for regular variables within PLC programs. For HMI variables, Schneider Electric's Vijeo Citect software does not support hyphens or periods, but does support backslashes ("\"). Therefore all hyphens will be replaced with underscores, and periods will be replaced with backslashes. Note that Vijeo Citect does support periods in the *Equipment.Item* hierarchy, which is further discussed in Section 5.

Variables shall be based on positive logic, with the "1 State" or 100% being the active state or full range of the signal. Tag naming should reflect this philosophy. I/O signals may use negative or fail safe logic, but they will need to be conditioned (negated in the discrete case) before use.

2.2 Format

Classes, function blocks, parameters, and variables implemented in the PCS shall be named using the following characters:

- Uppercase letters A through Z
- Lowercase letters a through z
- Numerals 0 through 9
- Underscore "_"
- Period "." (for PLC variables only)
- Backslash "\" (for HMI variables only)

All names shall start with a letter. Hyphens or spaces are not allowed in a name.

Periods are used in the PLC system as a separation character between a function block instance name and its parameters (eg. YC_P2041.CmdStart) and for tag structures. Periods are not used otherwise.

Periods are not permitted in HMI variable names and therefore backslashes are used in the HMI system as a separation character between a function block instance name and its parameters (eg. YC_P2041\CmdStart).

Where possible, use ISA 5.1 style identification as per Table 4.1 in ANSI/ISA-5.1-2009 for naming classes, function blocks, parameters, and variables (eg. "F" for flow, "P" for pressure, "C" for control, etc.). Where ISA 5.1 variables are used, they shall be capitalized. If ISA 5.1 variables are not suitable, English words, abbreviations, or acronyms may be used.

Where English words or abbreviations are used within a name, each will begin with an upper case letter and the remaining letters in lowercase. Additionally, acronyms are completely capitalized.

Names shall be unique. Names differing only in the use of lowercase and uppercase letters are not permitted (e.g. FAL and Fal).

2.3 Standard Abbreviations and Acronyms

Abbreviations and acronyms may be used in the naming of objects where ISA 5.1 style identification is not suitable. Note that it is permitted to use ISA 5.1 style identification along with abbreviations and acronyms in the naming of an object. The purpose of using abbreviations and acronyms, rather than complete English words, is to minimize the length of object names.

Standardized abbreviations and acronyms used in the identification of classes, function blocks, parameters and variables are provided in Appendix B.

It may be required to add new standard abbreviations or acronyms, where the existing list does not cover a new application. In this instance, the proposed abbreviation or acronym is to be reviewed with the City, and if approved then it shall be added to the list in Appendix B.

If additional abbreviations are used, ensure that they are consistently applied throughout the entire PLC and HMI program.

2.4 Concatenation

When concatenating multiple words or abbreviations to form a name or a part of a name, no spaces or underscores shall be present between identifiers or abbreviations, with the following exceptions:

- If a name or part of a name is formed by concatenating two strings and the first string ends with a number, an underscore ("_") will be used to separate the two strings:
  - E.g. "Eqmt1_Rdy" contains an underscore following "Eqmt1" because it ends with a number.
- All letters in ISA 5.1 style identifiers and variables are capitalized, therefore they will be separated from succeeding identifiers or abbreviations with an underscore ("_")
  - E.g. "KQ_Rst" contains an underscore following the "KQ" variable because it ends with a capital letter.
  - E.g. "F_Max" contains an underscore following the "F" variable because it ends with a capital letter.
- All letters in acronyms are capitalized, therefore they will be separated from succeeding identifiers or abbreviations with an underscore ("_")
  - E.g. "HOA_Auto" contains an underscore following the "HOA" acronym because it ends with a capital letter.

3 CLASSES

A class is a template that is used to create an object within the PCS. A typical class is a collection of PLC program logic together with HMI graphic objects. The PLC portion of a class is implemented in the Schneider Electric Unity Pro software using a Derived Function Block. The HMI portion of a class is implemented in Vijeo Citect using a Genie or Super-Genie that is linked to *Equipment* object(s) in Vijeo Citect.

A number of standard classes are currently in development for the City's Sewage Treatment Program. Contact the City for the current status on the development of these classes, and to obtain copies of completed classes. Additional classes may be developed as required for common control system functions to allow for rapid system development.

New classes that are developed shall be named in a manner that gives a clear indication of the functionality contained in the class. All class names shall follow the basic rules indicated in Section 2. Where the class could be used for different types of equipment, it should be named generically enough so that the name fits all pieces of equipment (e.g. EqmtStatus as opposed to MotorStatus).

Not all PLC program logic is necessarily templated from a class. In some cases, program logic may be implemented using Elementary Function Blocks in the PLC program. However, all variables read by the HMI system should be read from a derived function block (class) within the PLC.

4 PLC TAGS

4.1 I/O Tag Format

The tag naming standard for I/O signals is as per the City of Winnipeg Identification Standard, document 510276-0000-40ER-0002, Section 7.8.

The tag naming standard for fire alarm signals is as per the City of Winnipeg Identification Standard, document 510276-0000-40ER-0002, Section 6.7.

4.1.1 I/O Signal Conditioning

Input signals from physical I/O or a communication network require conditioning before being used in the PLC program. This is to ensure that all input signals remain constant throughout the program scan, and also allows for input channel re-assignment, signal inversion, and scaling if necessary. Input signal conditioning is performed in separate input signal conditioning routines. Likewise, output signals shall be mapped to the respective physical or network outputs in an output signal conditioning routine. While output signals do not always require conditioning, output channel reassignment may be required in the future, which would be performed in the output signal conditioning routine.

Signals directly associated with physical I/O or networked devices are called raw signals, and the tag name for all raw signals shall have an underscore appended to it.

The I/O conditioning logic may include a check on the quality of the signal. An error status will be set when there is a clear indication that the values are not being read or written properly, the wires are disconnected or shorted, or in the case of analog signals, the values are overrange or underrange (the possible checks depend on the I/O card and type of wiring). The tag indicating bad quality will be the conditioned I/O tag plus "_Err".

Examples:

TSH_M6011_	Temperature switch raw input.
TSH_M6011	Temperature switch conditioned input.
TSH_M6011_Err	Temperature switch input bad quality status.

Refer to the implementation examples in Section 4.5 for detailed I/O signal conditioning implementations for both physical I/O and networked devices.

4.2 Control System Functions

4.2.1 Control System Function Naming

4.2.1.1 Control System Functions for Devices

Control system functions shown on P&IDs or described in the Functional Requirements Specification (FRS) shall be given an ISA 5.1 style tag. These functions typically are directly related to the control and monitoring of a particular piece of equipment or instrument, and the Loop Number will be determined from the equipment or instrument Loop Number. The identifier of the Control System Function implemented in the PLC and HMI should match the identifier of the Control System Function shown on the P&ID.

The identification format for control system functions for devices is as follows:

X*	-	P	NNN	T
Functional Designation	-	Process Area	Equipment Number	Instrument Number
			Loop Number	

Where,

X* is the *Functional Designation*, which is typically composed of two to four uppercase letters based upon ISA 5.1. Common Functional Designations are shown below:

Table 1 – Common Functional Designations

Functional Designation	Description
YC	Controller for a major piece of equipment
XC	Controller for a valve or damper with discrete states
YL	Indicator for equipment with discrete states
PAL, LAL, etc.	Alarms
LIC, FIC, etc.	Controller of an analog variable
LI, FI, etc.	Indicator of an analog variable
FK	Control Station to allow HMI override

P is the *Process Area.* The process area code identifies the physical area or building in which the equipment is located. A single letter character from A to Z represents a process area as per Identification Standard, document 510276-0000-40ER-0002.

NNN is the *Equipment Number* of the associated equipment.

T is the *Instrument Number* of the associated instrument.

NNNT is the Loop Number of the associated equipment, composed of the *Equipment Number* together with the *Instrument Number*.

Examples:

YC-G1010 Controller for pump P-G101.

YL-B6510 Indicator for boiler BLR-B651. Note that there could be multiple signals being indicated.

FI-G2346 Flow indicator associated with flowmeter FIT-G2346.

LAH-R2100 Digital alarm/indicator to indicate high level alarm from high level switch LSH-R2100.

4.2.1.2 Control System Functions for Overall Control Schemes

Control system functions for overall control schemes provide higher level control for multiple pieces of equipment and shall be given an identifier similar to control system functions for devices.

The first and second digits of the loop number should match the first and second digits of the associated equipment loop numbers. The fourth digit should be a “0”, however this may not always be possible as it may conflict with an existing loop number assigned to an instrument. If a loop number ending in “0” would result in a conflict, consider using a loop number that ends with “8” or “9” to reduce potential conflicts with other instrumentation. In more complex controllers, a new Loop Number should be chosen.

The PLC logic for an overall control scheme is not required to be encapsulated in a Derived Function Block, however, a separate subroutine (logic diagram) should generally be provided.

The identification format for overall control schemes is as follows:

X*	**-**	**P**	**NNNN**	**_**	**F***
Functional Designation	-	Process Area	Loop Number	_	Functional Description

Where,

X* is the *Functional Designation*, which is typically composed of two to four uppercase letters based upon ISA 5.1. Common Functional Designations are provided in Table 1 above.

P is the *Process Area.* The process area code identifies the physical area or building in which the overall control scheme is used. A single letter character from A to Z represents a process area as per Identification Standard, document 510276-0000-40ER-0002.

NNNN is the *Loop Number*, which is a four digit number assigned to the control scheme. Where the overall control scheme is associated with equipment, the first and second digits of the Loop Number should match that of the equipment numbers.

F* is a description of the functionality. This should adequately describe the function to allow for easy interpretation of its purpose.

Examples:

XC-R4100_MasterController Master controller for blowers B-R411, B-R412, B-R413, and B-R414.

YC-P2001_DestSelector Controller that determines which location sludge should be pumped to.

4.2.2 Alarm Tags

Identification of alarms that are generated directly from a discrete input will be as per Section 4.2.1.1.

Identification of alarms that are not generated directly from a discrete input will be as follows:

C*	**s**	**A***
Control System Function	.	Alarm Designation

Where,

C* is the *Control System Function* tag, as defined in Section 4.2.1.

s is the *Separation Character*. If the *Control System Function* is an instance of a class, this will be a dot. If not, it will be an underscore.

A* is the *Alarm Designation*, which uses ISA alarm designations where possible. Where ISA alarm designations are not used, the Alarm Designation shall be composed of the letters “Alm” followed by a description of the alarm using abbreviations and acronyms where possible.

Examples:

XC-G6121.ZAO	An Open Fail Alarm associated with valve XC-G6121.
YC-B6710.PAL	Pressure Alarm for Low Seal Water from the YC-B6710 controller, which is associated with pump P-B671.
YC-S2160_AlmNoPumpsAvail	No Sludge Pumps available to run. YC-S2160 is a control system function for an overall control scheme, not an instance of a class.

4.2.3 Alarm Limit Tags

Identification of analog limit values for the generation of alarms will be as follows:

C*	**s**	**A***	_	**LMT**
Control System Function	.	Alarm Designation	_	Limit Designation

Where,

C* is the *Control System Function* tag, as defined in Section 4.2.1.

s is the *Separation Character*. If the *Control System Function* is an instance of a class, this will be a dot. If not, it will be an underscore.

A* is the *Alarm Designation*, which uses ISA alarm designations where possible. Where ISA alarm designations are not used, the Alarm Designation shall be composed of the letters “Alm” followed by a description of the alarm using abbreviations and acronyms where possible.

LMT is the *Limit Designation*, which is composed of the letters “LMT”.

Example:

TI-G6031.AlmHiHi_LMT A High-High Temperature Alarm Limit setting for TI_G6031.

4.2.4 Control Loop Variables

Identification of control loop variables for PID control loops, will be as follows:

C*	**s**	**F***
Control System Function	.	Control Loop Functional Designation

Where,

C* is the *Control System Function* name, as defined in Section 4.2.1.

s is the *Separation Character*. If the *Control System Function* is an instance of a class, this will be a dot. If not, it will be an underscore.

F* is the Control Loop Functional *Designation* defined in the table below:

Table 2 – Common Control Loop Functional Designations

Functional Designation	Description
PV	Process Variable
CV	Control Variable
Auto_SP	Setpoint when in Auto Mode
Oper_SP	Setpoint from Operator via HMI

Note that the above list is not exhaustive, and for other types of control loops (i.e. other than PID control), other functional designations may be required. Use ISA 5.1 style identification, and/or the standard abbreviations and acronyms found in Appendix B, for naming these control loop functional designations.

Examples:

FIC-S1501.PV — The process variable (flow signal) for PID controller FIC-S1501 from flow meter FIT-S1501.

LIC-R4001.CV — The control variable (output signal) from the PID controller LIC-R4001 associated with tank TK-R400.

TIC-R6021.Auto_SP — The automatic mode setpoint for PID controller TIC-R6021.

4.3 Internal Variables

Identification of internal variables not associated with a specific piece of equipment or instrument loop, where the variable will be not used beyond the originating PLC, will be as follows:

C*	s	F*
Control System Function	.	Signal Description

Where,

C — is the *Control System Function* name, formatted as per Section 2.2. Where the *Control System Function* name is associated with multiple pieces of equipment, a name is chosen that has some commonality with the identifiers of the equipment.

s — is the *Separation Character*. If the *Control System Function* is an instance of a class, this will be a dot. If not, it will be an underscore.

F* — is the *Signal Description* composed of abbreviations and acronyms where possible. This should adequately describe the signal to allow for easy interpretation.

Examples:

YC_S6001_State — The state variable for the state controller controlling Wet Well ventilation.

YC_G1000_WeatherMode — A discrete variable indicating Summer or Winter mode associated with the raw sewage pumps.

4.4 Global Variables

In some cases it will be required to read a variable from another PLC. A variable that is read from another PLC shall be considered a global variable. The global variable in the destination PLC shall be identified as follows:

GBL	**P**	**NNN**	_	**T***
Global Designation	Process Area	PLC Equipment Number	_	Originating Tag Name

Where,

GBL	is the *Global Designation*, consisting of the letters "GBL".
P	is the *Process Area* of the originating PLC.
NNN	is the *Equipment Number* of the originating PLC.
T*	is the *Originating Tag Name,* which is the name of the tag that is being read from the remote PLC.

Examples:

GBL_R801_AIC_R1051.PV	The process variable associated with PID controller AIC-R1051 originating from PLC-R801.
GBL_P801_FI_P1081	Flow signal from flow meter FIT-P1081 originating from PLC-P801.

4.5 Implementation Examples

4.5.1 Hardwired Motor Starter

The P&ID example below shows scum recirculation pump P-P217 with control system function YC-P2170. As per the Identification Standard, document 510276-0000-40ER-0002, the inputs are P-P217.Run, P-P217.Rem, and P-P217.PSL, and the output is P-P217.CmdRun.

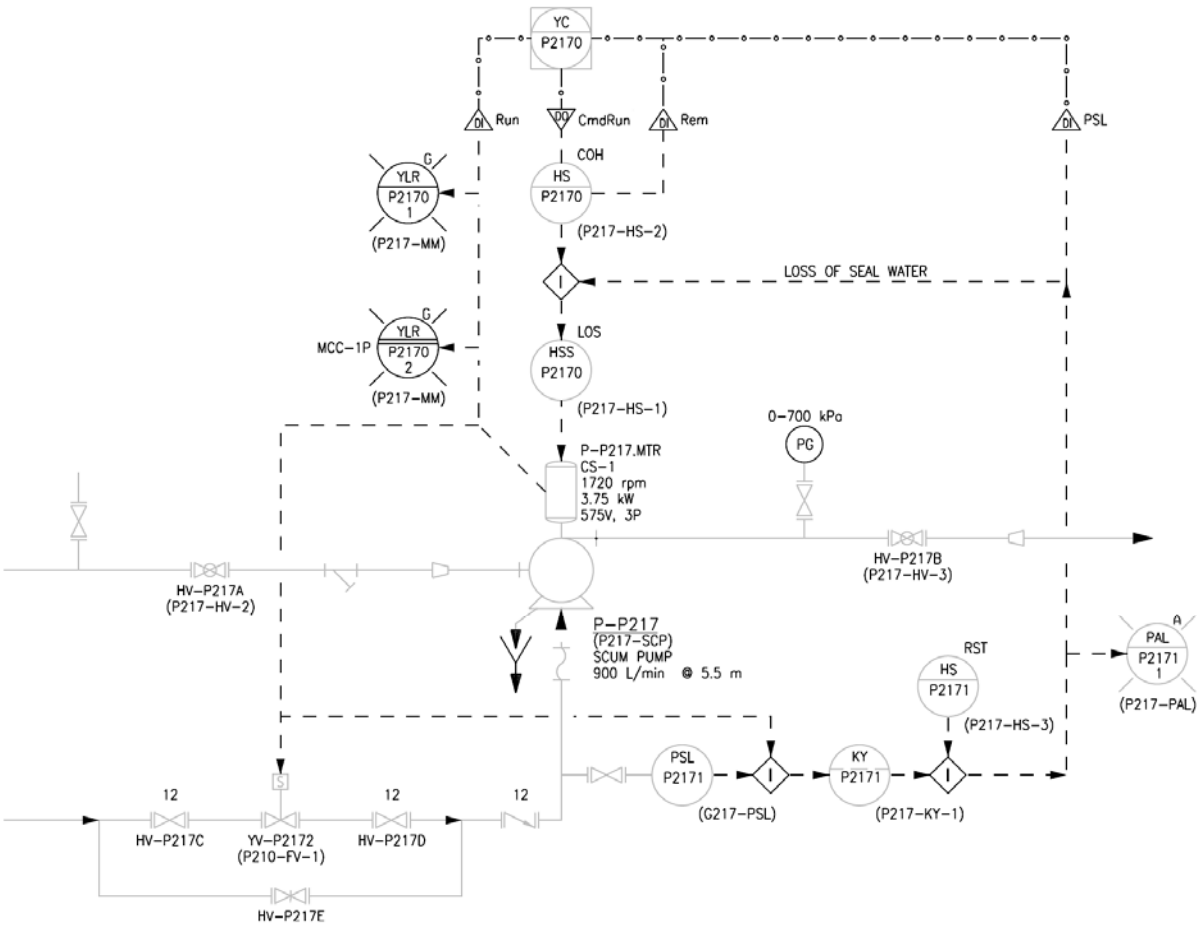

Figure 4-1 – Example P&ID for Hardwired Motor Starter

The raw PLC input tags before conditioning are:

- P_P217_Run_
- P_P217_Rem_
- PSL_P2171_

Within the input conditioning routing, the raw PLC input tags are conditioned to the following tags:

- P_P217_Run
- P_P217_Rem
- PSL_P2171

The function instance YC-P2170 will reside in the pump subroutine and will have the above conditioned PLC tags mapped to the following input parameters (not all parameters are shown):

- YC_P2170.Run
- YC_P2170.Rem
- YC_P2170.PSL

Some of the HMI commands that interface with the YC-P2170 function instance are:

- YC_P2170.ManStart
- YC_P2170.ManStop
- YC_P2170.Rst

YC-P2170 will have the following class output and alarm parameters (not all parameters are shown):

- YC_P2170.CmdRun
- YC_P2170.PAL
- YC_P2170.AlmRunFlt

Within the pump subroutine, the YC_P2170.CmdRun output will write to the following tag:

- P_P217_CmdRun

Within the signal conditioning routine, the P_P217_CmdRun tag will write to the following raw PLC output tag:

- P_P217_CmdRun_

4.5.2 Networked Motor Starter

The P&ID example below shows a fermenter recirculation pump P-D321 with control system function YC-D3210. The starter associated with this pump is a networked starter (eg. Schneider Electric TeSys T), and as such there will be a significant amount of data that can be read from the starter.

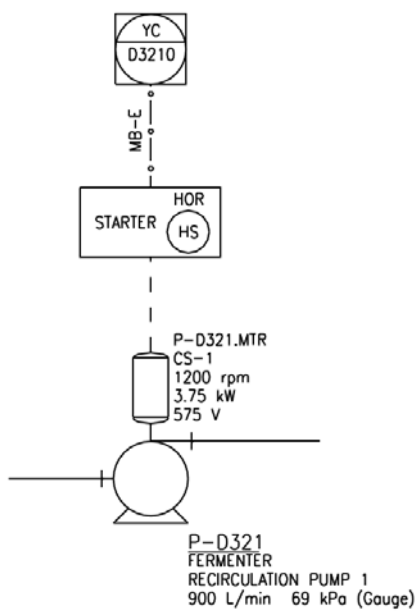

Figure 4-2 – Example P&ID for Networked Motor Starter

The control system function YC-D3210 is implemented as an instance of a PumpBasic class, which is a class developed for the City of Winnipeg Sewage Treatment Program. Within the PLC, the PumpBasic derived function block (DFB) does not perform the actual data exchange with the networked motor starter. The PumpBasic DFB is linked to a TeSys DFB that was developed by Schneider Electric, which performs the data exchange. The identifier for the TeSys DFB instance should be the same as the control system function but with an underscore (“_”) appended to the identifier (eg. YC_D3210_).

The PumpBasic DFB would reside in the subroutine dedicated to overall control and functionality of the equipment. The TeSys DFB would reside in a signal conditioning routine since it maps the raw (unconditioned) networked I/O signals to conditioned PLC tags.

The input and output pins of the TeSys DFB connect to conditioned tags within the signal conditioning routine. Conditioned tags do not end with an underscore. These conditioned tags then connect to the input and output pins of the PumpBasic DFB in the equipment subroutine.

The following provides an example of linking some of the signals between the TeSys DFB and the PumpBasic DFB. Due to the quantity of signals associated with the TeSys DFB, not all signals are included in this example.

Within the signal conditioning subroutine, some of the signals obtained from the TeSys DFB are written to the following conditioned tags:

- P_D321_Rdy
- P_D321_Running
- P_D321_Flt
- P_D321_I_Avg

In the pump subroutine, the above conditioned tags are connected to the following pins on the YC-D3210 PumpBasic DFB:

- YC-D3210.StarterRdy
- YC-D3210.Run
- YC-D3210.Flt
- YC-D3210.I_Avg

YC-D3210 will have the following class output parameters (not all parameters are shown):

- YC-D3210.CmdRun

Within the pump subroutine, the YC-D3210.CmdRun output writes to the following tag:

- P_D321_CmdRun

Within the signal conditioning routine, the P_D321_CmdRun tag is connected to the ‘Run_fwd’ input pin on the TeSys DFB.

4.5.3 Instrument-Valve Control Loop

The P&ID example below shows a control loop consisting of a flow meter and modulating valve. Both of these devices utilize a PROFIBUS connection for communication with the process control system.

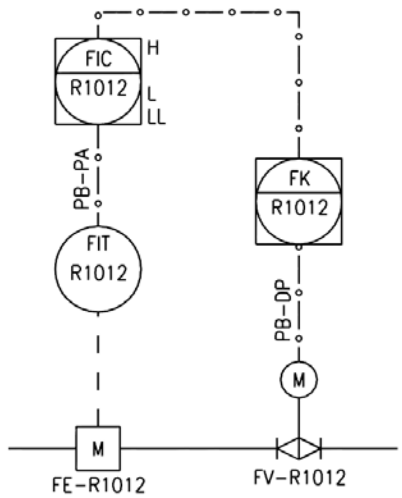

Figure 4-3 – Example P&ID for Instrument-Valve Control Loop

The control system function associated with the flowmeter (FIC-R1012) is an instance of the PID_Controller class, and the control system function associated with the valve (FK-R1012) is an instance of the LdStn (Loading Station) class. The FIC-R1012 PID controller accepts a process variable input, computes the control variable based on the setpoint, and outputs the control variable to the FK-R1012 loading station. The loading station accepts the valve position command and passes it on to the network output tag that controls the valve position. The loading station also monitors the position of the valve and generates alarms as required, and facilitates manual control of the valve via the HMI.

Within the PLC, the FIC-R1012 and FK-R1012 derived function blocks (DFBs) do not perform the actual data exchange with the networked devices. The data exchange is performed via a networking service within the PLC, which reads/writes data from/to the tag structures that were created by the FDT/DTM tool in Unity Pro.

The input and output tag structures created by the FDT/DTM tool should be named the same as the field device with "_IN" and "_OUT" appended to their name (eg. FIT_R1012_IN, FIT_R1012_OUT, FK_R1012_IN, and FK_R1012_OUT). Within these structures are status and control variables that are used by the PLC, and the names of these variables may or may not be pre-defined by the device manufacturer. Where the variable names are already pre-defined, they should not be renamed. However, if the variable names are not pre-defined, they should be renamed to be consistent with the standards outlined in this document.

In the following example, it is assumed that the variable names in the input and output structures have not been defined by the manufacturer, and that they have been renamed.

The flow signal in the input structure associated with the flow meter is:

- FIT_R1012_IN.F

Within the input signal conditioning routine, the above tag writes to:

- FIT_R1012_F

Within the equipment subroutine, the conditioned flow signal tag writes to the process variable (PV) input of the PID controller:

- FIC_R1012.PV

The output (control variable) of the PID controller is:

- FIC_R1012.CV

The control variable from the PID controller writes to the CV input of the valve's loading station:

- FK_R1012.CV_In

The output from the valve's loading station will be:

- FK_R1012.CV

The output from the valve's loading station writes to the position command variable in the output structure associated with the valve:

- FK_R1012_OUT.CmdZ_

The position feedback from the valve is stored in the following variable within the valve's input structure:

- FK_R1012_IN.Z_

The above position feedback variable is written to the feedback input of the loading station:

- FK_R1012.Fbk

5 HMI TAGS

5.1 General

The Vijeo Citect HMI software has a database to store HMI tags. Each record in the database is called a *Variable Tag*. Within each *Variable Tag* record there are two fields which can be used to identify the tag. These fields are called *Tag Name* and *Equipment.Item*. The *Equipment.Item* format allows for tags to be organized in a hierarchical fashion and provides additional options for searching for a specific tag.

Most of the data read by the HMI will be from derived function block parameters in the PLC since most of the logic will be templated from classes. However, in some cases the PLC logic will not be templated from a class and the HMI will read PLC tags. Where the HMI reads data from a derived function block parameter in the PLC, the *Tag Name* and *Equipment.Item* fields of the HMI variable tag are required to be populated so that the HMI tag links to HMI Equipment objects. In cases where the HMI reads PLC tags, typically only the *Tag Name* field is required.

It is not expected that the HMI will write to PLC tags directly. An instance of a derived function block should be used whenever practical. For example, when an output is not dependent on a measured process variable but can be varied only by manual adjustment, a manual loading station function block should be implemented instead of having the HMI write to the output directly.

5.2 *Tag Name* Format

5.2.1 HMI Tags associated with Derived Function Block Parameters

For HMI tags that are associated with derived function block parameters in the PLC, the *Tag Name* field will be identical to the function block instance name and the parameter name but with all periods replaced with a backslashes (“\”):

T*	****	**P***
Function Block Instance Name	\\	Function Block Parameter Name

Where,

T* is the associated PLC function block instance name.

P* is the associated PLC function block parameter name.

Examples:

YC_R2050\Run — The running status signal from the YC-R2050 pump controller.

LIC_R4001\ManSP — The manual mode setpoint for PID controller LIC-R4001.

5.2.2 HMI Tags associated with PLC Tags

For HMI tags that are associated with PLC variables (instances of elementary data types or derived data types), the *Tag Name* field will be identical to the associated PLC tag name with any periods replaced with backslashes (“\”):

T*
Associated PLC Tag

Where,

T* is the associated PLC tag with any periods replaced with backslashes.

Examples:

YC_R2050\Run	The running status signal from the YC-R2050 pump controller.
LIC_R4001\ManSP	The manual mode setpoint for PID controller LIC-R4001.

5.3 *Equipment.Item* Format

The format for the HMI *Equipment.Item* field will be as follows:

P	**.**	**E***
Process Area	.	Equipment / Instrument Identifier

Where,

P is the *Process Area*. The process area code identifies the physical area or building in which the equipment is located. A single letter character from A to Z represents a process area.

E* is the Equipment or Instrument Identifier related to the signal.

The format for the *Item Name* field should be as follows:

F*
Signal Description

Where,

F* is the *Signal Description* using abbreviations and acronyms where possible.

5.4 Example

The following table shows some of the HMI tag names and *Equipment.Item* names for pump P-S217 and control function YC-S2170 shown in Section 4.5.

PLC	HMI	
	Tag Name	**Equipment.Item**
YC_S2170.Run	YC_S2170\Run	S.P_S217.Run
YC_S2170.Flt	YC_S2170\Flt	S.P_S217.Flt
YC_S2170.PAL	YC_S2170\PAL	S.P_S217.PAL
YC_S2170.Rst	YC_S2170\Rst	S.P_S217.Rst

Additional examples are shown in the table below.

PLC	HMI	
	Tag Name	**Equipment.Item**
TI_B6471.PV	TI_B6471\PV	B.TI_B6471.PV
PAL_B5451.Out	PAL_B5451\Out	B.PAL_B5451.Out

Appendix A

A.1 Field Equipment Identification

The following is provided as a summary of instrument and equipment identification found in the Identification Standard, document 510276-0000-40ER-0002.

A.1.1 Instrument Identifier Format

As per Section 7.1.1 in the Identification Standard, document 510276-0000-40ER-0002, the identification format for instrumentation is as follows.

FFFF	**-**	**XXXX**	**-**	**P**	**NNN**	**T**	**-**	**S**
Facility Code (Optional)	-	Instrument Functional Designation	-	Process Area	Equipment Number	Instrument Number	-	Suffix
					Loop Number			

Where,

FFFF	is the *Facility Code*. The *Facility Code* will typically be implied, and would only be fully written where required.
XXXX	is the *Instrument Functional Designation*, which is typically composed of two to four characters based upon ISA 5.1. Note that five character *Instrument Functional Designations* are possible, but should be quite rare.
P	is the *Process Area.* The process area code identifies the physical area or building in which the equipment is located. A single letter character from A to Z represents a process area.
NNN	is the *Equipment Number* of the associated equipment. If no equipment is associated, allocate *Equipment Numbers* specific for the applicable instrumentation. Do not suppress 0's for equipment numbers, as all loop numbers at a site should have the same number of digits in the loop number.
T	is the *Instrument Number*, where the number increments from the number 0 through 9. Utilize the number 0 for instruments directly associated with motor starters and control. The *Instrument Number* does not increment for every instrument, but rather increments for every instrument loop.
NNNT	is the Loop Number, composed of the *Equipment Number* together with the *Instrument Number*.
S	is the *Suffix*, which is used in the cases of multiple instruments on the same or redundant loops. All suffixes are to be numeric.

Examples:

XY-G2501	A solenoid for the valve XV-G250, where the solenoid is remote from the valve.
LT-M1011-2	Redundant Wet Well level transmitter.
HSR-R1100	A start pushbutton associated with pump P-R110.
TY-B1500	A temperature relay that takes signals from TT-B1501, TT-B1502, TT-B1503, and TT-B1504 and converts to a Modbus protocol.
ZSS-F3212	A safety switch for CNV-F321.

A.1.2 Mechanical, Electrical and Automation Equipment Identifier Format

As per Sections 4.1, 6.1, and 7.2.1 in the Identification Standard, document 510276-0000-40ER-0002, the identification format for mechanical, electrical and automation equipment, other than instrumentation, is as follows.

FFFF	**-**	**EEEE**	**-**	**P**	**NNN**	**-**	**S**
Facility Code (Optional)	-	Equipment Functional Designation	-	Process Area	Equipment Number	-	Suffix (Optional)

Where,

FFFF — is the *Facility Code*. The *Facility Code* will typically be implied, and would only be fully written where required.

EEEE — is the *Equipment Functional Designation*, which is composed of two to four characters.

P — is the *Process Area*. The process area code identifies the physical area or building in which the equipment is located. A single letter character from A to Z represents a process area.

NNN — is the *Equipment Number*.

S — is the Suffix, an optional numeric or letter code to distinguish between multiple pieces of equipment with a common equipment number. Generally, numbers are utilized for equipment in series, and letters for equipment in parallel.

Examples:

CMP-G201	A compressor in the G process area.
P-M645	A glycol pump in the M process area.
R-R102	A reactor in the R process area.
MCC-M701	A MCC located in the M process area
DS-G510	A disconnect switch for pump P-G510.
CB-M723-B	The second (alternate) breaker feeding PNL-M723.
0101-PLC-G801	A PLC located in the Grit process area of the NEWPCC facility.
ADP-G110	An automation device panel dedicated to pump P-G110.

A.1.3 Subcomponent Identifier Format

As per Section 2.6 in the Identification Standard, document 510276-0000-40ER-0002, in some cases it is appropriate for equipment to be designated as a component of another identified piece of equipment, rather than an independent unit. Equipment subcomponents will typically be expressed as using a dot "." field, followed by the subcomponent identifier.

E*	.	SSSS	-	N
Equipment Identifier	.	Subcomponent Functional Designation	-	Subcomponent Number

Where,

E* is the *Equipment Identifier*, of the base equipment, as designated in this document.

SSSS is the *Subcomponent Functional Designation*, which is one to four letters.

N is the *Subcomponent Number*, an optional field to be utilized when there are multiple subcomponents within the base equipment.

Some examples of subcomponents are as follows:

CMP-R521.LOP Lube oil pump for compressor CMP-R521, where the pump is integrated into the compressor skid and driven by the compressor motor.

PNL-P712.MCB Panelboard PNL-P712 main breaker

VFD-G612.RCTR-1 Line reactor for VFD-G612 (integrated in VFD enclosure)

A.1.4 Facility Code

As per Section 2.2 in the Identification Standard, document 510276-0000-40ER-0002, each City of Winnipeg facility is assigned a unique, four-digit facility code. The facility code is deemed an optional component of equipment and instrument identifiers, with the preference to omit the facility code to reduce the overall length of identifiers. Thus, it is typically not included in PLC and HMI tags.

Appendix B

B.1 Standard Abbreviations and Acronyms

Table 3 – Standard Abbreviations

Abbreviation	Description
Accum	Accumulated / Accumulator
Act	Action
Alm	Alarm
Alt	Altitude
Avail	Available
Auto	Automatic
Avg	Average
Chan	Channel
Cls	Close
Cmd	Command
Comm	Communication
Compl	Complete
Cont	Continuous
Ctrl	Control
Curr	Current (eg. Current Selection)
CV	Control Variable
Dest	Destination
Dia	Diameter
Dis	Disable
Dly	Delay
Elec	Electrical
Enb	Enable
Eqmt	Equipment
Err	Error
Gen	General
Fail	Failure
Fbk	Feedback
Flt	Fault
Fwd	Forward
Hi	High
In	Input
Intlk	Interlock (Input)
Intlked	Interlocked (Output)
Lmt	Limit
Lo	Low

Abbreviation	Description
Op	Operator
Opn	Open
Out	Output
PV	Process Variable
Man	Manual
Max	Maximum
Mid	Middle
Min	Minimum
Num	Number
Pos	Position
RC	Rate of Change
Rdy	Ready
Req	Request / Requested
Rem	Remote
Rev	Reverse
Rst	Reset
Tgt	Target
Sel	Select / Selection / Selected
SP	Setpoint
Vol	Volume
Warn	Warning

B.1.1 Additional References

Fluid commodity codes may also be used in the naming of classes, function blocks, parameters, and variables. Refer to Table 5-2 in the City of Winnipeg Identification Standard, document 510276-0000-40ER-0002 for the complete list of standard fluid commodity codes.

APPENDIX R – WWD PAINT COLOUR STANDARD - R01

Winnipeg

The City of Winnipeg

North End Sewage Treatment Plant

Paint Colour Standard

Document Code:

Revision: 01

Approved By:	D Griffin Duane Griffin, Branch Head - Wastewater Planning & Project Delivery	Feb 21, 2020 Date

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REVISION REGISTER				
Rev.	**Description**	**Date**	**By**	**Approved**
00	Issued for City Use	2020-02-18	K. Schimke	D. Griffin
01	Replaced “color” with “colour”	2020-02-21	K. Schimke	D. Griffin

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Table of Contents

1 INTRODUCTION

This document identifies the standard paint colour requirements that are applicable to any work within the City of Winnipeg's North End Sewage Treatment Plant.

1.1 Scope of the Standard

This design standard will apply to the following facilities:

North End Sewage Treatment Plant

1.2 North End Sewage Treatment Plant Application

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 facilities are expected to comply with this standard.
- All major upgrades to a facility 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 there will be a deviation from this design standard. The rational for potential deviations from the design standard may include:

- Change in colour scheme classification,
- Addition of new processes,
- Updates to standards and regulations,
- Specific operations requirements.

For any deviation from this standard, 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.

2 PAINT COLOUR CODES-PIPING

1. All piping and specified equipment within the North End Sewage Treatment Plant shall match the below Sherwin Williams paint codes and colour types.
2. Paint products shall be low VOC (Volatile Organic Compound) or water based wherever possible.
3. In the event pipe material prevents it from being painted, coloured bands shall be used.

4. Directional arrows to be used to indicate flow

Item	New Colour Name	Sherwin Williams Paint Code
Centrate	Lemon Chiffon	SW 6686
Chlorine	Solar Yellow	SW 4075
Digester Gas	Safety Red	SW 4081
Dry Polymer Storage	Lime Granita	SW 6715
Ferric Chloride	Solar Yellow	SW 4075
Final/Secondary Effluent	Emerald Ice	SW 4069
Flushing Water	Safety Blue	SW 4086
Glycol Supply	Gala Pink	SW 6579
Glycol Return	Hibiscus	SW 6851
Hot Water Supply	Lucky Green	SW 6926
Hot Water Return	Picnic	SW 6731
Instrument Air	Shamrock (dark green)	SW 6454
Liquid Polymer Storage	Lime Rickey	SW 6717
Mixed Liquor	Extra White	SW 7006
Natural Gas	Safety Yellow	SW 4084
Oxygen	Mature Grape	SW 6286
Potable Water	Vapor (light blue)	MC-85
Primary Effluent	Lazy Grey	SW 6254
Primary Sludge	Iron Ore	SW 7069
Process Air	Grandview (bluer green)	SW 6466
Process Drain	Extra White	SW 7006
Rain Water Leader	Web Gray	SW 7075
Return Activated Sludge- Train 1	Pineapple Cream	SW 1668
Return Activated Sludge- Train 2	Invigorate (orange)	SW 6886
Return Activated Sludge- Train 3	Drift of Mist (Cream)	SW 9166
Sanitary Sewer	Web Gray	SW 7075
Scum/Degreasing	Grays Harbour	SW 6236
Sludge Cake Hopper	Extra White	SW 7006
Sludge Cake Line	Overjoy	SW 6689
Sludge Cake Pump Drive	Festival Green (very green)	SW 6923
Sludge Cake Storage	Overjoy	SW 6689
Sludge Feed/Transfer	Curry	SW 6671
Sludge Mixing System	Navel (kind of pumpkinish)	SW 6887
Thin Sludge	Solaria	SW 6688
Waste Activated Sludge	Tricorn Black	SW 6258
Well Water Supply	Flyway	SW 6794
Well Water Return	Sky Fall	SW 9049

3 PAINT COLOUR CODES- EQUIPMENT

1. Paint type should be selected as appropriate for the area in which it will be used. Environmental conditions of the area should be taken into consideration.

Item	New Colour Name	Sherwin Williams Paint Code
Boilers	Heat Resistant Aluminum	B 59S3
Mix Age Polymer Tanks	Outgoing Orange	SW 6641
Motor Bases	Poppy Flower	SW 2904
Polymer Feed Tanks	Techno Teal	SW 4065
Valve Hand/Chain wheels	Safety Red	SW 4081

4 PAINT COLOUR CODES- CIVIL STRUCTURE

1. Paint type should be selected as appropriate for the area in which it will be used. Environmental conditions of the area should be taken into consideration.

Item	New Colour Name	Sherwin Williams Paint Code
Concrete/Block work	Cirrus White	SW 4012

5 PAINT COLOUR CODES- DUCT

1. Paint type should be selected as appropriate for the area in which it will be used. Environmental conditions of the area should be taken into consideration.
2. Directional arrows to be used to indicate flow.

Item	New Colour Name	Sherwin Williams Paint Code
Duct Work	Unusual Gray	SW 7059

6 PAINT COLOUR CODES- OTHER MISCELLANEOUS

1. Paint type should be selected as appropriate for the area in which it will be used. Environmental conditions of the area should be taken into consideration.

Item	New Colour Name	Sherwin Williams Paint Code
Exterior Pedestals/Panels	Safety Yellow	SW 4084
Handrails (Painted)	Aluminum	B 59S2
Bollards	Safety Yellow	SW 4084
Rain Water Leaders	Web Gray	SW 7075
Steel Pipe Supports	Grey	Ansi 61 Grey

APPENDIX S – WSTP CHAIR PROCEDURE (DOCUMENT NUMBER: CD-CP-PC-01) - R2013-04-25 AND APPENDICES

Winnipeg Sewage Treatment Program Integrated Management System

CHAIR Procedure

DOCUMENT NUMBER: CD-CP-PC-01

Rev	Prepared by	Reviewed by	Date	Approved by	Date
2013-02-21	Bruno Valla			Jackie Veilleux	2013-02-21
2013-04-25	Philippe Biesse			Jackie Veilleux	2014-04-23

TABLE OF CONTENTS

SAFETY IN DESIGN TOOL

Disclaimer

This procedure contains information regarding occupational health, safety, injury management and workers compensation. It may include some of the consultant's and contractor's obligations under various workers compensation and occupational health and safety legislation. This procedure does not relieve the consultant or contractor of any legal obligations under these Acts or legislation.

This procedure is based on the Australian WorkCover NSW publication. More information can be found on their website **www.nsw.gov.au**

Introduction

The Construction Hazard Assessment Implication Review. or CHAIR, is a tool to assist designers, constructors, clients and other key stakeholders to work together to reduce construction, maintenance, repair and demolition safety risks associated with design.

CHAIR provides a rigorous framework for a facilitated discussion that is stimulated by guidewords or prompts. These prompts assist the key stakeholders to collectively identify and reduce safety risks associated with a design. The risks are formally listed for action by the appropriate stakeholders.

CHAIR recognizes that a design involves key considerations such as operability, aesthetics and economics with the elements of safety. It also acknowledges that a design process may be determined by many different stakeholders and/or influences. The CHAIR methodology aims to involve these elements and influences.

This procedure will be applied to projects where the design or construction is unique, complex, or of sufficient inherent hazard that a formal detailed assessment is warranted.

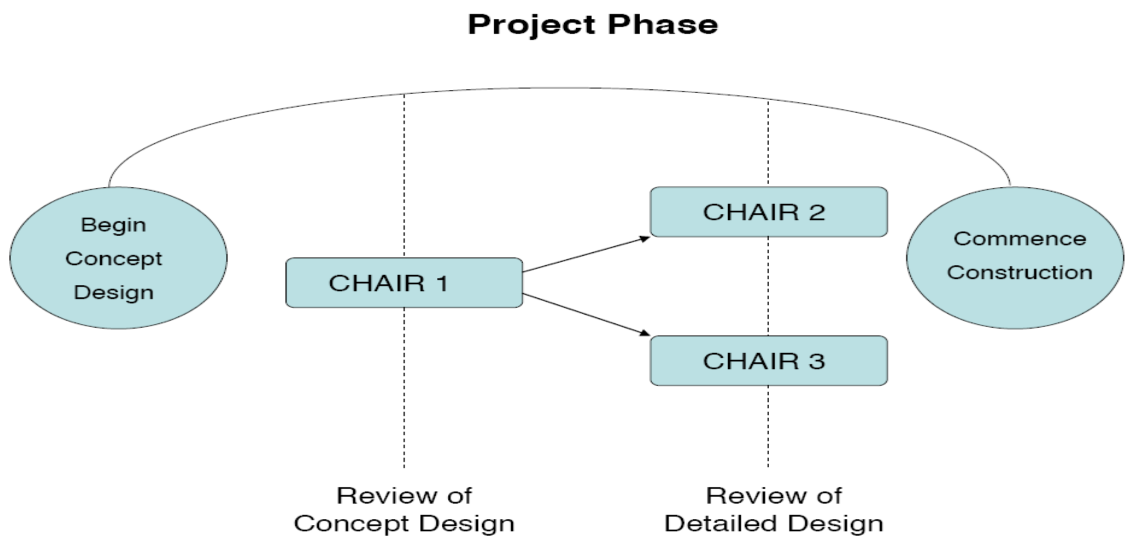
There are three phases of CHAIR:

CHAIR ONE is performed at the conceptual stage of a design, which is the best opportunity to make fundamental change, even though much of the design is still to be determined.

CHAIR TWO focuses on construction and demolition issues and is performed well before construction, when the full detailed design is known.

CHAIR THREE focuses on maintenance and repair issues and is performed at the same time as the CHAIR 2 study.

This is illustrated in the following diagram:


Project Phase
Begin
Concept
Design
CHAIR 1
CHAIR 2
CHAIR 3
Commence
Construction
Review of
Concept Design
Review of
Detailed Design

For example, a CHAIR study could be used during the design stage to improve safety during construction by:

- designing a multi-storey building such that the exterior wall covering (precast panels etc.) can be installed as soon as the framework is in place and most trades begin work on the floor;

- designing higher parapet walls or an integrated guardrail system along all roof edges thus eliminating the need for installing temporary barriers;

- designing permanent stairways and walkways to be constructed first and minimizing the use of temporary scaffolding.

By proactively considering construction, maintenance, repair and demolition issues, the CHAIR framework should not only help reduce the number of construction industry incidents, but also assist in improving constructability and reducing the life cycle costs associated with building and civil design projects.

1. Importance of safe design

The design process involves a range of participants and stakeholders. It includes designers, specialist consultants, clients, users, approval authorities and (at times) project managers and constructors. The art of design involves consideration of a range of issues such as aesthetics, function, safety and environment. Such considerations can arise due to experience, legislation, codes and standards, expertise, logic, checklists and any other means.

Previous experience greatly assists with identification of safety risks associated with a design. However, to learn from previous experience requires an incident to have occurred, be adequately documented and the information made available to the relevant parties involved in the design process.

Codes and standards tend to address the obvious risks and are less effective in identifying previously unforeseen hazards. When a design is no longer simple or straightforward, or involves unique, unusual or potentially hazardous design, sufficient experience or codes of practice may not exist to adequately consider all safety issues.

There is a balance of responsibilities between a designer, a constructor and other stakeholders, such as clients or specialist consultants. It is important that all participants highlight unusual safety risks associated with a design and required construction. Those involved in the design process should:

- ❖ identify the hazards presented by potential design solutions and consider the risks these hazards will generate for construction workers and others who may be affected by the construction work (e.g. members of the public);

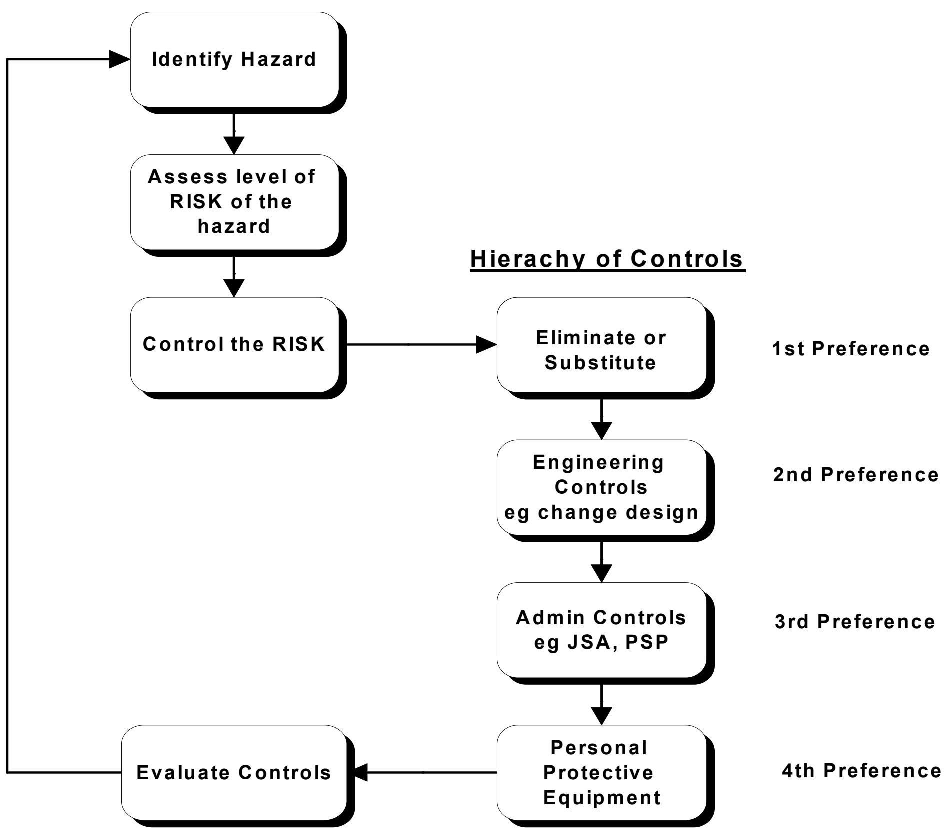
- ❖ include health and safety considerations among the design options so that they can avoid the hazards, reduce their impact or introduce control measures to protect those at risk where it is reasonably practicable;

❖ forewarn the contractor of the residual hazards that have been identified within the design and the need to manage them during the construction work.

Eliminating the hazard is the first risk control that should be considered. If the hazard cannot be eliminated (for example eliminating risks associated with maintenance by using aluminum/stainless steel, that doesn't require regular painting), the risk can be minimized by using a series of steps known as the hierarchy of risk control:

- substituting the system of work or plant with something safer (e.g. pre-assembled equipment at ground level rather than height);
- modifying the system of work or plant to make it safer (e.g. ensure attachment points for lifting, window cleaning, safety lines, etc.);
- isolating the hazard (e.g. introduce restricted areas);
- introducing engineering controls (e.g. prevent falls from buildings during construction or maintenance by increasing wall/edge height).

These controls are represented in the following flow chart:



Note: A combination of 2 or more controls may be necessary to control the risk.

Only when the above risk control options have been exhausted should consideration (and more importantly reliance) be given to personal protective equipment (e.g. safety harnesses) or adopting administrative controls such as hazard warning signs.

Design is the process of considering options and in developing and understanding these options, there is the ability to improve safety and reduce costs. For example, the costs associated with assembling large scale scaffolding may far exceed the costs associated with an alternate design and/or construction materials.
Essentially, given the opportunity to consider the design in a formal and systematic way, a smarter design results - and a smarter design invariably leads to a safer design.

2. The CHAIR Methodology

2.1. The CHAIR process

A CHAIR study is intended to help identify that a design needs to consider operability, aesthetics, and economics, with the elements of safety in constructability and maintainability. A CHAIR provides a structured forum to ensure there is opportunity to foresee construction, maintenance, repair and demolition safety issues, so they can be eliminated or modified as part of the design process.

The process for CHAIR is as follows:

- Assemble a CHAIR study team (include all stakeholders).
- Define the objectives and the scope of the study.
- Agree on a set of guidewords / prompts to assist brainstorming process.
- Partition the design (CHAIR-1, CHAIR-3) or the construction process (CHAIR-2) into logical blocks of appropriate size.
- For each logical block, use various guidewords to assist with the identification of safety aspects/issues.
- Discuss associated risks and determine if the safety risk can be eliminated.
- If the safety risk cannot be eliminated, determine how it might be reduced.
- Assess whether the proposed risk controls (i.e. expected safeguards, etc.) are appropriate (is the risk as low as reasonably practicable).
- Document comments, actions and recommendations - determine appropriate method for design issues still to be resolved.

2.2. CHAIR Guidewords

A CHAIR study is a form of safety analysis similar to a technique used in Hazard and Operability (HAZOP) study.
One of the main elements of a HAZOP is the use of guidewords, applied to various sections of the design, to stimulate discussion and risk identification. Similarly, the methodology of a CHAIR study is to divide the proposed design into logic blocks and consider the implications of the guidewords for that element.
It is critical that the guidewords provided be used as a prompt to promote discussion of issues

and not as a checklist of issues to be considered.
As all CHAIR phases have their own specificity, a typical list of CHAIR guide words was developed for each phase and will be presented in the respective sections of this document.

2.2.1. The CHAIR Facilitator

The success of a CHAIR study is dependent on the ability of a facilitator to select and use the experience and expertise of the study team to critically evaluate the design. Therefore, the selection of a facilitator is critical.
The facilitator should be sufficiently removed from the design process that he or she does not take the questions or suggestions coming from workshop participants as personal criticism, nor feel the need to defend the design concept. As the whole purpose of a workshop is to test the design concept from a safety-in-construction standpoint, the role of the facilitator is to encourage workshop participants to constructively challenge the design and explore whether issues have been overlooked or sufficiently thought through.
It is recommended that the facilitator should have the following attributes:

- an understanding of the principles of safety in construction;
- the respect, or potential to quickly gain the respect, of workshop participants;
- as a minimum, a broad understanding of the project;
- the ability to bring out the views of a diverse range of people participating in the workshop to constructively challenge the design concept;
- the ability to put forward their own views and thus provoke thought, but without dominating the workshop;
- the ability to keep the workshop on track and moving along (issues that can't be resolved relatively quickly should be listed for action outside the workshop).

2.3. CHAIR-1: conceptual design review

2.3.1. Introduction to CHAIR 1

The purpose of the CHAIR-1 study is to review the conceptual design and identify the significant construction, maintenance, repair and demolition safety risks associated with a project. By identifying and understanding these risks very early in the project phase, risk controls can be established to ensure that, if these risks cannot be eliminated, they are at least managed so they are as low as is reasonably practicable.
Organizations typically perform feasibility or conceptual operational design assessments which cover the various function and elements of a design, including safety. The focus of these assessments is at a fundamental level, where it is still possible to radically change the design concept and significantly improve safety and operability. The effectiveness of such studies is diminished when time is spent on less significant issues, which are more appropriately addressed as part of detailed design.
Those involved in the design process should have an informed view of the overall "constructability" and "maintainability" of the design, as not only do they influence safety, they also influence project and operability costs. Such influences may not necessarily be mutually

exclusive.
Only what is reasonable to foresee at the time a concept design is reviewed can be expected from any design review. It may be possible for risks which cannot be foreseen or addressed at the CHAIR-1 stage to be considered at the CHAIR-2 and CHAIR-3 stages.

2.3.2. CHAIR-1 Study Team

A designer should be well informed but is not expected to know everything, especially with regard to detailed construction techniques. Therefore, the designer, or a single third party, in isolation should not perform a CHAIR-1 study. What is required is essentially a systematic and formalized “brainstorming” workshop, which involves the appropriate stakeholders (designers, construction, maintenance, safety representatives, etc.), and is led by a facilitator who is a “third party” to the design (but could belong to one of the stakeholder organizations).
As the CHAIR-1 study is undertaken at the conceptual stage of the design process, it is difficult to indicate who should attend a CHAIR-1 meeting. The appropriate participants will depend on the type of project being considered. Participants may include: architect, design manager, construction manager, safety specialist, client, construction foreperson, project managers, engineers and service consultants. A CHAIR-1 study provides an opportunity for people to contribute to improving safety using their specialized knowledge. By using a diverse group of people and a systematic methodology, the chance of overlooking a major problem is significantly reduced.

2.3.3. CHAIR 1 Guidewords

A list of CHAIR-1 keywords is provided in CHAIR 1 & 2 - Record Template. The development of the CHAIR-1 guidewords was based on the assumption that the CHAIR-1 study would be structured on the design (and not a proposed construction method) being divided into logical blocks.
As occurs in all such methods, there is a tendency for the number of guidewords to be increased, until eventually the method begins to lose its value. Therefore, non-specific guidewords have been selected to provide prompts to the discussions.
The guidewords have been organized into two types: “generic” (applicable in most cases regardless of the type of design to each element) and “overview” (used at the end of a CHAIR-1 study to review issues that relate to the whole design concept).
A CHAIR-1 facilitator should review the applicability of guidewords (including additional words that may be required) as part of the preparation for the CHAIR-1 workshop. If additional guidewords are suggested during a CHAIR-1 meeting, then they should be used (and recorded) by the designer.

2.3.4. CHAIR-1 Procedure

The other difficulty is that there remains a tendency to use “add-on” safety measures as the first solution. The object of a CHAIR-1 study is to promote a full exchange of ideas in an enthusiastic environment.
A CHAIR-1 methodology follows that of most safety analysis in that:

- the design is divided into logical components for analysis;
- for each component of the design, sources of risks or other factors related to the risks of

accidents are identified;
- an assessment is carried out as to the appropriateness of the risk and its controls.

The critical examination of a system requires careful chairing to stop the meeting getting bogged down or rambling too widely. Given good guidance and common sense, it is possible to obtain sensible and useful results.

2.3.5. CHAIR-1 Documentation

It is important to document the findings, attendees, methodology, guidewords and findings of a CHAIR-1 study. A layout for recording the minutes of a CHAIR-1 meeting is provided in CHAIR 1 & 2 - Record Template. A major component of an effective CHAIR-1 study is the recording of the meeting minutes. These are best recorded by someone who has a good understanding of the project, to ensure records are taken accurately and efficiently.
The minutes typically only record those identified risks that require action or follow up, or to justify where, after a detailed decision is made by the CHAIR-1 team, the existing design element is retained.

2.4. CHAIR-2: detailed design construction or demolition review

2.4.1. Introduction

A CHAIR-2 study is performed as the detailed design is approaching completion, but well before commencement of construction. In some cases, it may be possible to identify a constructor to assist in performing the study.
CHAIR-2 is a specific type of study, in that it is focused on ways in which a design can be modified to eliminate or reduce construction and/or demolition hazards. It does not replace Job Safety Analysis or Safework Method Statements which are performed by the construction organization and outline all the safety controls to be employed to control the risk during construction. The primary focus of a CHAIR-2 study is to ensure that, from a design perspective, as much as practical has been contemplated and incorporated into the design to minimize construction or demolition hazards.

2.4.2. CHAIR-2 Study Team

As with a CHAIR-1 study, a CHAIR-2 study is performed by a group of people who are involved in the design and construction of the project, the composition of the team being dependent on the scope and nature of the design under examination. The critical elements being: an appropriate CHAIR-2 facilitator, appropriate selection of CHAIR-2 workshop attendees, application of specific CHAIR-2 guidewords, and clear recording and follow-up of the minutes from the CHAIR-2 meeting.

2.4.3. CHAIR-2 Guidewords

A critical difference between CHAIR-1 and CHAIR-2 studies is that analysis for a CHAIR-2 study is structured towards the proposed construction (or demolition) sequence, rather than using a logical breakdown of the specific design. The reason for this is that at the detailed design stage, there is less opportunity to fundamentally change the design. However, the possibility exists to

modify the design with regard to the intended construction or demolition method, the details of which would not have been available at a CHAIR-1 study stage. It also provides a different assessment perspective from a CHAIR-1 study for identifying safety risks.
Therefore, the guidewords to be used for a CHAIR-2 study are different to reflect the task oriented approach of the construction sequence. The aim of a CHAIR-2 methodology is to acknowledge that the basic design will be built, but also to identify design modifications that would result in safer construction or demolition techniques.
As the number of construction sequences may be large, the number of guidewords available is limited to ensure that a CHAIR-2 study does not become laborious. A list of the CHAIR 2 guidewords is provided in CHAIR 1 & 2 - Record Template.
The guidewords have been based on the approach of critical examination of system and are applied in the sequence presented. Thus the first aim is to eliminate or substitute a dangerous construction or demolition step or the main causes of accidents. In some cases, it might be best to combine certain construction processes to make them safer. To avoid is a less stringent action and means that it may be possible to evade certain conditions or actions deemed to be undesirable. The final guideword contains some basic suggestions that might prompt other construction or demolition safety issues.

2.4.4. CHAIR-2 Procedure

The purpose of the CHAIR-2 study is not to identify every single construction or demolition step or risk, as a majority of them should be well known to competent constructors. However, it is likely that there will be some risks which would not be expected in the context of normal construction, and it is these that are intended to be identified and assessed.
It should be noted that as part of the input prior to a CHAIR-2 meeting, it is expected that the design team would provide documentation, in broad terms, as to how it is expected the particular design would be constructed.
A CHAIR-2 methodology involves:

- the construction sequence divided into defined logical steps for analysis;
- each construction step, sources of risks or other factors related to the risks of accidents being identified;
- an assessment carried out as to the appropriateness of the risk and its controls to improve the design and clarify a preferred construction method and sequence.

2.4.5. CHAIR-2 Documentation

As with a CHAIR-1 study, it is important to adequately document the findings, attendees, methodology, guidewords and findings of a CHAIR-2 Study. A layout for recording the minutes of a CHAIR-2 meeting is provided in CHAIR 1 & 2 - Record Template.

2.5. CHAIR-3: detailed design maintenance & repair review

A CHAIR-3 study is more a document that demonstrates the appropriateness of maintenance and repair of items and plant and equipment.

A CHAIR-3 study is performed as the detailed design is approaching completion, but well before construction commences. It is essentially performed at the same time as a CHAIR-2. In some

cases, it may be possible to identify the owner's maintenance and repair personnel who could contribute information to the study.
Depending on the size and complexity of a design, a CHAIR-3 could be performed by a single person or a small team, provided they have:

- a knowledge of hazard identification techniques and an understanding of how to rate the importance (risk or level of danger) of the problems identified;
- a thorough knowledge of the current design to the extent of understanding the function of every plant and equipment item and knowledge of the way/s each item can fail (the failure modes);
- extensive practical experience.

It would be expected that the format of the study could be flexible, with an example format provided in CHAIR-3 section, CHAIR 3 Worksheet.

2.6. CHAIR action closing

CHAIR actions close-out are to be controlled by the Design Manager and reported individually using the HAZOP and CHAIR Closing Form. The design manager needs to update the action status HAZOP and CHAIR Recommendations Register.

The HAZOP and CHAIR Closing Form is updated with enough design information to demonstrate that the design has incorporated the changes / elements agreed for closing the CHAIR recommendations. The Design Manager is to sign the document as a verifier.

Filing of document is to be as per record management.

Appendices

CD-PD-TO-04 HAZOP and CHAIR Workshop Register

CD-PD-TO-05 HAZOP and CHAIR Recommendations Register

CD-PD-TO-06 HAZOP and CHAIR Closing Form

CD-PD-TO-07 CHAIR 1 & 2 - Record Template

CD-PD-TO-08 CHAIR 3 Worksheet

PROJECT:		DATE:		
		FILE NO.:		
		BID OPP. NO.:		

Document Code	Revision	Version	Hazop/CHAIR Session Title	File name	Status

Winnipeg

Water and Waste Department • Service des eaux et des déchets

WINNIPEG SEWAGE TREATMENT PROGRAM
HAZOP and CHAIR Recommendations Register

PROJECT:

DATE:
FILE NO.:
BID OPP. NO.:

MEETING LOCATION:

Recommendations	Place(s) Used	Session	Drawings Used	Person Responsible

Documentation on Completion	Comments [OPTIONAL]	Date of Completion	Discipline Target	Deliverable Type	Status

Water and Waste Department • Service des eaux et des déchets

WINNIPEG SEWAGE TREATMENT PROGRAM
HAZOP and CHAIR Closing Form

Recommendation Details

Recommendation Number:

Session:

Person Responsible:

Answer Details

Document Number(s) (With Rev-Ver) Detailing Completion:

Comments:

Completed By: ______________________ Date ________

Signature: ______________________ Date ________

Signature: ______________________ Date ________

Form: # Revision: # 0.1 Issue Date: #	DESIGN CONSULTATION / REVIEW RECORD	

Project: **Facilitator:** **Position:** **Date of Review:**

File #
Bid Opp #
Meeting location:

Design Review Stage: Kick off ☐ Intermediate ☑ Detailed ☐ **Design Review Participants:** Construction ☑ Maintenance ☑ Operations ☑

Scope of Design:

Attendees:

Part time:

Others:

Guide word Refer Safety in Design Prompt Words	**Sub-prompt** Refer Safety in Design Prompt Words	**Recommendation Number**	**Primary Impact** Const / Coms / O&M	**Suggested changes or issue/s to be considered**	**Actioner / Type**	**Action Undertaken**	**Status**	**Sign Off by Whom**	**Date of Sign Off**

Initial	Name

SUMMARY - CHAIR 1 - STUDY GUIDEWORDS - GENERIC

CARD NUMBER	GUIDEWORD	SUB-PROMPTS	CARD NUMBER	GUIDEWORD	SUB-PROMPTS
Chair 1. Generic 2	SIZE	Too large Too small Too long Too short Too wide Too narrow	Chair 1. Generic 7	LOAD / FORCE	High / Excess Low insufficient Additional loads (construction) Dynamics Temporary Weakness
Chair 1. Generic 3	HEIGHTS / DEPTHS	Working at heights Falls / struck by falling objects Scaffolding (shape, space to fit) Confined space Access / egress	Chair 1. Generic 8	ENERGY	Low / high energy Tension / compression Potential / kinetic Inertia / moment
Chair 1. Generic 4	POSITION / LOCATION	Too high Too low Too far Misaligned Wrong position	Chair 1. Generic 9	TIMING	Too late, too early Too short, too long Incorrect sequence Extended delays
Chair 1. Generic 5	POOR ERGONOMICS	Posture / manual handling RSI / discomfort / fatigue / stress Effect on PPE Visibility (lighting slightlines) Slips, trips, falls	Chair 1. Generic 10	EGRESS / ACCESS	No. of exit points Emergency egress, size Obstructions, lighting Entry / exit points External Impacts Maintenance People and Equipment Movements

Chair 1. Generic 6	MOVEMENT / DIRECTION	Stability Compression Physical damage Vibration Friction / slip Rotation Upwards / Downwards Reverse Expansion / Tension Rollover	Chair 1. Generic 11	MAINTENANCE / REPAIR	Posture / Manual Handling Size / Width Access / Egress Heights / Dropped Objects Weight Discomfort / Stress / PPE Visibility / Slips / Trips Rotating Equipment Other

SUMMARY - CHAIR 1 - STUDY GUIDEWORDS - OVERVIEW

CARD NUMBER	GUIDEWORD	SUB-PROMPTS	CARD NUMBER	GUIDEWORD	SUB-PROMPTS
Chair 1. Overview 2	ENVIRONMENTAL CONDITIONS	Extreme Weather Temperature Ground Noise Water	Chair 1. Overview 9	SAFETY EQUIPMENT	Personnel Protection Safety Showers Barriers / Guards
Chair 1. Overview 3	EXTERNAL SAFETY INTERFACES	Members of the public Traffic Adjacent Property Power / services External fire / plans Day / night / weekend	Chair 1. Overview 10	NATURAL HAZARDS	Earthquake Flooding Thunderstorm (lightning protection) High Winds
Chair 1. Overview 4	TOXICITY	Lead / Asbestos Handling Precautions Ventilation	Chair 1. Overview 11	INSPECTION / TESTING	Eliminating Isolation Access
Chair 1. Overview 5	FIRE / EXPLOSION	Prevention / detection Fire protection Emergency procedures	Chair 1. Overview 12	DEMOLITION	Ease Issues Documentation
Chair 1. Overview 6	ENVIRONMENTAL IMPACT	Vapour / dust Effluent / Noise Seepage / Waste	Chair 1. Overview 13	DOCUMENTATION	Operations Maintenance Inspection /Testing Sequence Emergency Records / Reports
Chair 1. Overview 7	UTILITIES & SERVICES	Lighting Air / Water Fuel / Electricity Oxygen / Water	Chair 1. Overview 14	QUALITY CONTROL	Inspection / Testing Quality Assurance
Chair 1. Overview 8	COMMISSION / STARTUP / SHUTDOWN	Requirements Sequence	Chair 1. Overview 15	CONSTRUCTION EQUIPMENT	Sequence Timing, Access

SAMPLE - CHAIR-2 - STUDY GUIDEWORDS
Construction Based Guidewords

Card Number	Guideword	Sub-Prompts	Card Number	Guideword	Sub-Prompts
CHAIR 2.2	ELIMINATE	Falls (of people) Falling material / objects Stepping on or striking against objects Caught or trapped Lifting and carrying - over exertion Asphyxiation / drowning Machinery Electricity Transport / mobile plant Toxicity, Fires	CHAIR 2.5	AVOID	Construction/Lifting Sequence Timing / Locations Temporary Instability Access / Egress Delays / Confined Space Erection / Dismantling Heat / Cold / Noise
CHAIR 2.3	SUBSTITUTE	Falls (of people) Falling material / objects Stepping on or striking against objects Caught or trapped Lifting and carrying - over exertion Asphyxiation / drowning Machinery Electricity Transport / mobile plant Toxicity, Fires	CHAIR 2.6	OTHER ISSUES?	Modification Isolation / engineering controls Personnel Protective Equipment Alter / rearrange Increase / reduce Simplify /Improve
CHAIR 2.4	COMBINE	Construction / Lifting Sequence Timing Locations			

PROJECT:

DATE:
FILE NO.:
BID OPP. NO.:

MEETING LOCATION:

Detailed Maintenance/Repair Safety in Detailed Design (Chair-3) Study				
System:		**Item/Component:**		
Sub System:			**Reference:**	
Maintainability Aspect	**Assessment (Good, Fair, Poor, N/A)**	**WHY?**	**Recommendation/Comment**	**Who/Date**
Posture/Manual Handling				
Access/Egress				
Heights/Dropped Objects				
Weight				
Discomfort/Stress				
Personnel Protection - Equipment				
Visibility				
Slips, Trips, Falls				
Rotating/Moving Equipment				
Is Repair Different?				
Others that may apply (list below)				

APPENDIX T – OPERATIONS MANUAL SPECIFICATION (DOCUMENT NUMBER: CD-CP-TO-06) - R2015-12-11 - FINAL REV A

Winnipeg Sewage Treatment Program

Operations Manual Specification

DOCUMENT NUMBER: CD-CP-TO-06

Rev	Description	Prepared by	Reviewed by	Approved by	Approved Date
2015-12-11	Final Rev A	NWA		JV	2016-02-22

Contents

1 Purpose

This document details the requirements for Operating Manuals for the Wastewater Treatment, Wastewater Services (WWS), City of Winnipeg. The purpose of this document is to provide guidance for the production of the Manuals.
The specification ensures information in the operations manuals of the facilities is presented in a consistent way and allows for the content of the manuals to be updated as the facilities develop over time.
The formats of all Operations Manuals delivered to the City of Winnipeg Wastewater Services Division must follow this specification and be based on the templates and examples it contains.

2 General requirements

This document describes a standard approach, across Wastewater Treatment Branch , for the format and presentation for documentation within the scope of the manual.

2.1 Standards

The Operating Manual shall comply with the following standards where appropriate:

IEC 82079-1:2012 Preparation of instructions for use -- Structuring, content and presentation -- Part 1: General principles and detailed requirements

Where information in this ISO conflicts with the City of Winnipeg instruction, the latter shall prevail.

In order to achieve consistent terminology throughout the Operations Manual, descriptions used throughout the manual to describe or define treatment processes must refer to (with the exception of the manufacturers literature provided in the Volume 3 - Equipment and Maintenance Task Manual):

- City of Winnipeg WSTP Paint Colour Standard (this standard is currently under development)
- City of Winnipeg numbering schedule
- Plant and equipment identification used in the Asset Data Manual

2.2 Readership and Style

Readership
The Operating Manuals must be written to provide information for experienced operations and maintenance staff, Engineers or Technicians who would not necessarily know the specific facilities described in the manual.

The manual must provide a comprehensive overview of the facilities for such experienced operators so that they can quickly assimilate and understand the facility, its function, and its operation.

Technical Language

The Manuals are technical documents intended to be used by professionals with an understanding of wastewater treatment. Any acronyms used must be defined. Language and style should be functional rather than imaginative i.e. Plain Statement.

The Manuals will be in the English language.

Level of details

The manuals will provide operations and maintenance staff with sufficient detail to be able to safely operate and maintain the facilities. Information on equipment will have sufficient detail to identify and order spare parts.

2.3 Number of copies and delivery

Requirements for the number of copies are defined in “CD-CP-TO-05 Project Documentation Requirement sheet”.

Electronic copies of the manual will be provided on non re-writable DVD.

DVD Label and Presentation

Each DVD will have a centrally applied label as detailed in Figure 1.

Notes for Figure 1: Replace the text in the square brackets, do not include the brackets.

Note 1 – The appropriate plant name will be chosen from the following:
North End Sewage Treatment Plant (NEWPCC)
South End Sewage Treatment Plant (SEWPCC)
West End Sewage Treatment Plant (WEWPCC)

Note 2 – Insert the name of the Project

Note 3 – Where a soft copy manual extends beyond a single DVD, data shall be logically divided and issued in multiple standard depth DVD cases. Each will be numbered “DVD xx of xx”, e,g, “DVD 1 of 5”

Note 4 – Insert the document number as per City of Winnipeg document numbering convention.

All DVDs shall be issued in full size jewel cases complete with the following:

- A clearly printed contents label on the spines of the jewel case, this shall typically read: [Facility Name] Operations Manual, [Project name], DVD # of #. The legend shall be read left to right in the horizontal direction with the DVD label side up.
- The rear cover of the jewel case shall include a list detailing the section contents of the DVD.
- The inside of the jewel case front insert shall contain identical data to that printed on the rear cover.
- The outside of the jewel case insert (front cover) shall contain a Repeat of the DVD label.

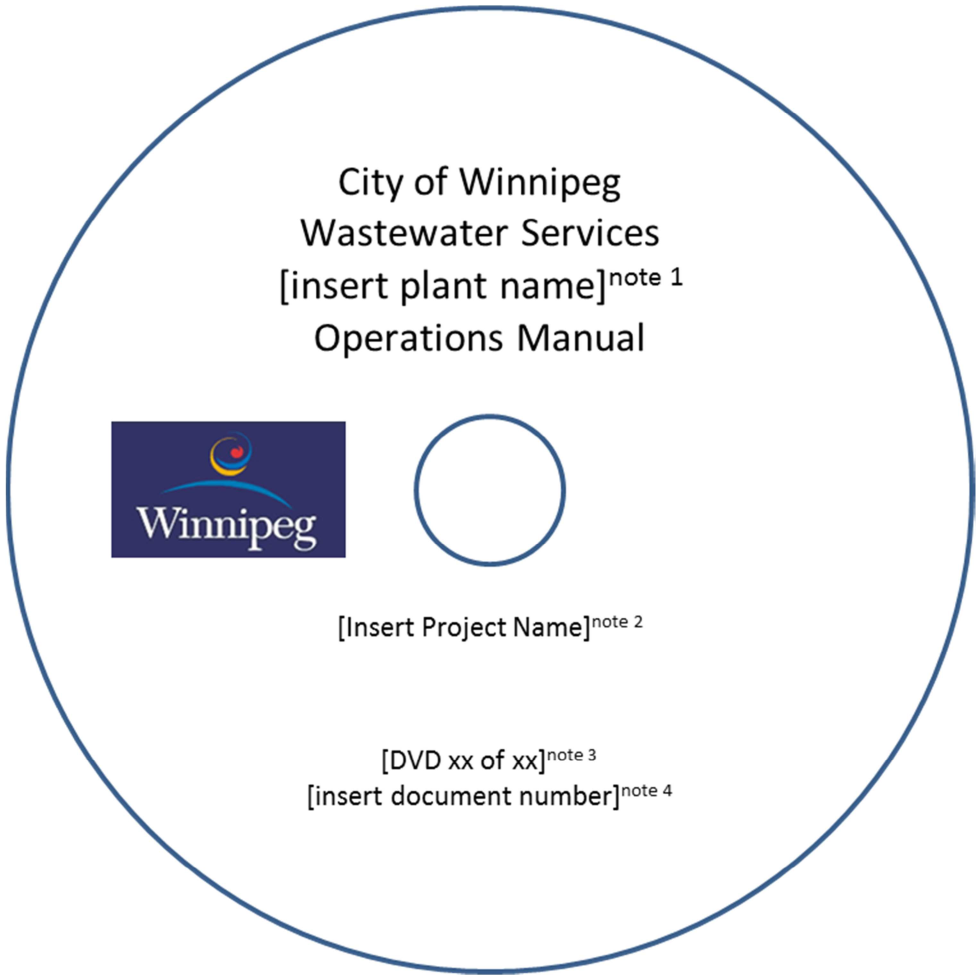


Figure 1 - Operations Manual, Typical DVD Label

2.4 Copyright

Operations Manuals will show copyright protection in favour of City of Winnipeg.

2.5 Presentation of Manuals

2.5.1 Operations Manual Structure

The Operating Manuals will consist of a set of volumes, constituting a complete suite of documents as follows:

Volume 1 – Area Process Operations Manual

Provides information on the operation of the facilities including: Safety and Health hazards and controls; Site services; Description of the Facility Control System; General description of the treatment process; Specific details of each unit process, including process control narratives; Standard Operating Procedures; Safe Work Procedure; Safety and Health records; Materials Safety Data Sheets; HAZOP Records

Volume 2 – Asset Data Manual

Provides data on all assets relating to the facilities, in the form of a data collection template.

Volume 3 – Equipment and Maintenance Task Manual

Provides information required for the maintenance of the facilities including: Technical description of installed equipment; Detailed maintenance tasks and schedule for installed equipment in the form of a data collection template; Lubricants schedule; Critical parts lists; Copies of manufacturers literature for installed equipment; List of suppliers.

Volume 4 – Training Manual

Provides the information used to train operations and maintenance staff for the facilities.

Volume 5 – Commissioning Manual

Provides a record of the plan for commissioning the facilities as carried out; Provides commissioning records and test documentation; Provides guidance on de-commissioning the facilities.

Volume 6 – Drawing Manual

Provides an index of drawings provided for the facilities and provides copies of key drawings required for operation and maintenance of the facilities.

Refer to xxx for an example of a completed Operating Manual.

Each Volume will be constructed of multiple sections. Refer to the specific part of this specification for an explanation of the organization of sections in each volume.

2.5.2 General Format Requirements

2.5.2.1 Headers and Footers

Footer will contain as a minimum: Volume number; page number and revision number

The principle intent is to ensure that if any section of the manual is removed from the hardcopy, staff will have no trouble to replace it.

2.5.2.2 Title pages,

Each volume will have a clear title page. Each section will have a clear section title page.
The back of title pages will be left blank.

2.5.2.3 Schematic Diagrams

Whenever possible, schematic diagrams will be incorporated to simplify the description or operating philosophy. These are for illustration purposes only and for more accurate information, the appropriate ‘as built’ should be referred to.

Schematic diagrams will be provided in native format in the electronic copy to allow for future updates.

2.5.2.4 Figures – Illustrations

Illustrations shall be used for the purpose of increasing or improving communication and should complement or replace text. Unnecessary illustrations should be avoided. Where multiple references are made to the same illustration on different pages, pullout [11x17] illustrations should be used, [11x17] size illustrations should allow the relevant illustration to be seen when using any of the related text pages. If it is inappropriate to use a pullout, the illustration must be relocated.

A list of abbreviations and symbols will be provided when producing process flow schematic illustrations.

On schematic drawings, valves / control gates to be shown in the normal operating position, with open valves / control gates to be in outline and closed valves / control gates to be blocked in.

Illustrations will be provided in native format in the electronic copy to allow for future updates.

2.5.2.5 Photographs

Photographs should be used following the same criteria as for illustrations. When digital photography is used, photographs must be saved using the medium JPEG format.

2.5.2.6 Colour

Grey scale is acceptable. In order to accommodate colour blindness, it is recommended that where colour is used to identify a specific feature on an illustration, a secondary form of identification is used as a back up such as hatching or shading to give different forms of visible patterns.

2.5.2.7 Warnings, Cautions and Notes

Warnings, Cautions and Notes must be used throughout the manual where appropriate to convey the following information: -

> **WARNING**: TO CALL ATTENTION TO INSTRUCTIONS OR INFORMATION WHICH MUST BE ACKNOWLEDGED TO AVOID POSSIBLE DEATH OR INJURY TO PERSONNEL.
>
> **Caution**: To call attention to instructions, which must be acknowledged to prevent damage to plant and equipment or degradation of plant product quality.
>
> **Notes**: used to document Items of importance about use of a system, activity etc.... Notes may be non-safety or safety related but not be "Warnings" or "Cautions".

2.5.2.8 Referencing

Cross referencing out-with each individual Document will not be used. Material referred to within that Document MUST be contained within the Document. With the following exceptions:

Volume 1 (sections on Health and Safety) will contain references to other Volumes to reduce duplication and

Volume 3 Equipment and Maintenance Task Manual, may contain references to Volume 2 – Asset Data Manual.

Volume 6 Drawing manual – Drawings from Volume 6 may be referenced in other volumes and not reproduced in those volumes.

The use of cross referencing to other procedures within a procedure shall only be used if absolutely necessary. Its use leads to complications when amending the manual and introduces increased risk of errors.

Where possible referenced material should be located in the appropriate section. Referenced material can be added in a specific reference section where it is referenced in multiple parts of that document.

2.5.3 Hard Copy Format Requirements

2.5.3.1 Operations Manual Identification and Binders

Operations Manuals will be printed in colour.

Volumes 1 to 5 of the Operating Manuals shall be contained in durable D ring ring-binders with three rings for 8.5” x 11” pages. The binders will have a maximum spine depth of 75 mm, hard backed with white PVC covers of suitable quality to last the expected life duration of the plant.

Volume 6 – Drawings Manual: Drawings shall be provided as 11”x17” pages in D ring durable ring-binders with three rings. The binders will have a maximum spine depth of 75 mm, hard backed with white PVC covers of suitable quality to last the expected life duration of the plant.

The binders for Volumes 1 to 6 will be organized in order of index. The D rings shall allow the manual pages to sit square and horizontal when the binder is opened on a flat surface.

Each Volume of the Operating Manuals Binders must have sufficient capacity for any individual page to be turned without jamming or tearing and allow at least 25% spare capacity for any future additions.

The binders shall have a clear PVC pocket at the front and on the spine for top entry insertion of a white title card headed with the City of Winnipeg logo which shall be printed in black.

Each binder will have a contents page which includes all volumes and binders, which will include: Volume; section; description.

Each binder will be labelled with the volume number, or numbers if more than one volume is included in a single binder.

The following will be in separate binders:
- Volume 4 - Training Manual
- Volume 6 – Drawings Manual

See Manuals Templates and Example Manual for example layout of the manual.

2.5.3.2 Separators for Sections

Divider cards for each Sections Within the individual Volumes shall be multiple part polypropylene coloured dividers, having stepped sides and rounded corners.

2.5.3.3 Table of Contents Pages for Sections

Bright blue paper shall be used at the beginning of each Section for the Table of Contents page.

2.5.3.4 Text Pages

Text pages shall be [letter] sized (portrait) having 3 No. punched holes. Final copy for issue shall be 90grms quality; draft pages may be produced in 80grms quality.

- Each Part shall begin on a new page
- Each Operating Procedure shall begin on a new page.
- [11x17] pullouts shall be 100 grms single sided.

Blank pages, including pull-outs, must have standard headers and footers with page numbers and must have the words – “This page intentionally blank” printed on them.

The first two pages of the manual shall be printed on white 130grm card to prevent tearing at the rings.

2.5.4 Electronic Format Requirements

All electronic data will be provided on labelled DVDs’ and MUST be in a recognizable directory / file structure. An example Operating Manual file structure is shown in Appendix 0-1.

Manuals shall be produced using Microsoft Word 2010, illustrations or Schematics may be provided in AutoCAD 20xx or Microsoft Visio 2010. A native file copy of all Illustrations or Schematics to be provided with a unique reference to associate them with their use in the manual.

The manual to be electronically presented as a searchable pdf complete with in-built Thumbnails and Bookmarks.

Provision of Native Files
All data and documentation to be provided in the NATIVE FORMAT of one the following software packages as appropriate for their creation.

- MS Word in .docx format
- MS Excel in .xlsx format
- MS Visio in .vsd format
- Presentations in MS Powerpoint .pptx format
- Photographic in .jpeg format, medium quality
- Adobe .pdf format
- AutoCAD or AutoCAD LT in .dwg format and saved in the version presently used in the City of Winnipeg Wastewater Department (WWD). Third party fonts, hatch patters, custom linetypes or shapefiles, shall not be used in Drawing Files submitted to the WWD.
- Audio visual in .mp3 format

To aid updating the Operations Manual over time, a single electronic file (Native file format and pdf) will not contain the material for more than one Section of the Operating Manual.

Specific variations to these requirements are specified in specific volumes of the Operations Manual.

Electronic formats related to manufacturers bespoke literature, instruction books etc.. will be acceptable, any bespoke or proprietary software required to read these formats will be provided.

3 Volume 1 – Area Process Operating Manual

The Area Process Operating Manual will be provided prior to substantial completion. The manuals will be structured by process area following the flow of the treatment process from inlet pumping to final effluent discharge and from raw (and WAS) sludge capture to final removal from site. Sub-sections will describe unit processes within each process area.

The Operating Manual will be structured as defined in this specification.

References will be made within the Area Process Operating Manual where necessary to avoid duplication of material. With the exception of the Asset Data Manual, or unless specifically defined in this specification, references will not be made to information outside of this manual.

To simplify updating of the manual, each section identified in this specification (x; x.x; x.x.x; etc…) will begin on a new page.

3.1 Introduction

This section will provide:

- Location and address of the facility;
- General description of the facility including a process flow diagram,
- Plant layout diagram;
- Key data such as dry weather and maximum treatment capacity, licence limits etc..

3.2 Safety (common)

This section will provide information on safety that is common to all process areas, and include the following sections.

3.2.1 Safety and Health Hazards (Facility Wide)

This section is to provide information on safety and health hazards that are common across all process areas in the facility.

Example hazards (area specific hazards will be moved to that specific section(s) of the manual):

- Chemicals Hazards
    - Chemical exposure; list of chemicals used in facility
    - Compressed gasses
    - Asbestos
- Physical Hazards (for example)
    - Temperature
    - Local exhaust ventilation (LEV)
    - Arc flash
    - Confined spaces
    - Electrical safety
    - Hazardous gasses

    - Explosive atmospheres
    - Pressurized systems
    - Noise
    - Manual handling
    - Traffic
    - Hazardous materials
    - Buried services
    - Overhead cables
    - Vibration
    - Lighting levels
- Biological Hazards
    - Bacteria and viruses
    - Bacteria

Include identification of all site services and restrictions – For example: Deliveries, Chemicals, gas, electricity, telecom, water, spills, discharges, drainage.

3.2.2 Hazard Controls

This section will describe the design features of the facility that have been used to mitigate each of the identified facility wide safety and health hazards.

The hierarchy of controls applied to mitigate hazard will be explained. For example:
- Engineering Controls;
- Administrative Controls
- and PPE controls.

Reference should be made to the appropriate section in the Area Process Manual where required.

A table of Safe Work Procedures (SWPs) common to all areas will be provided. Note: the SWPs themselves will be provided in the Appendix. The following process will be used for selection or creation of SWPs.

Process for allocation and creation of SWPs
- Review manufacturers or designers requirements as per their literature
- Review existing library of SWPs, provided by the City, and identify closest match.
- If there is an existing SWP with an acceptable match to the requirement, assign the existing SWP in Asset Loading Template (Appendix 2-1).
- If no suitable existing SWP is available, propose a new SWP using the template SWP in Appendix 1-1 and assign it to the asset in Asset Loading Template (Appendix 2-1).
- The Plant Supervisor will review proposed SWP and finalize.

3.2.3 Confined Space

This section will provide warning of the hazards of confined spaces in the facilities and reference the applicable legislation and Safe Work Procedures.

3.2.4 Fire Protection

3.2.4.1 Portable fire extinguishers

Include the following text in the Manual: Refer to the plant Fire Safety Plan for type and location of portable fire extinguishers.

3.2.4.2 Fixed fire protection systems

Include the following text in the Manual: Refer to the plant Fire Safety Plan for type and location of fixed fire protection systems.

Asset data and equipment details for fixed fire protection systems will be provided in Volume 2, Asset Data Manual and Volume 3, Equipment and Maintenance Task Manual respectively.

3.2.5 Hazardous Location Plan Drawings

This section will include a reference to a drawing (or set of drawings) identifying hazardous locations in accordance with the Electrical Design Guide with respect to explosive atmospheres and their classification. A reference will be made to the appropriate volume of the Operations Manual for special equipment installed and operational mitigation procedures.

Other hazardous areas which are not included in the scope of the Electrical Design Guide, will be identified on the Hazard Location Plans.

3.2.6 Signage

This section will include a list of all statutory and safety and health signage included in the design. The specification of the signage will be provided and location installed will be referenced.

3.3 Site services

This section will provide an overview of all site services including and any restrictions or constraints that apply. Reference will be made to the appropriate drawings. Site services scope will include:

- Electricity supply;
- Domestic services;
- Water supply;
- Telecommunications;
- Sewerage;
- Drainage;
- Chemicals;
- Containment of chemical /Fuel /Gas Discharges;
- Delivery of process chemicals. Etc;

3.4 Process By Area

The manual will organize the plant into physical treatment areas and then into unit processes within each process area.

The process areas will be plant specific, however suggested process areas are as follows, this list is not exhaustive:

- Inlet Pumping
- Head works
- Primary Treatment
- Sludge Thickening
- Secondary Treatment (including Return Activated Sludge and Waste Activated Sludge)
- UV Treatment or Disinfection
- Sludge Digestion
- Sludge Dewatering
- HVAC (For all buildings)
- Central effluent flushing water system

A description of applicable plant utilities (including: sump pumps; effluent wash water; compressed air; potable water) will be included in each process area.

To aid updating of the Area Process Manual, the section of the manual for each unit process will begin on the front side of a new page.

An example of the structure of each area is as follows.

3.4.1 General description of process area (E.g. Head works)

A general description of the process area will be provided and refer to the Process Flow Diagram (PFD).

3.4.2 Unit processes 1 – Bar Screens and Screenings Conveyor

3.4.2.1 Unit Process Description

This section will explain the function of each unit process within the process area. An explanation of following will be included: Process objective; process description. Reference will be made to process flow diagrams, P&IDs, SOPs, SWPs and control narratives where applicable. P&IDs will be provided in the Drawings Manual and not reproduced in this manual.

3.4.2.2 Design Criteria

Process design criteria for the specific unit process will be provided.

3.4.2.3 Operation and Process Control

This section will provide, for the specific unit process:

- The process control narratives, including control philosophy in manual and automatic modes;
- Use of manual controls;
- Process control parameters and key control parameters;
- Process trouble shooting guides;
- Description of protection systems installed;
- Emergency shut down and power failure procedures;
- Sampling and analysis requirements;
- Key HMI screen shots will be used to illustrate operation and process control;

Alarm and Warning limits are volatile data. A record of the recommendations of alarm and warning limits for each process parameter as commissioned will be provided in Volume 5 – Commissioning Manual. The values will be transferred to and maintained in the Process Control Management Plan (PCMP) by Operations.

Reference will be made to process flow diagrams, P&IDs, SOPs, SWPs and control narratives where applicable. P&IDs will be provided in the Drawings Manual and not reproduced in this manual.

3.4.2.4 Safety and SWPs

This section will contain safety information specific to the unit process, including safety hazards and safety controls.

Safe Work Procedures (SWPs) will be provided for all activities required for the safe operation of the unit process.

A reference table of all SWPs relevant for each unit process will be provided in the relevant section of the Area Process Manual, by following the process below. A complete list of SWPs will be included as an Appendix to Volume 1- Area Process Operating Manual.

Process for allocation and creation of SWPs

- Review manufacturers or designers requirements as per their literature
- Review existing library of SWPs, provided by the City, and identify closest match.
- If there is an existing SWP with an acceptable match to the requirement, assign the existing SWP in Asset Loading Template (Appendix 2-1).
- If no suitable existing SWP is available, propose a new SWP using the template SWP in Appendix 1-1 and assign it to the asset in Asset Loading Template (Appendix 2-1).

3.4.2.5 Standard Operating Procedures (SOPs)

Standard Operating Procedures (SOPs) will be provided for all activities required for the proper operation of the unit process.

A reference table of all SOPs relevant for each unit process will be provided in the relevant section of the Area Process Manual by following the process below. A complete list of SOPs will be included as an Appendix to Volume 1-Area Process Operating Manual.

Process for allocation and creation of SWPs

- Review manufacturers or designers requirements as per their literature
- Review existing library of SOPs, provided by the City, and identify closest match.
- If there is an existing SOP with an acceptable match to the requirement, assign the existing SOP in Asset Loading Template (Appendix 2-1).
- If no suitable existing SOP is available, create a new SOP using the template SOP in Appendix 1-2 and assign it to the asset in Asset Loading Template (Appendix 2-1).

3.4.3 Unit processes 2 – Channel Aeration

3.4.3.1 Unit Process Description

3.4.3.2 Safety and SWPs

3.4.3.3 Design Criteria

3.4.3.4 Operation and Process control

3.4.3.5 Standard Operating Procedures (SOPs)

3.4.4 Unit processes 3 – Grit Removal System

3.4.4.1 Unit Process Description

3.4.4.2 Safety and SWPs

3.4.4.3 Design Criteria

3.4.4.4 Operation and Process control

3.4.4.5 Standard Operating Procedures (SOPs)

3.4.5 Unit processes 4 – Grit Pumping and De-watering

3.4.5.1 Unit Process Description

3.4.5.2 Safety and SWPs

3.4.5.3 Design Criteria

3.4.5.4 Operation and Process control

3.4.5.5 Standard Operating Procedures (SOPs)

3.5 Volume 1 – Appendices

The following appendices will be included with the Area Process Operating Manual.

3.5.1 Appendix - Safe Work Procedures (SWPs)

An index of all SWPs will be provided.
SWPs will be provided for all activities identified in the Area Process Manual.
SWPs will be provided as individual files.
SWPs will be provided using the template in Appendix 1-2.

Process for providing Safe Work Procedures (SWP's)
The Wastewater Treatment Division holds standard SWPs for common tasks, which should be referenced to avoid duplicatation.

- Identify SWPs required
- Review existing SWPs, provided by the CWMS team, and identify closest match.
- Where there is an existing SWP with an acceptable match to the requirement, that SWP should be referenced
- If no suitable SWP is available, create a SWP using the template (Appendix 1-2)

3.5.2 Appendix - Standard Operating Procedures (SOPs)

An index of all SOPs will be provided.
SOPs will be provided for all activities identified in the Area Process Manual.
SOPs will be provided as individual files.
SOPs will be provided using the template in Appendix 1-2.

3.5.3 Appendix - Material Safety Data Sheets

Operations maintain a copy of all materials data sheets on an online application. This appendix will provide an index of materials data sheets applicable to the facility, a "pdf" version of the Material Safety Data Sheet will be provided in the electronic version of the Manual.

3.5.4 Appendix - HAZOP Records

This appendix will include a copy of records from any Hazard and Operability Study (HAZOP) produced by the project, all control measures (engineering and operational) identified in the HAZOP should be included in the hazard control section of this manual.

4 Volume 2 – Asset Data Manual

4.1 Purpose of the Asset Data Manual

This section describes a standard approach, across Wastewater Services (WWS), for the provision of asset data on new or modified assets.

The City of Winnipeg Water and Waste Department use Oracle Work and Asset Management (OWAM) as their Computerized Work Management System

4.2 Asset Data Submission Process and Timeline

This section sets out the process for submitting asset data to the City of Winnipeg resulting from a change in assets through a capital project.

- The City will provide current asset data for the facilities as an Excel file prior to the end of Preliminary Design.
- The Consultant will identify and flag assets, that are to be modified or retired, in the Excel file. The modified file will be submitted to the Project Manager as part of the Detail Design deliverables.
- The Consultant will fully complete asset data for new or modified assets using the Asset Loading Template (Appendix 2-1) no later than two (2) prior to Substantial Completion.

4.3 Guidance on Completion of the Asset Loading Template

The following table provides guidance for the completion of the Asset Template file.
Fields marked as Mandatory must be populated for the file to be accepted.

Field	Mandatory	Description	Codes
ASSET_NO	**To be left blank**	To be left blank. Asset reference number will be generated by OWAM.	Not applicable (n/a)
TAG_ID	**Yes**	Smart numbered Tag ID using City of Winnipeg standard format.	Refer to TAG specification.
PLANT	**Yes**	This refers to the OWAM database instance.	01
ASSET_RECORD_TYPE	**Yes**	Asset Record Type from code list	E = Equipment B = Building A = Virtual (used in Asset Hierarchy Structure)
ASSET_ID	**Yes** To be completed by the City CWMS	Same as Asset Number - to be left blank.	n/a

Field	Mandatory	Description	Codes
	Specialist		
ASSET_TYPE	**Yes**	Asset Type from code list	Appendix 2-3 If no appropriate Asset Type is listed provide proposed new Asset Type to City of Winnipeg for consideration.
ASSET_DESC	**Yes**	The Asset Description is the name by which plant staff would commonly refer to the asset. The description consists of the following separated by spaces: 1 - Wastewater Process Area Code = Building Code, excluding name of the plant 2 – Type (this is NOT the Asset_Type): this is the sub process of the Wastewater Process Area that is used to group similar assets and components together. See Note 1. 3 – TAG ID (smart number) 4 – Noun or Common Name: E.g. pump; Switch; Valve; Transmitter etc… Examples of "Asset_Desc": • Admin motor M681-F81ventilation fan motor • Grit hoist G565-CR 2 ton electric crane c/w monorail trolley hoist • Grit DCS PCU8-SA MMU Cabinet 15 • Grit switch G257-BS barscreen reverse switch • Grit switch G245-TSHblower high temperature switch • Primary valve P212 P213-FV1 transfer control valve	 Appendix 2-2
ASSET_STATUS	**Yes**	Asset status from code list	ACTIVE
DEPARTMENT	**Yes**	City department from code list	WWD
AREA	**Yes**	Water or Waste	Water Waste
PARENT_ASSET_ID	**To be left blank**	To be left blank. City to define asset hierarchy.	n/a

Field	Mandatory	Description	Codes
	To be completed by the City CWMS Specialist		
ACCOUNT_NO	**Yes** To be completed by the City CWMS Specialist	City account reference number	n/a
CRITICALITY	**Yes**	Asset criticality value	Criticality values are definitioned in the Asset Management Manual.
BUILDING	**Yes**	Select Building in which asset is located from code list. If no appropriate Building is listed provide proposed new Building to City of Winnipeg for consideration.	Appendix 2-2
LOCATION	**Yes**	Description of the general physical location within the Building. Examples: Gallery XX, Tunnel XX, Basement, Upper Level, Lower Level, Mezzanine, West Wall etc. Main Level Maximum data length = 30 characters	n/a
PARENT_ASSET_RECORD_TYPE	**To be left blank** To be completed by the City CWMS Specialist	Record Type of the Parent Asset.	n/a
ROOM	**Yes**	Name of room where the Asset is located. Chlorine, Pump, Control, Motor etc. Maximum data length 20 characters	n/a
The following fields are used to capture data from name plates. The data will be completed as fully as possible. Not all data will be applicable to every asset.			
MANUFACTURER	**Yes**	The manufacturer of the Asset.	n/a

Field	Mandatory	Description	Codes
		Maximum data length 50 characters	
MODEL_NO	**Yes**	The Make of the Asset Maximum data length 50 characters	n/a
SERIAL_NO	**Yes**	Serial number from the Asset Maximum data length 50 characters	n/a
TYPE	Where available	Provide relevant information, which is not covered by other fields, which helps define the asset. Maximum data length 50 characters	n/a
SIZE	Where available	Asset size if applicable. E.g: 6 Inch Diameter Maximum data length 50 characters	n/a
CAPACITY	Where available	Asset Capacity if applicable. E,g: 5 MLD. Maximum data length 50 characters	n/a
PUMP_BEARING	Where available	Type of pump bearing if applicable. Format: OD: ABC123 ODE: DEF456 Maximum data length 50 characters	n/a
HEAD_PRESSURE	Where available	Design head pressure of pumps, if applicable Maximum data length 50 characters	n/a
HP	Where available	Motor or engine Horse Power if applicable. Maximum data length 50 characters	n/a
VOLTS	Where available	The design voltage of the asset where applicable. Maximum data length 50 characters	n/a
AMPS	Where available	Full Load Amperage (FLA) as indicated on the motor nameplate. Example: 50 Amps Maximum data length 50 characters	n/a
PHASE	Where available	Electrical Phase from code list.	1 3
OUTPUT	Where available	State the output of instrument assets. Examples: 4-20 mA 3-15 PSI Maximum data length 50 characters	n/a
RANGE	Where available	State the range of instrument assets. Examples: 50MLD 1,500 LPS Maximum data length 50 characters	n/a

Field	Mandatory	Description	Codes
LOOP	**Yes** for instrumentation or control assets	Relevant loop drawing reference number. Maximum data length 50 characters	n/a
PID	**Yes**	Relevant P&ID drawing reference number. Maximum data length 50 characters	n/a
MOTOR_BEARING	Where available	Type of motor bearing if applicable. Format: OD: ABC123 ODE: DEF456 Maximum data length 50 characters	n/a
OTHER		Other relevant drawing numbers. Maximum data length 50 characters	n/a
Note 1 – Asset Description: Examples of most common process "Type" description: HVAC, RAS, DCS, Sump, Electrical, Sludge, Centrifuge, Scum, Hoist, Flushing water, WAS, Clarifier, Potable water, Bridge, Bailey, Boiler, Polymer, Storage bin, Overhead, Security, Heat exchanger, Raw sewage, Wet well, Generator, LOX, PSA, SCADA, Safety, Air System, Effluent, Influent. This list is not exhaustive.			

5 Volume 3 – Equipment and Maintenance Task Manual

5.1 Purpose of the Equipment and Maintenance Task Manual

This section describes a standard approach, across Wastewater Services (WWS), for the format, presentation and numbering procedure for documentation within the scope of the manual.

The Equipment and Maintenance Task Manual will be provided at least two (2) weeks prior to substantial completion.

Where a partial treatment works, or item of Plant or Equipment is replaced, an update to the plant Equipment Manual will be provided.

5.2 Maintenance Benchmark Work Orders

Maintenance Benchmark Work Orders are template work orders (with work order task, planned materials, craft, and estimated labour hours, checklists and safe work procedures) which are used to generate a real work order. They are used primarily for setting up reoccurring preventive maintenance type work orders.

Detailed instructions on maintenance requirements of each item of equipment will be provided in the form of a Maintenance Benchmark Work Order using the template in Appendix 3-1, which may require reproduction of information from manufacturers' documentation. To avoid duplication, the maintenance benchmark may refer to Volume 4 - Asset Data Manual.

The benchmarks will contain sufficient information to allow the plant & equipment to be maintained safely. Requirements for regular inspections by all trades, including operations, will be included.

Benchmark work orders are reviewed on regular basis using data from completed work to adjust the estimated labour hours and provided more accurate information for maintenance planning.

Process - Manufacturers Maintenance Requirements
New assets will initially be maintained to manufactures recommendations in order to respect warranties.

- Review manufacturers maintenance requirements as per their literature
- Review existing Maintenance Benchmark Work Orders, provided by the CWMS team, and identify closest match.
- If there is a benchmark Work Order with an acceptable match to the maintenance requirement, assign the benchmark work order to the asset in OWAM Asset List (Appendix 2-1).
- If no suitable benchmark Work Order is available, propose new benchmark Work Order and assign it to the asset in OWAM Asset List (Appendix 2-1).
- Maintenance Engineer will review proposed benchmark Work Orders and finalize.

Safety precautions such as equipment handling requirements including details of specific lifting points will be included in the Benchmark Work Order through referenced Safe Working Procedure attachments (SWPs).

5.3 Maintenance Task Intervals

This section will define the frequency at which maintenance tasks to be carried out on the specific assets in the form of a schedule that is used to build the Planned Maintenance Master (PM Master).

Process - Manufacturers Maintenance Requirements

New assets will initially be maintained to manufactures recommendations in order to respect warranties. The process to be used to define the initial maintenance task intervals is as follows:

- Review manufacturers maintenance requirements as per their literature
- Identify appropriate maintenance benchmark Work Orders
- Assign a frequency for execution of the Benchmark Work Order in the Asset Loading Template (Appendix 2-1). This data will be incorporated to manually build the PM Master.

5.4 Lubricants Schedule

A complete schedule of all lubricants used will be provided in the form of a matrix of lubricants against each asset using the Lubricant schedule template in Appendix 3-2.

5.5 Critical Parts lists

Critical spare parts will be identified using the process in the Wastewater Treatment Asset Management Manual. A list of critical spare parts for each assets identified through this process will be provided using the template schedule in Appendix 3-3.

Appendix 3-3 to include:

- Asset TAG ID;
- Asset description (as Volume 2 – Asset Data Manual);
- Asset location (as Volume 2 – Asset Data Manual);
- Critical spare part description (as per manufacturers manual);
- Equipment manufacturers item number;
- Reference to manufacturers documentation;
- Supplier name, at time of commissioning;

5.6 Manufacturers Literature

All applicable original literature from manufacturers SPECIFIC to the equipment installed will be provided. Where manufacturers' literature contains information on multiple equipment types or variants the SPECIFIC equipment installed will be clearly identified.

Manufacturers' literature will be provided as both hard copy and electronic formats as defined in the General Specification. Where either hard copy or electronic files are not available this will be clearly stated.

Manufacturers' literature will be provided by Process Area following a logical order. An index of manufacturers literature will be provided at the front of the section.

Where electronic versions of Manufacturers documentation are available through either the intranet or within equipment electronic interfaces, an electronic copy will be provided as part of this manual as per the General Specification.

5.7 Equipment Suppliers

A schedule of equipment suppliers, as existing at the time of commissioning, will be provided and will contain:

- Relevant Material Management award reference number (Bid Opp number);
- Supplier contact details (Supplier Name; Address; e-mail address; Telephone numbers etc..)

The schedule will be sorted by supplier name. Supplier names will be those used in the Critical Spare Parts schedule.

6 Volume 4 – Training Manual

This section describes a standard approach, across Wastewater Treatment, Wastewater Services (WWS), for the format, presentation and numbering procedure for documentation within the scope of the manual.

The Training material will be organized first by Discipline (Operations; Electrical; Mechanical; Automation etc.) then by process area.

The Training Manual shall provide the information required to train Operations and Maintenance staff (including control systems staff) in the safe and efficient operation and maintenance of plant and equipment. The Training Manual will be specific to the scope of a project, training material to include where applicable to that project but not be limited to:

- Works operation in fully automatic and manual mode
- Plant and equipment routine and non-routine procedures (operation and maintenance)
- Use of facility Operating & Maintenance Manual
- Facility external layout
- Facility internal layout
- Facility drainage
- Roof drainage
- Facility P&IDs
- Facility process flow
- All installed equipment
- As installed mechanical and electrical drawings
- Individual unit processes.
- Individual chemical process.
- Safety and Health risk assessments.
- Hazardous area classification.
- Electrical classification.
- Works specific emergency procedures
- Training in all specific electronic equipment (PCS, PLC's, HMI's Data Networks and Interfaces, Telemetry, security systems).
- Facility specific commissioning

The Training Manual will be a stand-alone Volume which may be contained in multiple binders.

The content of training courses will be focused on understanding how that subject is impacted / expressed through the project, rather than a tutorial on the subject itself. For example, training on P&IDs and electrical drawings will be make staff familiar with the drawings for the specific project, rather than how to read and interpret P&ID or electrical drawings.

6.1 Training Planning and Administration

This specification applies to all training for Operations and Maintenance staff required under the scope of the project.

Training will be planned in advance. The City sewage treatment plants are full time operations, planning and advance notice is required to ensure the appropriate operations and maintenance staff are able to attend training courses. Where training impacts plant operations and maintenance staff, multiple training sessions will be arranged to minimize the disruption to wastewater service delivery.

A training plan will be produced in advance of any training. A **two week** review period will be allowed for the City to provide comments on the training plan. The training plan will demonstrate arrangements to “mop up” training delegates who may not have been able to attend a planned session due to operational reasons.

The training plan will include: an assessment of training needs; a schedule of training which identifies training delegates, course title, dates, times and locations of individual training courses.

The training plan will include training on all SWPs/SOPs provided by the project.

A minimum of **two weeks’** notice is required to be given to delegates attending a particular training session once the training plan has been agreed, unless otherwise directed by the Project Manager.

Attendance registers will be completed for each training course. Post training evaluation forms will be issued at the end of each training course and the results complied in a summary.

For certain types of training courses it may be appropriate to use quizzes, learning reviews or other methods to test the understanding of course delegates of the training material. Consideration will be given to these techniques in the training plan. Quizzes (or similar) will be used on safety and health specific training courses.

The following forms will be used, unless agreed otherwise with the Project Manager:

- Attendance registers, Appendix 4-1.
- Individual post training course evaluation forms, Appendix 4-2.

6.2 Training Program

In coordination with the Training Coordinator, the Consultant will identify staff who will be impacted by the Project. The scope and content of the training material will be tailored for the specific audience.

Plant Start-up

The training plan will describe how operations and maintenance staff involved in start-up will be trained prior to their involvement in start-up activities. It can be the case that lessons are learned during the start-up of a process that will be useful to the long term operator, start-up lessons learned will be documented for communication to staff who may have had training prior to start-up. Start-up lessons learned will be included in the final record of training material.

6.3 General Training Requirements

6.3.1 Training Documentation Requirements

This minimum documentation required for a training session are:

- Training objectives. (May be contained in the course notes)
- Training course program (may be contained in the course notes)
- Training course notes / hand-outs

The Operations Manuals are to be used as part of training courses (where appropriate). The objective is to minimize the amount of bespoke training material required to be created and to allow training delegates to become familiar with where to find relevant information.

The contents of any specific training course will be specific to that course and subject. The training manual will contain copies of all material used during the training sessions.

Where quiz or knowledge assessments are used in the training, copies of the forms and anticipated answers will be provided.

Audio and/or Video Recording of Training
The City may identify particular courses from the training program to be recorded for future use. Where Audio and/or Video material is used in the training a copy will be provided.

6.3.2 Training Manual Contents

This section defines the structure of the Training Manual to be provided at the end of the training program. The manual is to be provided within four weeks of the completion of the training program.

The Training Manual will include the following sections as a minimum:

6.3.2.1 Purpose

Describe the purpose of the Training Manual.

For example

The purpose of the Training Manual is to contain a record of training delivered during the commissioning and handover of new assets to operations and to provide a copy of all training materials used to enable such training to be repeated as required during the operations and maintenance of the facilities.

6.3.2.2 Training Program

Provide a summary of the scope of the training provided and a copy of the final training program as carried out.

6.3.2.3 Training Records

This section will contain copies of the completed training attendance sheets and a summary of post course evaluations for each course in the program. The summary of post course evaluations will not contain information to match comments to specific individuals.

The training records will be organized first by Discipline (Operations; Electrical; Mechanical; Automation etc….) then by process area.

Discipline 1

Process Area 1

Training Course [Title]
- *[insert typical attendance sheets]*
- *[insert typical summary of post course evaluation]*

Training Course [Title]
- *[insert typical attendance sheets]*
- *[insert typical summary of post course evaluation]*

Discipline 2

Process Area 2

Training Course [Title]
- *[insert typical attendance sheets]*
- *[insert typical summary of post course evaluation]*

Training Course [Title]
- *[insert typical attendance sheets]*
- *[insert typical summary of post course evaluation]*

6.3.2.4 Training Material Organized By Discipline Then Process Area

This section to provide a copy of all materials used in each training course within the training program. The Training material will be organized first by Discipline (Operations; Electrical; Mechanical; Automation etc….) then by process area.

Discipline 1

Process Area 1

Training Course [Title]

- *List of course materials*
- *Training objectives*
- *Training course program*
- *Training course notes / hand-outs*

Training Course [Title]

- *List of course materials*
- *Training objectives*
- *Training course program*
- *Training course notes / hand-outs*

Process Area 2

Training Course [Title]

- *List of course materials*
- *Training objectives*
- *Training course program*
- *Training course notes / hand-outs*

Training Course [Title]

- *List of course materials*
- *Training objectives*
- *Training course program*
- *Training course notes / hand-outs*

Discipline 2

Process Area 1

Training Course [Title]

- *List of course materials*
- *Training objectives*
- *Training course program*
- *Training course notes / hand-outs*

Training Course [Title]

- *List of course materials*
- *Training objectives*
- *Training course program*
- *Training course notes / hand-outs*

Process Area 2

Training Course [Title]

- *List of course materials*

- *Training objectives*
- *Training course program*
- *Training course notes / hand-outs*

Training Course [Title]

- *List of course materials*
- *Training objectives*
- *Training course program*
- *Training course notes / hand-outs*

7 Volume 5 – Commissioning Manual

The WSTP IMS contain a number of Basis Of Design documents and standards which detail certain commissioning requirements depending upon the trade and the type of installation. This manual will document the outcome of those requirements.

Scope of the Commissioning Manual will include commissioning, re-commissioning and eventual de-commissioning considerations.

This Commissioning Manual will consist of two key parts:

Part 1 – Commissioning Plan
The commissioning plan is a set of documents which comprehensively document the procedures required to commission the facility. This includes acceptance criteria for the commissioning tests.

Part II – Commissioning Records

The commissioning records are a set of documents which record and demonstrate the results of the commissioning process and that the acceptance criteria have been met. The records will include test result documentation, checklists, letters of conformity and certificates.

Where sections of the plant are commissioned in phases of one project, or as separate projects, it is acceptable for the Commissioning Manual to be provided in parts aligned to the completion of each project or project phase.

The Commissioning Manual is to be provided within four (4) weeks of the completion of the facility commissioning for each project or project phase.

The Commissioning Manual will include the following sections.

7.1 Purpose

This section will describe the purpose of the Commissioning Manual.

For example:
The purpose of the Commissioning Manual is to contain a record of the commissioning process and handover of new assets to operations. The commissioning manual will enable operations and City personnel to re-commission systems as required.

7.2 Part I - Project Commissioning Plan

The Project Commissioning Plan defines the overall requirements for testing and commissioning the facility. The Commissioning Plan will document the methods and procedures for commissioning the works **as carried out (past tense)**.

The commissioning plan will include information arranged under the following section headings:

7.2.1 General

Provide an overall description of the commissioning approach.

7.2.2 Roles and Responsibilities

Provide and explanation of roles and responsibilities of organizations and personnel involved in the commissioning.

7.2.3 Scope

Provide a description of the scope of the works.

7.2.4 Sequence / Schedule

7.3 Commissioning Specification and Objectives

This section will describe the commissioning tests required to demonstrate the design intent of the project, along with the approved acceptance criteria.

7.4 Commissioning Procedures

The commissioning procedures provide the detailed information to describe the specific field activities necessary to complete the commissioning process and ensure the commissioning specification and objectives are met. Multiple documents will be included for various facility processes.

The commissioning procedures will be organized in a logical fashion most appropriate to the scope of work.

7.5 Part II – Project Commissioning Records

The commissioning records to be included within the Commissioning Manual are a subset of the complete set of Commissioning Records. The records included will be limited to safety, process and system performance verification, and not verification of individual components.

An index of certificates will be provided.

Examples of commissioning records to be included are as follows (but not limited to):
Safety

- Pressure vessel test certificates
- Fixed lifting equipment test certificates
- Portable lifting equipment test certificates
- Certificates of Acceptance, AHJ (Authority Having Jurisdiction).
- Engineers letter of Certification
- Fire alarm test certificates

Other

- Process
- Performance tests certificates.
- Structural
- Mechanical
- Equipment Commissioning Certificates
- Pressure Test Certificates.
- Electrical
- Power distribution system acceptance documentation
- Fire alarm acceptance documentation
- Security system acceptance documentation
- CCTV system acceptance documentation
- Automation
- Process Control System SAT (Site Acceptance Test) acceptance documentation, but not necessarily documentation of all detailed tests.
- Network acceptance documentation
- Equipment control limits as commissioned

The commissioning records section will be organized as follows:

7.5.1 Facility

This section will contain copies of the completed records, tests and certificates that are applicable to the entire facility. For example – Facility effluent quality commissioning record.

7.5.2 Area A

This section to provide a copy of all major completed commissioning records that are applicable to process area A.

7.5.2.1 System 1

This section to provide a copy of all major completed commissioning records that are applicable to the specific system. The records would detail overall system performance, but would not necessarily include detailed test results of components, such as cable testing forms.

7.5.2.2 System 2

Similar to System 1 … and continued for all systems.

7.5.3 Area B

Similar to Area A and continued for all systems.

8 Volume 6 – Drawing Manual

8.1 Purpose of the Drawing Manual

This section describes a standard approach, across Wastewater Treatment, Wastewater Services (WWS), for the format, presentation and numbering procedure for documentation within the scope of the manual.

“As Built” versions of all drawings will be provided as per the requirements of this specification no later than four weeks after Total Performance.

8.2 Index of Drawings

An index of all as constructed drawings provided as part of the design will be provided, the index will include:

- Drawing Number
- Drawing Title (Title Box Description)
- Version number
- Date of issue
- Type (Process and Instrumentation Drawings (P&ID); Electrical; Mechanical; Civil etc…)
- Process Area
- File name (as per file naming convention)

The index will be provided in an Excel file and in hard copy in this manual. The hard copy index will be arranged by process area then by drawing number.

The index of drawings should include, this list is not exhaustive:

- Civil Drawings
- Cranage points and load bearing capacity drawings for siting of mobile cranes during maintenance lifting operations
- Mechanical Drawings
- Pneumatic control systems
- Hydro electrical supply and gas supply drawings
- Telephone and other communication line drawings
- Telemetry drawings
- Electrical drawings
- Process flow diagrams
- P&IDs
- Works layout
- Works Drainage (Drainage, Chemical and Foul)
- Internal layout plans,
- Hazardous location plans
- Shop drawing
- Any Drawings referred to within any documentation.

Where 3D models have been provided, information will be included on how to navigate the tool.

8.3 Drawings General

The drawings produced to be in conformance with “CD-CP-TO-05 Project Documentation Requirement sheet”

Submit draft drawings for review in both paper and electronic format, use a paper size suitable for a detailed review. Draft drawings will be amended and finalized as requested.

All drawings will be saved with the first layout tab active.

All final files will be fully purged prior to submittal.

8.4 Number of copies

Requirements for the number of copies are defined in “CD-CP-TO-05 Project Documentation Requirement sheet”.

Two (2) hard copies and one (1) electronic of all final shop drawings will be provided.

Electronic and hard copies will be provided in the format as described in the General Specification.

9 Appendix

Drafting note: this appendix contains reference information needed for the completion of the manual, templates, reference lists etc. but will not end up in the final Operations Manuals.

9.1 Appendix 0-1 - Example electronic folder and file structure

The file and folder structure for the Operations Manuals are described here. The file and folder structure has been organized such that once it is applied to a specific wastewater facility the files and folders can be readily transferred to the City server for access by the relevant stakeholders.

The root folder will contain a full index of the complete Operations Manual consisting of six volumes.

The Technical Document Numbering System describes the convention for naming of files assuming the use of a Document Management System. Operations Manuals will finally reside on a City server in a traditional folder hierarchy, this document provides guidance on the required folder structure.

Individual files will be named according to the IMS document PG-RC-PC-03 Technical Document Numbering System.

E.g. Operations Manual files for the WEWPCC Perimeter Road Pumping Station will be in the format:

A-0103-OMAN-Axxx

Each volume will be a separate file or set of files within a folder hierarchy titles with the volume number and title. i.e. files from different Volumes will not be mixed within a folder.

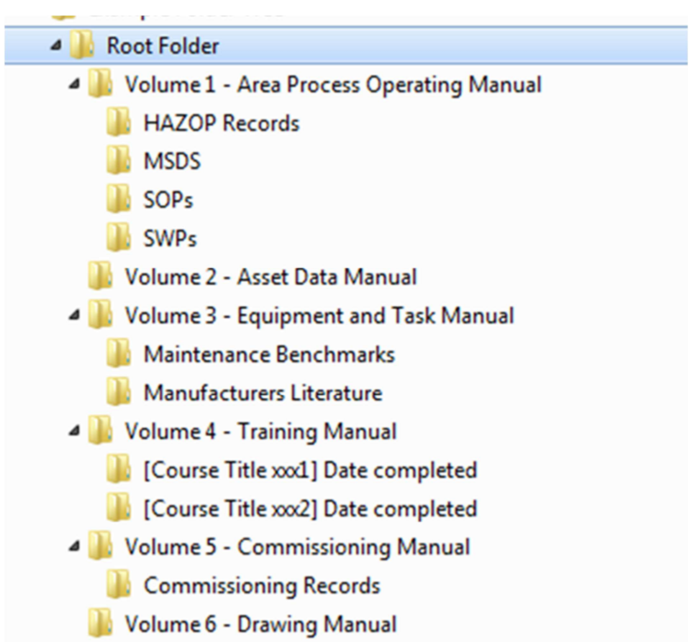


Figure 2 - Typical Operations Manual Electronic Version Folder Structure

The Volume folders will sit under a root Operations Manual Folder which will only contain a complete index of the entire Operations Manual.

Volume 1 – Area Process Operating Manual
- Sections 1 to 3 of the specification may be created as a single file or split into individual files depending on the size and complexity of the specific Manual.
- To aid document change control, sections 4 will be created as separate files for each Process Area. A Process Area may be split into multiple files depending on the size and complexity of the specific Manual. Where a Process area is split into multiple files they will follow a logical order.

Volume 1 Appendices:
- SOPs; SWPs; MSDSs and HAZOP Records will be contained in separate folders as Figure 1
- Each SOP; SWP; MSDS will be a separate file within the relevant folder
- The folder for HAZOP Records will be organized logically appropriate to the specific content
- Further Appendix folders may be included if appropriate to the specific Operations Manual

Volume 2 – Asset Data Manual
This volume consists of an Excel workbook(s) which will be in its own folder. No other files are required within this folder.

Multiple Excel workbooks may be provided depending on the specific Operations Manual if required depending on the complexity.

Volume 3 – Equipment and Maintenance Task Manual
The following sections of the specification will be provided as separate files within the Volume 3 folder:
- Maintenance Task Intervals
- Lubrication schedule (Excel File)
- Critical parts list (Excel File)
- Equipment suppliers

Maintenance Benchmark Work Orders will be provided in a separate folder.

Manufacturers literature will be provided in a separate folder. The folder will contain appropriate sub folders and be organized in a logical manner to suite the specific content. An index will be provided as an Excel file. Files provided by manufacturers and suppliers consisting of their proprietary literature and documentation do not need to be renamed to follow the Technical Document Numbering Standard, however the index must allow the documents to be identified without opening the specific files.

For organization of the DVD copy of the Operations Manual, Manufacturers Literature may be spread across multiple DVDs depending on the size of the specific Manual.

Volume 4 – Training Manual
The training Program will be provided as a separate file.

Training material will be organized into separate folders for specific training courses. Specific folders may contain sub folders as required to suite the material.
Training records will be provided as separate files in a specific folder.
A summary of training feedback forms will be provided as separate file. Copies of completed feedback forms are not to be provided.

Volume 5 – Commissioning Manual
The Commissioning Manual will be provided as a separate file(s).
Commissioning Records will be provided as separate files as appropriate to the content within a sub-folder, which will be organized into further sub folders appropriate to the content.

Volume 6 – Drawing Manual
Drawings files will be provided as pdf and numbered as per the Technical Document Numbering Standard.

An index of all drawings will be provided as an Excel file.

9.2 Appendix 1-1 Template Safe Work Procedure (SWP)

Refer to IMS document:
CD-CP-TO-xx Safe Work Procedure Template.doc.docx
CD-CP-TO-xx - Developing SWP Guideline.pdf
CD-CP-TO-xx - SWP Template Instructions.pdf

9.3 Appendix 1-2 Template Standard Operating Procedure (SOP)

Refer to IMS document: CD-CP-TO-01 Standard Operating Procedure Template.doc.doc

9.4 Appendix 2-1 –Asset List Loading Template – Excel File

Refer to IMS document: CD-CP-TO-xx - Asset Loading Template.

9.5 Appendix 2-2 – Building Codes

BUILDING_CODE	BUILDING_DESCRIPTION
NEWPCC ADMIN	NEWPCC MAIN ADMINISTRATION
NEWPCC BOILER	NEWPCC BOILER
NEWPCC DEWATERING	
NEWPCC DIGESTER	NEWPCC DIGESTER
NEWPCC DRYING BEDS	
NEWPCC GARAGE	NEWPCC MAIN GARAGE
NEWPCC GAS BURNER	
NEWPCC GAS SPHERE	
NEWPCC GRIT	NEWPCC GRIT
NEWPCC HAULED WASTE	
NEWPCC LAB	NEWPCC MAIN LAB
NEWPCC LEACHATE	NEWPCC LEACHATE
NEWPCC MAIN	NEWPCC MAIN PUMPING
NEWPCC N-REMOVAL	
NEWPCC P-REMOVAL	
NEWPCC PRIMARY	NEWPCC PRIMARY
NEWPCC REACTOR	NEWPCC REACTOR
NEWPCC SECONDARY	
NEWPCC UV	NEWPCC ULTRA VIOLET/TERTIARY
SEWPCC ADMIN	SEWPCC ADMINISTRATION
SEWPCC GENERATOR	
SEWPCC GRIT	SEWPCC GRIT
SEWPCC MAINT	SEWPCC MAINTENANCE
SEWPCC OIL STORAGE	
SEWPCC OUTFALL	SEWPCC OUTFALL
SEWPCC PRIMARY	SEWPCC PRIMARY
SEWPCC REACTOR	SEWPCC REACTOR
SEWPCC SECONDARY	
SEWPCC SEPTAGE	SEWPCC SEPTAGE
SEWPCC UV	SEWPCC ULTRA VIOLET/TERTIARY
WEWPCC ADMIN	WEWPCC ADMINISTRATION
WEWPCC DAF	WEWPCC DAF & CHEMICAL FEED
WEWPCC FERMENTER	
WEWPCC HEADWORKS	

BUILDING_CODE	BUILDING_DESCRIPTION
WEWPCC OUTFALL	WEWPCC OUTFALL
WEWPCC PRIMARY	WEWPCC PRIMARY
WEWPCC PRPS	WEWPCC PREIMETER ROAD PUMP STATION
WEWPCC SECONDARY	
WEWPCC UTILITY	WEWPCC UTILITY

9.6 Appendix 2-3 – Asset Type Codes

Asset Type Code	Description
ACTUATOR	VALVE ACTUATOR
ACU	AIR CONDITIONING UNIT
AHU	AIR HANDLING UNIT
ANALYZER	PROCESS ANALYSIS INSTRUMENTS CL2 / DE / DO / NH3 / NO3 / PO4
ARRESTER	FLAME / SPARK ARRESTER
AUGER	AUGER
BACKFLOW	BACKFLOW PREVENTER
BARSCREEN	BARSCREEN
BLOWER	PROCESS BLOWER
BOAT	MOTORBOAT / CANOE
BOILER	BOILER
BRAKE	BRIDGE MOTOR BRAKE
BREAKER	ELECTRICAL BREAKER
BRIDGE	CLARIFIER BRIDGE
BUILDING	BUILDING
BURNER	WASTE GAS BURNER
CATHODIC	CATHODIC PROTECTION
CELL	LOAD CELLS
CENTRIFUGE	CENTRIFUGE
CHANNEL	CHANNEL
CHARGER	BATTERY CHARGER
CHILLER	CHILLER AIR CONDITION UNIT
CHLORINATR	CHLORINE CHLORINATOR
CLASSIFIER	CLASSIFIER
CNTL PANEL	CONTROL PANEL FDP / TC / LCP / MCP
COMM	COMMUNICATION EQUIPMENT RADIOS/PAGERS/TELEPHONE/PAGING SYSTE
COMP-AIR	AIR COMPRESSOR
COMP-GAS	GAS COMPRESSOR
COMPUTER	COMPUTER EQUIPMENT
CONDENSER	CONDENSER
CONVEYOR	GRIT CONVEYOR
CRANE	CRANE
CULVERT	CULVERT
DAMPER	DAMPER
DCS	DISTRIBUTED CONTROL SYSTEM EQUIPMENT
DESTRUCT	OZONE CATALYTIC DESTRUCT
DETECTOR	GAS DETECTOR CL2 / CO / H2S / LEL / O2

Asset Type Code	Description
DIFFUSER	DIFFUSER
DIST PANEL	ELECTRICAL DISTRIBUTION PANEL
DRYER-AIR	AIR DRYER
DUCT HTR	ELECTRIC HEATING COIL
ELECTROLYZ	ELECTROLYZER
ELEVATOR	ELEVATOR
ENGINE	GAS / DIESEL ENGINE
EVAPORATOR	CHLORINE EVAPORATOR
FAN	FANS EXHAUST / CIRCULATION / FUMEHOOD
FEEDERMAIN	DISTRIBUTION FEEDERMAIN
FILTER	FILTER AIR / MOISTURE / OIL
FIRE	FIRE EQUIPMENT
FLEET	Fleet Asset
FLOWTUBE	FLOWTUBE
FLUIDCPLG	FLUID COUPLING
FORCEMAIN	SEWER FORCEMAIN
FOUNTAIN	RETENTION BASIN FOUNTAIN
FURNACE	FURNACE
GATE	GATE
GAUGE	GAUGE
GEARBOX	GEARBOX
GENERATOR	STANDBY GENERATOR
GRATE	GRATE FOR CULVERTS, OUTFALLS, ETC
GROUNDS	GROUNDS
HEAT EXCH	HEAT EXCHANGER
HEAT TRACE	HEAT TRACE
HMI	HUMAN MACHINE INTERFACE
HOIST	CRANE / HOIST UNIT
HOPPER	HOPPER
HYDRANT	HYDRANT
INDICATOR	VERTICAL SCALE INDICATOR
INJECTOR	CHLORINE INJECTOR
INLET	INLET GRATES
INSTRUMENT	INSTRUMENTATION EQUIPMENT
LAWNMOWER	LAWNMOWER
LIGHTING	ELECTRICAL LIGHTS
LOUVER	HVAC LOUVER
LUBRICATOR	AIR LINE LUBRICATOR
MANHOLE	MANHOLE
MCC	MOTOR CONTROL CENTRE
METER-GAS	GAS METER
METER-WTR	WATER METER

Asset Type Code	Description
MIXER	MIXER
MOTOR	MOTOR
MOTOR-PROT	MOTOR PROTECTION EQUIPMENT
OVRHD-DOOR	OVERHEAD DOOR
PGM	PERSONAL GAS MONITOR
PIPE	PIPE PROCESS / SERVICE
PIT	PIT METER / VALVE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PLUMBING	DOMESTIC PLUMBING
POSITIONER	VALVE POSITIONER
PROPERTY	PROPERTY INFORMATION
PUMP	PUMP
PUMP-UNIT	ENTIRE PUMP UNIT
RECIRC	GAS RECIRCULATOR
RECTIFIER	RECTIFIER
REGULATOR	PRESSURE REGULATOR
RESERVOIR	WATER DISTRIBUTION RESERVOIR
RIVER CROS	RIVER CROSSING
ROLLUP	COST ROLLUP ASSET
RTD	RESISTIVE TEMPERATURE DETECTOR
RTU	REMOTE TERMINAL UNIT
SAFETY	SAFETY RELATED EQUIPMENT
SAMPLER	PROCESS SAMPLER
SCADA	SUPERVISORY CONTROL AND DATA AQUISITION
SCALE	WEIGH SCALE
SCBA	SELF CONTAINED BREATHING APPARATUS
SCRUBBER	ODOUR CONTROL SCRUBBER
SECURITY	SECURITY EQUIPMENT
SERVICE	ELECTRICAL SERVICES
SEWERMAIN	SEWERMAIN
SHAFT	PUMP SHAFT
SIGNAL	DCS / SCADA CONTROL SYSTEM SIGNAL
SILENCER	SILENCER
SKID	PSA SYSTEM
SKIMMER	DAF SKIMMER MECHANISM
SLUICE	SLUICE GATE
SOFTSTART	SOLIDSTATE MOTOR STARTER
SRB	STORM RETENTION BASIN
STACK	CHIMNEY OR ODOUR DISPERSION STACK
STRAINER	STRAINER
SWEEP	CLARIFIER & FERMENTER SWEEP MECHANISM
SWITCH	SWITCH LEVEL / PRESSURE / TEMPERATURE / VIBRATION

Asset Type Code	Description
SWITCHGEAR	ELECTRICAL SWITCHGEAR
SYSTEM	SYSTEM RELATING TO COMPUTER OR SOFTWARE
TANK	TANK HOLDING / DIGESTOR / CLARIFIER / AERATION
TEST	TEST EQUIPMENT
TOOL	SHOP EQUIPMENT AND TOOLS
TRACK	RAILWAY TRACK
TRANS-SW	TRANSFER SWITCH
TRANSDUCE	TRANSDUCER
TRANSFORM	TRANSFORMER
TRANSMIT	TRANSMITTER FLOW / LEVEL / PRESSURE / TEMPERATURE
UNIT-HTR	UNIT HEATER
UPS	UNINTERRUPTIBLE POWER SUPPLY
USC	ULTRASONIC CLEANER
UV MOD	ULTRA VIOLET LIGHT MODULAR LAMP ASSEMBLY
UV UNIT	ULTRA VIOLET LIGHT PROCESS UNIT
VALVE	VALVE
VSD	VARIABLE SPEED DRIVE
WATERMAIN	WATERMAIN

9.7 Appendix 3-1 Maintenance Benchmark Template

Format of the maintenance benchmark is under development and will be defined from the maintenance project.

9.8 Appendix 3-2 Lubricant schedule

Refer to IMS document: CD-CP-TO-xx - Lubricant Schedule Template.xlsx

9.9 Appendix 3-3 Critical Parts schedule

Refer to IMS document: CD-CP-TO-xx - Critical Parts Schedule Template.xlsx

9.10 Appendix 4-1 – Example attendance registers

Refer to IMS document: CD-CP-TO-xx - Training attendance register.doc

The attendance record should contain the information in the template as a minimum. Training providers may use their own format.

9.11 Appendix 4-2 – Example individual post training course evaluation forms

Refer to IMS document: CD-CP-TO-xx - Post Course Evaluation Form.docx

The training course evaluation should contain the information in the template as a minimum. Training providers may use their own format.

9.12 Appendix 5 – Example manual (WEWPCC Perimeter Road Pumping Station)

Refer to IMS document: CD-CP-TO-xx-Example Operations Manual

APPENDIX U – WWD WSD GUIDELINE TO DOCUMENT ASSET REGISTRY FOR MAINTENANCE PROJECT (ONLY) (DOCUMENT NUMBER: OSB-AM-GUI-0003) - R5 2019-12-06

Water and Waste Department
Wastewater Services Division

Guideline to Document Asset Registry for Maintenance Project (ONLY)

Document Number: OSB-AM-GUI-0003

Revision History

Revision	Date	Revision Made	Revised By
(5)	2019-12-06	Version update	Operational Systems Branch

WWS Asset Classification and Specification Guideline

1 INTRODUCTION

Asset registry is the fundamental building block for asset management and it is a document that has assets organized by a unique identification number against which certain attributes are recorded. A registry organized in hierarchical order is the vehicle that enables the assessment of assets as individual components, composite assets, or groups of assets. It is important to emphasize that an efficient asset registry is built around four main concepts: asset hierarchy, asset classification, asset criticality information and asset specification record.

The purpose of the asset registry guideline is to create a set of instructions to ensure project consultants and contractors document asset information in a way that is OWAM-ready. Other benefits of a standardized asset registry framework are:

- Improved financial planning and integrated asset management planning for operations and maintenance.
- Structured asset visibility in OWAM
- Eliminate the complexity that arises with asset setup in OWAM
- Optimize management decision-making processes

Wastewater Services Division uses Oracle Work Asset Management (OWAM) Software for asset management. Therefore, adherence to these guideline instructions will simplify asset information update in OWAM post commissioning of any project.

1.1 Asset Hierarchy

Asset hierarchy is a representation of the relationships between infrastructure assets; and it is arranged in a family tree describing the parent-child relationship of an asset or component of an asset. Asset hierarchy is required to organize assets such that they are aggregated or rolled up to the higher level from lower level, but can never be disaggregated lower than the lowest threshold level. Properly documented asset hierarchy will organise assets by:

- System;
- Sub-system;
- Facility segments;
- Process area;
- Sub-process area;
- Parent asset;
- Child asset and;
- Components.

1.2 Asset Classification

Asset classification is a system for assigning assets into groups based on a number of common characteristics. The asset classification system is essential to effectively manage OWAM. Well documented asset classification will provide the following asset information:

- Asset Class Type;
- CODE Asset Class Type;
- Asset Class Description;
- Asset Class;
- Asset Type and;
- CODE Asset Type.

1.3 Asset Criticality information

Asset criticality identifies the worst case of asset's availability to perform its function. It is a measure of the asset's capability to impact the business drivers of the organization by impacting the goals of the Process Department/Area to which it belongs. Properly documented asset criticality will capture information on the asset risk using the total consequence of failure (impact/severity) of the following business drivers (impact areas):

Business Drivers	Consequences of Failure
Environmental Stewardship	Based on the assets ability to discharge potential pollutants including Wastewater & Effluent; Air Emissions: odour, dust, fumes, gases, smoke; Chemicals: process additives, lubes, cleaners, degreasers, chemicals etc.
Occupational Safety	Measures the ability of the asset to create an unsafe condition that leads to the injury or loss of limb/life.
Operational Consequences	
(3a) Level of Service Reduction	Measures how the failure will affect the Process Department/Area's ability to meet its mission requirements. It considers plant configuration that could mitigate the impact of an asset failure, chiefly through redundant plant or storage/buffer capacity after the asset.
(3b) Cost of Repair / Replacement	Measures the approximate cost to repair the asset following a debilitating failure or, in extreme cases, to replace it if repair is not appropriate.
(3c) Maintainability	Based on serviceability and supportability of assets
(3d) Detectability	Measures the ease with which a failure can be identified.
Total Scoring for Consequence of Failure	Total Consequence of Failure

Table 1: Criticality Business Driver and their Impacts

1.4 Asset Specification record

Asset specification is the asset information that is required to provide input for preventative maintenance and asset reliability to support operational efficiency. Properly documented asset record and specification will provide the following asset information: Asset data record and specification data record.

2 ASSET REGISTRY DOCUMENTATION EXPECTATION

This Guideline should be used to document asset hierarchy, classification, criticality and specification. Consultants or contractors are expected to provide asset information to the City's representative in the format below:

- A complete hierarchical list of all assets, child assets and components showing the parent-child assets relationship on PowerPoint and excel as required.
- Listing of asset classification and specifications according to the templates provided.

3 PREREQUISITE REQUIRED TO DOCUMENT ASSET REGISTRY

a) Prior to documenting asset registry, contractors or consultants shall request from the City Representative for the existing asset list that are scheduled for maintenance as defined in the project scope of the RFP. This will set the ball rolling to document the asset registry correctly.
b) Upon the receipt of the spreadsheet that has the listing of the assets, in the same spreadsheet, in sheet two (tab), contractors or consultants should categorise the assets into the following categories: Assets; Components and Parts (Spare parts). Also, in another column, in the same sheet two (tab), contractors or consultants shall include the nature of the work done on the asset e.g if the asset is new or retired or repaired or replaced or untouched.
c) After documenting the required information in (b) above, contractors or consultants shall return the spreadsheet to the City Representative and this shall be forwarded to the Wastewater Services Division Process Improvement Coordinator for review.
d) Contractors or consultants shall await the feedback from the Wastewater Services Process Improvement Coordinator before proceeding to document the asset hierarchy, classification, criticality and specifications.

4 METHODOLOGY TO DOCUMENT INFORMATION

To ensure consultants or contractors use the guideline successfully, it is important to explain that there are four parts to this guide and they include:

- Part A: It provides instructions to document asset hierarchy using the asset hierarchy framework.
- Part B: It provides instructions to document asset classification such that assets identified within a project are structured using Wastewater Services Division's standardized format.
- Part C: It provides instructions to document asset criticality information.
- Part D: It provides instructions to document asset specifications.

4.1 Part A: Asset Hierarchy (First Sheet of the Spreadsheet)

In order to provide detailed information for all project assets, consultants or contractors shall provide hierarchical structure that shows all assets from process area through to child asset and components in PowerPoint. An empty one-page PowerPoint is embedded to the left of this document. Within the PowerPoint slide is a flowchart to help initiate the process of documenting the asset hierarchy. The asset hierarchy for all the assets retrieved from the project should also be provided on the "First sheet" of all the eleven spreadsheets listed below per individual asset class type. In the same first sheet, there is an empty hierarchy structure chart that can help document the asset hierarchy in the appropriate format. This chart can be copied and pasted to complete the required asset hierarchy. Locate this logo on the left hand side of this document to retrieve the embedded attachments of the eleven asset class type spreadsheets:

1. Ancillary & Accessory Plant Equipment (1-AAPE) Spreadsheet;
2. Information and Communication Equipment (2-(COBE) Spreadsheet;
3. Minor Mechanical Equipment (3-MIME) Spreadsheet;
4. Automation & Control Equipment (4-ACEQ) Spreadsheet;
5. Major Mechanical Equipment (5-MAME) Spreadsheet;
6. All Electrical Equipment (6-AEEQ) Spreadsheet;
7. Outdoor Metal Structures (7-OMST) Spreadsheet;
8. Major Process Equipment (8-MPEQ) Spreadsheet;
9. Indoor Metal Structures (9-IMST) Spreadsheet;
10. Concrete Structures & Underground Piping (10-CUSP) Spreadsheet and;
11. Green Landscape (11-GRLA) Spreadsheet.

Note:

i. **If the embedded templates cannot be retrieved, please request for electronic versions from the City representative.**

ii. **All the first sheets (tabs) of each of the eleven spreadsheets shall have all the asset hierarchy images for all assets identified from the project**

4.1.1 **Asset Hierarchy Framework:** Use the asset hierarchy level below to organise all project assets that will be handed over to the city post commissioning. In order to complete the Asset Hierarchy structure, please familiarize yourself with the definitions below:

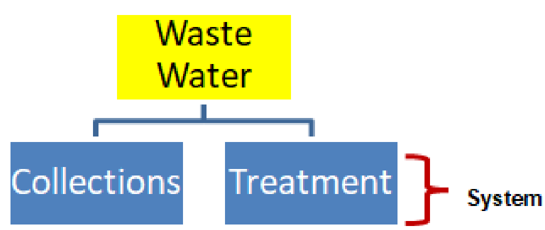
	Hierarchy Level	Definition
1	Department ***(Water & Waste)***	Accounting Department
2	Division ***(WWSD)***	Lowest-level GL bin. All Assets below this roll costs up to the Area.
3	System ***(Treatment or Collections)***	Highest Asset Level. This is a functional group of assets delivering a primary service, such as wastewater system or water system

4	Sub-System ***(NEWPCC OR SEWPCC OR WEWPCC)***	A sub-group of assets in a system that perform a specific function, such as Treatment Plant or Water Mains.
5	Process ***(Secondary Treatment)***	A sub-group of assets that further categorizes a complex sub-system. This level is used primarily in Treatment Plants (Primary Clarification, Digestion, etc.) and Pumping Stations (Pumping, Reservoir).
7	Asset	The physical asset on which work is performed on.
8	Child Asset	If an asset is complex, it may have child assets or components. A child asset will be used if it is worked on separately from the parent, and if costs are required to be tracked against it.
9	Component	Repairable and track-able parts used on an asset. Spare parts that are replaced when broken should not be included.

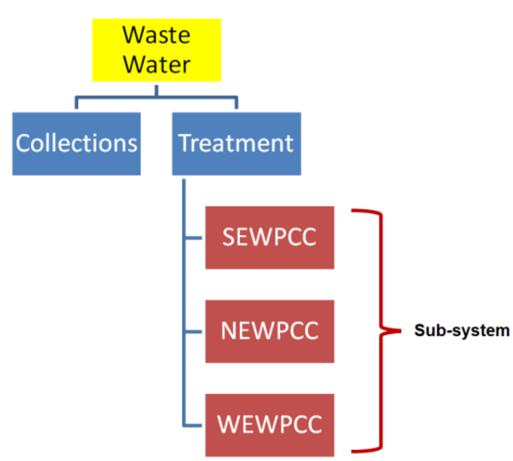
Table 2: Asset Hierarchy Framework

Note: Asset definition can be found in appendix 1.

4.1.2 **System:** The first level of the asset hierarchy is the systems level**.** Please identify the system level for all project assets as shown in the image below:



4.1.3 **Sub-system:** The next level after the system is the sub-system. Please identify the sub-system level as shown in the image below:



4.1.4 Process **Area (Also known as Areas):** Subsequent to identifying the sub-system in 4.1.3 above, please identify the process area for all the projects. Process area ideas are illustrated within the red highlighted oval field in the example below. Existing area code descriptions are included in the WWD

Identification Standard. The existing areas should also be verified with the City Representative prior to the consultant/ contractor determining new process area.

Note: Each treatment plant has different process areas so be sure to verify the process area where the project is implemented. The list below and the image on the next page will guide you to identify the correct process level.

FACILITY	PROCESS	SUB-PROCESS
SEWPCC	Power Supply System	• Main Power Supply; • Standby Power Supply and; • Instrumentation
	Process Control System	No sub-process
	Fire & Security	No sub-process
	Administrative Building	• Main Admin Building; • Mechanical Workshop; • Electrical Workshop and; • Instrumentation Workshop
	Pre-Treatment	• Influent Pumping; • Influent Screening; • Grit System; • Odour Control and Ventilation; • Electrical Power Supply; • Process Building and Concrete Structures; • Instrumentation
	Primary Treatment	• Primary Clarification; • High Rate Clarification; • Buildings and Concrete Structures; • Odour Control; • Electrical Power Supply and; • Instrumentation
	Sludge Treatment	• Sludge Fermentation; • Primary Sludge Thickening; • Waste Activated Sludge Thickening; • Sludge Storage & Transportation; • Buildings and Concrete Structures; • Odour Control and ; • Electrical Power Supply • Instrumentation

	Secondary Treatment	• BNR Bioreactors; • Secondary Clarification; • Buildings and Concrete Structures; • Odour Control • Compressed Air System; • Electrical Power Supply and; • Instrumentation
	Disinfection & Outfall	• UV Disinfection; • Outfall; • Buildings and Concrete Structures • Odour Control and; • Electrical Power Supply
	Foul Air Treatment	• Bio-Filtration; • Ventilation System 1; • Ventilation System 2; • Buildings and Concrete Structures; • Odour Control; • Electrical Power Supply
	Piping	• Flushing water; • RAS; • WAS; • Instrument Air; • Process Air and; • Potable Water
	Chemical Dosing System	• Ferric Chloride; • Polymer; • Glycol; • Sodium Hypochlorite; • Sodium Hydroxide • Sodium Bisulphite and; • Instrumentation
	Testing and Verification	• Process Sampling and ; • Process Testing

Table 3: SEWPCC Process Areas and Sub-Processes

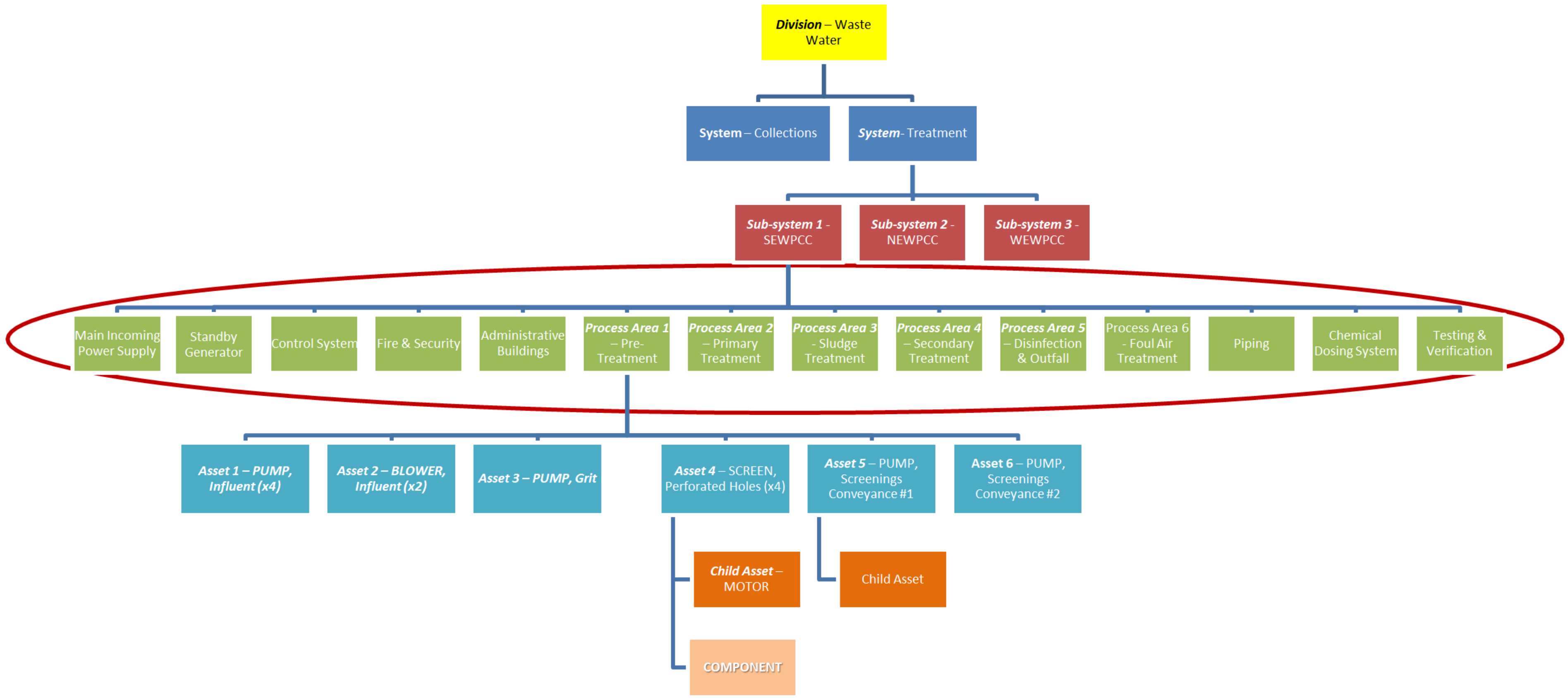
FACILITY	PROCESS	SUB-PROCESS
NEW	Power Supply System	• Main Power Supply; • Standby Power Supply and; • Instrumentation
	Process Control System	No sub-process
	Fire & Security	No sub-process
	Administrative Buildings & Services	• Main Admin Building; • Mechanical Workshop; • Electrical Workshop and;

		• Instrumentation Workshop
	Headworks	**To be updated**
	Primary Treatment	• Primary Clarification; • High Rate Clarification; • Buildings and Concrete Structures; • Odour Control; • Electrical Power Supply and; • Instrumentation
	Secondary Treatment	• BNR Bioreactors; • Secondary Clarification; • Buildings and Concrete Structures; • Odour Control • Compressed Air System; • Electrical Power Supply and; • Instrumentation
	Disinfection & Outfall	• UV Disinfection; • Outfall; • Buildings and Concrete Structures • Odour Control and; • Electrical Power Supply
	Sludge Digestion	**To be update**
	Dewatering	**To be update**
	SBR	**To be update**
	Foul Air Treatment **(Tentative)**	**To be decided**
	Piping	• Flushing water; • RAS; • WAS; • Instrument Air; • Process Air and; • Potable Water
	Testing and Verification	• Process Sampling and; • Process Testing

Table 4: NEWPCC Process Areas and Sub-Processes

Note: Electrical power supply and instrumentation sub-processes are almost constant for all the process areas. These two sub-processes are totally different from the general plant power supply process as they identify the electrical assets in each process area rather than the general electrical assets in the entire facility's power supply building. The above difference helps to distinguish between the power supply assets within a process area and the entire facility's power supply assets.

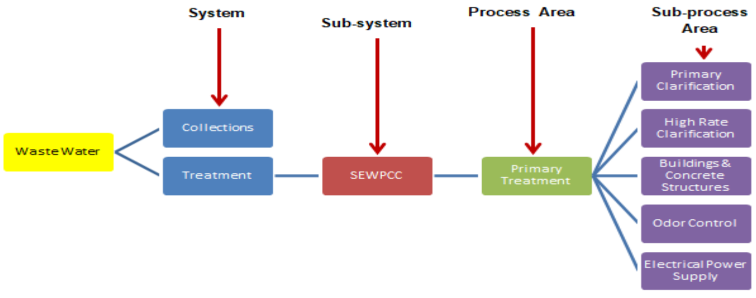
WWS Asset Classification and Specification Guideline



Colour codes for completing all asset hierarchy in Visio or Excel

4.1.5 **Sub-process area:** After identifying the process area, please identify the sub-process area (if any) as demonstrated below. Tables 3 and 4 are resource to identify sub-process areas.

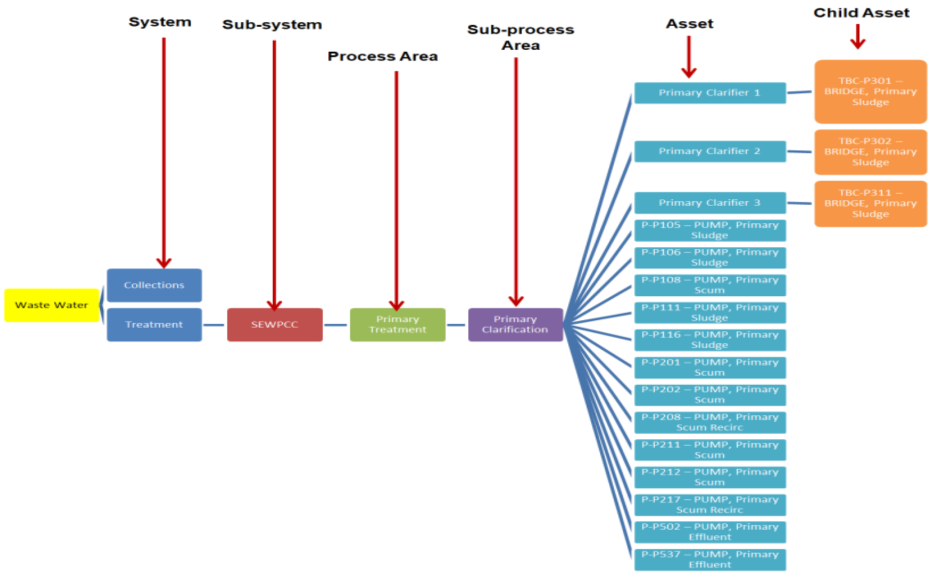
Note: There may be more than one category of sub-process area as the case may be for proper grouping of project assets post commissioning.



4.1.6 **Asset and Child Asset:** Asset is the physical equipment on which work is performed on. The complexity of the asset will determine if the asset has a child asset and/or a sub-child asset. Please identify the assets, child assets and component.

Note:

i. **It is important to keep the child asset structure at one asset level for the most part.**
ii. **Components of an asset should not be described as a child or sub-child asset.**



Appendices 7 and 8 are examples of asset hierarchy in one of the facilities that could give you a better understanding of what the asset hierarchy expectations are.

4.2 Part B: Asset Classification (Second Sheet of the Spreadsheet)

Note that contractors or consultants are not required to document any asset information in part B. This part only provides you with the prerequisite knowledge required to understand how to populate column 'E' and 'F' of the third sheet- data sheet (tab) as required in part C.

Contractors or consultants are expected to use the Asset Classification System sheet as seen on the second sheet of each Asset Class Type spreadsheet to identify the project assets. All asset types delivered to the city in the case of a new project or that were worked on in the case of a maintenance project are expected to be documented. Within each spreadsheet provided in 4.1 (Part A), locate the second sheet (tab) labelled per asset class type e. g. (1-AAPE) to identify the following fields:

- *Asset Class Type*;
- *CODE, Asset Class Type*;
- *Asset Class Description*
- Asset Class
- *Asset Type*
- *CODE, Asset Type*

4.2.1 **Asset Class Type**

ASSET CLASS TYPE is a group of Asset classes that share some common characteristics. It is the highest level of the asset classification in OWAM.

The arrow below shows the column for asset class type for all assets.

Asset Class Type	CODE, Asset Class Type	Asset Class Description	Asset Class	Asset Type	CODE, Asset Type	Useful Life (years) for Depreciation
Ancillary & Accessory Plant Equipment	1-AAPE	Actuator	WW-ACTUATOR	ACTUATOR, Electric	WW-ACTU_EL	5
				ACTUATOR, Hydraulic	WW-ACTU_HY	
				ACTUATOR, Pneumatic	WW-ACTU_PN	
		Analytical Instruments	WW-INSTR ANALYTIC	SAMPLER, Refrigerated	WW-SMPR_RE	
				ANALYZER, Gas	WW-ANAL_GA	
				TRANSMITTER, Analytic	WW-XMTR_AN	
				DETECTOR, Gas	WW-DETR_GA	
				PROBE	WW-PROBE	
		Fire Alarm System	WW-FIRE ALARM SYSTEM	ALARM, FIRE	WW-ALRM_FI	
		CCTV	WW-CCTV	CCTV	WW-CCTV	
		Security System	WW-SECURITY SYSTEM	ACCESS CONTROL	WW-CTRL_AC	
		Ultrasonic Cleaner	WW-ULTRASONIC CLEANR	CLEANER, Ultrasonic	WW-CLNR_UT	
		Brake System	WW-BRAKE SYSTEM	SYSTEM, Brake	WW-SYS_BRA	
		Dehumidifier	WW-DEHUMIDIFIER	DEHUMIDIFIER	WW-DEHUMID	
		Smoke Detector	WW-SMOKE DETECTOR	DETECTOR, Smoke	WW-DETR_SM	
		Filter System	WW-FILTER SYSTEM	SYSTEM, Filter	WW-SYS_FTR	
		Fire Extinguisher	WW-FIRE EXTINGUISHER	EXTINGUISHER, Fire	WW-EXTR_FI	
		Heater	WW-HEATER	HEATER, Electric Space	WW-HTR_ESP	
				HEATER, Electric Water	WW-HTR_EWT	
				HEATER, Glycol	WW-HTR_GLY	
		Humidifier	WW-HUMIDIFIER	HUMIDIFIER	WW-HUMID	
		Lighting System	WW-LIGHTING SYSTEM	LIGHTING, FIXTURES	WW-FIXT_LI	
				BEACON, Alarm	WW-BEAC_AL	

4.2.2 CODE, Asset Class Type

The arrow below shows the column for the CODE of the asset class type for all assets.

Asset Class Type	CODE, Asset Class Type	Asset Class Description	Asset Class	Asset Type	CODE, Asset Type	Useful Life (years) for Depreciation
Ancillary & Accessory Plant Equipment	1-AAPE	Actuator	WW-ACTUATOR	ACTUATOR, Electric	WW-ACTU_EL	5
				ACTUATOR, Hydraulic	WW-ACTU_HY	
				ACTUATOR, Pneumatic	WW-ACTU_PN	
		Analytical Instruments	WW-INSTR ANALYTIC	SAMPLER, Refrigerated	WW-SMPR_RE	
				ANALYZER, Gas	WW-ANAL_GA	
				TRANSMITTER, Analytic	WW-XMTR_AN	
				DETECTOR, Gas	WW-DETR_GA	
				PROBE	WW-PROBE	
		Fire Alarm System	WW-FIRE ALARM SYSTEM	ALARM, FIRE	WW-ALRM_FI	
		CCTV	WW-CCTV	CCTV	WW-CCTV	
		Security System	WW-SECURITY SYSTEM	ACCESS CONTROL	WW-CTRL_AC	
		Ultrasonic Cleaner	WW-ULTRASONIC CLEANR	CLEANER, Ultrasonic	WW-CLNR_UT	
		Brake System	WW-BRAKE SYSTEM	SYSTEM, Brake	WW-SYS_BRA	
		Dehumidifier	WW-DEHUMIDIFIER	DEHUMIDIFIER	WW-DEHUMID	
		Smoke Detector	WW-SMOKE DETECTOR	DETECTOR, Smoke	WW-DETR_SM	
		Filter System	WW-FILTER SYSTEM	SYSTEM, Filter	WW-SYS_FTR	
		Fire Extinguisher	WW-FIRE EXTINGUISHER	EXTINGUISHER, Fire	WW-EXTR_FI	
		Heater	WW-HEATER	HEATER, Electric Space	WW-HTR_ESP	
				HEATER, Electric Water	WW-HTR_EWT	
				HEATER, Glycol	WW-HTR_GLY	
		Humidifier	WW-HUMIDIFIER	HUMIDIFIER	WW-HUMID	
		Lighting System	WW-LIGHTING SYSTEM	LIGHTING, FIXTURES	WW-FIXT_LI	
				BEACON, Alarm	WW-BEAC_AL	

4.2.3 Asset Class Description

The arrow below shows the column for the asset class description for all assets.

Asset Class Type	CODE, Asset Class Type	Asset Class Description	Asset Class	Asset Type	CODE, Asset Type	Useful Life (years) for Depreciation
Ancillary & Accessory Plant Equipment	1-AAPE	Actuator	WW-ACTUATOR	ACTUATOR, Electric	WW-ACTU_EL	5
				ACTUATOR, Hydraulic	WW-ACTU_HY	
				ACTUATOR, Pneumatic	WW-ACTU_PN	
		Analytical Instruments	WW-INSTR ANALYTIC	SAMPLER, Refrigerated	WW-SMPR_RE	
				ANALYZER, Gas	WW-ANAL_GA	
				TRANSMITTER, Analytic	WW-XMTR_AN	
				DETECTOR, Gas	WW-DETR_GA	
				PROBE	WW-PROBE	
		Fire Alarm System	WW-FIRE ALARM SYSTEM	ALARM, FIRE	WW-ALRM_FI	
		CCTV	WW-CCTV	CCTV	WW-CCTV	
		Security System	WW-SECURITY SYSTEM	ACCESS CONTROL	WW-CTRL_AC	
		Ultrasonic Cleaner	WW-ULTRASONIC CLEANR	CLEANER, Ultrasonic	WW-CLNR_UT	
		Brake System	WW-BRAKE SYSTEM	SYSTEM, Brake	WW-SYS_BRA	
		Dehumidifier	WW-DEHUMIDIFIER	DEHUMIDIFIER	WW-DEHUMID	
		Smoke Detector	WW-SMOKE DETECTOR	DETECTOR, Smoke	WW-DETR_SM	
		Filter System	WW-FILTER SYSTEM	SYSTEM, Filter	WW-SYS_FTR	
		Fire Extinguisher	WW-FIRE EXTINGUISHER	EXTINGUISHER, Fire	WW-EXTR_FI	
		Heater	WW-HEATER	HEATER, Electric Space	WW-HTR_ESP	
				HEATER, Electric Water	WW-HTR_EWT	
				HEATER, Glycol	WW-HTR_GLY	
		Humidifier	WW-HUMIDIFIER	HUMIDIFIER	WW-HUMID	
		Lighting System	WW-LIGHTING SYSTEM	LIGHTING, FIXTURES	WW-FIXT_LI	
				BEACON, Alarm	WW-BEAC_AL	

WWS Asset Classification and Specification Guideline

4.2.4 **Asset Class**

ASSET CLASS is a sub-grouping of Asset Class Type. An asset Class is a group of assets which have a common operational philosophy and share a common purpose. The arrow below shows the column for asset class for all assets.

Asset Class Type	CODE, Asset Class Type	Asset Class Description	Asset Class	Asset Type	CODE, Asset Type	Useful Life (years) for Depreciation
Ancillary & Accessory Plant Equipment	1-AAPE	Actuator	WW-ACTUATOR	ACTUATOR, Electric	WW-ACTU_EL	5
				ACTUATOR, Hydraulic	WW-ACTU_HY	
				ACTUATOR, Pneumatic	WW-ACTU_PN	
		Analytical Instruments	WW-INSTR ANALYTIC	SAMPLER, Refrigerated	WW-SMPR_RE	
				ANALYZER, Gas	WW-ANAL_GA	
				TRANSMITTER, Analytic	WW-XMTR_AN	
				DETECTOR, Gas	WW-DETR_GA	
				PROBE	WW-PROBE	
		Fire Alarm System	WW-FIRE ALARM SYSTEM	ALARM, FIRE	WW-ALRM_FI	
		CCTV	WW-CCTV	CCTV	WW-CCTV	
		Security System	WW-SECURITY SYSTEM	ACCESS CONTROL	WW-CTRL_AC	
		Ultrasonic Cleaner	WW-ULTRASONIC CLEANR	CLEANER, Ultrasonic	WW-CLNR_UT	
		Brake System	WW-BRAKE SYSTEM	SYSTEM, Brake	WW-SYS_BRA	
		Dehumidifier	WW-DEHUMIDIFIER	DEHUMIDIFIER	WW-DEHUMID	
		Smoke Detector	WW-SMOKE DETECTOR	DETECTOR, Smoke	WW-DETR_SM	
		Filter System	WW-FILTER SYSTEM	SYSTEM, Filter	WW-SYS_FTR	
		Fire Extinguisher	WW-FIRE EXTINGUISHER	EXTINGUISHER, Fire	WW-EXTR_FI	
		Heater	WW-HEATER	HEATER, Electric Space	WW-HTR_ESP	
				HEATER, Electric Water	WW-HTR_EWT	
				HEATER, Glycol	WW-HTR_GLY	
		Humidifier	WW-HUMIDIFIER	HUMIDIFIER	WW-HUMID	
		Lighting System	WW-LIGHTING SYSTEM	LIGHTING, FIXTURES	WW-FIXT_LI	
				BEACON, Alarm	WW-BEAC_AL	

4.2.5 **Asset Type**

ASSET TYPE is a sub-category within the Asset Class category. Asset type describes an asset based on the principle of operation and assembly. The arrow below shows the column for asset type for all assets

Asset Class Type	CODE, Asset Class Type	Asset Class Description	Asset Class	Asset Type	CODE, Asset Type	Useful Life (years) for Depreciation
Ancillary & Accessory Plant Equipment	1-AAPE	Actuator	WW-ACTUATOR	ACTUATOR, Electric	WW-ACTU_EL	5
				ACTUATOR, Hydraulic	WW-ACTU_HY	
				ACTUATOR, Pneumatic	WW-ACTU_PN	
		Analytical Instruments	WW-INSTR ANALYTIC	SAMPLER, Refrigerated	WW-SMPR_RE	
				ANALYZER, Gas	WW-ANAL_GA	
				TRANSMITTER, Analytic	WW-XMTR_AN	
				DETECTOR, Gas	WW-DETR_GA	
				PROBE	WW-PROBE	
		Fire Alarm System	WW-FIRE ALARM SYSTEM	ALARM, FIRE	WW-ALRM_FI	
		CCTV	WW-CCTV	CCTV	WW-CCTV	
		Security System	WW-SECURITY SYSTEM	ACCESS CONTROL	WW-CTRL_AC	
		Ultrasonic Cleaner	WW-ULTRASONIC CLEANR	CLEANER, Ultrasonic	WW-CLNR_UT	
		Brake System	WW-BRAKE SYSTEM	SYSTEM, Brake	WW-SYS_BRA	
		Dehumidifier	WW-DEHUMIDIFIER	DEHUMIDIFIER	WW-DEHUMID	
		Smoke Detector	WW-SMOKE DETECTOR	DETECTOR, Smoke	WW-DETR_SM	
		Filter System	WW-FILTER SYSTEM	SYSTEM, Filter	WW-SYS_FTR	
		Fire Extinguisher	WW-FIRE EXTINGUISHER	EXTINGUISHER, Fire	WW-EXTR_FI	
		Heater	WW-HEATER	HEATER, Electric Space	WW-HTR_ESP	
				HEATER, Electric Water	WW-HTR_EWT	
				HEATER, Glycol	WW-HTR_GLY	
		Humidifier	WW-HUMIDIFIER	HUMIDIFIER	WW-HUMID	
		Lighting System	WW-LIGHTING SYSTEM	LIGHTING, FIXTURES	WW-FIXT_LI	
				BEACON, Alarm	WW-BEAC_AL	

4.2.6 CODE, Asset Type

The arrow below shows the column for the CODE of the asset type for all assets.

Asset Class Type	CODE, Asset Class Type	Asset Class Description	Asset Class	Asset Type	CODE, Asset Type	Useful Life (years) for Depreciation
Ancillary & Accessory Plant Equipment	1-AAPE	Actuator	WW-ACTUATOR	ACTUATOR, Electric	WW-ACTU_EL	5
				ACTUATOR, Hydraulic	WW-ACTU_HY	
				ACTUATOR, Pneumatic	WW-ACTU_PN	
		Analytical Instruments	WW-INSTR ANALYTIC	SAMPLER, Refrigerated	WW-SMPR_RE	
				ANALYZER, Gas	WW-ANAL_GA	
				TRANSMITTER, Analytic	WW-XMTR_AN	
				DETECTOR, Gas	WW-DETR_GA	
				PROBE	WW-PROBE	
		Fire Alarm System	WW-FIRE ALARM SYSTEM	ALARM, FIRE	WW-ALRM_FI	
		CCTV	WW-CCTV	CCTV	WW-CCTV	
		Security System	WW-SECURITY SYSTEM	ACCESS CONTROL	WW-CTRL_AC	
		Ultrasonic Cleaner	WW-ULTRASONIC CLEANR	CLEANER, Ultrasonic	WW-CLNR_UT	
		Brake System	WW-BRAKE SYSTEM	SYSTEM, Brake	WW-SYS_BRA	
		Dehumidifier	WW-DEHUMIDIFIER	DEHUMIDIFIER	WW-DEHUMID	
		Smoke Detector	WW-SMOKE DETECTOR	DETECTOR, Smoke	WW-DETR_SM	
		Filter System	WW-FILTER SYSTEM	SYSTEM, Filter	WW-SYS_FTR	
		Fire Extinguisher	WW-FIRE EXTINGUISHER	EXTINGUISHER, Fire	WW-EXTR_FI	
		Heater	WW-HEATER	HEATER, Electric Space	WW-HTR_ESP	
				HEATER, Electric Water	WW-HTR_EWT	
				HEATER, Glycol	WW-HTR_GLY	
		Humidifier	WW-HUMIDIFIER	HUMIDIFIER	WW-HUMID	
		Lighting System	WW-LIGHTING SYSTEM	LIGHTING, FIXTURES	WW-FIXT_LI	
				BEACON, Alarm	WW-BEAC_AL	

4.2.7 How to address missing fields in part B

If an asset type cannot be found in the "Asset Type" field (colour coded purple), please contact the City Representative prior to proceeding to completing part C of this guideline.

4.3 Part C: Asset Information, Data and Criticality (Third Sheet of the Spreadsheet)

This section is divided into three which includes:

Phase I: Documentation of asset information in the columns that are colour coded light green based on the maintenance activities as described in the RFP.

Phase II: Documentation of asset data in the columns that are colour coded pink, blue and yellow.

Phase III: Documentation of asset criticality in the columns that are colour coded light brown

Consultants or contractors are expected to populate the "Data" sheet (Third Tab) in each of the eleven asset class type spreadsheet provided in Part A. In each case, ensure the correct asset class type spreadsheet is used to document all the asset types identified from the project. Fill each cell based on the comments that are included in each column title. Continue to populate all the columns within the "Data" sheet and ensure all the significant assets from the project are captured by the data sheet of the respective asset class type.

4.3.1 PHASE I: ASSET INFORMATION

Consultants or contractors shall use the spreadsheet obtained from 3 (d) to populate the asset information column (colour coded light green) following the feedback from the asset listing review from the Wastewater Services Process Improvement Coordinator.

Notable facts below will help with populating the "Data" Sheet (Third Sheet)

Serial #: If applicable, indicate the asset serial number based on the asset list you have provided in 3(d).

Asset scope as per RFP: Populate this column with the list of assets that were maintained as indicated in the scope of the RFP.

Asset Maintenance Update: Indicate the nature of work done on the asset i.e if the asset is new or retired or repaired or replaced or untouched.

Asset Category: Indicate the asset category for each asset as predetermined from the asset listing exercise 3 (d): i.e Asset, Components or Spare part.

4.3.2 PHASE II: ASSET DATA

Asset Type Attribute Description: For cases of multiple assets, use numbers to differentiate them within the key column as they have different tag ID. An example is WW-GEN_DSL1, WW-GEN_DSL2. This example can also be seen in the spreadsheet for better understanding.

Parent Asset:

i. The process area or sub-process area may be the virtual parent asset for all assets (equipments) that fall within an identified process or sub-process area.
ii. Some identified equipment may be the parent asset for some child assets (equipments) that is a subsidary of the asset.

Process Area: See tables 3 and 4 to identify the process area of an asset

Sub-process Area: See tables 3 and 4 to identify the sub-process area of an asset

Name plate: Appendix 5 shows examples of asset name plates

Tag ID: Each asset has its unique identifier number as seen on the name tag images in appendix 6

Plant OWAM: "01" should be populated for all assets for Plant OWAM.

Asset Record types: This describes the asset record as required by the Wastewater Services Division OWAM system. If the asset is identified as a process or a sub-process, then it is 'A" Asset. If the asset is a building then it is "B" Asset. If the asset is equipment, then it is "E" Asset.

Asset Description: All assets description should be written in the standardized format used in WWD. This format is:

Plant where Asset is located: **NE-;**

Process building where Asset is located: **LHW #1;**

Asset Type Name: **SAMPLER, Refrigerated;**

Actual location of Asset: **Lane #1;**

Asset Tag: **S-Y910**

The above will be put together to make the example below:

Example: **NE- LHW #1 SAMPLER, Refrigerated, Lane #1, S-Y910,**

Note: Actual location could be the closet land mark to the asset, which floor or level the asset resides or the room the asset is located.

Asset Status: Asset delivered during the project will have "ACTIVE" status and Assets to be decommissioned will have "INACTIVE" status.

Administrative Department: All Assets are under the administration of WWD.

Administrative Area: All Assets are under the administrative area "WASTE"

Breaker Number: The source breaker identification number is the same as the tag ID for any asset and the maximum data length should not be more 12 characters.

Control Panel ID Number: This is required only if applicable to the asset.

Building Segment: This is the facility segment where the asset can be found. Identify the correct building segment below:

NEWPCC BUILDING SEGMENTS

CODE TABLE 25	BUILDING DESCRIPTION
NEWPCC ADMIN	NEWPCC MAIN ADMINISTRATION
NEWPCC BLDG LEACHATE	NEWPCC LEACHATE BUILGING
NEWPCC BLDG LHW #1	NEWPCC LIQUID HAULED WASTEWATER BUILDING #1
NEWPCC BLDG LHW #2	NEWPCC LIQUID HAULED WASTEWATER BUILDING #2
NEWPCC BOILER	NEWPCC BOILER
NEWPCC DEWATERING	NEWPCC DEWATERNG
NEWPCC DIGESTER	NEWPCC DIGESTER
NEWPCC DRYING BEDS	NEWPCC DRYING BEDS BLDG #3
NEWPCC GARAGE	NEWPCC MAIN GARAGE
NEWPCC GAS BURNER	NEWPCC GAS BURNER
NEWPCC GAS SPHERE	NEWPCC GAS SPHERE
NEWPCC GRIT	NEWPCC GRIT
NEWPCC HAULED WASTE	NEWPCC HAULED WASTEWATER
NEWPCC LAB	NEWPCC MAIN LAB
NEWPCC LEACHATE	NEWPCC LEACHATE

NEWPCC MAIN	NEWPCC MAIN PUMPING
NEWPCC N-REMOVAL	NEWPCC NITROGEN REMOVAL
NEWPCC P-REMOVAL	NEWPCC PHOSPHORUS REMOVAL
NEWPCC PRIMARY	NEWPCC PRIMARY
NEWPCC REACTOR	NEWPCC REACTOR
NEWPCC SECONDARY	NEWPCC SECONDARY
NEWPCC UV	NEWPCC ULTRA VIOLET / TERTIARY

Table 5: NEWPCC Building Segment

SEWPCC BUILDING SEGMENTS

Code Table 25	Building Description
SEWPCC ADMIN	SEWPCC ADMINISTRATION
SEWPCC GENERATOR	SEWPCC GENERATOR
SEWPCC GRIT	SEWPCC GRIT
SEWPCC MAINT	SEWPCC MAINTENANCE
SEWPCC OIL STORAGE	SEWPCC OIL STORAGE
SEWPCC OUTFALL	SEWPCC OUTFALL
SEWPCC PRIMARY	SEWPCC PRIMARY
SEWPCC REACTOR	SEWPCC REACTOR
SEWPCC SECONDARY	SEWPCC SECONDARY
SEWPCC SEPTAGE	SEWPCC SEPTAGE
SEWPCC UV	SEWPCC ULTRA VIOLET / TERTIARY

Table 6: SEWPCC Building Segment

WEWPCC BUILDING SEGMENTS

Code Table 25	Building Description
WEWPCC ADMIN	WEWPCC ADMINISTRATION
WEWPCC DAF	WEWPCC DAF & CHEMICAL FEED
WEWPCC FERMENTER	WEWPCC FERMENTER
WEWPCC HEADWORKS	WEWPCC HEADWORKS
WEWPCC MONITORING	WEWPCC EFFLUENT MONITORING STATION
WEWPCC OUTFALL	WEWPCC OUTFALL
WEWPCC PRIMARY	WEWPCC PRIMARY
WEWPCC PRPS	WEWPCC PERIMETER ROAD PUMP STAION
WEWPCC SECONDARY	WEWPCC SECONDARY
WEWPCC UTILITY	WEWPCC UTILITY

Table 7: WEWPCC Building Segment

Note: Please contact the City representative if the applicable project building segment cannot be found.

Physical location of Asset: This is the physical location of the asset, where it was installed e.g. Gallery XX, Tunnel XX, Basement, Upper Level, Lower Level, Mezzanine, West Wall etc. The maximum data length is 30 characters.

Room Location: This is the room where the asset is located if applicable. The maximum data length is 20 characters.

Drawing number: This is either the PPID or P&ID number for the most recent drawing where the asset can be found

4.3.3 PHASE III: ASSET CRITICALITY

Consultants or contractors are expected to document the asset criticality by using criticality ranking exercise. This ranking exercise should take place in a facilitated workshop that comprises of multi-disciplinary, multi-hierarchal group with wide-ranging experience on the assets to be ranked. Consultants or contractors may notify the City representative of the schedule of the facilitated workshop so the City can delegate a senior operator from the plant to attend the workshop. During the workshop, assets should be individually ranked, but the exercise should be done for all identified assets. The "granularity" or spread of the criticality scores is a function of the number of questions asked and the range of each question. The actual sum is not important, only the actual range which provides the ranking of equipment is important. Note that there may be multiple pieces of equipment with the same criticality.

Criticality is done per asset and as such, every single asset must be analysed. The supporting documents required to analyse asset criticality include: P&ID, PFDs & Electrical Distribution Single Line Diagrams.

Steps to determine the asset criticality:

Step 1: In determining the asset criticality, appendix 4 may be helpful to facilitate the workshop to assess the criticality ranking using a standard risk severity rating scale to determine the consequences of failure (impacts/severity) of the business drivers below:

1. **Environmental Stewardship -** Release of effluent/chemicals/gaseous pollutants to surface/ground water/soil/air

- 00 = No Environmental Impact
- 35 = Low Impact - Minor environmental impact. Not reportable.
- 60 = Moderate Impact - Reversible effect. Reportable licence violation.
- 175 = Significant Impact - Major spill or release. Reportable licence violation.
- 275 = Severe Impact - Catastrophic environmental impact. Reportable licence violation.

2. **Occupational Safety-** Loss / injury of life / limb

- 00 = No Impact on safety of personnel.
- 30 = Low Impact - Minor injury. Report only.
- 50 = Moderate Impact - Injuring requiring first aid/medical treatment.
- 175 = Significant Impact - Lost Time Injury.
- 325 = Severe Impact - Fatality possible.

3. **Operational Consequence of Failure**

3 (a) Level of Service Reduction

- 00 = No Impact - Complete redundancy, auto-switching available if required or 2 - 4 Weeks of buffer capacity available. A failure of this asset does not impact other assets.
- 75 = Low Impact - Complete redundancy, manual switching required or 1 - 2 Weeks of buffer capacity available. A failure of this asset does not impact other assets.
- 125 = Moderate Impact - Some redundancy available, 1 - 33% of process capacity lost. Lost capacity can be recovered through excess plant capacity or 24 Hours of buffer capacity. This asset may cause other assets to trip due to interlocks.
- 175 = Significant Impact - Minimal redundancy available, 34 - 66% of process capacity lost. May recover some of the lost capacity through excess plant capacity. This asset may cause other assets to trip due to interlocks or fail.
- 250 = Severe Impact - No redundancy, Immediate loss of >67% of process capacity lost with no recovery potential. No buffer capacity available. This asset may cause other assets to trip due to interlocks or fail.

3 (b) Cost of Repair/Replacement

- 00 = No Impact - Minor costs < $4,999
- 50 = Low Impact - $5,000 - $79,999
- 80 = Moderate Impact - $80,000 - $159,999
- 120 = Significant Impact - $160,000 - $249,999
- 200 = Severe Impact - $\geq$ $250K

3 (c) Maintainability

- 00 = No Impact - Serviceability high (asset accessible, no special tools required, Low Impact maintenance effort) and Supportability is high (in-house resources required, spares are accessible)
- 80 = Moderate Impact - Serviceability Low Impact (asset accessible only with special tools, high maintenance effort) or vice versa Supportability high (only in-house resources required and spares are accessible)
- 130 = Significant Impact - Serviceability Low Impact (asset accessible with only special tools, high maintenance effort) or vice versa Supportability Low Impact (special (external) resources required and spares are un-accessible or need to be fabricated)
- 200 = Severe Impact - Serviceability is Low Impact (asset accessible with special tools, high maintenance effort) and Supportability is Low Impact (external resources required, spares are un-accessible or need to be fabricated, asset needs to be shipped to special workshop)

3 (d) Detectability

- 00 = No Impact - Failure is detectable before occurrence based on high levels of equipment instrumentation.
- 50 = Severe Impact - Failure is only detectable after occurrence based on department performance or output.

Step 2: For every asset identified in the data sheet (Third tab of each embedded spreadsheet), populate column "AA through column AH" with the risk score obtained from the analysis of each business driver during the workshop (Step 1); Environmental stewardship; Safety; Level of Service Reduction; Cost of repair/repairmen; Maintainability; Detectability

Step 3: Once you have populated column "AA through column AH", column "AG" will automatically calculate the total consequence of failure.

Step 4: Populate column "AH" with the asset criticality by mapping the total consequences of failure to the OWAM criticality code outlined below:

TOTAL CONSEQUENCE OF FAILURE NUMBER	OWAM Criticality Code
00 - 80	1
81 - 160	2
161 - 240	3
241 - 340	4
341 - 440	5
441 - 590	6
591 - 790	7
791 - 1040	8
1041 - 1300	9

Table 8 – Mapping the Total Consequence of Failure to the OWAM Criticality Code

4.4 Part D: Asset Specification and Data (Fourth sheet and the rest of the sheets)

4.4.1 Asset Specification Fields

For each asset type identified in part C above, consultants or contractors are expected to populate the asset data record (colour coded blue) and specification data record (colour coded gray) in each of the eleven asset class type spreadsheet provided in Part A above. From the fourth sheet of each of the eleven spreadsheets, each sheet is named by the asset type code of all asset type listed in the classification sheet (Second sheet); for ease of understanding and accuracy of requirement documentation **e.g WW-PUMP_DI** as in the case of asset type- PUMP. Ensure the correct asset class type spreadsheet is used to document all the asset types identified from the project. Fill each cell based on the comments that are included in each column title. Continue to populate all the columns within asset specification data and specification. The image of a typical asset type specification and data sheet is shown below.

Note: If an asset type sheet is missing in any of the eleven spreadsheets, please contact the City Representative to retrieve it.

The image below is an exact replica of the embedded excel spreadsheet that gives you an idea of the content of the excel document (OSB-AM-LOG-0002).

Classification Specification Template

Asset Type: PROBE, Analytic
Asset Type: WW-PROBE

	Asset Data Record															Specification Data Record																			
Attribute Description	ASSET_NO - Asset Number	TAGGED - Asset Tag/Name Plate	TAGID - Tag ID	PLANT - Synergen Plant	ASSET_RECORD_TYPE - Asset Record Type	ASSET_DESC - Asset Description	ASSET_STATUS - Asset Status	DEPARTMENT - Administrative	AREA - Administrative Area	CRITICALITY - Asset Criticality Rating	BREAKER_NO - Breaker Number	CONTROL_PANEL - Control Panel ID Number	BUILDING - Building Number	LOCATION - Physical location of Asset	ROOM - Room (location)	MANUFACTURER - Manufacturer	MAKE - Make	MODEL_NO - Model	CAT_NO - Catalog/spare part number	SERIAL_NO - Serial Number	DATEMFR - Date of Manufacture	SIGNAL_OUT - Output Signal Range	PROB_MAT - Probe material	FLUID_TYPE - Type of fluid being analyzed	PRESS_MIN - Minimum Operating Pressure (kPa)	PRESS_MAX - Maximum Operating Pressure (kPa)	TEMP_MIN - Minimum Operating Temperature	TEMP_MAX - Maximum Operating Temperature	RANG_MEAS - Measuring Range	HUMIDITY - Humidity (%, Non-condensing)	PORT_NUMB - Number of Ports	PORT_SIZE - Size of Ports (mm)	CONSTRUCT - Construction Material	DIAMTR - Probe Diameter (mm)	LENGTH - Length (mm)

Figure 1: Image of Asset Specification Record and Data Sheet

Hints:

- While populating the asset type specification, you may hide the asset type sheets (tab) that will not be used.
- **Repaired or untouched asset:** The specification information for repaired or untouched assets will not change. Therefore specification information will not be documented for repaired or untouched assets.
- **New or replaced asset:** The specification information for new or replaced assets will change. Therefore specification information will be documented for new or replaced assets.

GUIDELINE APPENDICES

APPENDIX 1: DEFINITION OF AN ASSET

Assets shall be created in the asset registry under any of the following conditions:

1. An asset may be tangible such as physical assets or intangible such as software systems and information.
2. The asset is a high-value asset against which useful life, maintenance work, costs and history should be recorded and analyzed;
3. The asset is expected to have a high criticality reflecting significant environmental, safety, operational and maintenance impact;
4. The asset is required for parent hierarchy grouping purposes. These are artificial systems that will not incur any costs, work or schedule but will facilitate roll up for reporting purposes;
5. There are operational or maintenance requirements to record statistical details;
6. There are requirements to record and manage warranty details against the asset;
7. There is a need to identify total cost of ownership or life cycle costs;
8. There is a need to assess condition over its service life.

If an asset does not fall within any of the above categories, it is unlikely to be needed for entry into the asset registry. There is a change request process to include an asset in the asset registry or to change any of the asset's attributes.

APPENDIX 2: ASSET HIERARCHY STANDARDS

The standards for the asset hierarchy are as follows:

1. The asset hierarchy is a logical reflection of how the assets physically relate with other assets.
2. All managed assets must belong to a hierarchy.
3. Assets from within one asset class may form part of a hierarchy with assets from another asset class.
4. All effort should be made to limit the asset layers to a single layer of assets and child-assets where needed.
5. **Child Assets** are assets within a parent asset system. They are assets in their own rights so they may also consume labor, materials and services. Criteria for designating a child asset are that the asset:
    a. Must be of significant value compared to the value of the asset
    b. Must have a need to track cost independent of the parent asset
    c. Be most likely to have different depreciation time periods than that of the parent asset
6. **Components** are repairable sub-assemblies of an asset system which may be used on multiple assets. A Component could be: an after-cooler; a gearbox or a motor. They may be held in inventory or as shop spares.

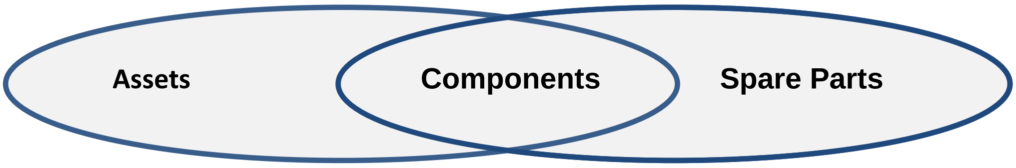


Figure 2: Asset, Component, and Spare Part Relationship

7. **Specific Rules for Child Assets:** Where one asset is serving another. E.g. BNR Mixers 100% dedicated to mixing the individual reactors. Child assets could include the following:

- **Motors / Size Driven Assets e.g:** Motors and VFDs / starters > 30KW
- **Safety Driven Assets e.g.** Gas detectors
- **Process Driven Assets**

Note: This rule is not to be applied without critical thinking

APPENDIX 3: HELPFUL HINTS FOR ASSET IDENTIFICATION

Louvers/Dampers:

- Dampers should not be specifically identified since they are part of either the exhaust fan or AHU. If Preventative Maintenance (PM) Schedule is required for these dampers they could be initiated with their respective associated asset with a clear description of the maintenance task that needs to be done on the damper.
- Identify exhaust fan and AHU which have dampers by including the dampers in parenthesis within the description of each of the identified exhaust fan or AHU to help maintenance planner identify the associated asset to initiate damper PM.

Heat Exchanger: Identify all liquid to liquid heat exchanger and glycol heat exchanger as asset. Other heat exchangers e.g. liquid to air should not be specifically identified.

Valve: Identify all “backflow preventer valve” and “automatic valve that get a control signal” (actuated) as asset. Manual or non-actuated valves should not be specifically identified

Filter: All filters should be identified as components.

Unit Heater: All Unit heaters should be specifically identified as asset

AHU: All Air Handling Units (AHU) should be identified as parent assets and Air Conditioning Units (ACU) should be identified as the child asset of AHU.

WWS Asset Classification and Specification Guideline

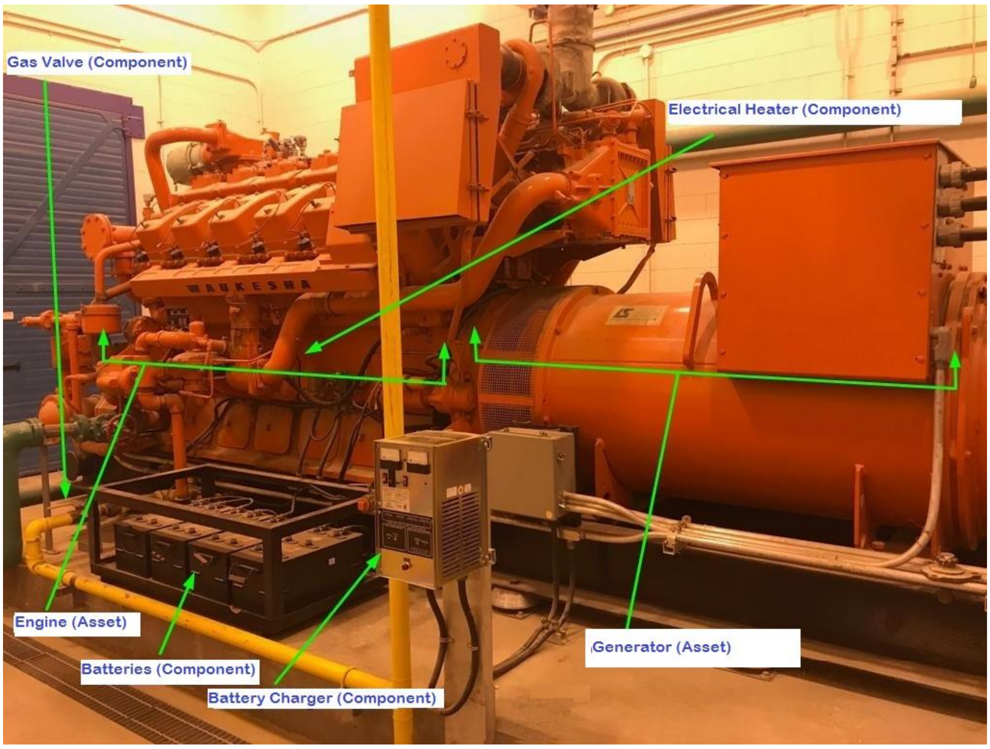


Figure: Image of Asset, Component, and Spare Part for an Engine

APPENDIX 4: FACILITATION HINTS FOR ASSET CRITICALITY WORKSHOP

4.1 Environmental Stewardship - Release of effluent/chemicals/gaseous pollutants to surface/ground water/soil/air

Based on impact of plant's potential pollutants including Wastewater & Effluent; Air Emissions: odor, dust, fumes, gases, smoke; Chemicals: process additives, lubes, cleaners, degreasers, chemicals etc.

Facilitation question:

- Does asset impact the release of Wastewater to surface/ground water/soil; Air Emissions or chemical spills?

Note: Rate 0 for all assets that do not directly impact the release of Wastewater to surface/ground water/soil; Air Emissions or chemical spills.

4.2 Occupational Safety- Loss / injury of life / limb

Based on personnel safety evaluation

Facilitation question:

- What is impact of asset on the safety of personnel during failure and during repairs/maintenance?

4.3 Operational Consequence of Failure

3 (a) Level of Service Reduction

Based upon throughput reduction and whether plant configuration allows for redundancy or single point of failure. Based upon design or Best Demonstrated Capacity not schedule requirements.

Facilitation question:

- How will failure affect the Process Department/Area's ability to meet mission requirements?
- Is there redundant plant or storage/buffer capacity after the asset that could minimize impact of failure?
- Does a failure of this asset cause other assets to fail or trip out of service?

4 (b) Cost of Repair/Replacement

Based upon most recent repairs or best estimates.

Facilitation question:

- What will it cost to repair/replace the asset?

4 (c) Maintainability

Based on Serviceability (ease of access, level of maintenance effort required to understand the nature of the failure (RCA) and the repair and to restore asset) and Supportability (internal and external resources available to support repairs, includes access to spares.)

Facilitation question:

- What is the ease of access of the assets
- What is the level of maintenance effort required to understand the nature of the failure (RCA) and the repair and to restore asset

1042 (d) Detectability

Based upon appropriate levels of instrumentation or the failure being evident before it has impacted the process or other equipment.

Facilitation question:

- How will it be known that the asset has failed occurred?

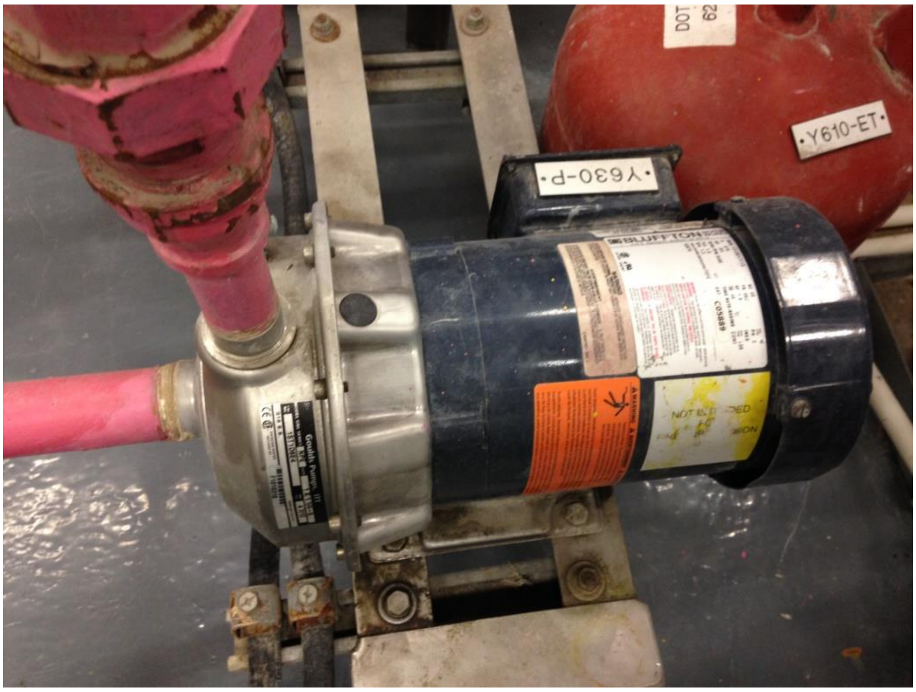
WWS Asset Classification and Specification Guideline

APPENDIX 5: EXAMPLES OF ASSET NAME PLATES (A-D)

A

WWS Asset Classification and Specification Guideline

B

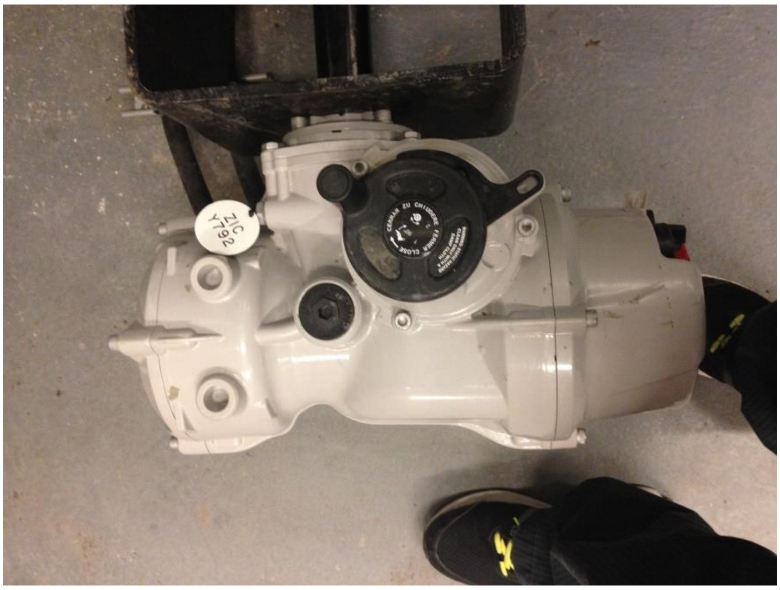


C

WWS Asset Classification and Specification Guideline

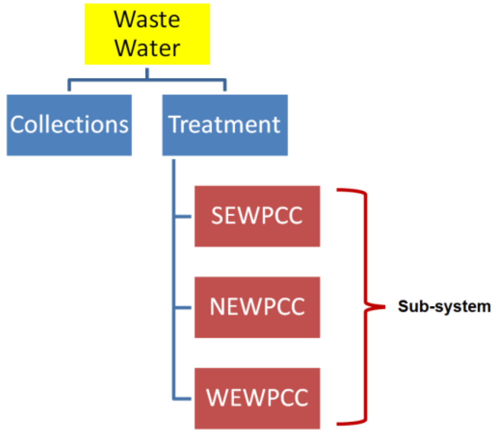
D

APPENDIX 6: EXAMPLES OF ASSET TAG ID(S)

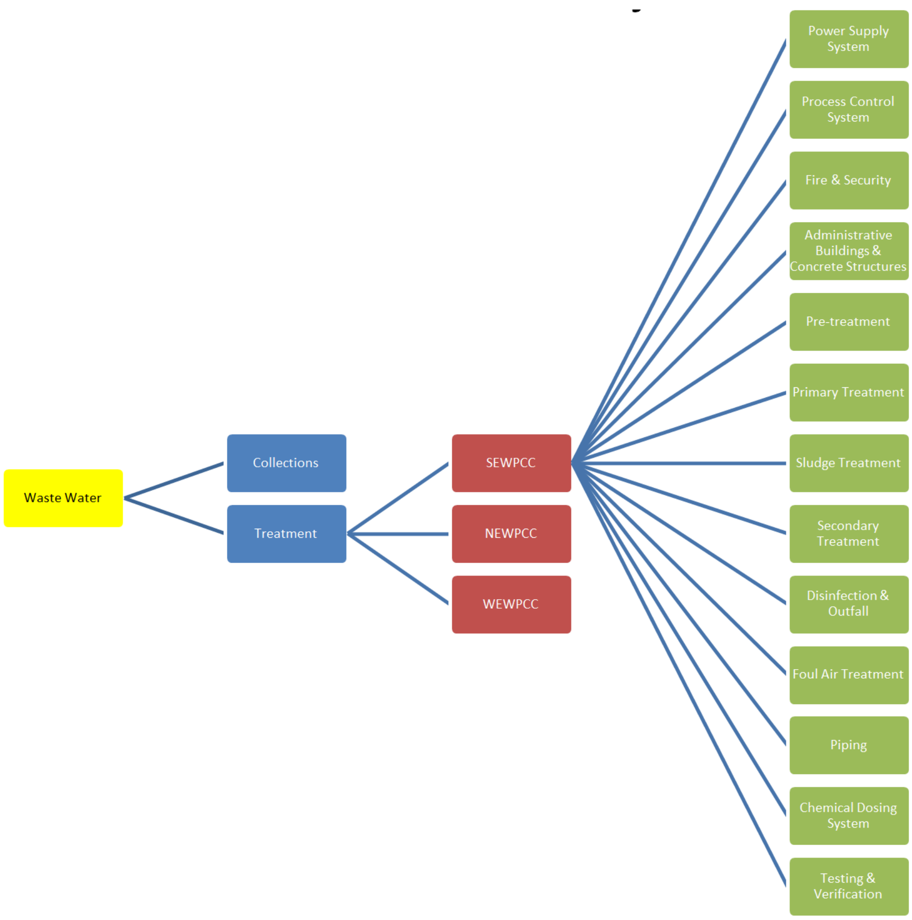


APPENDIX 7: EXAMPLE OF SEWPCC ASSET HIERARCY

7.1 SEWPCC Asset Hierarchy – Main Administrative Leve

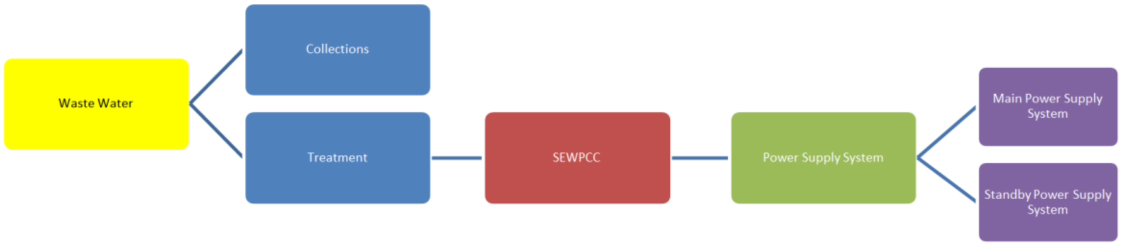


7.2 SEWPCC Asset Hierarchy – Main Processes

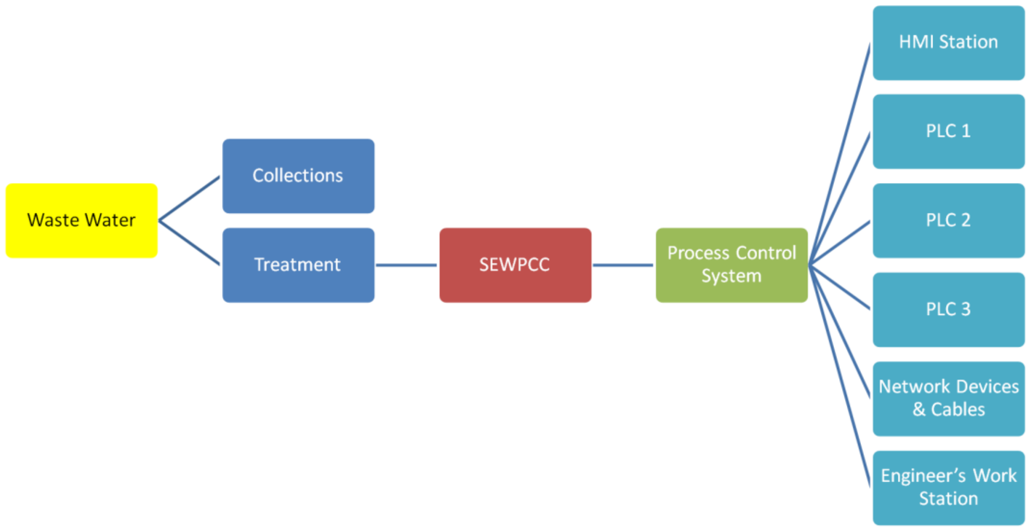


WWS Asset Classification and Specification Guideline

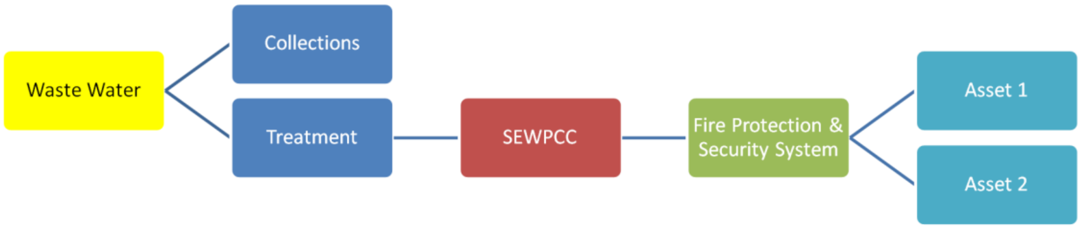
7.3 SEWPCC Asset Hierarchy – Power Supply System



7.4 SEWPCC Asset Hierarchy – Process Control System

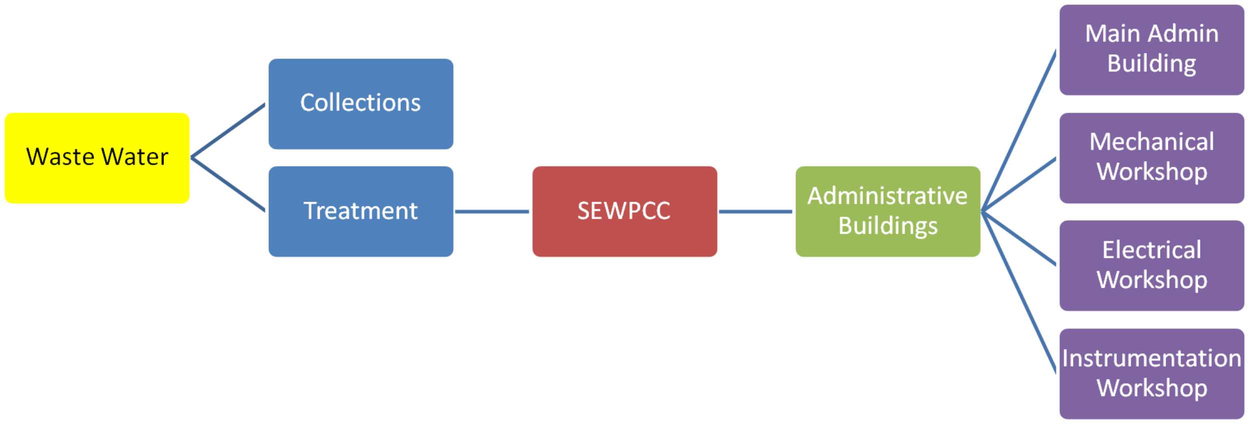


7.5 SEWPCC Asset Hierarchy – Fire Protection & Security System

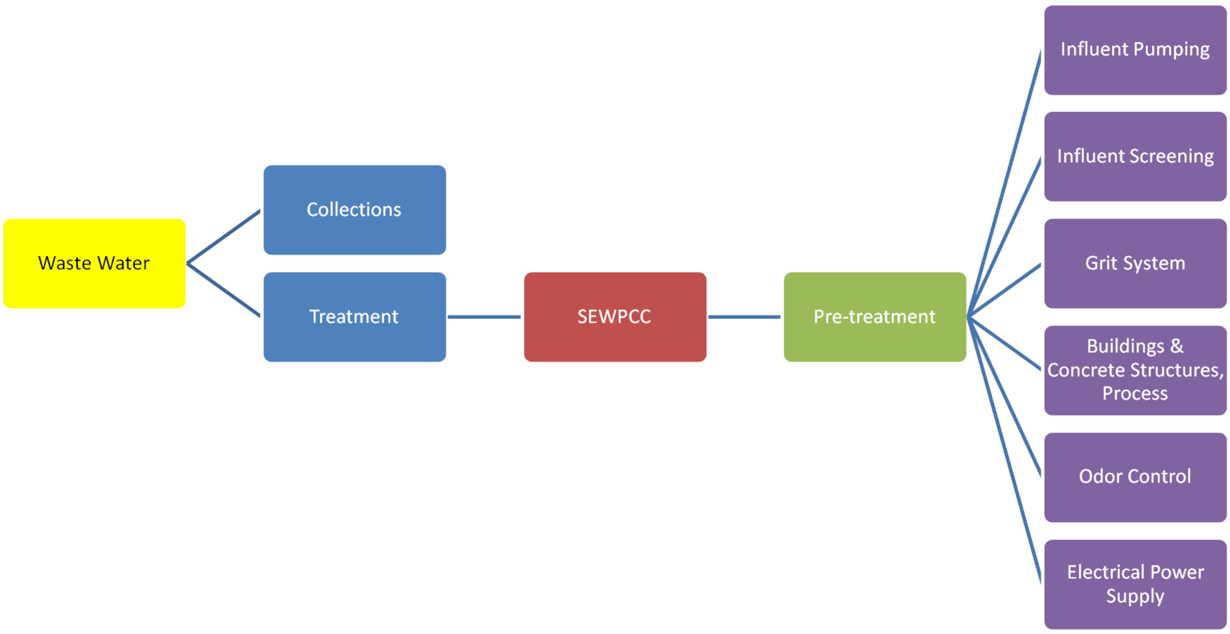


WWS Asset Classification and Specification Guideline

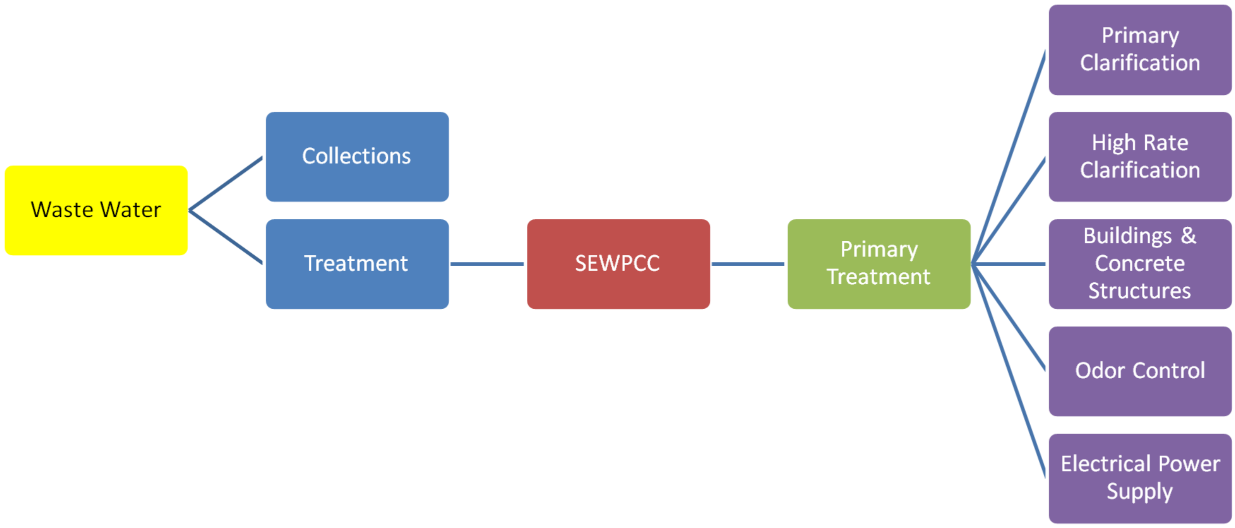
7.6 SEWPCC Asset Hierarchy – Administrative Building and Concrete Structure



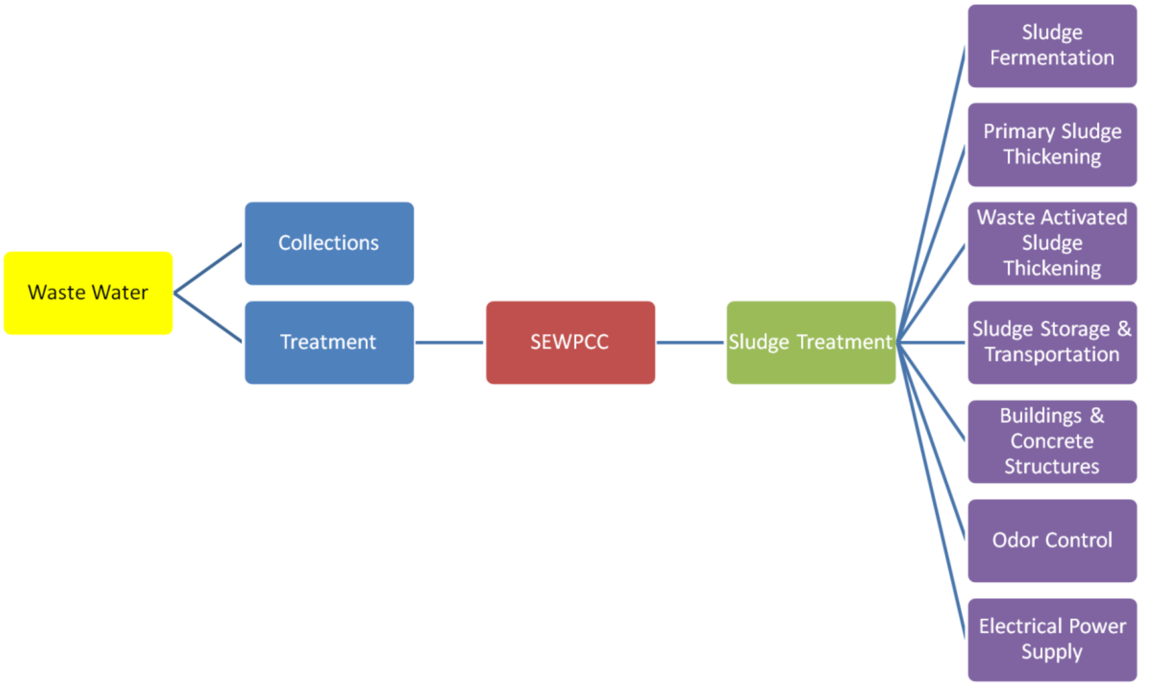
7.7 SEWPCC Asset Hierarchy – Pre-treatment Process



7.8 SEWPCC Asset Hierarchy – Primary Treatment Process

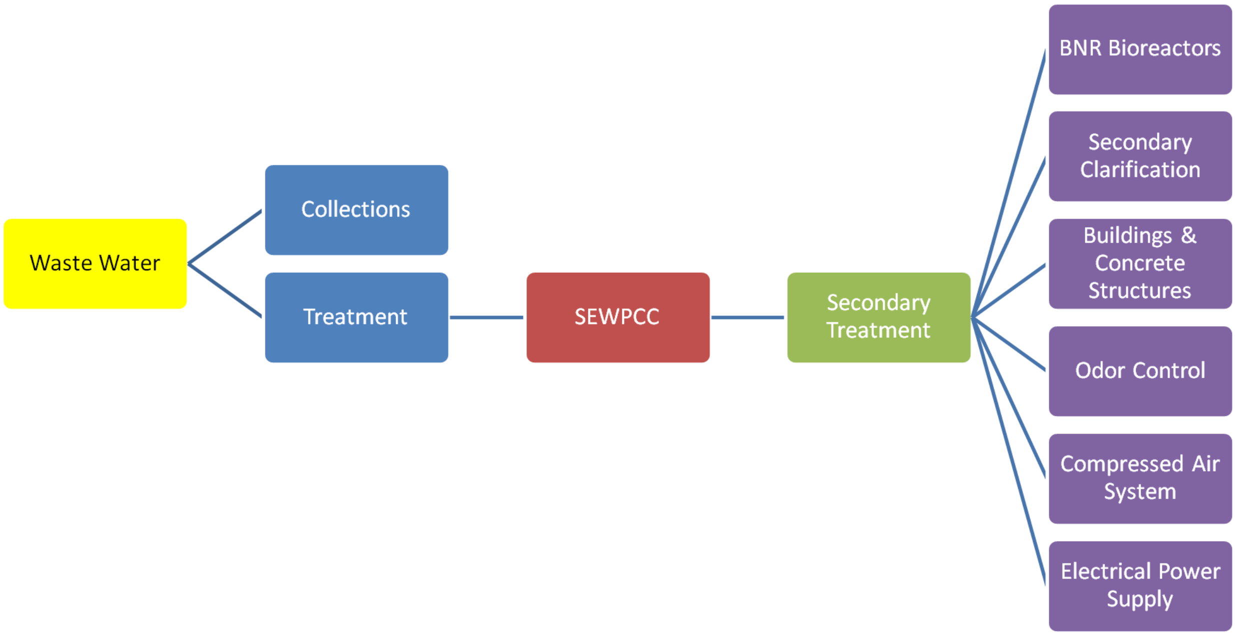


7.9 SEWPCC Asset Hierarchy – Sludge Treatment Process

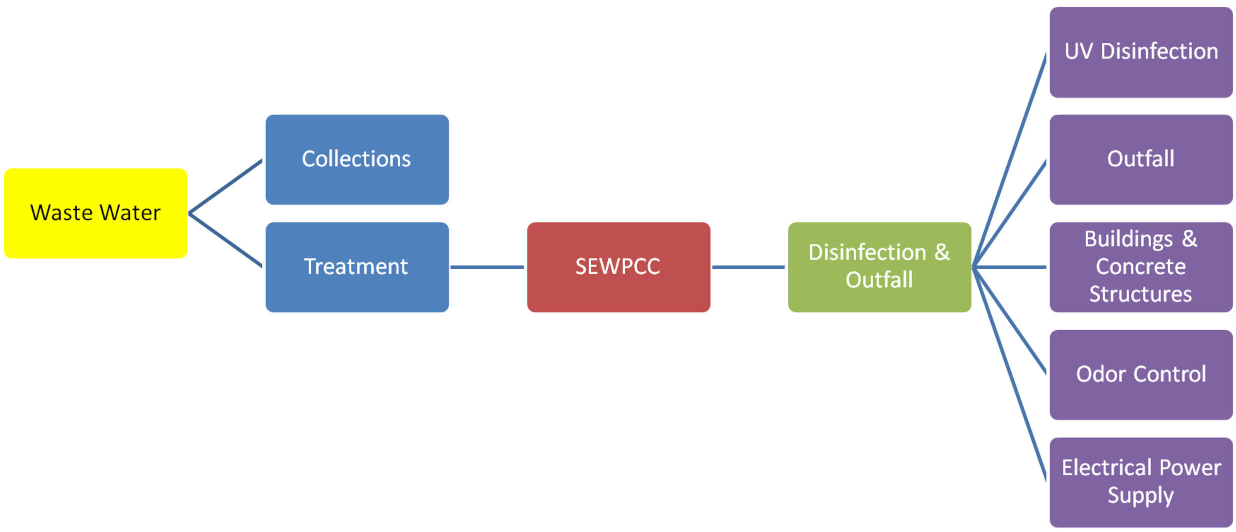


WWS Asset Classification and Specification Guideline

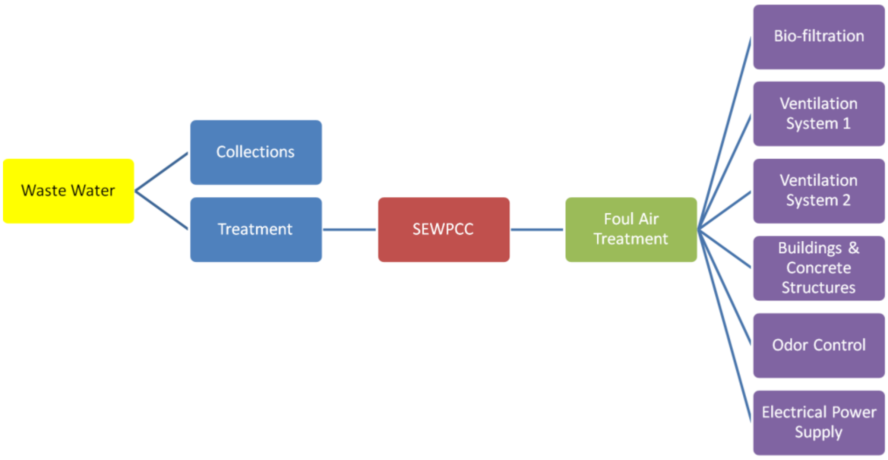
7.10 SEWPCC Asset Hierarchy – Secondary Treatment Process



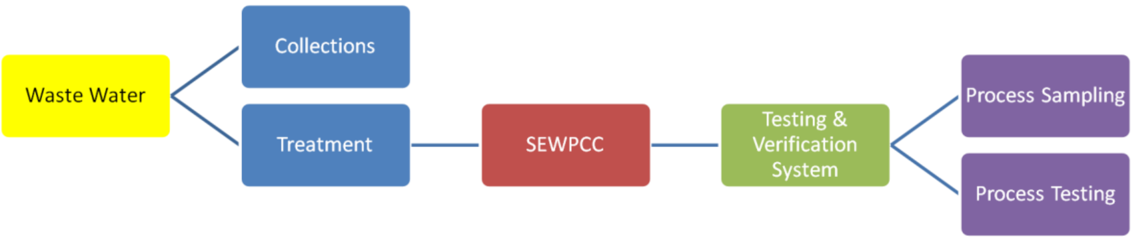
7.11 SEWPCC Asset Hierarchy – Disinfection and Outfall Process



7.12 SEWPCC Asset Hierarchy – Foul Air Treatment Process

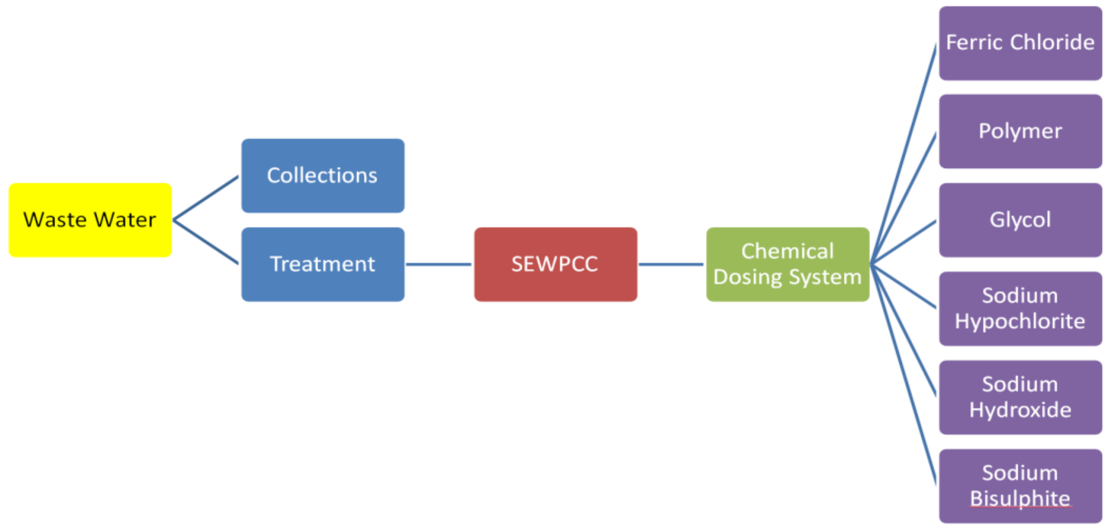


7.13 SEWPCC Asset Hierarchy – Testing and Verification System



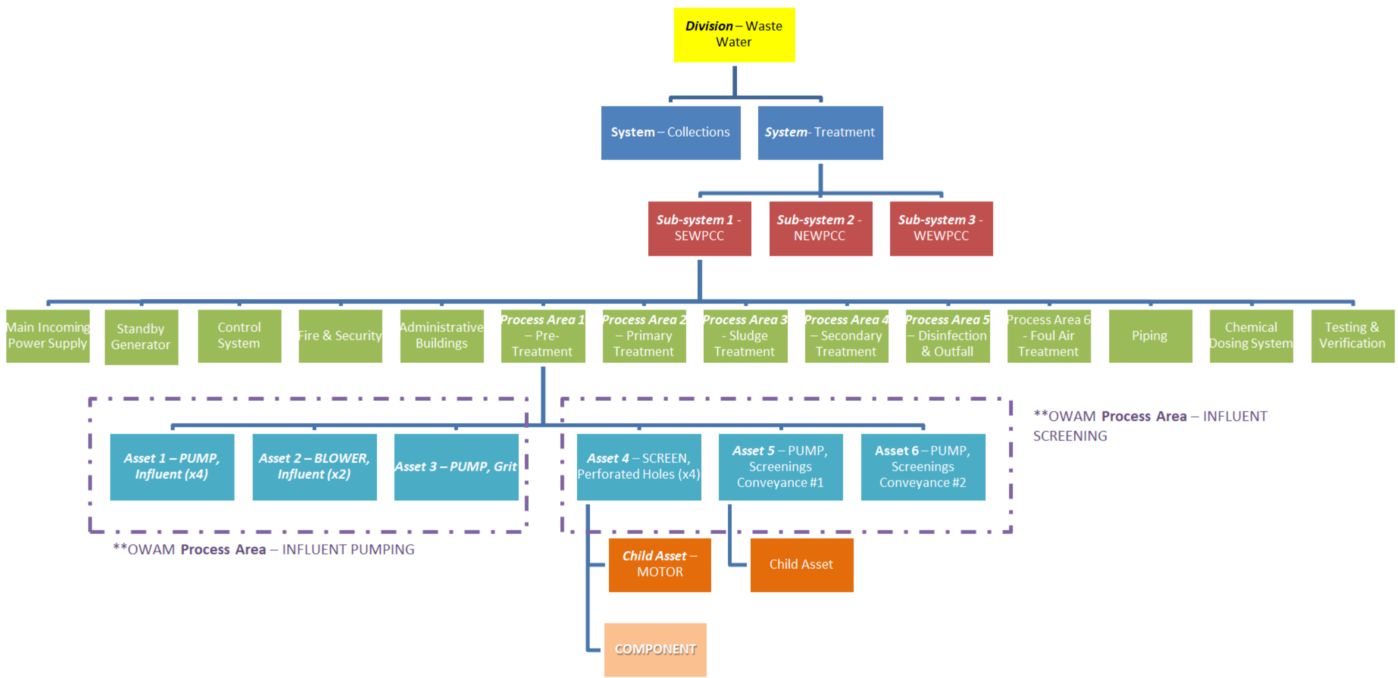
7.14 SEWPCC Asset Hierarchy – Piping System

7.15 SEWPCC Asset Hierarchy – Chemical Dosing System



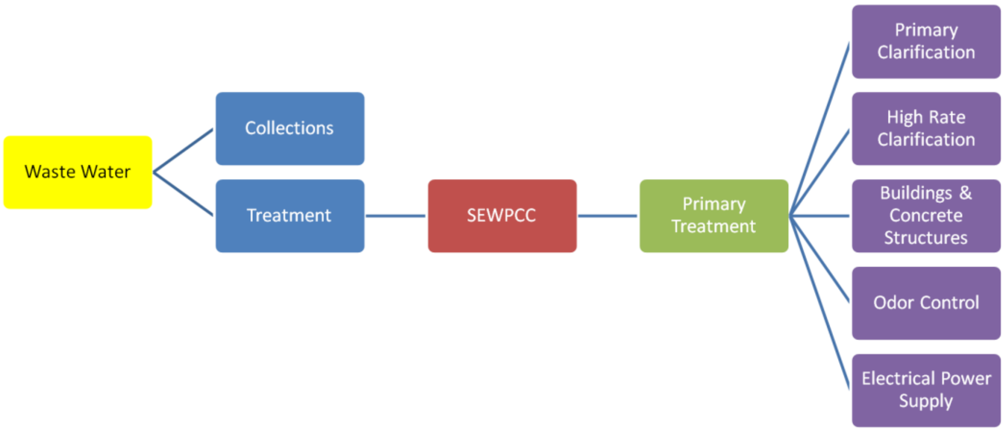
APPENDIX 8: EXAMPLE OF ASSET HIERARCY FOR COMPLETE DEPARTMENT IN SEWPCC (PRIMARY TREATMENT)

8.1 SEWPCC Asset Hierarchy Template identifying the subsystem (SEWPCC), process area (Pre-treatment), Child asset (Motor) and component.

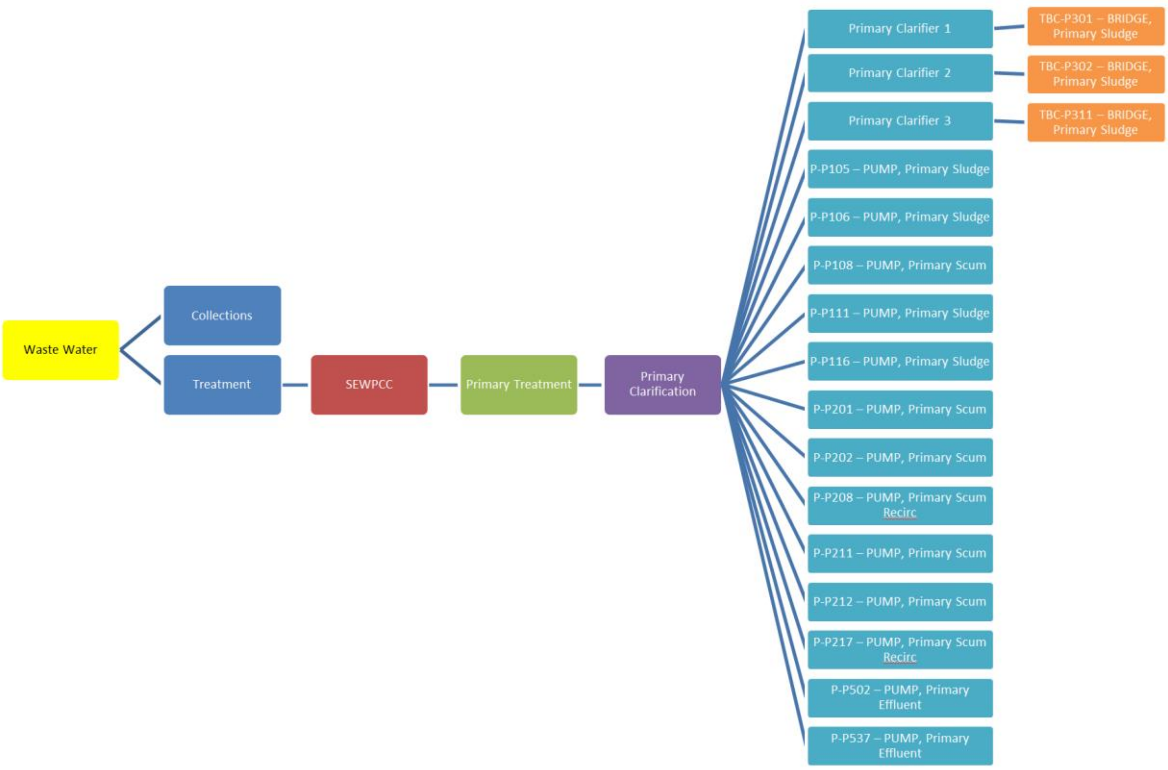


WWS Asset Classification and Specification Guideline

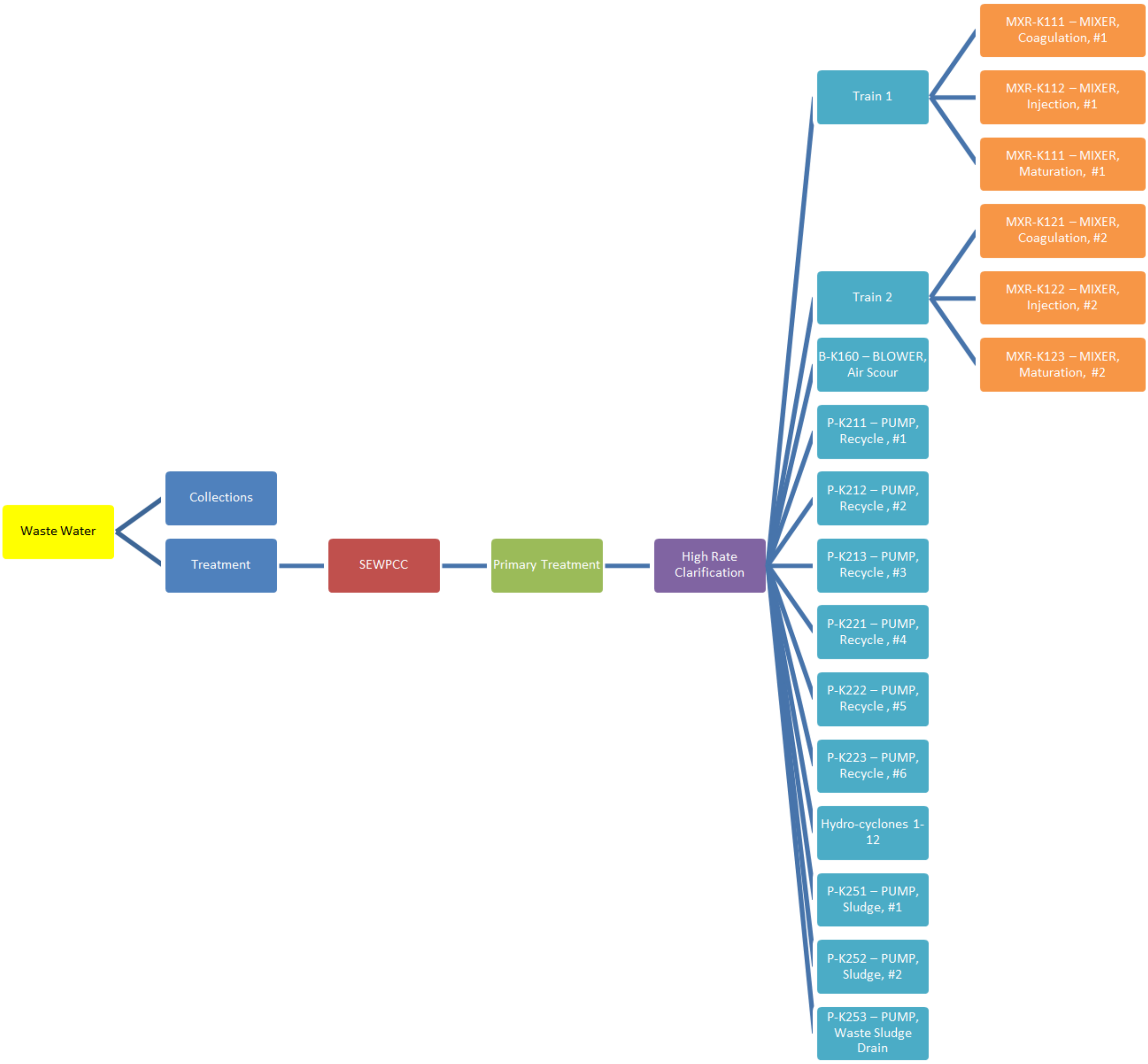
8.1.1 SEWPCC Primary Treatment Process



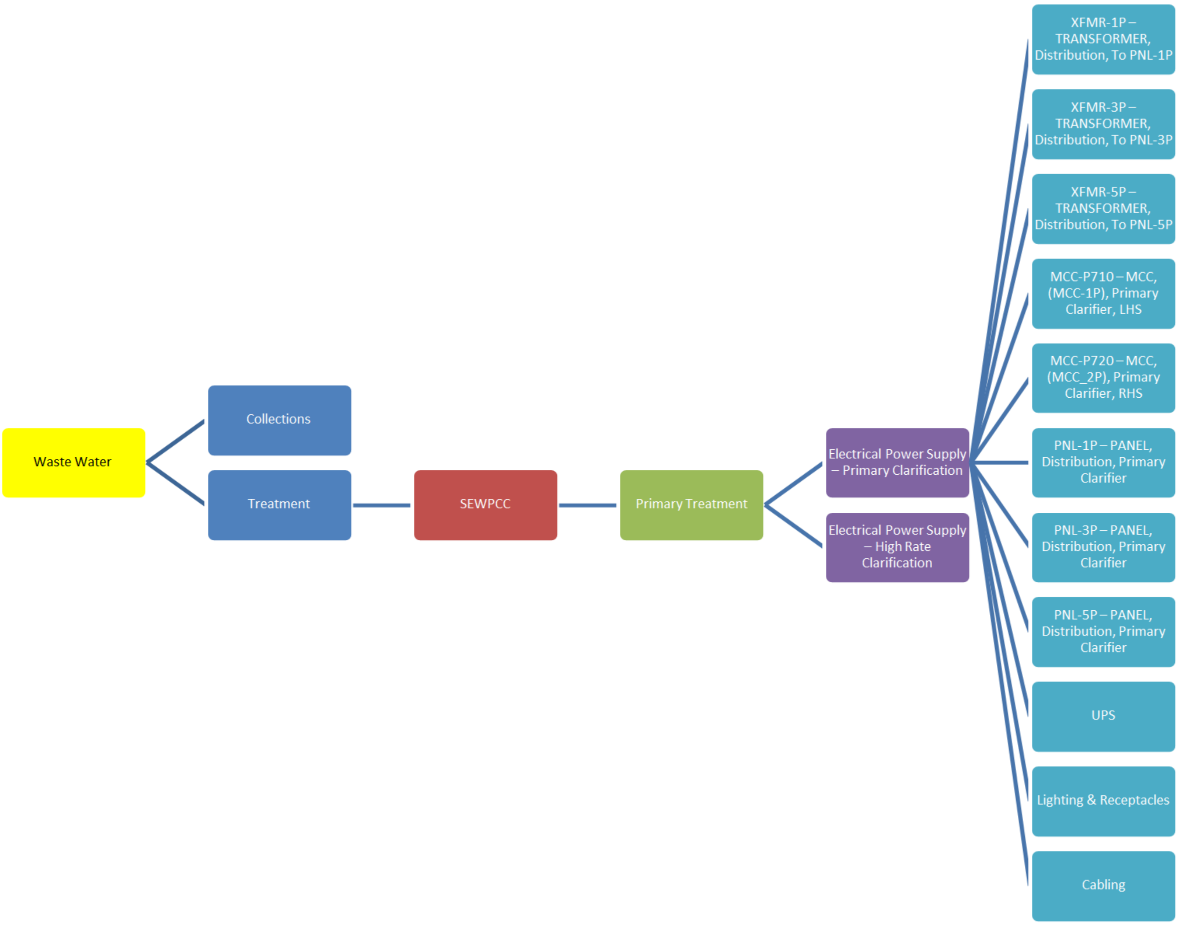
8.1.2 SEWPCC Primary Treatment Process (*Primary Clarification Sub-Process)*



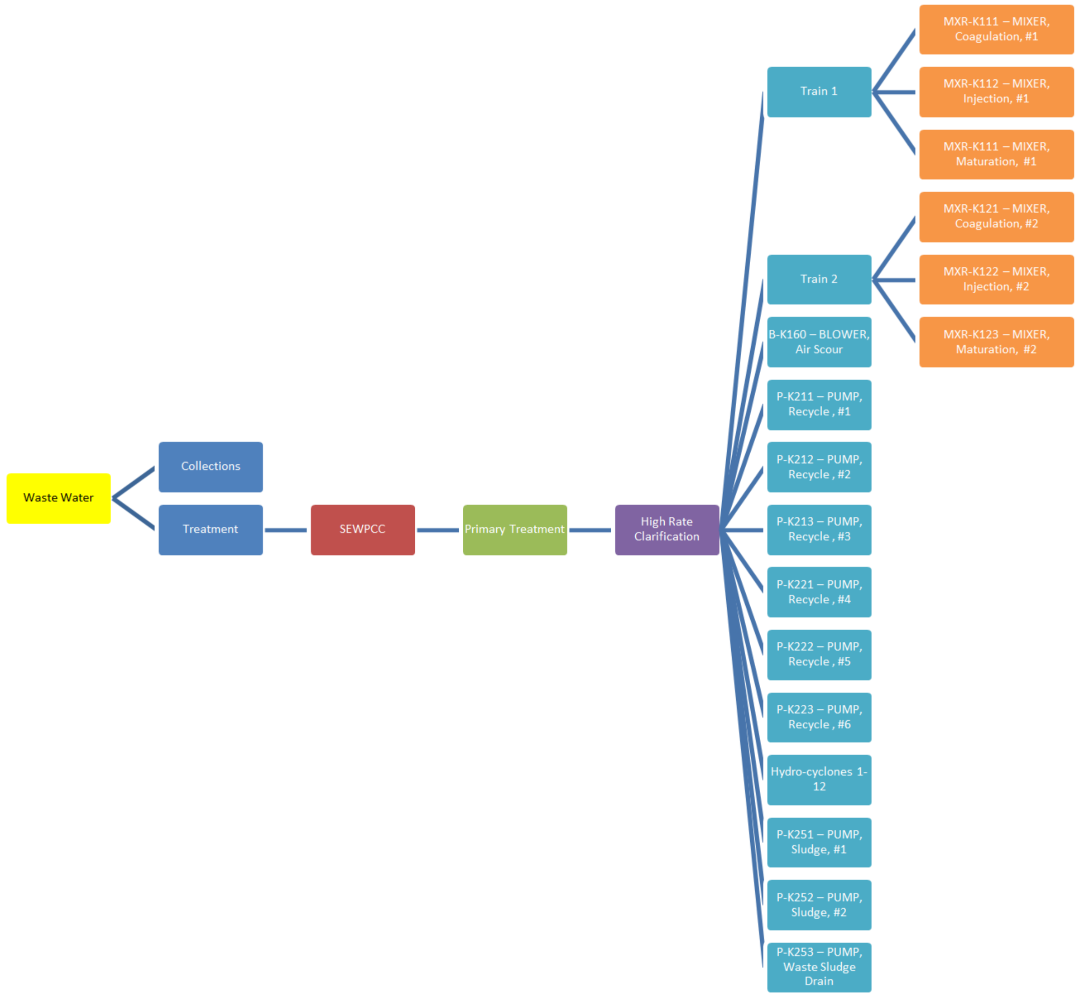
8.1.3 SEWPCC Primary Treatment Process (*High Rate Clarification Sub-Process)*



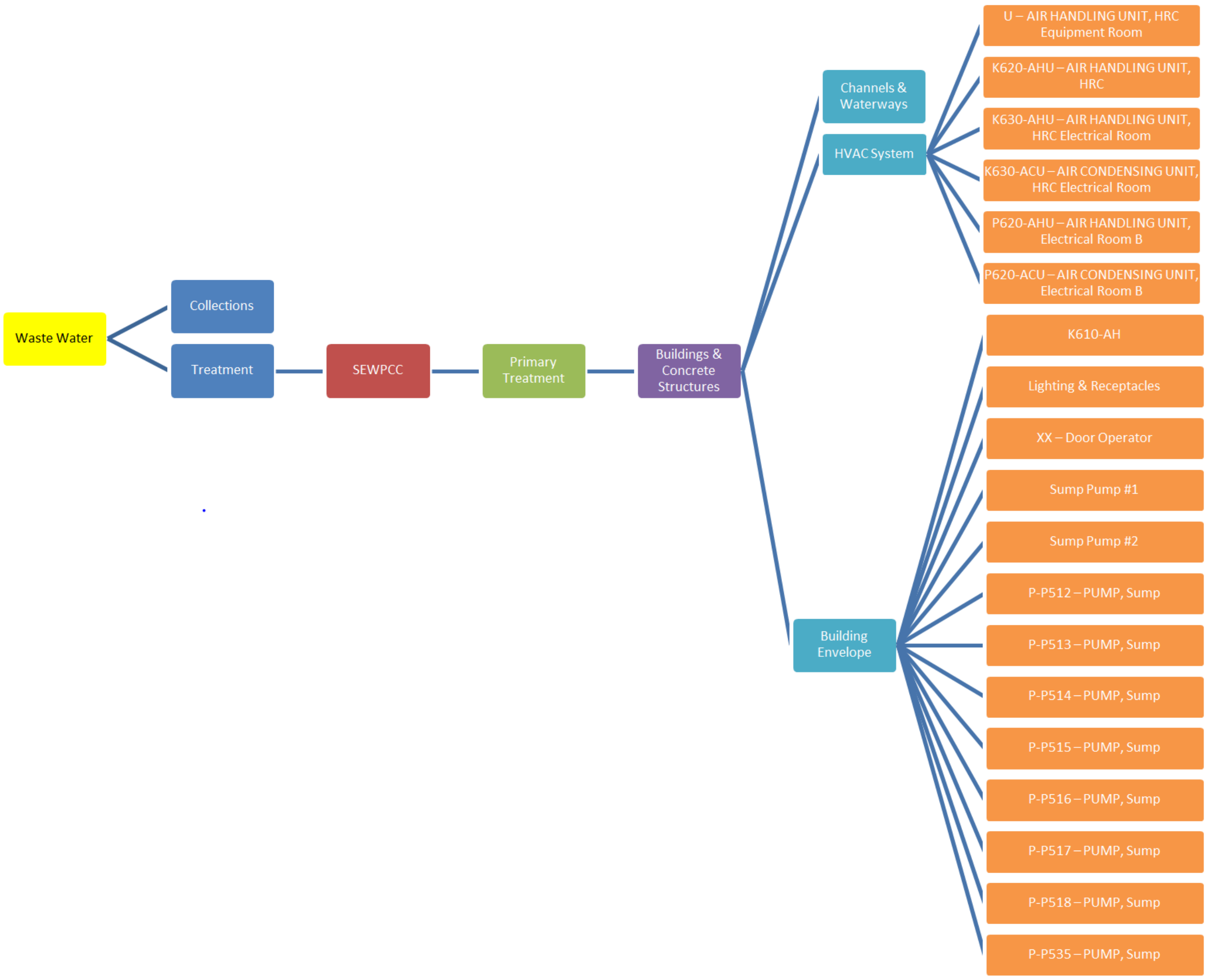
8.1.4 SEWPCC Primary Treatment Process (*Electrical Power Supply Sub-system- Primary Clarification)*



8.1.5 SEWPCC Primary Treatment Process (*Electrical Power Supply Sub-system- High Rate Clarification)*



8.1.6 SEWPCC Primary Treatment Process- *Buildings & Concrete Structures*



APPENDIX V – ADDITIONAL CITY TEMPLATES

Winnipeg

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Form 100
CERTIFICATE OF EQUIPMENT DELIVERY

We certify that the equipment listed below has been delivered into the care and custody of the Installation Contractor. The equipment has been found to be in satisfactory condition. There is no visible evidence of exterior damage or defects.

Project:
Equipment Description:
Equipment Supply Bid Opp. No.:
Equipment Install Bid Opp. No.:
Equipment Tag No.:
Specification Reference:

______________________________________ ____________

(Authorized Representative of Supply Contractor) Date

______________________________________ ____________

(Authorized Representative of Install Contractor) Date

______________________________________ ____________

(Authorized Representative of Contract Administrator) Date

Form 101
CERTIFICATE OF READINESS TO INSTALL

We have familiarized the installing contractor of the specific requirements related to the equipment listed below and am satisfied that the installing contractor understands the required installation procedures.

Project:
Equipment Description:
Equipment Supply Bid Opp. No.:
Equipment Install Bid Opp. No.:
Equipment Tag No.:
Specification Reference:

(Authorized Representative of Supply Contractor) Date

We certify that we have received satisfactory installation instructions from the equipment manufacturer/vendor.

(Authorized Representative of Install Contractor) Date

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Form 102
CERTIFICATE OF SATISFACTORY INSTALLATION

We have completed our checks and inspection of the installation of our equipment as listed below and confirm that it is satisfactory and that any defects have been remedied except any as noted below.

Project:
Equipment Description:
Equipment Supply Bid Opp. No.:
Equipment Install Bid Opp. No.:
Equipment Tag No.:
Specification Reference:
Outstanding Defects:

____________________________________ ____________
(Authorized Representative of Supply Contractor) Date

____________________________________ ____________
(Authorized Representative of Install Contractor) Date

____________________________________ ____________
(Authorized Representative of Contractor Administrator) Date

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Form 103
CERTIFICATE OF EQUIPMENT SATISFACTORY PERFORMANCE

We certify that the equipment listed below has been continuously operated for a minimum of three (3) consecutive days and that the equipment operates satisfactorily and meets it's specified operating criteria. No defects in the equipment were found and as such are classified as "conforming".

Project:
Equipment Description:
Equipment Supply Bid Opp. No.:
Equipment Install Bid Opp. No.:
Equipment Tag No.:
Specification Reference:

____________________________________ ____________
(Authorized representative of Supply Contractor) Date

____________________________________ ____________
(Authorized representative of Install Contractor) Date

____________________________________ ____________
(Authorized representative of Contract Administrator) Date

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Form 104
CERTIFICATE OF SATISFACTORY PROCESS PERFORMANCE

We certify that the process system listed below has been continuously operated and tested as per the Specifications using process fluid and that the equipment meets its Performance Testing and Operating Criteria. No defects in the process system were found and as such are classified as “conforming”.

Project:
Equipment Description:
Equipment Supply Bid Opp. No.:
Equipment Install Bid Opp. No.:
Equipment Tag No.:
Specification Reference:

____ ____________

(Authorized Representative of Supply Contractor) Date

____ ____________

(Authorized Representative of Install Contractor) Date

____ ____________

(Authorized Representative of Contract Administrator i.e. Commissioning Lead or Design Discipline Lead) Date

____ ____________

(Authorized Representative of City) Date

Winnipeg

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Form T-1
CERTIFICATE OF SATISFACTORY CLASSROOM TRAINING

We have completed classroom training in the operation and maintenance of the equipment as listed below.

Project:
Equipment Description:
Equipment Supply Bid Opp. No.:
Equipment Install Bid Opp. No.:
Equipment Tag No.:
Specification Reference:

List of Attendees:

____________________________________ ____________

(Trainer) Date

____________________________________ ____________

(Authorized Representative of Contract Administrator) Date

____________________________________ ____________

(Authorized Representative of City) Date

Winnipeg

Water and Waste Department • Service des eaux et des déchets

Form T-2
CERTIFICATE OF SATISFACTORY FIELD TRAINING

We have completed field training in the operation and maintenance of our equipment as listed below.

Project:
Equipment Description:
Equipment Supply Bid Opp. No.:
Equipment Install Bid Opp. No.:
Equipment Tag No.:
Specification Reference:

List of Attendees:

______________________________ ____________
(Trainer) Date

______________________________ ____________
(Authorized Representative of Contract Administrator) Date

______________________________ ____________
(Authorized Representative of City) Date

APPENDIX W – ENVIRONMENTAL PRESERVATION AND COMPLIANCE AND ENVIRONMENTAL MANAGEMENT POLICY

Water and Waste Department
Wastewater Services Division

ENVIRONMENTAL PRESERVATION AND COMPLIANCE

Environmental Preservation and Compliance

Working on behalf of Wastewater Services, your performance during all contracted obligations is critical to our commitment to protect the environment and comply with all environmental legislation. Please read our attached Environmental Policy.

Without limiting or otherwise affecting the generality or application of any other term or condition of the Contract, you shall, at no additional cost to the Wastewater Services Division:

a) strictly comply with all applicable environmental laws and regulations and have suitable corrective and/or preventive measures in place to address any previous environmental warnings, fines or convictions;

b) do or cause to be done all things required or ordered, and shall bear all costs and expenses for same, to mitigate environmental damage caused, directly or indirectly, by itself or by its servants, agents, employees or subcontractors, accidentally or as a result of practices that are or may be in contravention of the Contract or any environmental laws or regulations, or to prevent any or all of the same;

c) ensure that all persons engaged in the performance of the Work and the Contract shall not dispose of oil or waste materials in any way which might cause pollution of land, water, lakes, rivers, streams;

d) ensure that all persons engaged in the performance of the Work and the Contract shall follow any Safe Work Procedures provided by the contract administrator;

e) ensure the Work, and all work sites are clean and free from fire hazards and other hazards, accumulations of waste materials, rubbish and debris;

f) create as little waste as reasonably possible during the course of the Work and handle all waste created in the course of the Work in a environmentally preferable, and legal, manner;

g) in respect of the Work, use all resources as efficiently and reasonably possible;

h) the person who is responsible for a spill or who has custody and control of the substances involved in a spill must **immediately** notify the designated official (see contact list below), and must provide all information about the spill, including:

i) the date and time of the spill;

ii) the content and quantity of the spill;

iii) the location of the spill;

iv) the cause and nature of the spill;

v) the action completed and any work still in progress to mitigate the spill;

vi) the name and contact information of the person reporting the spill.

i) the person who is responsible for a spill or who has custody and control of the substances involved in a spill must notify all appropriate regulatory agencies e.g. Fisheries and Oceans Canada, Manitoba Ministry of Sustainable Development as required by law;

j) if a spill poses an immediate danger to human health or safety, property or the environment, the person responsible for the spill or who has custody and control of the substances involved in a spill must call 911 to report the spill;

k) the person who is responsible for a spill or who has custody and control of the substances involved in a spill must take all reasonable measures to:

i) contain the spill;

ii) reduce the risk of harm to human health and safety, property, and the environment;

iii) clean up the spill and contaminated residue and dispose of spill material appropriately, and

iv) restore the affected area to its condition before the spill.

l) the person who is responsible for a spill or who has custody and control of the substances involved in a spill must submit a written report to the Purchaser within five working days of the spill, containing information required to determine:

i) information required in (h); and

ii) actions necessary to reduce the effect of the spill and to prevent future spills.

Water and Waste Department
Wastewater Services Division

ENVIRONMENTAL PRESERVATION AND COMPLIANCE

Contact List	
Federal (Winnipeg Offices) Fisheries and Oceans Canada	204.983.5163
Provincial Manitoba Ministry of Sustainable Development	204.944.4888
Wastewater Services (normal work hours) Collection System Issue: Superintendent of Wastewater Collection	204.986.3492
Wastewater Treatment Plant Issue: Supervisor for NEWPCC: Supervisor for SEWPCC: Supervisor for WEWPCC:	204.986.4845 204.986.6159 204.986.5220
Wastewater Services (after hours) Collection System Issue: Wastewater Services Control Centre	204.986.7948
Wastewater Treatment Plant Issue:	204.794.4468

ENVIRONMENTAL PRESERVATION AND COMPLIANCE

APPENDIX X – PROJECT DOCUMENTATION REQUIREMENTS SHEET (DOCUMENT NUMBER: CD-CP-TO-05)

Appendix	X	for City of Winnipeg Request for Proposal No.	384-2020

Project submittals requirements for quantities and formats by category:

Document Description	Version	Paper Copies	Unit / General Format	Searchable pdf file	Electronic native file
Minutes of Meetings	all	none		1	
Technical Plans/ Memorandums/ Reports	for review	10	Sets / Bound	1	
Technical Plans/Memorandums/Reports	final	10	Sets / Bound	1	
Drawings issued independently from above	for review	10	Sets 11"x17"/ Collated - Fastened	1	
Technical Specifications/Design Criteria/Lists etc.	for review	10	Sets / Collated - Fastened	1	
Design Cost Development Drawings (in addition to the requirements for final presentations, tenders, etc.)	final	+2	Full Size sets/Collated - Fastened	1	
Risk Management Plan - Risk Register	for review/final	10	Sets / Collated - Fastened	1	1
Schedules or other documents with City required specific electronic file format	for review/final		as per applicable Item above	1	1
Tender Documents	for 60% and 90% reviews	10	Sets / Collated - Fastened	1	
Tender Drawings	for 60% and 90% reviews	10	Sets 11"x17"/ Collated - Fastened	1	
Tender Documents	final	10	Sets / Collated - Fastened	1	1
Tender Drawings	final	10	Sets 11"x17"/ Collated - Fastened	1	
Contractual documents for which wet signature is required.	original	1	Original	1	
Other Contract Administrative documents	review/final	none		1	
Consultant Progress Invoices	final	3	Sets	1	1
Tender Progress Estimates	final	3	Sets / Collated	1	
Inspection, testing, training, commissioning records	final	6	Sets / Collated - Fastened	1	
Record Drawings	for review/final	x/6	Sets 11"x17"/ Collated - Fastened	1	
Record Drawings	final	1	Mylar Full Size Set		+1-Autocad
Operation and Maintenance Manuals	for review/final	x/6	Sets in Ring Binders	1	
Process Areal Operating Manuals	for review/final	x/6	Sets in Ring Binders	1	1
Standard Operating Procedures	for review/final	x/6	Sets in Ring Binders	1	1

Note: Prior to any submission the Consultant shall confirm with the City Project Manager the required format(s) and quantities of the submission.

APPENDIX Y – WSTP STANDARDS DEVIATION FORM - R00

Winnipeg	**WSTP Standards Deviation Form**	Page	1 of 1
		Revision #	00
		ID:	

Instructions:
1. Complete this document as part of each major submittal.
2. Deviations to the WSTP Standards shall only be incorporated into the final design with written approval of the City Project Manager.

Project Number:	Project Name:				
Package :					
Submission Stage:					
Applicable Disciplines:	☐ Civil ☐ Electrical	☐ Architectural ☐ Automation	☐ Structural	☐ Building Mechanical	☐ Process

Design Summary	☐ The design has no deviations from the WSTP Design Guidelines and Standards. ☐ The design has deviations from the WSTP Design Guidelines and Standards, which have been previously approved by the City Project Manager. ☐ The design has deviations from the WSTP Design Guidelines and Standards, as indicated below.

Document Number	Location within Document:	
WSTP Design Standard Infringed Upon:		
Description of Deviation:		
Rationale:		
Benefit to City:		
Cost Impact:		
Change to WSTP Standards Recommended:	☐ Yes	☐ No
Additional Comments:		

Repeat this section as applicable for all deviations to the standards.

Submitted By (Design Engineer)				
	Company	**Name**	**Signature**	**Date** (yyyy/mm/dd)
Design Engineer				
Design Project Manager				