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END OF SECTION

SUBMITTAL PROCEDURES

1. GENERAL

1.1 Description

.1 This Specification shall revise, amend, and supplement the requirements of CW 1110 of the City of Winnipeg's Standard Construction Specifications.

.2 Submit to the Contract Administrator the submittals required by individual Specification Sections for review. Submit promptly and in an orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.3 Do not proceed with Work affected by the submittal until reviewed by the Contract Administrator.

.4 Present Shop Drawings, product data, and samples in SI Metric units.

.1 Where items or information is not produced in SI Metric units, converted units are acceptable.

.5 Review submittals prior to submission to Contract Administrator. The Contractor review represents that necessary requirements have been determined and verified, for incorporation into Work.

.6 The review by the Contract Administrator is for the sole purpose of ascertaining general conformance with concept. It does not provide 'approval' of the detail design inherent in Shop Drawings (which remains with the Contractor), nor does it relieve the Contractor of responsibility for errors or omissions in Submittal or for meeting all requirements of the Work.

.7 Verify that field measurements and affected adjacent Work are coordinated in advance of the Submittal to the Contract Administrator.

.8 The Contractor shall make any corrections required by the Contract Administrator and shall resubmit corrections when the Contract Administrator's review so notes. The Contractor shall direct specific attention in writing on resubmitted submittals to revisions other than the corrections requested by the Contract Administrator on previous submission.

.9 Keep one (1) reviewed hard copy of each submission on Site.

1.2 Submittal Procedures

.1 Direct submittals to the Contract Administrator via email. Use of proprietary document management software will not be permitted for submissions.

.1 Include in the email subject shall contain:

.1 City Bid Opportunity number.

.2 General project title.

.3 Submittal number in sequence and short submittal description.

SUBMITTAL PROCEDURES

.2 Electronic Submittals: Submittals made in electronic format shall be as follows:

.1 Each submittal shall be electronic file in Adobe Acrobat Portable Document Format (PDF). Use 2010 version or newer.

.2 Electronic files that contain more than ten (10) pages in PDF format shall contain internal book marking from index page to major sections of document.

.3 Add general information to each PDF file, including title, subject, author, and keywords.

.4 PDF files shall be set up to print legibly at 215.9 mm by 279.4 mm (8.5” by 11”), 279.4 mm by 431.8 mm (11” by 17”), or 559 mm by 864 mm (22” by 34”). No other paper sizes will be accepted.

.5 Submit new electronic files for each resubmittal.

.6 Include copy of transmittal of Contractor’s submittal.

.7 Contract Administrator will reject submittals that are not accompanied by an electronic copy.

.3 Schedule of Submittals:

.1 Prepare a table listing all anticipated submittals required to complete the Work.

.2 For each Specification Section show, at a minimum, the following:

.1 Specification Section.

.2 Total number of submittals for each Specification Section.

.3 Identify each submittal by its submittal number in accordance with a numbering and tracking system.

.4 Identify each submittal by its name or title.

.5 Identify the estimated date of submission to the Contract Administrator.

.6 State the revision number and status for each submittal.

.3 On a monthly basis, submit an updated schedule of submittals to the Contract Administrator if changes have occurred.

.4 Transmittal of Submittal:

.1 Stamp each submittal with uniform Contractor’s approval stamp before submitting to Contract Administrator.

.1 Stamp to include project name, submittal number, Specification number, Contractor’s reviewer name, date of Contractor’s approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with Contract. Stamp will be provided with the Contractor’s signature.

.2 Contract Administrator will not review submittals that do not bear Contractor's approval stamp and signature and will return them without action.

.2 Identify each submittal with the following:

.1 Numbering and tracking system:

.1 Sequentially number each submittal.

.2 Resubmission of a submittal shall have original number with sequential alphabetic suffix.

.2 Specification Section and paragraph to which submittal applies.

.3 Project title and City Tender number (447-2024).

.4 Date of transmittal.

.5 Name of Contractor.

.3 Identify and describe each deviation or variation from Contract.

.4 Include Contractor's written response to each of Contract Administrator's review comments with resubmission of submittals.

.5 Format:

.1 Do not base Shop Drawings on reproductions of Contract Documents.

.2 Package submittal information by individual Specification Section. Do not combine different Specification Sections together in submittal package, unless otherwise directed in Specification.

.3 Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract.

.6 Timeliness:

.1 Submit Shop Drawings and samples well in advance of scheduled delivery date for associated equipment or material and in an orderly sequence so as to cause no delay in the Work.

.7 Processing Time:

.1 Time for review shall commence on Contract Administrator's receipt of submittal.

.2 Contract Administrator will act upon Contractor's submittal and transmit response to Contractor not later than ten (10) Working Days after receipt, unless otherwise specified.

.3 Resubmittals will be subject to the same review time.

.4 The review time required will not alleviate the Contractor of his responsibility to deliver the completed Work within the required time frame and schedule. Planning for submittal reviews and the risk to the construction schedule remains the Contractor's sole responsibility.

.8 Incomplete Submittals:

.1 The Contract Administrator will return the entire submittal for the Contractor's revision if preliminary review deems it incomplete.

.2 Incomplete Shop Drawing information will be considered as stipulated deductions for the purposes of progress payment certificates.

.3 When any of the following are missing, the submittal will be deemed incomplete:

.1 Contractor's review stamp, completed and signed.

.2 Transmittal of Contractor's Submittal form, completed and signed.

.3 Insufficient number of copies.

.4 All requested information is not provided.

.5 Submittals missing Professional Engineer's seal and signature, where it is required.

.9 Resubmittals:

.1 Clearly identify each correction or change made and include revision date.

.2 No adjustment of the schedule outlined in the Supplemental Conditions or Contract Price will be allowed due to delays in progress of Work caused by rejection and subsequent resubmittals.

.3 The City may deduct cost of additional reviews from the Contract Price.

1.3 Shop Drawings and Product Data

.1 The term "Shop Drawing" as defined in the City's General Conditions for Construction.

.2 Where specified within the technical specifications, Shop Drawings shall bear the seal of a Registered Professional Engineer in the Province of Manitoba.

.3 Additional submittal requirements for each component of Work may be listed within the relevant Specification Section.

.4 In general, all equipment to be installed at the Site will require Shop Drawings, which shall be submitted to the Contract Administrator.

.5 Sales bulletins or other general publications are not acceptable as submittals for review except where necessary to provide supplemental technical data.

.6 Submissions to include applicable standards, such as CSA or CGSB numbers.

.7 Adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract Price. If adjustments affect the value of the Work state such in writing to the Contract Administrator prior to proceeding with the Work.

.8 Only two (2) reviews of Shop Drawings will be made by the Contract Administrator at no cost. Each additional review will be charged to the Contractor at the Contract Administrator's scheduled rates. The Contract Administrator's charges for the additional Work will be deducted from the payment to the Contractor.

.9 All final reviewed Shop Drawings with red lines shall be drafted as original documents (CAD) with no red lines. These shall then be incorporated into the Operations and Maintenance Manuals.

1.4 Samples

.1 As required in the Contract Documents the Contractor shall submit samples of items or components to be incorporated in the Work which shall be submitted to the Contract Administrator. Coordinate location of samples to be delivered to the Contract Administrator's office at the cost of the Contractor. If the Contract Administration determines that the sample is to be kept on the project site, provide a heated, secured space for the samples to be located in and readily accessible by the Contract Administrator for the duration of the on-site Works.

.2 Adjustments made on samples by the Contract Administrator are not intended to change the Contract Price. If adjustments affect the value of the Work state such in writing to the Contract Administrator prior to proceeding with the Work.

1.5 Requests for Information

.1 In the event that the Contractor or any Subcontractor involved in the Work, determines that some portion of the Drawings, Specifications, or other Contract documents requires clarification or interpretation by the Contract Administrator, the Contractor shall submit a Request for Information (RFI) Form in writing to the Contract Administrator.

.2 Submission Procedure:

.1 Submit RFI's to the Contract Administrator on the "Request for Information" in accordance with the link to the City's RFI form provided below. The Contract Administrator shall not respond to a RFI except as submitted on this form.

https://www.winnipeg.ca/infrastructure/templates/ExecutionControl/Request_for_Information_(RFI)_v2.0.docx

.2 Number RFI's consecutively in one sequence in order submitted, in a numbering system established by the Contract Administrator.

.3 Submit one (1) distinct subject per RFI request. Do not combine unrelated items on one (1) form.

.4 Where RFI form does not have sufficient space, attach additional sheets as required.

.5 Submit with RFI form all necessary supporting documentation.

.3 In the RFI, the Contractor shall clearly and concisely set forth:

.1 The issue for which clarification or interpretation is sought and why a response is needed from the Contract Administrator; and

.2 An interpretation or understanding of the requirement along with reasons why such an understanding was reached.

.4 The Contract Administrator will review all RFIs to determine whether they are valid RFIs. If it is determined that the document is not a valid RFI, it will be returned to the Contractor not having been reviewed with an explanation why it was deemed not valid.

.5 An RFI response shall be issued within ten (10) Working Days of receipt of the request from the Contractor unless the Contract Administrator determines that a longer time is necessary to provide an adequate response. When the RFI submission is received by the Contract Administrator before noon, the review period commences on that Working Day. When the RFI submission is received by the Contract Administrator after noon, the review period commences on the subsequent Working Day.

.6 If, at any time, the Contractor submits a large number of RFI's or the Contract Administrator considers the RFI to be of such complexity that the Contract Administrator cannot process the RFI's within ten (10) Working Days, the Contract Administrator shall confer with the Contractor within five (5) Working Days of receipt of such RFI's and the Contract Administrator and the Contractor will jointly prepare an estimate of the time necessary for processing same as well as an order of priority among the RFI's submitted. The Contractor shall accommodate such necessary time at no impact to the schedule and at no additional cost to the Contract.

.7 If the Contractor submits a RFI on an activity with ten (10) Working Days or less of available time to the impacted activity on the current project schedule, the Contractor shall not be entitled to any time extension due to the time it takes the Contractor Administrator to respond to the request provided that the Contract Administrator responds within the ten (10) Working Days set forth above.

.8 An RFI response from the Contract Administrator will not change any requirement of the Contract. In the event the Contractor believes that the RFI response from the Contract Administrator will cause a change to the requirements of the Contract, the Contractor shall within ten (10) Working Days give written notice to the Contract Administrator stating that the Contractor believes the RFI response will result in the Contract and the Contractor intends to submit a change request. Failure to give such written notice of fourteen (10) Working Days shall waive the Contractor's right to seek additional time or cost under the requirements of the Contract.

1.6 Closeout Submittals

.1 Refer to Section 01 78 00 - Closeout Submittals for closeout submittal requirements.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

ENVIRONMENTAL PROCEDURES

1. GENERAL

1.1 Definitions

.1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humans; or degrade environment aesthetically, culturally and/or historically.

.2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction.

1.2 Submittals

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.3 Environmental Protection Plan

.1 Submit a Contractor developed Environmental Protection Plan (EPP) for review by the Contract Administrator before commencing construction activities.

.2 EPP shall include comprehensive overview of known or potential environmental issues to be addressed on site during construction and shall comply with Section 4 of the Remedial Action Plan – North End Winnipeg Pollution Control Center (NEWPCC) – Parcel B, February 2024, attached in Appendix D1.

.3 Address topics at level of detail commensurate with environmental issue and required construction tasks.

.4 The EPP shall be available for inspection by the City and regulatory agency personnel, and shall be posted at conspicuous locations throughout the Work Site.

.5 Include in EPP:

.1 Names of contractor persons responsible for ensuring adherence to EPP.

.2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from Site.

.3 Names and qualifications of persons responsible for training site personnel.

.4 Descriptions of environmental protection personnel training program.

.5 Submit a Contractor developed Soil Management Plan (SMP) including soil excavation and backfilling plan for the various material types, confirmed size and location of any temporary soil containment cells, and stockpiling plan including the following:

.1 Section 6 Proposed Remedial Actions as reference in Appendix D1, Remedial Action Plan – North End Winnipeg Pollution Control Center (NEWPCC) – Parcel B, February 2024.

.2 The Contractor shall delete reference to the sentence “The Prairie Green Landfill in the Rural Municipality of Rosser is located approximately 20 km northwest of the Site” in Section 6.2.2.1 Soil Disposal of in Appendix D1, Remedial Action Plan – North End Winnipeg Pollution Control Center (NEWPCC) – Parcel B, February 2024.

.3 Contractor is solely responsible for the coordination and selection of the licenced soil disposal select site.

.1 If the licenced soil disposal site restricts soil disposal for any reason, the Contractor shall bear all costs associated with the coordination and selection of another licenced soil disposal site.

.2 Contractor shall make itself aware of current proposed searches that may, or may not, impact disposal sites ability to receive materials.

.6 Submit a Contractor developed site-specific Stormwater Pollution Prevention Plan (SPPP) in accordance with EPA-833-R-06-004. Include the site-specific Erosion and Sediment Control Plan (ESCP) identifying the type and location of erosion and sediment control measures to be provided on site. Include monitoring and reporting requirements to ensure that erosion and sediment control measures are in compliance with erosion and sediment control plan, Federal and Provincial regulations, and Municipal by-laws.

.7 Refer to E8 Traffic Control and E9 Traffic Management on City Streets and include measures to reduce erosion of temporary and existing roadbeds by construction traffic, especially during wet weather.

.1 Traffic Control Plan (TCP) to include measures to minimize amount of material transported onto paved public roads by vehicles or runoff, including truck wash stations if required or other measures or practices to prevent inadvertent spread of impacted soils during construction.

.8 Submit a Contractor developed Site Work Plan (SWP) showing work areas for proposed activities in each portion of area and identifying areas of limited use or non-use.

.1 SWP to include measures for marking limits of use areas and methods for protection of features to be preserved within authorized work areas.

.2 Submit drawings indicating locations of proposed temporary excavations or embankments for haul roads, ditch crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on Site.

.9 Submit a Contractor developed Spill Control Plan (SCP) including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance. Typically, the plan shall include:

.1 The probability and severity of an adverse effect to health, property, or the environment, of a spill of sewage, chlorinated water, or hazardous materials, used, handled, or stored on the Work Site,

.2 Spill/release notification and alerting procedures,

.3 Spill containment, recovery, and clean-up procedures,

.4 On Site spill/release clean-up materials, equipment, and locations;

.5 Names and telephone numbers of persons and organizations that may be contacted in the event of a potential environmental incident;

.6 The Contractor shall maintain a readily available supply of spill prevention and emergency response equipment on the Work Site at all times in effective working condition and shall ensure that its personnel are adequately trained in its use to deal with environmental emergency situations;

.7 In the event of an environmental emergency, the Contractor shall immediately notify the Contract Administrator. If the environmental emergency is a spill to land of a hazardous material in quantities equal to or greater than those listed in the Environmental Accident Reporting Regulation under the Dangerous Goods Handling and Transportation Act, the Contractor shall immediately notify the Provincial Emergency Reporting Line at 204 944-4888; and

.8 The Contractor shall submit written incident reports to the Contract Administrator within 24 hours of any environmental incident or spill/release. The incident report shall identify the reporting organization, date, time, location, hazardous materials involved, source and persons or organizations notified. In addition, the report shall describe how the spill or release occurred, remedial action taken or planned, and actions necessary to prevent recurrence.

.10 Submit a Contractor developed Solid Waste Disposal Plan (SWDP) for non-hazardous solid wastes identifying methods and locations for solid waste disposal including clearing debris. Reference Section 6.2.2.1 of the Remedial Action Plan (Appendix D1).

.11 Submit a Contractor developed Air Pollution Control Plan (APCP) detailing provisions to ensure that dust, debris, materials, and trash, are contained within the project Site. Further measures could include the covering of any stockpiles with loose or dry material and the wetting of exposed soils that are generating dust.

.12 Submit a Contractor developed site-specific Contaminant Prevention Plan (CPP) identifying the proper procedures and actions to be implemented to prevent impacts due to the presence of any hazardous substances within the project Site. The intent of the CPP is to:

.1 Prevent introduction of hazardous substances into air, water, or ground; and

.2 Detail provisions for storage and handling of these materials in compliance with Federal, Provincial, and Municipal laws.

.13 Submit a Contractor developed Wastewater Management Plan (WMP) identifying methods and procedures for management and discharge of waste waters which are directly derived from construction activities, such as clean-up water, dewatering of ground water, decontamination water, and water collected in containment berms. Reference Section 6.2.3 of the Remediation Action Plan (Appendix D1).

1.4 Fires

.1 Fire and burning of rubbish on site are not permitted.

.2 Submit a Contractor developed Fire Safety Plan to the Contract Administrator with details as identified in the National Fire Code of Canada 2020 for Construction and Demolition Sites.

1.5 Contractor Environmental Representative

.1 The Contractor shall designate a Contractor Environmental Representative (CER) to perform environmental monitoring and reporting throughout construction according to the EMP. The CER will interact with the project team throughout the Work.

.2 The CER shall be adequately trained and experienced to perform the role according to the requirements of the EMP.

.3 The CER shall represent the Contractor and information and instructions given to the CER by the Contract Administrator shall be deemed to have been given to the Contractor.

.4 The Contractor shall not claim for delays for any the activities, findings or requirements set forth by the CER in the performance of their duties toward Environmental Monitoring nor those of the Contract Administrator as a result of inspections.

.5 The Contractor is responsible for all costs relating to the CER for the entire duration of the project. This is not expected to be a full time role, but is needed for the Contractor to meet the Contractual and regulatory obligations related to environmental protection.

1.6 Pre-Construction Procedures

.1 Pre-Construction procedures shall be followed for wildlife species:

.1 The Site shall be cleared of natural vegetation and grubbed prior to construction outside of the breeding bird season for Winnipeg (April 30 – August 18) to prevent birds from establishing nests in vegetation on or above ground, to minimize adverse impacts on other wildlife species during the breeding season, and to avoid contravening wildlife protection legislation. Vegetation regrowth must be controlled (e.g., weekly mowing of grassy areas) throughout the breeding bird nesting season to prevent bird nesting activities.

.2 Pre-Clearing - Wildlife Species with Activity Restrictions:

.1 The CER shall locate, identify, classify and report wildlife species requiring activity restrictions discovered within and adjacent to the site during pre-clearing and the Contractor shall report to the Contract Administrator.

.2 The Contractor shall review, with the CER and Contract Administrator the wildlife species encountered and take reasonable measures, at Contractor’s expense, to schedule activities outside of any timing restrictions and distance restrictions.

.3 The validity of the pre-clearing exercise is dependent on the time from when the pre-clearing is conducted to commencement of construction activity and thus must be coordinated with the Contractor Progress Schedule.

.4 The Contractor shall coordinate pre-clearing activities with the progress schedule, so that pre-clearing is conducted and coordinated with the Contractor's planned activities.

.5 Bird Nests:

.1 No bird nests shall be disturbed during the construction process.

.2 If a bird nest is encountered in conflict with any construction activity, a mitigation strategy to avoid impact to the nest must be developed in consultation with the City and the Contract Administrator, Manitoba Environment and Climate and the federal Department of Environment and Climate Change Canada which may include postponing work within a no-activity buffer area until fledgling young have left the area, and/or the nest is no longer active.

1.7 Site Preparation and Plant Protection

.1 Protect trees and plants on site and adjacent properties in accordance with the City of Winnipeg By-laws, Standard Construction Specifications and the Work Drawings and Specifications.

.2 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones.

.3 Minimize vegetation stripping and grubbing where not necessary. Minimize soil removal and stockpiling.

1.8 Drainage

.1 Ensure that the ESCP measures are provided and that its recommendations are followed on site, in accordance with the site-specific SPPP, at all times during construction.

.2 Provide temporary drainage and pumping as required to keep excavations on Site free of standing water.

.3 Do not pump water containing excessive suspended materials into storm sewers, wetlands, waterways, surface drainage runs or adjacent properties.

.4 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with the site-specific SPPP in compliance with the requirements of authorities having jurisdiction.

1.9 Pollution Control

.1 Maintain temporary erosion and pollution control features installed under this Contract in accordance with site-specific SPPP.

.2 Control emissions from equipment and plant in accordance with local authorities' emission requirements. Check with local authorities for any environmental compliance requirements.

.3 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads. Use of anything other than water (e.g. tackifiers, chemical suppressants) shall be reviewed and only used if prior approved by the Contract Administrator. The use of oil for dust control is prohibited.

.4 Tightly seal against corrosion and rust all containers of fuel, hazardous or toxic chemicals. Tanks for refueling should have secondary containment and be licensed with the Province of Manitoba.

.5 Vehicle and equipment maintenance shall occur in designated areas. Contain and handle all maintenance fluids in accordance with the current National Fire Code of Canada. Spillage on the ground is prohibited.

.6 Hoses and equipment for transfer of fuels and other hazardous fluids shall be in good condition, properly functioning with approved check valves and shall be attended by a qualified person for the duration of transfer of fuels or hazardous fluids. Do not fuel, lubricate or service equipment where spills may enter storm or sanitary sewer systems.

.7 Greasy and oily rags and oil waste shall be contained in approved, sealed containers. Remove from the work Site and dispose of this material in accordance with the most stringent of applicable Federal, Provincial and Municipal Regulations.

.8 Comply with any Local, Provincial or Federal Noise By-laws or Regulations.

.9 Discharge of water containing any chlorine residual into open drainage channels, including the City’s storm sewer system, is strictly prohibited.

1.10 Notification

.1 Contract Administrator will notify the Contractor in writing of observed noncompliance with Federal, Provincial environmental laws and regulations or Municipal environmental by-laws, permits, and other elements of site-specific plans.

.2 Contractor after receipt of such notice, shall inform the Contract Administrator of proposed corrective action and take such action to obtain the approval of Contract Administrator.

.1 Take action only after receipt of written approval by the Contract Administrator.

.3 Contract Administrator will issue stop order of Work until satisfactory corrective action has been taken.

.4 No time extensions granted, or equitable adjustments allowed to Contractor for such suspensions.

ENVIRONMENTAL PROCEDURES

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Cleaning

.1 Clean in accordance with CW 1130.

.2 Burying rubbish and waste materials on Site is not permitted.

.3 Ensure public waterways, storm and sanitary sewers remain free of waste and volatile materials disposal.

.4 Proceed with final cleaning upon completion and removal of surplus materials, rubbish, tools and equipment in accordance with CW 1130.

.5 Waste Management: separate waste materials in accordance with CW 1130.

END OF SECTION

MATERIAL AND EQUIPMENT

1. GENERAL

1.1 Intent

.1 Use new material and equipment unless otherwise specified.

.2 Provide material and equipment of specified design and quality, performing to published ratings and for which replacement parts are readily available.

.3 Use products of one manufacturer for equipment or material of same type or classification unless otherwise specified.

1.2 Manufacturer’s Instructions

.1 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.

.2 Notify Contract Administrator in writing of any conflict between these specifications and manufacturer's instructions. Contract Administrator will designate which document is to be followed.

1.3 Fasteners

.1 Provide metal fastenings and accessories in same texture, colour and finish as base metal in which they occur. Prevent electrolytic action between dissimilar metals. Use non-corrosive fastenings, anchors and spacers for securing exterior work.

.2 Space anchors within limits of load bearing or shear capacity and ensure that they provide positive permanent anchorage. Wood plugs not acceptable.

.3 Keep exposed fastenings to minimum, space evenly and lay out neatly.

.4 Fastenings which cause spalling or cracking of material to which anchorage is made is not acceptable.

.5 Obtain Contract Administrator's approval before using explosive actuated fastening devices. If approval is obtained comply with CSA Z166-1975.

1.4 Fastenings Equipment

.1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.

.2 Use heavy hexagon heads, semi-finished unless otherwise specified. Unless more stringent requirements are designated in the technical specifications, use No. 304 stainless steel for exterior areas.

.3 Bolts may not project more than one diameter beyond nuts. Sand off any burrs or sharp metal surfaces.

.4 Use plain type washers on equipment, sheet metal and soft gasket, lock-type washers where vibrations occur and resilient washers with stainless steel.

.5 All bolting used for buried or submerged appurtenances, fittings and metal projects shall be Type A 304 stainless steel as per ASTM A276.

1.5 Storage, Handling and Protection of Products

.1 Handle and store products in a manner to prevent damage, contamination, deterioration, and soiling, and in accordance with manufacturer's recommendations when applicable.

.2 Store packaged or bundled products in original and undamaged condition with manufacturer's seals and labels intact. Do not remove from packaging or bundling until required in Work.

.3 Products subject to damage from weather are to be stored in weatherproof enclosures, heated if required.

.4 Store cementitious materials clear of earth or concrete floors, and away from walls.

.5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet material and lumber on flat, solid supports and keep clear of ground. Cover during storage.

.7 Store and mix paints in a room assigned for this purpose. Keep room under lock and key at all times. Remove oily rags and other combustible debris from Site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged products at own expense and to the satisfaction of the Contract Administrator.

1.6 Quality of Material and Workmanship

.1 All materials which are described in these Specifications, and on the Drawings shall be new and the best of their respective kinds.

.2 All Work and materials shall be at all times open to inspection, acceptance or rejection by the Contract Administrator, but any failure or omission on the part of the Contract Administrator to disapprove or reject any Work or materials shall not be construed to be an acceptance of any defective Work or material.

.3 The Contractor shall remove at own his expense, any work or material condemned by the Contract Administrator and re-build or replace the same to the satisfaction of the Contract Administrator without additional charge.

.4 The performance of this Work shall be in accordance with the best practices and the finished Work shall be neat in appearance.

MATERIAL AND EQUIPMENT

1.7 Substitution

.1 Substitutions of equivalent products and materials shall be in accordance with B7 Substitutes.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

FACILITY START-UP/COMMISSIONING

1. GENERAL

1.1 Quality Assurance

.1 Test equipment and material where required by Specification or Authority Having Jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures in accordance with applicable portions of ASME, ASHRAE and other recognized test codes as far as field conditions permit.

.3 Perform tests on Site must be witnessed by the Contract Administrator.

1.2 Commissioning Plan

.1 Submit a detailed Start-up and Commissioning Plan to the Contract Administrator for review within two (2) weeks of the scheduled start of commissioning. The Plan shall include:

.1 Detailed schedule of events.

.2 Provide plans for offline testing and tie-ins.

.3 Drawings and sketches as required to illustrate the planned sequence of events.

.4 List and details for all temporary equipment (pumps, piping, etc.) required for commissioning.

.5 Process control and equipment testing.

.6 Planned attendance schedule for supplier's representatives.

.7 Identify any risks to schedule, shutdown durations, equipment operation, associated processes or other factors which could negatively influence commissioning and provide risk mitigation strategies.

.8 Contingency plans in the event of a process malfunction.

1.3 Submittals

.1 Submit in accordance with Section 01 33 00 Submittal Procedures.

.2 The Contractor shall submit a Commissioning Plan which shall be approved by the Contract Administrator in advance. The Commissioning Plan shall be in accordance with Clause 1.2.

.3 Submit completed and signed Form 101. Commissioning shall not proceed until all Form 101 are submitted to the satisfaction of the Contract Administrator.

.4 Provide inspection/start-up reports from all manufacturer's representatives for all major equipment.

.5 Perform tests as specified and upon completion of mechanical certification of tests with detailed data as required. Itemize each test as to time performed and personnel responsibility.

.6 Submit completed and signed Form 102.

1.4 Liability

.1 Take charge of facility during tests, assume responsibility for damages in event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration in this connection.

1.5 Coordination

.1 Coordinate start-up and commissioning schedule with the City and Contract Administrator.

1.6 Definitions

.1 Major Equipment: for the purposes of this Section, major equipment shall include:

.1 All pumps with motors larger than 0.75 kW.

.2 Lift station.

.3 Cantilevered Access Gate.

.4 Electronically controlled person/man gate.

2. PRODUCTS

2.1 General

.1 The Contractor shall provide all materials to complete start-up and commissioning.

.2 The Contractor shall arrange for any temporary piping as required for facility start-up/commissioning activities. Include details for temporary pipe material, supports/anchors, and connection locations in the Commissioning Plan.

3. EXECUTION

3.1 Scope

.1 Start-up and commissioning shall include all equipment and lift station systems installed under this Contract.

3.2 General

.1 Start-up and commissioning shall be performed when the facilities are sufficiently complete to operate for their intended use.

.2 Start-up and commissioning must be completed to the satisfaction of the Contract Administrator before the Certificate of Substantial Performance will be issued in accordance with D23.

.3 Prior to commissioning, all equipment installed under this Contract shall be operated by the Contractor for the purposes of flushing out and testing to determine that the equipment operates in a satisfactory manner and that it meets the performance requirements set out in these specifications.

.4 In all cases, the labour, material, power, water, etc., necessary to do the draining, filling, cleaning and testing shall be provided by the Contractor.

.5 The Contractor shall develop a lock out/tag out procedure for equipment to prevent unsafe operation. The Contractor shall manage the procedure and communicate the requirements to all personnel involved in commissioning.

3.3 Lubricants

.1 For designated equipment, furnish all lubricants required for testing and prior to acceptance. In addition, furnish an estimated six (6) months' supply of grease and oil necessary for proper lubrication of the equipment.

.2 Furnish lubricants in the original sealed containers, correctly identified as to brand, grade and with reference to the particular piece of equipment for which it is intended.

.3 Provide all lubricants of Canadian manufacture and which are readily available in Canada.

.4 Provide a complete listing of recommended lubricants with designated application as an integral part of the instruction and maintenance manuals.

3.4 Trial Testing of Equipment

.1 Equipment shall be inspected by the Contractor and the equipment shall be ready to run in all respects.

.2 Prior to operating any equipment by the process equipment suppliers, provide the Contract Administrator with two (2) weeks' notice to arrange for a pre-start-up inspection.

.3 At the completion of the two-day trial test, complete and submit Form 101 for the following components.

.1 All pumps with motors larger than 0.75 kW.

.2 Lift station.

.4 At the completion of the 20 full open and full close trial test sequences, complete and submit Form 101 for the following components.

.1 Cantilevered Access Gate.

.2 Electronically controlled person/man gate.

3.5 Performance Testing

.1 The Work required under the Performance Testing shall be the operation and testing of all Major Equipment in a simulated systems operation.

.2 Complete the additional start-up and commissioning requirements for the wastewater treatment and mechanical systems as described in the Division 26, 32, 40 and 43 Specifications.

.3 Performance testing of the two-day continuous test, complete and submit Form 102 for the following components.

.1 All pumps with motors larger than 0.75 kW.

.2 Lift station.

.4 Performance testing of 20 full open and full close test sequences, complete and submit Form 102 for the following components.

.1 Cantilevered Access Gate.

.2 Electronically controlled person/man gate.

.5 Facility operating personnel will normally be present during the testing procedures for training purposes, but they will not in any way participate in operating the equipment.

.6 The Contractor shall be responsible for the safe discharge of the test flows.

.7 Conduct performance tests to demonstrate equipment and systems meet specified requirements after installations are completed.

.8 Conduct final operating tests in presence of the Contract Administrator. Illustrate start-up and shutdown, sequence and simulate emergency conditions for safety shutdowns, with automatic and manual reset. Test all alarms. Repair and test defects until satisfactory. Make final adjustments to suit actual conditions.

.9 All equipment shall be operated in “manual” and “automatic” modes through entire range of equipment capacities.

3.6 Procedure for Handing over to Operating Personnel

.1 When the commissioning has been completed to the satisfaction of the Contract Administrator it shall be handed over for operation by the City’s operating personnel, or upon request of Contract Administrator.

FACILITY START-UP/COMMISSIONING

CERTIFICATE OF SATISFACTORY EQUIPMENT TRIAL TESTING
FORM 101

We certify that the equipment listed below has been continuously operated for specified time frame and that the equipment operates satisfactorily and meets its specified operating criteria. No defects in the equipment were found. The equipment is therefore classed as "conforming".

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Supplier) Date

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

FACILITY START-UP/COMMISSIONING

CERTIFICATE OF SATISFACTORY SYSTEM PERFORMANCE TESTING FORM 102

We certify that the System listed below has been operated and tested as per the Specifications and that the System meets its Performance Testing Criteria, including fully automatic controls. The System is therefore classed as "conforming".

PROJECT: _____

SYSTEM: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

(Authorized Signing Representative of the Supplier)	Date
(Authorized Signing Representative of the Contractor)	Date
(Authorized Signing Representative of the Contract Administrator)	Date

END OF SECTION

OPERATION AND MAINTENANCE MANUAL

1. GENERAL

1.1 Manual

.1 An organized compilation of operating and maintenance data including detailed technical information, documents and records describing operation and maintenance of individual products or systems.

1.2 General

.1 Assemble, coordinate, bind and index required data into Operation and Maintenance Manuals for the:

.1 Lift station.

.2 Cantilevered Access Gate.

.3 Electronically controlled person/man gate.

.2 Submit one (1) copy of draft operation and maintenance manuals to Contract Administrator fifteen (15) days prior to application of Substantial Performance of project.

.3 Submit three (3) sets of final manuals in English.

.4 Material: label each section with tabs protected with celluloid covers fastened to hard paper dividing sheets.

.5 Type lists and notes.

.6 Drawings, diagrams and manufacturer's literature must be legible.

.7 A draft copy of the manuals is required prior to applying for Substantial Performance.

1.3 Binders

.1 Prepare sets of manuals for various divisions using identical bindings, and the same indexing system and format for all manuals.

.2 Provide 215 x 280 mm hard covered, three-hole extension type catalogue binders with a 75 mm spine bound with heavy weight fabricord, hot stamped in silver lettering front and spine. Acceptable Material: Universal Bindery, ACCO or approved equal. The Contractor shall be responsible for determining the required number and thickness of the binder(s) for each set.

.3 Wording shall be prepared by the Contractor and submitted for approval to the Contract Administrator prior to embossing.

.4 The number of binders shall be determined by the Contractor based on the amount of material submitted. To determine the required number of binders, the contents of each binder shall not be more than 75 mm thick. Where more than one (1) binder is required, label lower section as Volume I, and the second one as Volume II.

OPERATION AND MAINTENANCE MANUAL

1.4 Contents

.1 The manuals, including manuals prepared by subcontractors, shall be prepared as one (1) manual with consistent numbering and tabs.

.2 The information to be included in the binder is as follows:

.1 Title sheet, labelled "Operations and Maintenance Instructions", containing project name and date.

.2 Table of contents.

.3 List with names, addresses, telephone numbers of Contractor, Subcontractors, Manufacturers, Suppliers and Agents, Service Companies. Only one list shall be provided and shall include the suppliers of all subcontractors.

.4 A master check list with operations, maintenance and lubrication tasks for all equipment in the facility organized into daily, weekly, monthly, bi-monthly, bi-yearly categories.

.5 Copies of all final Shop Drawings (review stamped).

.6 Manufacturer's data sheets (operating and maintenance brochure) on all equipment. Locate this information with the shop drawings for the same piece of equipment.

.7 Installation and performance test data on all equipment including start-up and commissioning sheets from Section 01 60 00 - Material and Equipment and Section 01 65 00 - Facility Start-up/Commissioning.

.8 Reports and certificates of inspection including Electrical / Mechanical Inspection certificates.

.9 Operations, maintenance and lubrication instructions, for each section, including daily, weekly, monthly, semi-annual and annual checks for equipment and systems, including complete list of equipment and tools.

.10 Valve directory listing serial number, purpose, location, size, make, tag numbers as marked on the project record drawings and other pertinent information of each valve.

.11 Operational information on all mechanical components.

.12 Parts list for all equipment.

.13 Recommended spare parts list for each piece of equipment.

.14 Start-up reports prepared by manufacturer's representatives.

.15 List of maintenance tools supplied.

.16 Calibration sheets for all instruments.

.17 Regulatory inspection certificates.

.18 Warranty certificates for materials and equipment that have warranty periods greater than one (1) year.

.19 Reduce set of record drawings (supplied by Contract Administrator).

.20 Process Narrative (per Section 40 61 96 – Process Control Descriptions).

.21 Provide a maintenance schedule.

.22 Provide a pump removal procedure.

.3 Information shall be provided in the form of original Manufacturer's printed literature, supplemented by typed sheets when necessary. Originals are to be provided for all three (3) manuals. Faxes or poor-quality photocopies are not acceptable.

1.5 Documents by Contract Administrator

.1 The Contract Administrator will insert reduced Record Drawings with changes submitted by the Contractor.

.2 The Table of Contents shall identify that these documents are included in the Manual.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

CLOSEOUT SUBMITTALS

1. GENERAL

1.1 Work Included

.1 Furnish complete information as specified in this Section for Closeout Submittals.

.2 Provide the On Site, Hands-On Training as specified in this Section for Closeout Submittals.

1.2 Submittals

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Provide signed attendance list for all providers and attendees of the On-site, Hands-On Training.

.3 Substantial Performance shall not be granted until review and acceptance of all Closeout Submittals is achieved.

1.3 Closeout Submittals

.1 Operating and Maintenance Manuals for the following items as referenced in Section 01 73 00 - Operating and Maintenance Manual.

.1 Lift station.

.2 Cantilevered Access Gate.

.3 Electronically controlled person/man gate.

.2 As-Built Drawings:

.1 Within public right of ways, buried sewer and water utilities and surface works as-builts are the responsibility of the Contract Administrator. The Contractor is responsible for as-built drawings of the remaining works to the requirements below:

.1 Possess a complete set of Drawings for the purpose of maintaining project as-built Drawings. Accurately mark up deviations from the Contract caused by the Site conditions and changes ordered by the Contract Administrator. Update daily.

.2 The Contractor shall keep one (1) complete set of white prints at the Site during the Work, including all addenda, change orders, Site instructions, clarifications, and revisions for the purpose of the as-built and Record Drawings. As the Work proceeds, the Contractor shall clearly mark up the white prints in red pen all the Work which deviated from the original Contract. The marked-up information is to include locations of all devices and locations of all equipment.

.3 Identify Drawings as "Project Record Copy". Maintain in good condition and make available for review on-site by the Contract Administrator at all times.

.4 On completion of the Work, submit as-built Drawings to the Contract Administrator for review.

.3 On Site, Hands-On Training:

.1 Coordinate with Contract Administrator a minimum of fourteen (14) Working days prior to the Contractor designated training date.

.2 Allow for up to eight (8) City staff as attendees.

.3 Contractor training staff with be educated in the systems in which they are providing training on.

.4 Provide hands-on equipment training for operations personnel will include:

.1 Identifying instrumentation: location of primary element; location of instrument readout; discuss purpose, basic operation, and information interpretation.

.2 Discussing, demonstrating, and performing standard operating procedures and daily visual inspection of system operation.

.3 Discussing preventive maintenance activities.

.4 Discussing start-up and shutdown procedures.

.5 Discuss naming conventions and equipment tagging.

.6 Discuss electrical and mechanical fuse locations.

.7 Discuss overall Trailer Complex primary electrical panel disconnect location and any equipment panel naming conventions within the primary electrical panel.

.8 Performing the required equipment exercise procedures.

.9 Performing routine disassembly and assembly of equipment if applicable.

.10 Identifying and reviewing safety items and performing general safety procedures.

.11 Reviewing normal repair procedures.

.12 Discussing preventive maintenance activities.

.13 Performing routine start-up and shutdown procedures (including seasonal).

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

SOIL REMEDIATION

1. GENERAL

1.1 Summary

.1 Work Includes:

.1 Provision and installation of materials and equipment necessary to remediate Project Site.

.2 Implementation of safety work zones, Site Specific Health and Safety Plans and Environmental Protection Plan.

.3 Protection of utilities, structures, and other areas of concern.

.4 Management of contaminated soil generated during soil remediation Work, including storing, loading, hauling, and removal, as necessary.

.5 Management of contaminated waters generated during soil remediation Work, including separation, recovery, and elimination of free-phase hydrocarbons.

.6 Backfilling of excavations with clean borrow material.

.7 Obtaining required permits and approvals for waste disposal.

1.2 References

.1 Applicable environmental and health and safety Laws and Regulations for Province of Manitoba and Municipal By-Laws.

.2 CCME (Canadian Council of Ministers of the Environment) and applicable publications.

.3 Manitoba Environment and Climate Change.

.4 National Fire Code 2020.

.5 National Building Code 2020.

1.3 Environmental Procedures

.1 Section 01 35 43 - Environmental Procedures.

1.4 Submittals

.1 Provide submittals in accordance with 01 33 00 - Submittal Procedures.

.2 Closeout Submittals:

.1 Provide Closeout Submittals in accordance with Section 01 73 00 as follows:

.1 Provide documentation of volume of contaminated soil that has been excavated from the Parcel B and transported to the landfill.

.2 Provide documentation of volume of clean backfill loaded, transported, placed and compacted at Parcl B Site.

.3 Provide documentation of required labour, equipment usage, fuel and/or power usage, environmental monitoring and inspection records, as required.

1.5 Quality Assurance

.1 Qualifications:

.1 Identify key members of project team including Project Manager and Site Supervisor. Define experience and qualifications of each key team members.

.2 Field Samples:

.1 Impacted soil will be collected by the Contractor Administrator for potential laboratory analyses, with assistance by the Contractor, as requested by the Contractor Administrator.

.3 Survey:

.1 The Contractor Administrator will perform surveys in collaboration with the Contractor as required.

.4 Kick-off meeting:

.1 The Contractor shall organize a Pre-Excavation Conference for soil remediation one (1) week prior to excavation works, equipment/machine operators, third party/subcontractor representative, and Contractor Administrator to review the following:

.1 General project requirements.

.2 Contractor's Quality Control Plan for the soil remediation.

.3 Contractor's procedures prior, during and following soil excavation.

.4 Also provide agenda and meeting minutes, distribute the agenda to the attendee four (4) days prior to the Pre-Excavation Conference. Distribute Pre-Excavation Conference minutes within four (4) days of the meeting.

1.6 Site Conditions

.1 The approximate locations of known service or utility and buried objects are as indicated on the Drawings however it is the responsibility of the Contractor to establish location (horizontal position and depth) and extent of utility service lines in area of work before starting Work.

.2 Suspend operations whenever climatic conditions are unsatisfactory for excavation to conform with this Specification.

.3 After occurrence of heavy rains, do not operate equipment in designated areas until the material has dried sufficiently to prevent excessive rutting.

1.7 Protection

.1 Prevent damage to fencing, trees, landscaping, natural features, benchmarks, property pins, existing buildings, existing pavement, utility lines and Project Site appurtenances, which are to remain. Correct any damage caused by construction operations.

.2 Provide protection to utilities, structures and other areas of concern with the implementation of shoring or support, in areas shown on Specification Drawings.

.1 Contractor shall be responsible for design, installation, maintenance, and removal of all temporary shoring or supports.

.2 Provide physical barrier to prevent accidental equipment collision to communication tower guy anchors. Physical barrier shall be able to resist impact from equipment working in the proximity of the guy anchors.

.3 Provide temporary fencing and gates as required to surround all excavations and work areas necessary at the Project Site to secure the work areas and protect the public.

.4 Environmental protection measures shall be in accordance with the requirements specified in Section 01 35 43.

.5 The release of all contact accumulated water, contact water, groundwater, and rinse water shall conform to the requirements outlined in Section 01 35 43.

1.8 Personnel Protection

.1 Areas designated for cleanup under this Section involve soils or groundwater containing petroleum hydrocarbon products, which may be dangerous to human health and/or environment.

.2 When working with petroleum hydrocarbon contaminated media, workers shall wear the required personal protective clothing and equipment that is acceptable for the Work.

.3 Supply sufficient quantities of designated protection equipment to fit all site personnel including the authorized visitors. Educate workers as to risks and train in safe work practices.

.4 No separate pay item shall apply to the work practice requirements, including personnel protection, of this Section. Costs shall be included in the applicable payment items to which this Section applies.

1.9 Signs

.1 Signage: Provide and erect signage at access points to the Project Site as required. Signage shall be visible from all sides of these areas. The English version of the sign shall read:

CAUTION: CONTAMINATED SOIL EXCAVATION AREA

AUTHORIZED PERSONNEL ONLY

.2 Signage shall indicate all required personal protective equipment to enter the area.

.3 Post a similar sign in any other language of that is applicable.

.4 All lettering shall be black, not less than 100 mm high, with a 25 mm wide stroke, on a light-coloured background.

1.10 Testing

.1 Assist Contract Administrator in collection of confirmatory soil samples from excavations for field screening at 1.0 m depth intervals or at obvious stratigraphic boundaries along the excavation margins on a 5 m by 5 m grid, or as directed by the Contract Administrator. Confirmatory soil samples will be selected for laboratory analysis by the Contract Administrator.

.2 The Contractor shall provide access to the Contract Administrator to collect confirmatory samples in the excavation area.

1.11 Measurement for Payment

.1 Measurement and Payment in accordance with E31 Earthworks.

2. PRODUCTS

2.1 Materials

.1 Backfill in accordance with E31 Earthworks.

3. EXECUTION

3.1 Application

.1 Soil Management:

.1 Do not dilute contaminated soil with less contaminated soil.

.2 Water Management:

.1 Any groundwater, storm water or precipitation accumulated within excavations encountered during remedial work at the Project Site requires analytical testing and, if required, treatment and disposal.

.2 Treat groundwater, storm water and precipitation which contains contaminants in excess of the CCME Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life and Canada Drinking Water Guidelines.

.3 Store, transport, and eliminate off site or treat residues generated by water treatment process in accordance with standards, requirements and regulations of Manitoba Sustainable Development.

3.2 Site Excavation

.1 Provide for access to the site to facilitate entrance and exit of equipment and trucks from the area during operation.

SOIL REMEDIATION

.2 Repair and maintain the access road, as required, prior to use.

.3 Clear and grub the area designated for the backfill borrow source and excavation as necessary.

.4 Provide and erect signage at access points to the site as required.

.5 Initial excavation limits will be identified by the Contract Administrator, generally as described in Appendix D1 Remedial Action Plan – North End Winnipeg Pollution Control Center (NEWPCC) - Parcel B.

.6 Excavation, disposal, and backfill procedure as described in Appendix D1.

END OF SECTION

PAINTING

1. GENERAL

1.1 Summary

.1 Finish painting defined under this Section is to specify the general requirements of the Work and is applicable to items not covered under other Sections of this Specification.

1.2 Quality Assurance/Submittals

.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.

.2 Perform painting Work by applicator with minimum five (5) years of proven and successful painting experience.

.3 Submit in writing list of proposed materials, for approval at least four (4) weeks before materials are required. List shall contain following for record:

.1 Manufacturer's product number, Master Paint Institute (MPI) Product Index Number and application instructions.

.2 Finish formula.

.3 Product type.

.4 Colour number.

1.3 Environmental Requirements

.1 Comply with requirements of WHMIS regarding use, handling, storage, and disposal of hazardous materials; and material safety data sheets acceptable to Ministry of Labour.

.2 Provide heating to maintain minimum temperatures recommended by Manufacturers.

.3 Apply paint finish only in areas where dust is no longer being generated by related construction operations such that airborne particles will not affect the quality of the finished surface. Apply paint only when surface to be painted is dry, properly cured and adequately prepared.

1.4 Painting and Finishing Work Standards

.1 The best practices specified or recommended in MPI Architectural Painting Specification Manual are to govern for painting methods and procedures, unless specified otherwise in this Section.

1.5 Colour Selections

.1 Provide one (1) topcoat colour for bollards.

1.6 Extra Stock

.1 Prior to final completion, supply and deliver to the Site, 1 L of extra stock for products for which less than 45 L were used.

2. PRODUCTS

2.1 Painting, Finishing, and Coating Products

.1 Only materials (primers, paints, coatings, fillers, etc.) listed in the latest edition of the MPI Approved Product List (APL) are acceptable for use at this Site unless specifically noted in the schedule of Paint Formulas. All such material shall be from a single manufacturer for each system used.

.2 Design is based on Dulux.

.3 Equivalent manufacturers for utilizing the same MPI Product Index Number as the Design Standard are the following:

.1 Sherwin Williams.

.2 Benjamin Moore.

.3 Pittsburgh Paints.

.4 Finishing products such as oils or putties not specified in this Section are to be premium quality and as recommended by the Manufacturer of the paint or finish product it is associated with.

.5 Final coat shall exhibit uniformity of colour and uniformity of sheen across full surface area.

3. EXECUTION

3.1 Examination of Substrate

.1 Examine surfaces to receive paint or protective coating to ensure that they are in the proper condition to be painted or coated. Commencement of painting and protective coating Work will be interpreted as acceptance of the surface to receive the Work. Correction of defective painting or protective coating Work resulting from application to unsatisfactory surfaces will be the responsibility of the painting contractor.

3.2 Special Conditions

.1 Post "Wet Paint" signs throughout freshly finished areas and remove when finishes are dry.

.2 Prohibit traffic where possible, from areas where painting is being carried out until paint is cured.

3.3 Preparation of Surfaces

.1 Cleaning Procedures:

.1 Surface preparation methods shall remove any contaminant that will interfere with full adhesion of protective painting and coating systems.

3.4 General Application of Paint and Finishes

.1 Paint Formula.

.2 Design Standard of acceptance is Dulux.

.1 Accepted alternate paint manufacturers: Benjamin Moore, Behr, Cloverdale and Para.

.1 Each accepted alternate paint manufacturer shall be the requirements of the Design Standard manufacturer.

.3 Apply paint to surfaces with the following:

.1 All exterior bollard surfaces:

.1 Minimum preparation: SSPC-1.

.2 One (1) coat Dulux Weatherguard Exterior Primer (1535)at 1.4 – 1.6 mils DFT.

.3 Minimum of two (2) coats Dulux Diamond Exterior Latex Semi-gloss (16520). Each coat at 1.2 mils DFT per coat. Colour: “safety yellow”.

3.5 Adjustment and Cleaning

.1 Touch-up and refinish minor defective Work. Refinish the entire surface where the finish is damaged or not acceptable, including areas exhibiting incomplete or unsatisfactory coverage. Patching will not be permitted.

.2 Remove spilled or splattered finish materials from surfaces of Work performed under other Sections. Do not mar surfaces while removing.

.3 Upon completion, remove masking and clean adjacent surfaces free of over spray spatters, drips, smears and over spray.

3.6 Disposal of Paint Waste

.1 Dispose paint that cannot be recycled as hazardous waste. Generators of hazardous waste shall be registered, and disposal shall be in accordance with regulations of authorities.

END OF SECTION

COMMON WORK RESULTS – ELECTRICAL

1. GENERAL

1.1 Related Sections

.1 Requirements specified within this section apply to all sections in Division 26, Electrical. This section supplements requirements of other Divisions.

1.2 Codes and Standards

.1 Manitoba Building Code (MBC).

.2 The Winnipeg Electrical By-law (WEB).

.3 CSA C22.1 Canadian Electrical Code - Part 1 (CEC).

.4 CSA C22.2 No. 0 General Requirements - Canadian Electrical Code - Part 2.

.5 CAN3-C235 Preferred Voltage Levels for AC Systems, 0-50,000 V.

.6 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.7 National Electrical Manufacturers Association (NEMA).

.8 Institute of the Electrical and Electronic Engineers (IEEE).

.9 Insulated Cable Engineers Association (ICEA).

.10 Canadian Standards Association (CSA).

.11 Underwriters Laboratories Canada (ULC).

.12 American National Standards Institute (ANSI).

.13 National Fire Protection Agency (NFPA).

.14 Comply with the most current locally enforced edition of CSA C22.1 Canadian Electrical Code - Part 1, Winnipeg Electrical By-law, Provincial Safety Electrical Authority Codes and Bulletins.

.15 Comply with all laws, ordinances, rules, regulations, codes, and orders of all Authorities Having Jurisdiction relating to this Work. Where these regulations conflict, comply with the most stringent condition.

.16 Comply with latest editions of the CSA Certification Standards and Bulletins.

1.3 Drawings and Specifications

.1 All materials, equipment, labor, work denoted on the Drawing set is to be considered as new work, to be provided by the Contractor unless specifically noted otherwise. Some of the electrical and automation Drawings show existing systems (with modifications to these systems). These Drawings specifically indicated that there are existing systems shown. Where

Drawings do not specifically indicate that existing systems are depicted, the Contractor shall assume that the materials, equipment, labor, work indicated will form part of his scope, and the Contractor shall include all costs (including materials, labor, etc.) to perform the Work.

.2 Prior to installing power and control cabling for process equipment, the Contractor shall review the equipment Shop Drawings, and to ensure that cabling requirements are understood. There may be variations in wiring requirements with process and HVAC equipment, that may require alternate wiring requirements from that shown on the Drawings. Include such wiring and connections in Tender at no additional costs.

.3 The electrical Drawings in some cases indicate the size of cables, breakers, conduits, etc. These sizes are based on the supply of specific sizes of equipment. For cases where the Contractor supplies equipment that varies from these assumptions it is the responsibility of the Contractor to provide the correct size of breaker, cable, etc. to suit the installation, at no additional cost to the Contract.

.4 The intent of the Drawings and Specifications is to indicate labor, products, and services necessary for a complete, installed, tested, commissioned and functional installation.

.5 Electrical Drawings may indicate approximate route to be followed by conduits and cables and general location of electrical equipment. They do not show all structural, architectural and mechanical details. In some cases, conduit or wiring is only shown diagrammatically on the Drawings. The details on exact cable or conduit routing, and exact equipment installation location is to be determined on site and coordinated with all other trades.

.6 Where circuit numbers are shown adjacent to equipment, the Electrical Contractor shall provide all wiring, conduit, supports, and any other requirements to provide power to that piece of equipment from the circuit indicated. Where circuit numbers are not shown adjacent to a piece of 575 V equipment, refer to the single line drawings for connections details. Provide all wiring, conduit, supports, and any other requirements to provide power to that piece of equipment.

.7 To provide sufficient detail and maximum degree of clarity on the Drawings, symbols used for various electrical devices, particularly wall mounted devices, take up more space on the Drawings than devices physically do. Locate devices with primary regard for convenience of operation, accessibility and space utilization, rather than locating devices to comply with the exact scaled locations of the electrical symbols.

.8 If discrepancies or omissions in the Drawings or Specifications are found, or if the intent or meaning is not clear, advise the Contract Administrator for clarification before submitting a Bid.

.9 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work.

.10 Various package unit types of equipment are included in the work. It is the responsibility of the Contractor to familiarize themselves with the requirements of the equipment vendor, and to include all materials and labor for a complete and working installation. In some cases this means that motors, valves, actuators, etc. need to be wired and connected in the field. The Contractor shall include all costs to perform such services as part of his Tender submittal. Coordination between the equipment vendor and the Contractor shall be performed prior to

Tender bid closing date, and all costs shall be included in the tender. Request for extras due to lack of coordination between the Contractor and the equipment vendors will not be accepted.

.11 In some cases the plan Drawings indicate the symbol for one (1) motor - for package units – when in reality, there are multiple motors, valves, dampers, solenoids, associated with the piece of equipment. It is the responsibility of the Contractor to understand the intricacies of the packaged equipment, and to perform all field connections for a complete and working system.

.12 In some cases motorized dampers are shown only with one symbol on the Drawings, when in fact multiple motorized dampers are required in order to accommodate the opening size and the actuators. In these cases it is the responsibility of the Contractor to wire and connect all required actuators to allow for correct operation of the system at no additional cost.

.13 Cables schedules / lists where shown do not include all cables required to perform the complete Facility installation. They shall be used as a general guide. Accurate cable lists, quantities, take-offs remain the responsibility of the Contractor. Cable schedules only show cabling where specific cable tags are available on the Drawings. Refer to the cable schedule for specific systems which are not included on the schedule, and include materials, and installation for all remaining cabling.

1.4 Care, Operation, and Start-Up

.1 Instruct the Contract Administrator's maintenance and operating personnel in the operation, care and maintenance of systems, system equipment and components.

.2 Where services of a Manufacturer's Factory Service Engineer is required, arrange and pay for services to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.3 Provide factory service engineer support for such a period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are familiar and fully trained with all aspects of its care and operation.

1.5 Permits, Fees, and Inspection

.1 The Contractor will submit to Electrical Inspection Department and Supply Authority necessary number of Drawings and Specifications for examination and approval prior to commencement of Work.

.2 The Contractor shall pay associated fees as required by the Electrical Inspections and Permitting department.

.3 Notify the Contract Administrator of changes required by Electrical Inspection Department prior to making changes.

.4 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.

1.6 Definitions

.1 The following are definitions used in Division 26.

.1 Inspection Authority means agent of any authority having jurisdiction over construction and safety standards associated with any part of electrical Site Work.

.2 Supply Authority or Supply Utility means electrical power company or commission responsible for delivering electrical power to the Project Site.

.3 Electrical Code or Code means the Electrical Code in force at the project location.

.4 CEC means Canadian Electrical Code (latest edition being enforced by-law).

.5 Contractor and Electrical Contractor means the entity retained to perform the Work listed herein.

.6 Contract Administrator means the person with the authority to make decisions and administer the Contract on behalf of the City.

.7 Provide means to supply, install, wire, connect, test, commission and leave in complete and working order.

.8 The term “Shop Drawing” means Drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work.

1.7 Design Requirements

.1 Design equipment, anchorage, and support systems for vertical and lateral loading in accordance with MBC.

.2 Operating voltages to be within those defined in CAN3-C235.

.3 Verify before energization that equipment supplied under this Contract is compatible with the site electrical power supply system.

.4 All equipment, devices and installation methods (even where not specifically expressed on the Drawings) shall comply with the Manitoba Energy Code for Buildings (MECB).

1.8 Electrical Coordination

.1 Coordinate Work with all other trades to ensure that conflicts do not occur.

.2 Coordinate requirement of mechanical equipment requiring electrical connection with the Mechanical Contractor. Pay specific attention to equipment full load amps, voltage, phase and breaker size.

.3 Verify that all equipment ordered is compliant with the Manitoba Energy Code for Buildings.

.4 Coordinate work with utilities where appropriate, including but not limited to:

.1 Incoming overhead lines,

.2 Underground buried services,

.3 Transformer(s) supplying main electrical service to the Facility,

.4 Installation of Supply Authority meter, and

.5 Installation of incoming telephone / data communication service conductors or cables.

1.9 Submittals

.1 Permits, Fees and Inspection:

.1 Furnish copies of all inspection reports and Certificate of Final Acceptance from Electrical Inspection Authority and any authorities having jurisdiction on completion of Work to Contract Administrator and include copies in the O & M manuals.

.2 Within fifteen (15) days of award of the Contract, the Contractor shall submit a completed equipment procurement schedule, which lists the Manufacturer and model of equipment, indicating the projected ordering, Shop Drawing submittal date and delivery dates of all products to meet the required construction schedule.

.3 Prior to delivery of any products to the job site and sufficiently in advance of requirements to allow ample time for checking, submit Shop Drawings for review as specified in Division 1.

.4 Submit Shop Drawings (including product data) for all equipment as required in each Section of this Specification.

.5 Prior to submitting the Shop Drawings to the Contract Administrator, the Contractor shall review, date and sign the Shop Drawings to determine that the equipment complies with the requirements of the Specifications and Drawings.

.6 Shop Drawings shall indicate materials, methods of construction and attachment of support, wiring diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of the Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the Section under which the adjacent items will be supplied and installed. Indicate cross-references to design Drawings and Specifications. Adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract price. If adjustments affect the value of the Work, state so in writing to the Contract Administrator prior to proceeding with the Work.

.7 Manufacture of products shall conform to the revised Shop Drawings. Failure to supply a product based on the revised, marked up Shop Drawings may require on site product revisions or modifications, which will be at the cost of the Contractor.

.8 Keep one (1) complete set of Shop Drawings at job Site during construction.

.9 Prior to shipping prefabricated control panels, photos of completed panels shall be sent to the Contract Administrator of final review. The resolution of the photos should be such that individual wire tags can be read.

.10 Shop Drawings shall have the specific equipment numbers on all pages to clearly indicate which piece of equipment the Shop Drawing refers to. In addition, the entire product part number or catalog number should be adjacent to the tag.

1.10 As-Built Drawings

.1 Refer to Section 01 78 00 - Closeout Submittals - for additional requirements for As-Built Drawings.

.2 The Contractor shall keep one (1) complete set of white prints at the Site during work, including all addenda, change orders, site instructions, clarifications, and revisions for the purpose of As-Built Drawings. As the Work on-site proceeds, the Contractor shall clearly record in red pencil all as-built conditions, which deviate from the original Contract Documents. As-Built Drawings to include circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all electrical equipment.

.3 On completion of the work, minimum of four (4) weeks prior to final inspection, submit As-Built Drawings to Contract Administrator for review. The Contractor shall certify, in writing signed and dated, that the As-Built Drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items.

.4 Print, frame, and mount all as-built single line drawings on size D sheet in the electrical room(s). For modifications to areas with existing electrical installations, replace the existing single line drawing with the latest As-Built.

.5 Comply with all other City of Winnipeg standards and requirements.

1.11 Environmental Conditions

.1 Equipment and systems are to be rated to correctly operate in the environment in which they are to be installed.

.2 Exterior devices shall be rated to operate in an exterior environment with temperature range of -40°C to +40°C.

1.12 Quality Assurance

.1 Qualifications:

.1 For work involving specialties, including, but not limited to, the installation of high voltage switchgear, high voltage cables, overhead pole lines, sound and intercommunication systems, fire alarm systems, lightning protection systems, equipment cathodic protection, grounding systems, instrumentation, controls, electronic access, security systems, fibre optics systems, etc. employ only workers fully trained, qualified and experienced in the aspects of such work.

2. PRODUCTS

2.1 Accepted Materials

.1 Materials: approved by and bearing a CSA label. Where there is no alternative to supplying equipment or material that is not approved or certified as indicated, obtain and pay for special approvals from the Office of the Fire Commissioner, Inspection and Technical Services Manitoba.

.2 Factory assemble control panels and component assemblies. Control panels to be CSA certified. Include current interrupting rating on the front panel. Shop Drawings for custom built control panels (which are not designed and sealed as part of the Issued for Construction documents) shall be signed and sealed by an engineer, registered in the Province of Manitoba.

.3 Minimum enclosure type to be NEMA 12 unless otherwise specified. Refer to the Drawings and other Specification section for specific requirements.

.4 Provide materials and equipment in accordance with Section 01 60 00 - Material and Equipment.

2.2 Equipment Finish

.1 Where on Site finishing is required, properly prepare and prime surfaces.

.2 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two (2) coats of finish enamel.

.3 Paint indoor switchgear and distribution enclosures light grey to ANSI 61 grey enamel, unless otherwise specified.

2.3 Equipment Identification

.1 Identify electrical equipment with nameplates as described below.

.2 Nameplates:

.1 Lamacoid, 3 mm thick plastic nameplates, mechanically attached with self tapping stainless steel screws, white face with black lettering. Note: “Sheet Metal Screws” or other sharp pointed screws are NOT acceptable.

.2 Sizes as follows:

Table 1: Nameplate Sizes

Size	Dimension	Lines of Text	Text Height
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	40 x 90 mm	2 lines	8 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	5 mm high letters
Size 8	35 x 100 mm	3 lines	5 mm high letters
Size 9	45 x 100 mm	4 lines	5 mm high letters
Size 10	75 x 160 mm	3 or 4 lines	8 mm high letters
Size 11	150 x 250 mm	3 or 4 lines	10 mm high letters

.3 Lamacoids must not be susceptible to UV or any weather conditions that could fade them, crack them or tear them.

.4 Wording on nameplates to be approved by Contract Administrator prior to manufacture.

.5 Allow for average of fifty (50) letters per nameplate.

.6 Identification to be in English and by tag.

.7 Provide nameplates for the following, sizes as shown:

.1 Power, voice and data receptacles – Size 1.

.2 Panelboards – Size 9.

.3 Dry Type Transformer – Size 10.

.4 Cabinets – Size 8.

.5 Small Junction Boxes (150mm x 150mm or smaller) – Size 1.

.6 Large Junction Boxes – Size 2.

.7 Control panels – Size 8.

.8 Contactors – Size 8.

.9 Terminal / splitter cabinets – Size 8.

.10 MCCs, switchgear, distribution equipment – Size 10.

.11 Each cell or bucket in an MCC – Size 7.

.12 Each breaker cell located within switchgear – Size 5.

.13 Motor starters – Size 8.

.14 Light Switches – Size 1.

.15 Emergency lighting battery banks – Size 7 or Size 8.

.16 Emergency lights – Size 1.

.17 Exit signs – Size 3.

.18 Disconnect switch – Size 8.

.19 Wall mounted fire alarm devices – Size 2.

.20 Ceiling mounted fire alarm devices – Size 4.

.21 Oil filled padmount transformers – Size 11.

2.4 Wiring Identification

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

.5 Wire identification must be UV and weather resistant for outdoor applications and must be able to maintain its physical consistency with weather between -50 and +50°C. Do not use zip ties on outdoor installations.

2.5 Conduit and Cable Identification

.1 Colour code conduits, boxes and cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 5 m intervals.

.3 Colours: 38 mm wide prime colour and 19 mm wide auxiliary colours.

Table2: Conduit and Cable Colour Code

System	Prime Band	Aux. Band
Medium Voltage (>750 V)	Orange	
347/600 V	Yellow	
120/208/240 V Power	Black	
UPS 120/208/240 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
Ground	Green	
Fibre Optic	Purple	

.4 Cable Identification: Supply and install lamacoid type cable identification tags for all cables. Install identification tag at both ends.

3. EXECUTION

3.1 Preparation and Protection

.1 Schedule expediting of materials and execution of Work in conjunction with associated Work of other trades in order to meet the required Work schedule.

.2 Post engraved warning signs to meet requirements of local by-laws, Inspection Authority and Contract Administrator.

.3 Protect those working on or in vicinity of exposed electrically energized equipment from physical danger. Shield and mark live parts in accordance with local regulations. Indicate the appropriate voltage.

.4 Arrange for installation of temporary doors, barriers and similar items for access to rooms and areas containing electrical equipment. Keep these doors locked at all times, except when under direct supervision.

.5 Permanently identify with lamacoid nameplate, equipment energized from multiple power sources, noting voltages, power source locations, supply disconnect designations and grounding electrode location.

3.2 Warning Signs

.1 As specified and to meet the requirements of Electrical Inspection Department and the Contract Administrator.

.2 Lamacoid 3 mm thick plastic engraving sheet, red face, white core, mechanically attached with self tapping screws, 20 mm text.

3.3 Mounting Heights

.1 Unless otherwise noted, or in contravention of codes and standards, mount equipment replacing existing equipment at the same height.

.2 Mounting height of equipment is from finished floor to centerline of equipment unless specified or indicated otherwise.

.3 If mounting height of equipment is not indicated, verify with the Contract Administrator before proceeding with the installation.

.4 Mount indoor electrical distribution equipment utilizing one of the following:

.1 Floor mount on 89 mm (3.5") concrete housekeeping pad.

.2 Surface wall mount to concrete walls (inside electrical rooms).

.3 For areas of elevated humidity or moisture (or where a suitable wall is not available) – mount on modular metal support system: Unistrut, Cantruss, or similar.

.4 Surface wall mount on 19 mm (3/4") thick fire-retardant plywood backboard (for non structural type of walls and to provide a level of fire-retardant barrier where needed).

.5 Recess mount (as indicated on the Drawings).

.5 Install electrical equipment at the following heights unless indicated or directed otherwise (to bottom of the equipment):

.1 Outlets above counters: 150 mm (6"); splashbacks: 100 mm (4").

.2 General receptacles & communications outlets: 400 mm (16").

.3 Receptacles in mechanical and shop areas: 1 m (40").

.4 Switches, dimmers, push buttons: 1.2 m (48").

.5 Thermostats: 1.4 m (56").

.6 Security alarm bells, horns, speakers: 2.2 m (88").

.7 Motor starters: 1675 mm (66") to top.

.8 Panelboard: 2.0 m (78") to top.

.9 Control Panels: 1675 mm (66") to top.

.10 Clock outlets: 2.15 m (84").

.11 Emergency lighting battery bank unit: 2.1 m (82").

.12 Emergency light remote head: 150 mm (6”) below ceiling, to a maximum height of 3.0 m (118”).

.13 Wall mount Exit signs: 2.2 m (87”) or higher as required to coordinate with door height.

.14 Pushbutton for power door assist: 900 mm (35.4”).

.15 Intrusion alarm motion detectors: 150 mm (6”) below ceiling, to a maximum height of 3.0 m (118”).

.16 Intrusion alarm keypad: 1500 mm (59”).

.17 Fire alarm panel: 1650 mm (65”) to top.

.18 End of line resistors: 1.6 m (64”).

.19 Fire alarm pull stations: 1320 mm (52”).

.20 Fire alarm horn / strobe: a minimum of 150 mm (6”) below ceiling to the top edge of the device (for low ceiling areas). Where ceilings allow, mount devices at 2400 mm (94.5”) (measured to top of device) above finished floor.

.21 Coordinate and confirm elevations indicated on the Architectural Drawings. Where discrepancies occur, request clarification from the Contract Administrator.

.22 Mounting heights to meet all codes and regulations. Fire alarm devices to be in accordance with CAN / ULC-S524.

.23 Coordinate and confirm elevations indicated on the Architectural elevations. Where discrepancies occur, request clarification from the Contract Administrator.

3.4 Location of Devices

.1 Allow for change of location of devices at no extra cost or credit, provided that the distance does not exceed 3000 mm (10’) from that shown on the Drawings, when the requirement is made known prior to installation.

3.5 Conduit and Cable Installation

.1 Sleeves through concrete: schedule 40 galvanized steel pipe, sized for free passage of conduit.

.2 For wall, partitions, and ceilings the sleeve ends shall be flush with the finish on both sides but for floors they shall extend 25 mm (1”) above finished floor level.

.3 Fire stop opening with ULC approved assembly for the installation conditions.

.4 Provide a detailed proposed conduit routing plan to the Contract Administrator prior to proceeding with the installation of conduit.

.5 If possible, avoid routing conduits through hazardous area.

.6 Separate cables of different voltage levels when cables are installed parallel to each other.

3.6 Field Quality Control

.1 All electrical Work to be carried out by qualified, licensed electricians or apprentices as per the conditions of the Provincial Act respecting manpower vocational training and qualification. Employees registered in a provincial apprentices program shall be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks - the activities permitted shall be determined based on the level of training attained and the demonstration of ability to perform specific duties. A maximum of one (1) apprentice is permitted per qualified electrician.

.2 The Work of this Division to be carried out by a Contractor who holds a valid Master Electrical Contractor license as issued by the Province of Manitoba.

.3 Furnish Manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to Manufacturer's instructions.

3.7 Load Balance

.1 Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

.2 Balance electrical load between phases as closely as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

.3 When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit panel directory that lists final circuit arrangement.

3.8 Tests

.1 Test and check electrical, instrumentation and control systems for correct operation and compliance with statutory and regulatory authority requirements.

.2 Perform tests in presence of Contract Administrator. Log, tabulate, sign and include testing and Commissioning results in the O & M manuals.

.3 Testing shall include, but not be limited to, the following:

.1 All items indicated in Section 26 08 05, Acceptance Testing and the testing and Commissioning requirements.

.2 Electrical power distribution systems.

.3 Wire and cable system.

.4 Lighting, emergency lighting, photocell, lighting controls and interlocks.

.5 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.6 Communications, control and instrumentation.

.7 Fire alarm and intercom systems.

.8 Standby genset power systems.

.9 All other equipment and systems as indicated in the Drawings and Specifications.

.4 Refer to appropriate Specification sections for specific system or equipment tests.

.5 Supply instruments, meters, consumable parts (such as fuses) and equipment. Arrange for qualified personnel to conduct tests.

.6 In cooperation with mechanical trades, take clamp-on ammeter readings with motors operating at full load. Compare values against the equipment nameplate rating. Log, tabulate and include readings in Maintenance Data and Operating Instructions.

.7 Correct systems which fail any test, correct and re-do tests to ensure proper operation of the system.

3.9 Checkout and Start-Up

.1 Voltage Field Test:

.1 Refer to Section 26 08 05 - Acceptance Testing as applicable.

.2 Check Supply Utility voltage at point of termination of supply conductors when installation is essentially complete and is in operation.

.3 Check voltage amplitude between phases, and phase to neutral for loaded and unloaded conditions.

.4 Check voltage drop on at all distribution panels and ensure that it is less than 2% in accordance with CEC requirements.

.5 Check voltage drop on equipment loads and ensure that total voltage drop from the service to the farthest device is less than 5% in accordance with the CEC. Adjust transformer taps, and upsize conductors as required to meet the CEC.

.6 Unbalance Corrections:

.1 Make written request to the Supply Utility to correct conditions if the service voltage unbalance exceeds 3%.

.2 Current Field Tests:

.1 Make line current check after supply utility has made final adjustments to supply voltage.

.2 Check current balance at the service demarcation point. Adjust loads to ensure that each phase is appropriately balanced.

.3 Check line current in each phase for each piece of equipment.

.4 If the phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.10 Touch-Up Painting

.1 Clean and touch-up surfaces of shop painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Obtain necessary touch-up paint of original type and quality from equipment Manufacturer.

.3 Clean surfaces to be painted. Feather out edges of scratch marks. Make patch inconspicuous.

.4 Apply one (1) or more coats until damaged surface has been restored to original finish condition.

.5 Clean and prime exposed non galvanized hangers, racks and fastenings to prevent rusting.

.6 Do not paint nameplates, tags, CSA labels, warning plates and operating instructions. Observe field painting of electrical equipment or raceways. Labels shall be visible and legible after the equipment is installed.

3.11 Cleaning

.1 Clean construction debris and materials from enclosures, before final electrical tests. Vacuum the interior and exterior of enclosures to ensure all equipment is free from debris.

3.12 Training

.1 Provide training of City personnel in all aspects of maintenance, operation, and functionality for the Lift Station.

.2 Training shall be performed at the NEWPCC Facility in Winnipeg, Manitoba. Training shall involve both classroom style of training, as well as practical training with the equipment present.

END OF SECTION

WIRE AND BOX CONNECTORS (0-1000 V)

1. GENERAL

1.1 Section Includes

.1 Materials and installation for wire and box connectors.

1.2 References

.1 Canadian Standards Association (CSA):

.1 CSA C22.2 No.18.3, Conduit, Tubing, and Cable Fittings, and Update No. 1.

.2 CSA C22.2 No.18.4, Hardware for the Support of Conduit, Tubing, and Cable.

.3 CSA C22.2 No.18.5, Positioning Devices.

.4 CSA-C22.2 No.18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.5 CSA C22.2 No.65, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).

.2 National Electrical Manufacturers Association (NEMA):

.1 C119.4 Connectors for Use between Aluminum-to-Aluminum and Aluminum-to-Copper, and Copper-to-Copper.

.3 Electrical and Electronic Manufacturer's Association of Canada (EEMAC):

.1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

1.3 Action and Informational Submittals

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Sustainable Design Submittals:

.1 Construction Waste Management:

.1 Submit project Waste Management Plan and Waste Reduction Workplan highlighting recycling and salvage requirements.

.2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75% of construction wastes were recycled or salvaged.

1.4 Closeout Submittals

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

1.5 Delivery, Storage and Handling

.1 Deliver, store and handle materials in accordance with Section01 60 00 - Material and Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to Site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off the floor indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect wire and box connectors from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 Materials

.1 Service and Power Feeder Cables:

.1 Compression type terminations for copper incoming power service cables. Utility approved compression type connectors at transformer, for installation by utility.

.2 Compression type terminations for all feeder connections.

.2 Splicing only to be performed inside of suitable rated boxes.

.1 General locations: Fixture type splicing connectors (Marette twist on) to: CSA C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.

.2 Wet Locations or Underground: Use CSA splice kits suitable for direct burial to ensure moisture seal.

.3 Clamps or connectors for armoured cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required to: CSA-C22.2 No.18.3, 18.4 and 18.5.

.1 Provide appropriate terminals or power distribution blocks.

.4 Bushing stud connectors to consist of:

.1 Connector body and stud clamp for stranded round copper conductors.

.2 Clamp for stranded round copper conductors.

.3 Stud clamp bolts.

.4 Bolts for copper conductors.

3. EXECUTION

3.1 Examination

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connector's installation in accordance with manufacturer's written instructions.

.1 Inform General Contractor of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Installation

.1 Remove insulation carefully from ends of conductors and:

.1 For Compression Type:

.1 Install all compression terminations and connectors using purpose made mechanical tool.

.2 For aluminum compression terminations also apply conductive paste (i.e. zinc joint compound) to conductor ends prior to installation of conductors.

.2 For Fixture type splicing connectors (Marette twist on wire nut):

.1 Twist wires together, insert into insulating cap and tighten.

.2 Place a strip of electrical tape over the full circumference of the cap ensuring the gap between the cap and the wires is covered. Firmly press tape in place.

.3 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by Manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65. Installation shall pass tug test, and meet secureness tests in accordance with the manufacturers requirements and CSA.

.4 Install bushing stud connectors per manufacturers requirements, and in accordance with NEMA and EEMAC 1Y-2.

3.3 Cleaning

.1 Progress Cleaning: clean in accordance with the requirements and basic rules applicable to the working area.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from Site and dispose of materials at appropriate facility.

END OF SECTION

WIRES AND CABLES (0-1000 V)

1. GENERAL

1.1 Description

.1 This Section of the Specifications forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

.2 Provide all wire and cable requirements for voltage systems 1000 V or less as indicated within this Section.

1.2 References, Codes, Standards

.1 American Society for Testing and Materials (ASTM):

.1 B3, Standard Specification for Soft or Annealed Copper Wire.

.2 B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

.2 Canadian Standards Association (CSA):

.1 CSA C22.1, Canadian Electrical Code (CEC), Part 1), Safety Standard for Electrical Installations.

.2 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.

.3 CSA C22.2 No. 18.3, Conduit, Tubing, and Cable fittings.

.4 CSA C22.2 No. 38, Thermoset-Insulated Wires and Cables.

.5 CSA C22.2 No. 49, Flexible Cords and Cables.

.6 CSA C22.2 No. 51, Armoured Cables.

.7 CSA C22.2 No. 65, Wire connectors.

.8 CSA C22.2 No. 123, Metal sheathed cables.

.9 CSA C22.2 No. 131, Type TECK 90 Cable.

.10 CSA C22.2 No. 174, Cable and cable glands for use in hazardous locations.

.11 CSA C22.2 No. 188, Splicing wire connectors.

.12 CSA C22.2 No. 197, PVC Insulating Tape.

.13 CSA C22.2 No. 208, Fire Alarm and Signal Control.

.14 CSA C22.2 No. 230, Tray Cables.

.15 CSA C22.2 No. 239, Control and Instrumentation Cables.

.3 Insulated Cable Engineers Association (ICEA) requirements where permissible.

.4 Institute of Electrical and Electronics Engineers (IEEE):

.1 383, IEEE Standard for Qualifying Electric Cables and Splices for Nuclear Facilities.

.2 1682, IEEE Standard for Qualifying Fiber Optic Cables, Connections, and Optical Fiber Splices for Use in Safety Systems in Nuclear Power Generating Stations.

.5 Underwriters Laboratories (UL):

.1 514B, Standard for Conduit, Tubing, and Cable Fittings.

1.3 Definitions

.1 Conductor: the current carrying portion of an insulated wire or an uninsulated wire. All conductors shall be stranded copper.

.2 Wire: a single, insulated conductor.

.3 Cables: an assembly of a single or multiple insulated conductors, with overall sheaths or jackets, with or without metallic armour or shielding.

.4 Wiring: describes wires, cables and conduit in a general way.

1.4 Submittals for Review

.1 Submit product data in accordance with Division 1 and Division 26.

.1 Catalogue and technical data.

.2 Installation data including allowable pulling tension, pulling radius, and bending radius.

.2 Submit Cable Schedule when indicated on the Drawings or other Specifications.

1.5 Shipment, Protection and Storage

.1 Ship, protect and store equipment as required by Division 26.

2. PRODUCTS

2.1 General

.1 Where manufacturer or series is specified, these are provided for the purpose of establishing the grade of quality for the materials specified in this section and are taken from one (1) manufacturer's product line. Unless otherwise noted, products from other listed manufacturers which have identical features and characteristics are acceptable.

.2 Refer to the other Division 26 specifications for acceptable cable and wire connectors.

.3 To prevent corrosion due in Hazardous locations that can have Group IIB gases present (i.e. H_2S), steel armor, steel conduit, and steel cable supports are generally not permitted. Utilize aluminum materials to prevent corrosion.

.4 All conductors (including grounds and bonds) to be high conductivity copper.

.5 Materials to be manufactured to Canadian CSA standards, approved and suitable for -40°C to +90°C operation. Wires and cables shall meet their applicable CSA standard for construction and for testing.

.6 Increase conductor sizes to account for loading, cable and conductor spacing with the associated de-rating factors, voltage drop, ambient temperature, equipment termination temperature ratings, and all other requirements in accordance with CEC requirements.

.1 Space out conductors and separate different systems and voltages in accordance with the CEC and the City of Winnipeg requirements.

.7 Outdoor applications: Manufacturer literature shall include sunlight resistant, and suitability for direct burial.

.8 Acceptable Cable Manufacturer: Nexans, General Cable, Southwire.

2.2 Fastenings and Supports

.1 Design wire and cable anchorage and support system for vertical and lateral loading in accordance with the Manitoba Building Code (MBC).

.2 One whole malleable iron, steel, aluminum, zinc straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.3 Channel type or cable tray supports for two (2) or more cables.

.4 Threaded rods: minimum 6 mm diameter to support suspended channels, increase size as required for the loads.

2.3 Wire Insulation Voltage

.1 The minimum wire insulation ratings as provided below is in general, and pending the mean and methods employed as part of the installation work. For example, barriers will be required in cable tray where insulation ratings are not the same, between power and control cabling systems, or between noisy cabling systems.

.1 Wiring at 50 V and less shall be a minimum of 300 V insulated.

.2 Wiring at 300 V and less shall be a minimum of 600 V insulated.

.3 Wiring at greater than 300 V:

.1 Shall be a minimum of 1000 V insulated when feeding equipment that can branch to multiple loads. Feed cabling to services, MCC's, distribution panelboards, distribution transformers etc. are generally 1000 V rated.

.2 Between a 600 V VFD and motor shall be a minimum of 2500 V insulated, and VFD/inverter rated.

.3 Shall be a minimum of 600 V insulated otherwise.

.2 Composite 600 V power and 120 V control cables will not be permitted on this project.

2.4 Insulated Ground Conductors

.1 Insulated copper ground conductors:

.1 Size: as indicated on the Drawings, but in no case smaller than CEC required sizes.

.2 Type: soft drawn, stranded, flexible, high conductivity.

.1 Use tinned-coated in corrosive/hazardous environments including when buried in earth, or embedded in concrete.

.3 Shall meet the requirements of ASTM B8.

.4 Insulation: chemically cross-linked thermosetting polyethylene (XLPE) material, rated RWU90

.5 Flame Test Rating:

.1 CSA FT4 (if exposed).

.2 CSA FT1 (if entirely within conduit).

.6 Insulation voltage rating: 600 V.

.7 Colour: green or green with yellow stripes as indicated on the Drawings.

2.5 Bare Ground Conductors

.1 Bare copper ground conductors:

.1 Size: as indicated on the Drawings, but in no case smaller than CEC required sizes.

.2 Type: soft drawn, stranded, flexible, high conductivity.

.1 Use tinned-coated in corrosive/hazardous environments including when buried in earth, or embedded in concrete.

.3 Shall meet the requirements of ASTM B8.

.2 Refer to the Drawings and other grounding Specifications for additional application and other requirements.

2.6 Building Wires

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE. RWU90 XLPE for grounding pigtails.

.3 Wires sized 2 AWG and smaller to be factory colour coded, taping will not be accepted.

2.7 Single Conductor Wire(s) in Conduit

.1 Insulation chemically cross-linked, thermosetting polyethylene, and, unless otherwise specified, rated RWU90, 1000 V. Use RWU90 insulation where specified, or in conduit systems in wet locations including below grade.

.2 Ensure conduit is dry and clean prior to pulling conductors in. If moisture is present, thoroughly dry and clean conduits.

.3 Use pulling lubricant when pulling conductors in conduit to reduce the strain on the wires. Lubricants must be polymer based and must not adversely affect or degrade cable insulation.

.4 Do not combine conductors in a common duct or conduit without regard for de-rating.

.5 Conductors, unless otherwise shown or specified:

.1 Stranded copper.

.2 Minimum size No. 12 AWG, for control signals No. 14 AWG may be provided.

.6 Colour coding and labeling per Division 26 05 00 requirements; wires sized No. 2 AWG and smaller to be factory-coded, taping will not be accepted.

2.8 Teck 90 Cable

.1 Cable and Colour Coding in accordance with Section 26 05 00 - Common Work Results - Electrical

.1 Conductors and insulation same as for Building Wires, except that manufacturer's standard insulation colour coding for multi-conductor cabling is acceptable.

.2 Shall be installed in industrial, hazardous, underground, or wet areas and where noted on the Drawings and cable schedules.

.3 Where surface mounted, cables shall be securely supported using aluminum cable clamps and cabling support systems. Space supports a maximum of 1 m apart.

.4 Where multiple cables are run into an area, install cables on cable tray or on cabling support hangers.

.5 Cable consists of multi-conductor, composite, or single-conductor construction as shown on the drawings or as specified, plus grounding conductor, with interlocking aluminum armour and outer jacket.

.1 Outer jacket of thermoplastic polyvinyl chloride (PVC) material with low gas emissions, rated minus (-) 40°C, with flame test rating as required by building code.

.2 FT4 flame test requirements when installed in buildings of non-combustible and combustible construction. Refer to CEC Rule 2-130 and the National Building Code of Canada Article 3.6.4.3 for further information and requirements.

.3 FT6 flame test requirements when installed in spaces between a ceiling and floor, or ceiling and roof, that may be used as a plenum in buildings of combustible or non-combustible construction. Refer to CEC Rule 2-130 and the National Building Code of Canada Article 3.6.4.3 for further information and requirements.

.6 Minimum bend radius is 12 times, or larger as required by the cable Manufacturer.

.7 Hazardous Locations: Cable shall come with “HL” rating for hazardous locations in Zone 1 or Zone 2 areas.

.8 Conductors:

.1 Inner jacket thermosetting polyvinyl chloride (PVC) compound.

.2 Grounding conductor: copper.

.3 Circuit conductors: copper, size as indicated.

.9 Insulation:

.1 Outer jacket: chemically Cross-linked polyethylene XLPE type RW90.

.2 Inner jacket: polyvinyl chloride (PVC), 600V or 1000V (as applicable), 100% insulation level.

.3 Voltage Rating: as required for the application/installation.

.10 Avoid damaging outer jacket covering the armor. In some areas, such as the chemical building, exposed armor is not desirable. Replace cables at no additional cost where outer jacket is damaged.

2.9 Instrumentation and Control Cables

.1 Armoured Control and Instrumentation Cable (ACIC) and Control and Instrumentation Cable (CIC) to: CAN/CSA-C22.2 No. 239.

.1 Armoured control and instrumentation cable (ACIC), to have aluminum, interlocked armour with overall PVC jacket. ACIC cable may be installed in cable tray, provided that:

.1 The cable tray does not contain power cables or at the very least a tray-rated barrier has been installed providing physical separation. When tray-rated barriers have been installed maintain separation between power and instrument/control systems.

.2 The ACIC cable voltage rating is equal to or greater than the highest voltage contained in the cable tray.

.2 Install Instrumentation Cable (CIC) in conduit, this cable may not be installed in cable tray. Protection in conduit is required over the entire length.

.2 Conductors: minimum size, #16 AWG, stranded, annealed (7 strand minimum), tinned copper, unless otherwise specifically noted on the Drawings.

.3 Insulation: chemically cross-linked thermosetting polyethylene (XLPE), rated type RW90, 300 V.

.4 Conductor identification: Each grouping (pair, triplet, quad) by consecutive number coding, permanently marked at regular intervals.

.5 Construction: twisted pair, triplet, and quad grouping with staggered lay.

.6 Shielding shall be in conformance with:

.1 Minimum 100% coverage aluminum foil or mylar tape shield with minimum 25% overlap.

.2 Separate drain wire, minimum size 18 AWG, bare, stranded tinned copper. Drain wire to be in direct, continuous contact with the shield.

.3 One or more twisted shielded pairs as indicated.

.4 Shield drain wires, at the ungrounded end, are to be taped back to the cable. Do not cut the shield drain wire off.

.7 Jacket: PVC (-40 °C to +90 °C), low acid gas, minimum FT4 rated flame spread.

.8 Termination fittings: Type, configuration and gender required to connect cable directly to equipment without additional adapters or fittings.

2.10 Fire Alarm Cables

.1 Refer to the drawings and fire alarm specifications for additional requirements.

.2 Low energy, 300 V, FAS 105 shielded cable: minimum #16AWG, with PVC insulation.

.3 Overall aluminum /polyester foil shield, with tinned copper drain wire.

.1 Shields to be grounded at one end only (source end).

.4 All fire alarm cables shall be installed in a separate, dedicated conduit system.

.1 Install conductors to be entirely independent of all other wiring. Do not enter raceway, boxes or enclosures occupied by other wiring except where necessary to connect to power supply, communication circuit, or ancillary devices.

.5 For data communication link A (DCLA) fire alarm circuits, install primary wiring circuit and alternate wiring circuit in separate conduit having a minimum separation of:

.1 300 mm when installed vertically.

.2 1200 mm when installed horizontally.

.6 For data communication link A (DCLA) fire alarm circuits, the primary wiring circuit and alternate wiring circuit may share the same conduit:

.1 For a distance of less than 3000 mm where the primary and return conductors enter or exit field devices, control unit or transponder enclosures.

.2 For single conduit drops to individual field devices.

.3 For single conduit drops to multiple field devices installed in a single room not exceeding 100 m².

2.11 Flexible and Portable Cables

.1 Designations and Compliance:

.1 Flexible Cords; Type SOW, to CSA C22.2 No. 49, Type ST, to CSA C22.2 No. 49.

.2 Portable Cables up to No. 2 AWG, Type SGOW, to CSA C22.2 No. 96.

.3 Portable Power Cables up to 500 kcmil, Type G, to ICEA S-68-516.

.2 Type SOOW, flexible, extra hard usage conductor, watertight, rubber EPDM insulation, with CPE oil resistant outer covering and incorporated ground conductor, 90°C rated.

.3 Flexible, non-armored cables to be installed where plug / cord assemblies are specified and required.

.4 Flexible festoon cables to be installed where specifically required for mobile equipment. Terminate both ends of festoon cables, providing cable strain relief.

.5 Instrumentation and control flexible cables, to have braided flexible shield, minimum size 16 AWG.

.6 Conductors and Insulation:

.1 Stranded.

.2 Size as shown or specified.

.3 Insulation and conductor arrangement as determined by governing standard.

2.12 Mineral Insulated Cables

.1 Install cable securely supported by straps and hangers.

.2 Support 2-hour fire rated cable a minimum of every 1-meter interval (or less).

.3 Make cable terminations by using cable Facility approved termination kits. Termination must be performed by personnel specifically trained by the equipment Facility.

2.13 Connectors for Armored Cables

.1 All metal-clad cable fittings, for jacketed and non-jacketed interlocked armour cable, shall incorporate an easily removable armour stop (not requiring fitting disassembly) ensuring proper positioning of the cable armour during cable termination.

.2 All connectors be watertight, approved for TECK cable. All connectors shall be packed with Liquid-type sealing compound (includes pouch of sealing compound with integral spout and fiber damming material. Putty-type sealing compound may also be used except for shielded cable applications. Watertight type shall include:

.1 An elastomeric bevelled bushing.

.2 A funnel entry, splined gland nut.

.3 A non-magnetic, stainless steel grounding device with dual grounding action.

.4 A taper threaded hub.

.5 A hexagonal body and gland nut.

.3 Integral seal type with metal-to-metal contact construction.

.4 Sealing of multi-conductor cable shall be accomplished with a liquid-type polyurethane compound.

.5 Wet and Ordinary location: Regular TECK connector.

.6 Corrosive location: TECK Connector made of chemically resistive materials, or sealed and covered with Thomas & Betts (ABB) Shrink-Kon, heavy wall, heat-shrinkable protective tubing.

.7 Hazardous Locations:

.1 Provide an environmental seal around the outer jacket of the cable and electrically bond the fitting to the cable armour prior to potting the explosion-proof seal.

.2 Allow the possibility of disconnection without disturbing the environmental seal, the electrical bonding, or the explosion proof seal.

.3 Includes hazardous ratings sufficient for the Zone for which it is installed. TECK Connector made of chemically resistive materials, or sealed and covered with Thomas & Betts (ABB) Shirnk-Kon, heavy wall, heat-shrinkable protective tubing.

.8 Approved products:

.1 Teck Cable, (Non-Hazardous Locations):

.1 Approved Manufacturers: ABB (Thomas & Betts) or Eaton (Cooper Crouse-Hinds).

.2 Thomas & Betts Star® Teck ST series, aluminum.

.2 Teck Cable, (Hazardous Locations):

.1 Shall meet the requirements of CSA C22.2 No. 174 and be marked accordingly.

.2 Approved Manufacturers: ABB (Thomas & Betts) or Eaton (Cooper Crouse-Hinds).

.1 Thomas & Betts, Star® Teck XP (STX) series, explosion proof aluminum, CSA certified Class I, Divisions 1 and 2, Groups A, B, C, D.

2.14 Strain Relief Connectors

.1 Watertight type for use with flexible cables.

.2 Material compatible with connecting body such as junction, outlet or splice box to which connection is made.

.3 Stainless steel wire mesh cord grip where connector is used with free-hanging cable.

.4 Typical Products: Thomas & Betts Type RANGER.

2.15 Wire Connectors

.1 The following listings specify products for copper conductors only. Aluminum conductors are not foreseen for this project. In the event that aluminum conductors are specifically approved by the Contract Administrator, it is the Contractor's responsibility to select the appropriate connector, using the following specifications as the guideline.

.2 Twist-On Connectors:

.1 Insulated serrated or wing-type cap.

.2 Internal spiral spring; set-screw or crimp-type not acceptable.

.3 Minimum rating 600 V.

.4 Limited for use up to No. 10 AWG wire.

.3 Terminal Connectors:

.1 Ring-type or locking fork-type, crimp-on terminal with nylon insulating sleeve over brazed seam shank.

.2 Minimum rating 600 V, 105°C.

.3 Conductive member made from electro tin-plated copper.

.4 Use limited for conductors up to No. 10 AWG.

.4 Compression Lugs:

.1 Made from one-piece pure electrolytic copper tubing, tin plated.

.2 Colour coded or marked with manufacturer's die index.

.3 Long barrel for minimum two (2) crimps.

.4 For use with conductors No. 8 AWG and larger.

.5 For No. 1/0 AWG and larger conductors, use two-hole long barrel compression lugs wherever possible.

.6 Install ferrules with nylon insulating sleeves on all No. 14 AWG and smaller stranded wires being terminated on terminal strips. Individual ferrule is required for each conductor.

.5 Compression splices: similar to compression lugs, suitable for in-line, C-tap and similar configurations.

2.16 Joint Compound

.1 Conductive compound, suitable for application to threaded and compression connections.

.2 Compatible with cable and conductor insulation and material.

.3 Capable of being brushed on at temperatures from minus (-) 25°C to (+) 110°C.

.4 Typical products, within the limitations outlined:

.1 Aluma-Shield.

.2 Burndy Penetrox.

.3 Thomas & Betts Kopr-Shield.

2.17 Electrical Tape

.1 To be compatible with conductor or cable insulation or jacketing, as applicable.

.2 For general purpose (indoors): vinyl plastic (PVC insulating), premium grade, minimum 0.18 mm (7 mil) thickness, black or colour coded, as required. The tape is intended to be applied in layers, each layer being half-lapped. Typical product: 3M Super 33+ or 35.

.1 Where tape is used for identification of conductors at a supply connection point or similar location, “Weather Resistance” tape shall be used.

.3 Self-vulcanizing linerless rubber tape, minimum 0.76 mm (30 mil) thickness. Typical product: 3M Type 130 C.

3. EXECUTION

3.1 Coordination

.1 Provide adequate notice to the Contract Administrator so that all cable installations can be inspected prior to connecting equipment.

.2 Coordinate with Division 26:

.1 Provide complete run lengths for all power cables from Equipment “A” to Equipment “B”, and a copy to the Contract Administrator for their records. For each cable run indicate the type of installation method (i.e., cable tray (& spacing), strut hangers, conduit (& type), underground etc.)

.1 Provide cable type (i.e. RW90, Teck90, THWN etc.)

.2 Provide Conductor type (i.e.. Aluminum or Copper).

.3 Provide Number of Conductors in cable, and size of conductors.

.4 Provide Number of Conductors per phase.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Perform testing before energizing electrical systems.

.3 Perform megohmmeter testing of all cables (each conductor) for cable sizes 10 AWG and larger - with the following exceptions - megohmmeter testing is not required for: lighting circuit, 120 VAC duplex receptacle cabling. Provide test documentation for all cables tested.

3.3 General Cable Installation

.1 Lay cable in cable ducts in accordance with Division 26 05 44 - Installation of Cable in Trenches and Ducts.

.2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors (0-1000 V).

.3 Re-use of existing wiring:

.1 Except where specifically identified or approved, reuse of existing wiring is not permitted.

.2 Ensure all existing wiring is tagged prior to disconnection of equipment.

.3 Tag spare wires as “Spare” and indicate the location of the other end of the wire. In addition, correlate / identify both ends of each conductor.

.4 Establish exact location of equipment and their connection points before wiring installation is commenced.

.5 Provide non-ferrous GPO (glastic) or aluminum plates for single conductor cable entry into an enclosure. Aluminum entry plate shall be used where conductor armour is required to be bonded to the enclosure. GPO (glastic) materials shall be used where cable armour is not bonded to the enclosure.

.6 In some cases, the electrical conductor size may be too big to terminate on vendor supplied lugs. In these cases, the Contractor remains responsible for making all cable terminations. The Contractor shall replace the lugs or shall provide reducing compression connectors to make the termination. Alternatively, the Contractor may provide appropriate junction boxes to reduce the conductors' sizes as required to perform the cable termination.

.7 Do not embed cables or conduits in masonry or concrete without written approval from the Contract Administrator. Wiring through conduit sleeves for short, direct wall or floor penetration is accepted.

.8 Protect wiring against damage from welding spatter and other construction activity by suitable means.

.9 Protect metallic cable connectors in process areas with heat-shrinkage sleeves. Sleeve length to extend 75 mm past the connector and to provide a tight fit around connector and cable.

.10 Arrange wiring in process area such that motor connection boxes and other field mounted devices are entered at the side or bottom of the connection box or enclosure.

.11 Install reducing bushings where threaded entry in a motor connection box is larger than the hub size of the cable connector.

.12 Install wires and cables in a continuous length between termination points. Splices are not permitted, except within junction boxes or where specifically approved by the Contract Administrator. Where splices are necessary and approved utilize the cable Manufacturer approved and recommended kit. In-line splices are not acceptable.

.13 At the discretion of the Contract Administrator damage to a cable jacket may be repaired in accordance with the manufacturer's recommendation. If requested by Contract Administrator, replace the entire length of a damaged cable.

.14 Arrange cable supports such that maintenance work or removal of the equipment served by the cable, will not cause any damage to the cable.

.15 Fire stop completed conduit and cable penetrations at fire rated walls with approved materials.

.16 Provide an approved hazardous location barrier to maintain the hazardous location classification, at the location the conduit or cable penetrates the hazardous location boundary.

.17 Do not pull conductors into conduit or cable tray until rough building construction operations have been completed.

.18 Conduits and cable supports are only to support conduits or cables. Contractor shall not attach pipes, fixtures, and the like to conduit or cable supports.

.19 Conductor length for parallel feeders to be identical.

.20 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

.21 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

.22 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common/shared neutrals are not permitted.

.23 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

.24 Utilize weatherproofing sealing system appropriate for the area of installation. Install to the manufacturer's recommendations, flush with the exterior of the wall.

.1 Prior to covering up wall penetration work, arrange for a site inspection of the work with the Contract Administrator. Proof of proper installation is required.

.25 For outdoor or exposed installations, make all entries of cables or wires to equipment or panel from the bottom or side to minimize water entry points. Make no entries of cables or wires from the top unless specifically approved by the Contract Administrator.

.26 No wiring must be allowed to be installed laying on ground material inside or outside. All wiring/cabling installation must be installed as required by code and free from trip hazards or infringe on equipment operation / maintenance or testing.

3.4 Installation of Building Wires

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings, and as indicated on the Drawings.

3.5 Installation of Jacketed Armoured Cable (TECK, VFD rated etc.)

.1 Install on surface. One or two surface mounted cables may be strapped using one-hole aluminum straps with clamp back (Thomas & Betts 1275AL series or equal). Fastening, strapping and support materials shall be compatible with the area conditions. Strap at every 1 m intervals. Cables shall not be strapped to handrails and piping wherever possible.

.2 A group of three (3) or more cables running parallel to each other shall be installed in a cable tray.

.3 Install cable connectors at both ends of each armoured cable.

.4 Provide protection for cables where subject to mechanical damage, notably where cable passes through a floor slab.

.5 Tighten and mark Teck connector gland nuts following tightening. Mark shall be made with felt pen as a line between gland nut surface and surface of connector body to show relative position of gland nut after final tightening has been done.

.6 Where hazardous rated Teck connectors are used, installer shall follow manufacturer's assembly procedures for all stages of the installation. Allow cable sealing compound to harden in connector bodies before inserting connector and wires into connector hub.

.7 Group cables wherever possible on channels.

.8 Installation of VFD cables:

.1 VFD cable to be installed between a variable frequency drive (VFD) and the load which it serves.

.2 Secure using aluminum cable clamps.

.3 Route armored cable on cable tray or strapped to cabling system supports (for short runs only).

.4 Non-armored VFD cable is to be run in conduit.

.5 Metallic armor to be bonded to ground at both ends.

.6 Supply end of the VFD cable to have the bond conductors connected to the VFD drive and connected to ground. Load end of cables to have the bond conductors connected to the motor bond/ground lug.

.7 Wire and connect in accordance with the Facility's recommendations.

.8 Space VFD cable as per the following minimum distances:

.1 From 120/208 V wiring: 300 mm.

.2 From 24 VDC instrumentation and control wiring: 300 mm.

.9 Avoid damaging outer jacket covering the armor. In some areas, such as the chemical building, exposed armor is not desirable. Replace cables at no additional cost where outer jacket is damaged.

.9 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings, and as indicated on the Drawings.

.10 In cable tray systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings, and as indicated on the Drawings.

.11 Install cable exposed, securely supported by straps/clamps, secured in spacing intervals as required by the code.

3.6 Installation of Control Cables

.1 Install control cables in conduit, cable troughs, or by direct burial as indicated on the Drawings.

.2 Ground control cable shield.

3.7 Installation of Flexible Cables

.1 Must be installed with strain relief-type connectors to take the tension from the cable termination.

.2 Provide wire mesh grip where cable is free hanging or subject to frequent flexing.

.3 Where excess cabling is to be provided, neatly coil and tie excess length and attach to structure using hooks or supports as specified.

3.8 Connector Sizing

.1 Strictly adhere to manufacturer's listing for matching connector and terminal sizes to cable and conductor sizes.

.2 Similarly, the proper compression tools and dies must be selected for each compression fitting to obtain the correct compression strength and as not to damage insulation sleeves and finishes.

.3 Select cable connectors with correctly sized grommets, bushings, glanding devices and threads. The application of tape or using reducers is not an acceptable alternative to selecting the correct size connector.

3.9 Terminations and Splices

.1 Use locking fork-type connectors on flat screw-type terminals.

.2 Use ring-type connectors for No. 10 AWG and smaller on stud and post-type terminals and any termination subject to vibration.

.1 Twist-on connectors are limited for use on lighting circuits, control wiring in outlet boxes, luminaires, and with factory-supplied leads or pig-tails in field devices. Pre-twist the conductors tightly prior to installation of twist-on connectors. Do not use twist-on connectors inside panels and apparatus which are equipped with terminal blocks.

.2 Splice connectors for equipment pigtail, lighting, and receptacle circuits: For wire sizes #12 and #10 AWG inclusive, twist-on compression spring type. Wing-Nut by Ideal, Marrette Type II by Marr Electric Ltd., or approved equal.

.3 Use compression-type lugs for No. 8 AWG and larger unless equipment is provided with proper lugs designed for conductor terminations.

.1 Equipment pig-tail power circuit connections: For wire sizes #8 AWG minimum, split-bolt type, sized to suit number and size of conductors. SERVIT Type KS by Burndy Inc., or approved equal.

.4 Unless motor connection boxes are equipped with terminals, use compression-type motor connection lugs and machine bolts with belville washers at motors for conductors up to No. 1 AWG. For No. 1/0 AWG and larger conductors use two-hole long barrel compression lugs and apply self-vulcanizing tape or heat-shrink end cap over termination.

.5 In moist or corrosive areas, apply joint compound to conductor prior to installation of compression fitting.

.6 Exercise care in stripping insulation from wire. Do not nick conductors.

.7 Strictly follow manufacturer's instructions with regards to tool size and application methods of terminations and compounds.

3.10 Accessories

.1 Cable grips: To accommodate type and geometry of cable supported, single weave, variable mesh design, by ABB (Thomas and Betts), Eaton (Crouse Hinds), or approved equal.

3.11 Colour Coding

.1 See Section 26 05 00 - Common Work Results - Electrical for additional requirements, and City of Winnipeg standards.

.2 Colour code all power distribution and control conductors at both ends throughout Facility.

.3 Same colour for same phase throughout, by insulation colour or permanently applied colour banding at all distribution centres, panels and outlet boxes.

.4 Colour tape shall be vinyl, 19 mm wide.

.5 Conductor Colour coding to be in accordance with CEC and as follows:

Conductor	**Colour**
Equipment Grounding Conductor	Green
Neutral Conductor	White
1 Phase, 3 Wire	Red, Black, White
3 Phase	Red (Phase 1), Black (Phase 2), Blue (Phase 3)
DC (Positive), 3 Wire	Red
DC (Negative), 3 Wire	Black
DC (Ground), 3 Wire	White or Gray

3.12 Cable Identification Tags

.1 See Section 26 05 00 - Common Work Results - Electrical for additional requirements.

.2 Sleeve: Permanent, PVC, white, with legible machine-printed black markings.

.1 Manufacturer and Product: Raychem; Type D-SCE or ZH-SCE.

.3 Heat Bond Marker:

.1 Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.

.2 Self-laminating protective shield over text.

.3 Machine printed black text.

.4 Manufacturer and Product: 3M Co.; SCS-HB.

.4 Marker Plate: Nylon, with legible designations permanently hot stamped on plate.

.5 Tie-On Cable Marker Tags:

.1 Chemical resistant white tag.

.2 Size: 13 mm by 51 mm.

.3 Manufacturer and Product: Raychem; Type CM-SCE.

.6 Grounding Conductor: Permanent green heat-shrink sleeve, 51 mm minimum.

.7 Cable Ties:

.1 Nylon, adjustable, self-locking.

.2 Use nylon cable ties only in horizontal cable tray runs to secure cables to the tray. Nylon cable ties are not to be used for cable support.

.3 Manufacturer and Product: Thomas & Betts Ty-Rap.

.8 All 120/208V power cables require a tag. If tag is not indicated on Drawings, request tag from Contractor Administrator.

.9 Use wire markers in terminating all wiring, including but not limited to power, control, signal, communication, and lighting wiring.

.10 Identify all multi-conductor cables at all termination points with wire markers. In addition to identifying the cable, identify each of the individual conductors at all termination points, unless it is a colour-coded power conductor. All cable markers must be readily visible when the device cover is open.

.11 All control conductors shall have wire numbers at both ends of each wire using Brady heat shrink sleeves with typewritten wire numbers. Wire markers shall have a white background and black lettering. Handwritten tags on adhesive tape is not acceptable. The Contractor shall adhere to the tagging scheme shown on the control Drawings.

.1 Heat shrink insulation shall be used where additional insulation or dressing of connected cables is required. Electrical tape shall not be used for additional insulation or dressing of connected cables. The use of heat shrink tubing and electric heat gun to heat the shrink tubing is the required method.

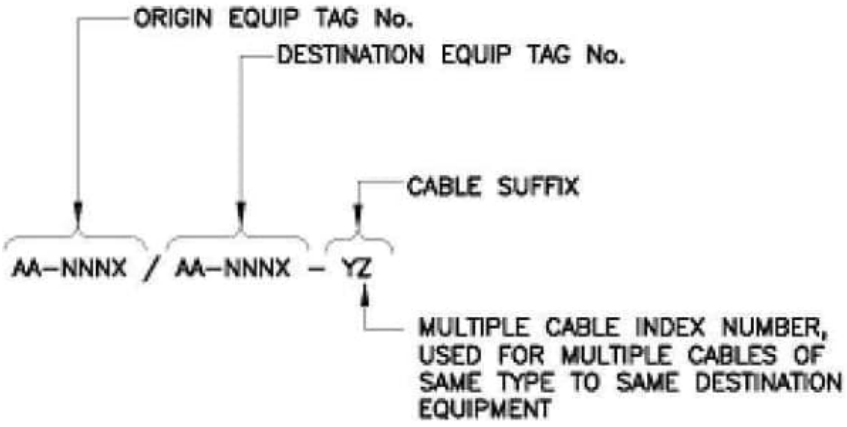
.1 Thermally stabilized, crosslinked polyolefin.

.2 Manufacturer and Product: Thomas & Betts Shrink-Kon. or approved equal.

.12 Cable identification must be UV and weather resistant for outdoor applications and must be able to maintain placement with weather between -50 and +50°C. Do not use zip ties on outdoor installations.

3.13 Cable Tagging

.1 Cables shall be identified by Original Equipment Tag, Destination Equipment Tag, and Cable suffix. All cables shall have the full tag for complete identification, partial tagging is unacceptable.



.1 Cable Suffix “Y”:

.1 For Instrument/Control Cable types use:

.1 A = Analog Cable.

.2 C = Control Cable.

.3 D = Data Cable.

.4 E = Ethernet Cable.

.5 F = Fiber Cable.

.6 S = Security Cable.

.7 T = Telephone Cable.

.2 For Power cable types use:

.1 P = Power Cable.

.2 M = Motor Cable.

.2 Cable Suffix “Z” examples have been provided, use the appropriate number of sets:

.1 One set of cable = 1.

.2 Two sets of cables = 2.

.3 Example Cable Tags (full identification) has been provided:

.1 Example Power Feed Cable: CSTE-1 / SWBRD-001-P3.

.2 Example Motor Cable: MCC-1 / P-100-M1.

.3 Example Instrument Cable: LCP-PLC-001 / 30-FIT-4112-A1.

3.14 Testing

.1 As required under Division 26, other Divisions, by manufacturers, and by vendors.

.2 See Section 26 05 00 - Common Work Results - Electrical for additional requirements.

.3 See Division 26 08 05 - Acceptance Testing - Electrical for additional requirements.

END OF SECTION

GROUNDING SECONDARY

1. GENERAL

1.1 Description

.1 Supply and install a complete permanent, continuous grounding system to include new equipment provided in this Contract. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest Canadian Electrical Code, Local Building Code, the local Electrical Inspection Branch, and the Contract Documents.

.2 Provide a single, complete, integrated grounding system, including conductors, raceways, and connections, indicated and specified, and in accordance with the CSA. The system is to consist of cables, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.

.3 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Switchgear, substations, motor control centers (MCC), electric equipment enclosures etc., outdoor substations, transformers, switch structures, frames of motors, duct systems, control panels, generators, elevators and escalators, distribution panels, outdoor lighting etc.; ground grid systems with ground rod and water pipe connections; structural steel (building steel work), and lightning protection system.

.4 Include grounding conductors completely inter-connecting water supply pipe, ground rods, ground grid, substation, switchgear and motor control center ground buses, other distribution equipment, and other groundable equipment.

1.2 References

.1 ASTM International (ASTM):

.1 B3, Standard Specification for Soft or Annealed Copper Wire.

.2 B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

.3 B33, Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

.2 Canadian Standards Association (CSA):

.1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations, and Update No. 1.

.2 CSA C22.3 No. 3, Electrical Coordination.

.3 CSA C22.2 No. 27, Busways (Tri-national standard with UL-857 and NMX-J-148-ANCE).

.4 CSA B72, Installation code for lightning protection systems.

.3 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE 80, Guide for Safety in AC Substation Grounding.

.2 IEEE 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

.3 IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems.

.4 IEEE 399, Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book).

.5 IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.

.4 National Fire Protection Association (NFPA):

.1 780, Lightning Protection Code.

.5 Underwriters Laboratories (UL):

.1 467, Standard for Grounding and Bonding Equipment.

1.3 Action and Informational Submittals

.1 Submit Shop Drawings and manufacturers' product data in accordance with requirements of Division 1 and Division 26.

.2 All hardware shall bear either CSA or cUL approvals.

.3 Submit catalog and dimensional data for the following:

.1 Ground rods.

.2 Connecting hardware.

.3 Product Data: Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.4 Submit all ground continuity and all ground resistance system test results.

2. PRODUCTS

2.1 Manufacturer's Compliance

.1 Manufacturer's acceptance contingent upon products' compliance with the specifications.

.2 Manufacturers adherence to the Canadian Electrical Code and UL Standard 467.

2.2 Grounding Conductors

.1 Provide copper grounding conductors bare or insulated, sized as indicated. When not indicated on the drawing provide in accordance with CSA. Provide protection of conductors in locations where physical damage would result from direct exposure.

.1 Grounding and bonding conductors for substations, main panels and distribution points, and ground rod connections shall be annealed copper type conforming to ASTM B3, stranded, with 98% conductivity.

.2 Unless noted otherwise, all conductors No. 8 AWG and larger shall be stranded, Class B in accordance with ASTM B8.

.1 Uninsulated conductors shall be bare copper in accordance with ASTM B3 for soft annealed copper (CU), tinned in accordance with ASTM B33.

.2 Use tinned-coated in corrosive/hazardous environments including when buried in earth, or embedded in concrete.

.2 Equipment and Facility bonding where portions of the underground installation are in RPVC conduit only: use green jacketed RWU90 XLPE, copper, size as indicated.

.1 Equipment ground conductors run with circuit conductors and grounding electrode conductor shall be 600 V with green insulation, unless noted otherwise on the Contract Documents.

.3 Portions of the installation are above ground with connection to the underground grounding system: Installations in vertical RPVC conduit with connection to the underground grounding system: use green jacketed RWU90 XLPE, copper, size as indicated.

.1 Conductors: PVC insulated coloured green, stranded soft annealed copper wire No. 10 AWG for grounding meter and relay cases.

.4 Grounding Conductor Electrode: All other portions of underground and/or exterior installations shall be direct burial in contact with bare earth: bare copper, size as indicated.

.1 Conductors: bare, stranded, soft annealed copper wire, size No. 4/0 AWG and 2/0 AWG for ground bus, electrode interconnections, metal structures, gradient control mats, transformers, switchgear, motors, ground connections etc.

.5 Interior Facility (cable trays, conduits, interconnections between switchgears/MCCs etc.) for above grade connections only.

.1 Ordinary Location: size as indicated, green jacketed, copper, with thermoplastic insulation type TWH rated at 600 V, minimum FT1, typically used for insulated ground wires. Alternatively, RW90 XLPE with minimum FT1 is also acceptable.

2.3 Connectors and Fasteners

.1 Dry Locations Only (above grade, or inspection wells):

.1 Cast, set screw, or bolted are permitted.

.2 Cadweld joints are permitted.

.3 Use mechanical connectors for grounding connections to equipment provided with lugs.

.2 Compression-tool applied. Burndy “Hyground Compression System,” or equal.

.3 Grounding lugs where furnished as standard manufacturer’s items on equipment.

.4 Provide ground clamps which are CSA listed for use on copper or brass pipes.

.5 Provide ground clamps, for use on iron pipes, of galvanized or malleable iron, or of standard noncorrosive material for use on iron pipes.

.6 Provide ground clamps, for use on pipes, with rigid metal base providing good contact by proper seating on the pipe. Do not use strap type clamps.

2.4 Ground Rod Electrode

.1 Vertical Rod electrodes: copper clad steel, shall be a minimum size of 19 mm (3/4”) diameter by 3 m (10 ft) long.

.1 Where ground wells are indicated, provide a 12 inch deep, 8 inch diameter precast concrete well with flush lid for accessibility and inspection of compressed connections.

.2 Ground rods shall be clean and smooth with the following characteristics:

.1 Cone-shaped point on the first section.

.2 Die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in millimeters or feet.

.3 Install rod electrodes and make grounding connections.

2.5 Concrete Encased Electrode

.1 Copper conductor: minimum 6.0 m long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size as indicated.

.2 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

.3 Install concrete encased electrodes with terminal connected to grounding network.

2.6 Ground Busbar Assemblies

.1 Facility Ground Busbar (for exposed wall-mount installations only):

.1 Provide tinned copper ground bar(s) complete with lugs suitable to terminate all ground cables, insulated supports, fastenings, connectors. Bus shall be complete with pre-drilled holes suitable for lug mounting as required. Refer to Drawings for further details.

.2 Installation shall be in accordance with CEC 10-616, and Table 16.

.3 Minimum cross-sectional area of the busbar shall be provided in accordance with Table 16, and the number of bonding connections required plus 20%. In smaller installations the minimum size shall be 12 mm thick, 100 mm high, and 1000 mm long.

.4 The minimum electrical rating for the ground bus shall be 600 V, factory complete with pre-installed 1.5 kV insulated stand-offs. Where installations call for back-to-back insulated stand-offs the ground bus shall first be ordered as a complete assembly that includes factory pre-installed insulated stand-offs to ensure the assembly arrives to site CSA certified/listed. Only onsite shall additional back-to-back insulated stand-offs be installed in addition to the standoffs that already come with the CSA certified/listed busbar assembly.

.5 The facility ground busbar assembly shall be ordered as a complete unit including insulated standoffs to maintain its certified/listing to C22.2 No. 27 (joint standard with UL 857 and NMX-J-148-ANCE). This standard applies to service-entrance, feeder, and branch-circuit busways and associated fittings rated at 600V or less, 6000A or less, and intended for use in accordance with the CEC (and NEC), NFPA 70, and the Mexican standard for Electrical Installations (Utility, NOM-001-SEDE). These requirements do not apply to metal enclosed bus intended for connecting switchgear assemblies for use in prefabricated electrical distribution systems.

.2 Cables shall be connected to ground bars via heavy duty, 2 Hole, compression Lug Connector for bolt-on connection to the ground busbar.

.1 Connectors for cables equal or less then 2/0 shall be compact type.

.2 Connectors for cables equal or grater then 3/0 shall be brazed type.

.3 Exterior/Outdoor Ground Busbar:

.1 The same requirements as the Facility ground Busbar above except:

.1 Bus bar shall have a minimum 18 pre-drilled holes, two standoff insulators, two stainless steel mounting brackets and four stainless steel assembly bolts and lock washer.

.2 The ground busbar assembly shall be installed an enclosure with a minimum rating of CSA/NEMA 3R.

2.7 Accessories

.1 Shall be non-corroding type, necessary for complete grounding system, type, size material as indicated, including:

.1 Grounding and bonding bushings.

.2 Protective type clamps.

.3 Bolted type conductor connectors.

.4 Thermit welded type conductor connectors.

.5 Bonding jumpers, straps.

.6 Pressure wire connectors.

2.8 Manufacturers

.1 Ground Rods (Copper):

.1 Thomas & Betts (ABB).

.2 Compression Connecting Hardware:

.1 Thomas & Betts (ABB).

.2 Brundy.

.3 Ground bar (tin plated) with Insulated Standoffs:

.1 Erico.

3. EXECUTION

3.1 Installation – General

.1 Make special provision for installing electrodes that will give acceptable resistance to ground value, where rock or sand terrain prevails.

.2 Install complete permanent, continuous grounding system, including conductors, accessories. All connectors shall be installed in accordance with Manufacturers' requirements, and to the requirements of the local Authority Having Jurisdiction (AHJ). All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded via a ground conductor.

.3 All bolted connections must be accessible.

.4 Bond individual cable tray sections with bonding jumpers.

.5 Ground all utility services to the electrical system ground.

.6 Bond all building columns, structural steel, and metal siding, within or forming part of building/facility envelope. Including any current carrying exposed metal such as fences, tanks, equipment, or structures using copper welding by thermit process.

.7 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per Canadian Electrical Code.

.8 Protect exposed grounding conductors from mechanical injury.

.9 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.10 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

.11 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process.

.1 Make ground connections to continuously conductive underground water pipe on street side of water meter.

.12 Ground secondary service pedestals.

.13 Protect exposed grounding conductors during and after construction.

3.2 Compression Fittings

.1 Use compression connectors for all grounding splices and terminations unless otherwise shown on the Drawings.

.2 Compression fittings will make a connection without corroding or loosening.

.3 The compression joint shall join all strands and not cause the parts to be damaged or weakened.

.4 Completed connection or joint shall be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor.

.5 Paint buried ground connection with a bitumastic paint.

3.3 Installation of Grounding Conductors

.1 Install grounding conductors so that they will not be exposed to physical damage. Install connections firm and tight. Arrange conductors and connectors so no strain on connections.

.2 Run grounding conductors associated with direct burial cables in common trenches above cables except as indicated otherwise.

.3 Bury equipment grounding conductors 30 inches deep. Bring loops or taps up for connection to equipment or other items to be grounded.

.4 Where raceways are used to contain and protect grounding conductors, install in accordance with Division 26.

.5 Where bare grounding conductors are contained within metallic raceways, bond ends of raceways to conductors.

.6 Install loop type, low impedance, grounding system interconnecting all components so at least two grounding connections are provided for each major item of electrical equipment. Ensure that severing of any single grounding conductor in this system does not remove grounding protection on any major item.

.7 Connect structural steel to the external perimeter loop of grounding conductors installed around all sides of building foundation as indicated on the drawings otherwise buried a minimum 30 inches below grade. Connect to each vertical column by loop or tap. Connect two opposite points on external loop to two different points on grounding system.

.1 Connect building structural steel and metal siding to ground by welding copper to steel.

.8 Make accessible connections to structural members by bolted connector. Connections to equipment or ground bus by bolted connectors.

3.4 Installation of Ground Rods

.1 Install ground rods in manholes in accordance with requirements specified under the section Underground Distribution Systems. Connect each grounding conductor entering a manhole to ground rod by compression joint.

.1 Install conveniently located grounding electrode and size 3/0 stranded copper conductor in each manhole.

.2 Install ground rod in each manhole so that top projects through bottom of manhole. Provide with lug to which grounding connection can be made.

.2 Install ground rods where indicated. Unless otherwise indicated on the Drawings, install the top of the rod 12 inch (300 mm) below the ground surface.

.3 Make connection to overall grounding system as indicated.

.4 Connect individual ground rods to the grounding loop using the direct burial grounding cable.

.5 Make grounding connections in radial configuration only, with connections terminating at single grounding point with CT’s of equal spacing. Avoid loop connections.

3.5 Equipment Grounding

.1 Connect grounding conductors from equipment in area where ground bus is required to ground bus. Connect ground bus to grounding system.

.2 All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded via a ground wire. Use mechanical connectors for grounding connections to equipment provided with lugs.

.3 Facility Distribution Equipment:

.1 All service equipment, power transformers, switchgear, motor control centers (MCCs), switchboard/panelboards and splitters fed from the main distribution centre shall be grounded by grounding conductors sized as shown, or as required by code. The ground

conductor shall be terminated at each end with an appropriate grounding lug which shall be connected to the equipment ground bus. Provide grounding conductor with green insulation. Use mechanical connectors for grounding connections to equipment provided with lugs.

.1 Install electrical room ground bus to wall at location as indicated, utilizing insulated off sets.

.2 All main distribution centres, MCCs, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground conductor required.

.3 Connect two (2) separate ground connections from ground grid to ground bus of switchgear assemblies, MCCs, switchboards and all outdoor substation and transformer equipment. Ensure that each connection for item of equipment is from different section of ground grid.

.4 Connect a grounding conductor between panelboard and grounding system. Where a grounding bar is furnished with panelboard, connect grounding conductor to bar.

.5 Connect power transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two (2) separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.

.1 Connect generator neutral to grounding system by a grounding conductor. Connect grounding conductor to generator disconnect enclosure and generator neutral on generator side of disconnect. Ground generator frame with two separate independent connections, so removal of one connection will not impair continuity of other.

.2 All sub panels such as lighting panels, local distribution panelboards, etc., shall be grounded with a green ground conductor run back to the panel from which it is fed. The ground conductor shall be sized according to the Canadian Electrical Code.

.3 Install grounding connections to duct systems, frames of motors, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting.

.4 Connect surge protection devices to ground system by suitable conductors. Where lightning arresters are furnished with electrical equipment and grounding connections are not inherently provided, ensure that suitable separate grounding conductor connects lightning arresters with system ground.

.5 Other Equipment:

.1 Ground each piece of electrical equipment by means of a grounding & bonding conductor installed in raceway feeding that piece of equipment. Grounding conductors installed in conduit with insulated conductors to be furnished with green, 600 V insulation. Ground conductors are in addition to and not to be considered as the neutral wire of the system, and may be additional bonds as indicated on the drawings.

.2 All motors shall be bonded by means of an adequately sized ground conductor contained within the feeder cable. In larger sized motors installations, or as indicated on the Drawings, or where specialty applications require it provide an additional bonding conductor.

.1 Install a separate grounding conductor from ground system to motors of 100 horsepower and larger, in addition to the raceway system. Ground motor ground connection to motor frame, independent of mounting bolts or sliding base. Ground motor to nearest point on grounding system, unless otherwise indicated.

3.6 Conduits

.1 Include a separate green ground conductor in all power conduits including branch circuit wiring sized to Canadian Electrical Code.

.2 Install RPVC conduit sleeves where ground conduits pass through concrete slabs.

.3 Conduit installed buried in earth or installed in or under grade floor slabs shall have separate ground conductors installed.

.4 Conduits entering metal enclosures shall utilize bonding type locknuts and grounding bushings. Locknuts that gouge into the metal enclosures are not acceptable.

.5 Where conduits are not effectively grounded by firm contact with a grounded enclosure, apply grounding bushings on at least one end of conduit run. Conduit connections shall be wrench tight.

.6 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

3.7 Other Outdoor Grounding

.1 Ground each street lighting standard by ground rod driven near base of standard, in accordance with requirements of CSA. Connect ground rods to grounding conductor brought with street lighting feeder cable.

.1 Ground transformers, lightning arresters, insulators and other appurtenances, installed on poles, poles and timber structures, or metal structure. Run grounding conductors between poles or structure and ground rods. Install ground rod at base of pole and drive the rod down until it is a minimum of 300 mm (12”) below ground.

.2 Wood poles: Provide protective molding cover over the grounding conductor to a height at least 2500 mm (8 feet) above ground, with both molding and conductor stapled.

.3 Install separate ground conductor to outdoor lighting standards.

.2 Ground wire fences when used to enclose electrical equipment or when overhead electrical lines cross fence. Unless otherwise indicated, provide grounding by buried outside peripheral ground loop; connections to each corner fence post and nearby ground rod; flexible

connections to each gate; and at least two connections to grounding system from approximately opposite positions on fence.

3.8 Signal Grounding

.1 Ground signal surge protection and shields of twisted, shielded cable using a signal bonding conductor. The signal bonding conductor shall be a continuous path from the instrument surge protection or shield to the grounding electrode conductor. The signal bonding conductor shall be isolated from the equipment grounding conductor for its entire path.

.2 Where convenient several signal bonding conductors may be combined, providing that all the following conditions are met:

.1 The combined signal bonding conductor shall have the equivalent cross section of the conductors that it was combined from or three times the cross section of the largest conductor that it was combined from, whichever is less.

.2 The combined signal bonding conductor shall be isolated from the equipment grounding conductor.

.3 Where two signal bonding conductors are combined use a three port insulated splice.

.4 Where three or more signal bonding conductors are combined, use a copper bus mounted on 600 V insulators. Attach each conductor to the bus using an insulated ring tongue lug and screw terminal.

3.9 Neutral Grounding

.1 Install system and circuit grounding connections to neutral of secondary 600 V systems, secondary 208 V systems.

.2 Connect transformer neutral and distribution neutral together using 1000 V insulated conductor to one side of ground test link, the other side of the test link being connected directly to main station ground. Ensure distribution neutral and neutrals of potential transformers and service banks are bonded directly to transformer neutral and not to main station ground.

.3 Interconnect electrodes and neutrals at each grounding installation.

.4 Connect neutral of station service transformer to main neutral bus with tap of same size as secondary neutral.

.1 Run a second Neutral cable for transformers as indicated on the drawings.

.5 Ground transformer tank with continuous conductor from tank ground lug through connector on ground bus to primary neutral. Connect neutral bushing at transformer to primary neutral in same manner.

3.10 Communications Grounding

.1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:

.1 Telephones: make telephone grounding system in accordance with telephone company's requirements.

.1 Install one No. 2 insulated ground conductor to ground bus in telephone equipment cabinet.

.2 Connect one No. 12 insulated ground conductor to all conduits terminating at backboard.

.2 Sound, fire alarm, intercommunication systems as indicated.

3.11 Field Quality Control

.1 Perform tests in accordance with Section 26 08 05 - Acceptance Testing - Electrical.

.2 Test grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise must not exceed 50 milliohms.

.3 Ensure that final resistance of interconnected ground system is 5 ohms, or less.

.1 Ground resistance and counterpoise tests must be made during dry weather and no sooner than forty-eight (48) hours after rainfall. Conditions of soil and weather shall be documented on test forms.

.2 Complete grounding testing and validations prior to backfill.

.4 Perform continuity test on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

.5 Indicating instrument must be self-contained and include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Calibrate direct-reading ohmmeter for ranges of 0 to 20 ohms and 0 to 200 ohms.

.6 Perform ground continuity and resistance tests using method appropriate to Site conditions and to approval of Contract Administrator and local Authority Having Jurisdiction over installation.

.1 Temporary disconnect the two grounding conductors between the facility ground busbar and the facilities underground grounding system. Reconnect when testing is complete.

.2 Mark on the drawings clarifying ground rod(s) where the testing took place (i.e. Gridline X and Gridline X).

.3 Optional Method 1 – The 4-pole Earth Resistance Test:

.1 On the mark-up drawing, include the Testing instrument electrode names and distance between them.

.2 Place auxiliary grounding electrodes in accordance with instrument manufacturer's recommendations but not less than 50 feet (15 m) apart, in accordance with IEEE Standard 81.

.4 Optional Method 2 – The Induced Frequency Method (Radio method):

.1 If proceeding with this method ensure a minimum of four (4) ground rods are checked (i.e. at each corner of the grid or facility).

.2 Measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE Standard 81.

.7 Perform tests before energizing electrical system.

.8 Disconnect ground fault indicator during tests.

.9 Submit all ground continuity and resistance test results and markup sheets within three (3) days of field tests, and prior to commissioning activities for Contract Administrator's review.

3.12 Contract Closeout

.1 Provide in accordance with Section 01 78 00 - Closeout Submittals.

END OF SECTION

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1. GENERAL

1.1 Work Included

.1 Supply and install all hangers, supporters and inserts for the installation shown on the Drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

.2 Provide supports from building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 References

.1 ASTM International (ASTM):

.1 A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.2 A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.3 A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

.4 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.5 E119, Standard Method for Fire Tests of Building Construction and Materials.

.6 E814, Standard Test Method of Fire Tests of Through Penetration Firestops.

.2 FM Global (FM):

.1 Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

.3 Canada Standards Association (CSA):

.1 CSA C22.1, Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.

.4 Manitoba Electrical Code (MEC):

.1 Manitoba amendments to the Canadian Electrical Code.

.5 Underwriters Laboratories, (UL): Applicable listings.

.1 FRD, Fire Resistance Directory.

.2 263, Fire Tests of Building Construction and Materials.

.3 723, Test for Surface Burning Characteristics of Building Materials.

.4 1479, Fire Tests of Through-Penetration Firestops.

1.3 Submittals

.1 Submit the Shop Drawings in accordance with Division 1 and Division 26.

.2 Submit Shop Drawings and manufacturers' product data in accordance with the requirements of Division 26.

2. PRODUCT

2.1 Framing and Support System

.1 Materials:

.1 Intermediate duty supporting structures shall employ 41 mm square strut channel together with the Manufacturer’s connecting components and fasteners for a complete system.

.2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.

.3 Shall be rated for use in hazardous locations and category environments as necessary.

.4 Steel or malleable iron.

.5 Aluminum where indicated.

.6 Stainless steel where indicated.

.2 Coatings/Finishes:

.1 Provide products for use outdoors.

.1 Hot dipped galvanized.

.2 Supports, support hardware, fasteners, nuts, bolts, machine screws:

.1 Protect Steel and malleable iron:

.1 Cadmium plated for assemblies where sacrificial deterioration would normally take place damaging other fittings.

.2 Zinc coated where sacrificial deterioration will not take place.

.3 Use PVC coating where indicated on Drawings.

.3 Square strut channel:

.1 Section 41 mm square strut channel or as required for load and span, with mounting screws, or approved. 41 mm square strut channel is a minimum standard for supporting conduits 50 mm and larger.

2.2 Concrete and Masonry Anchors

.1 Materials: hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of 4.

2.3 Non-Metallic Anchors

.1 Material: plastic anchors for sheet metal screws.

2.4 Cable Supports and Clamps

.1 General: as per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

2.5 Manufactured Supporting Devices

.1 Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

.2 Fasteners: Types, materials, and construction features as follows:

.1 Expansion Anchors: Carbon steel wedge or sleeve type.

.2 Toggle Bolts: All steel springhead type.

.3 Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for intended service.

.4 Nuts, Washers, and Bolts: Stainless steel.

.3 Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

.4 Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers.

.5 U-Channel Systems: Channels, with 9/16 inch (14 mm) diameter holes, at minimum of 8 inch (200 mm) on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacture.

2.6 U-Channel Systems

.1 Manufacturers, Stainless Steel/Galvanized Steel Channel.

.1 Unistrut Corp.

.2 B-Line Systems, Inc.

.2 Provide Type 316 stainless steel channel with corresponding accessories.

.3 Channels, with 9/16 inch (14 mm) diameter holes, at minimum of 8 inch (200 mm) on center, in top surface.

.4 Provide fittings and accessories that mate and match with U-channel and are of same manufacture.

.5 Provide hot-dipped galvanized after fabrication for steel channel and accessories.

.6 Provide channel of the proper material to match equipment classifications.

2.7 Fabricated Supporting Devices

.1 Shop or field fabricate supports or manufacture supports assembled from U-channel components.

.2 Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

.3 Pipe Sleeves: Provide pipe sleeves using one of the following:

.1 Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from following gage metal for sleeve diameter noted:

.1 3 inch (75 mm) and smaller: 20 gage (0.9 mm).

.2 4 inch (100 mm) to 6 inch (150 mm): 16 gage (1.5 mm).

.3 Over 6 inch (150 mm): 14 gage (1.9 mm).

.2 Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.

.3 Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

2.8 Fire Resistant Joint Sealers

.1 Manufacturers:

.1 “Dow Corning Fire Stop Foam,” Dow Corning Corp.

.2 “Pensil 851,” General Electric Co.

.3 Or Approved Equal.

.2 Two part, foamed-in-place, silicone sealant formulated for use in through penetration fire stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.

.3 Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to Authorities Having Jurisdiction.

3. EXECUTION

3.1 General

.1 Do not cut or drill beams, joists or structural steel unless written permission of the Contract Administrator is obtained.

.2 Distance between conduit or cable supports not to exceed code requirements.

.3 Supports to be suitable for the real loads imposed by equipment.

.4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 m span and 8 mm over a 2 m span.

.5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

.6 Provide rack with 25% spare capacity for multiple runs.

.7 Provide channel support with fittings for vertical runs of conduit and cables.

3.2 Installation

.1 Coordinate with structural system and with other electrical installations, the building manufacturer, or structural engineer. Ceiling installations shall only commence after confirming the anticipated weight and attachment locations have been coordinated with the building manufacturer, or structural engineer.

.2 Install supporting devices to fasten electrical components securely and permanently in accordance with CSA and Building code requirements.

.1 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.3 Secure equipment:

.1 To solid masonry, tile and plaster surfaces with lead anchors or nylon shields.

.2 To poured concrete with expandable inserts.

.3 To hollow masonry walls or suspended ceilings with toggle bolts.

.4 For surface mount with twist clip fasteners to inverted T-bar ceilings. Ensure that T-bars are adequately supported to carry weight of equipment specified before installation.

.4 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole malleable iron or steel straps to secure surface conduits and cables 50 mm and smaller.

.2 Two-hole steel straps for conduits and cables larger than 50 mm.

.3 Beam clamps to secure conduit to exposed steel Work.

.5 Suspended support systems.

.1 Support individual cable or conduit runs with a minimum of 6 mm diameter threaded rods and spring clips.

.2 Support two (2) or more cables or conduits on channels supported by a minimum of 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.

.3 When selecting threaded rod utilize a safety factor of five (5) times the maximum load tray system load (i.e. the installed weight needs to be less than the maximum load divided by 5). Loading factors may vary by manufacturer, threading type and pitch, material properties, anchoring, accessories, mechanical/seismic moments, stiffners etc. Also refer to the manufacturers product literature for additional requirements and limitations.

.1 All other materials for the cable tray support system(s) shall be a minimum of three (3) times the weight of all cabling installed in the cable tray / channel.

Threaded Rod Size mm (inches)	**Maximum Load** kN (lbs)
6 (1/4)	1.07 (240)
8 (5/16)	1.78 (400)
10 (3/8)	3.24 (730)
13 (1/2)	6.00 (1350)
16 (5/8)	9.60 (2160)
19 (3/4)	14.37 (3230)
22 (7/8)	19.93 (4480)
25 (1)	26.24 (5900)

.6 The Contractor shall NOT:

.1 Use plastic anchors unless for lighter loads. Use metal anchors for all other loads.

.2 Use wire lashing or perforated strap to support or secure raceways or cables.

.3 Use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Contract Administrator.

.4 Use Shot driven pins. These may only be used with written approval of the Contract Administrator.

.7 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.9 Raceway Supports: Minimum material requirements:

.1 Conform to manufacturer's recommendations for selection and installation of supports.

.2 Strength of each support shall be adequate to carry present and future load multiplied by safety factor of at least 4. Where this determination results in safety allowance of less than 200 lbs (890 N), provide additional strength until there is minimum of 200 lbs (890 N) safety allowance in strength of each support.

.3 Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

.4 Support parallel runs of horizontal raceways together on trapeze-type hangers.

.5 Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 inch (25 mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch (6 mm) diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

.6 In vertical runs, arrange support so load produced by weight of raceway and enclosed conductors is carried entirely by conduit supports with no weight load on raceway terminals.

.10 Vertical Conductor Supports: Install simultaneously with installation of conductors.

.11 Sleeves: Install in concrete slabs and walls and other fire-rated floors and walls for raceways and cable installations. For sleeves through fire rated wall or floor construction, apply CSA/cUL listed firestopping sealant in gaps between sleeves and enclosed conduits and cables. Refer to Building Code and Division 26 for further requirements.

.12 Conduit Seals: Install seals for conduit penetrations of slabs below grade and exterior walls below grade and where indicated required by Code. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

.13 Conduit extending through roof shall pass through ceiling box at roof line.

.1 Provide 14 gage (1.9 mm) minimum copper box complete with watertight soldered seams and flanged to serve as pitch pocket for each conduit.

.2 Install conduit and pitch pocket in advance of roofing work.

.14 Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with following:

.1 Fasten by means of wood screws or screw type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring tension clamps on steel. Threaded studs driven by powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

.2 Holes cut in concrete shall not cut main reinforcing bars. Fill holes that are not used.

.3 Load applied to any fastener shall not exceed 25% of proof test load. Use vibration and shock resistant fasteners for attachments to concrete slabs.

.15 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four (4) 6 mm fasteners.

.1 Use round or pan head screws for fastening straps, boxes, etc.

3.3 Channels

.1 Support electrical components as required to produce same structural safety factors as specified for raceway supports.

.2 Install metal U-channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

.3 Install Type 316 stainless steel for mounting of electrical equipment in outdoor areas and on below grade, outside building and structure walls.

.4 Install galvanized steel channels for interior building mounting of electrical equipment except for those locations listed above and unless otherwise indicated.

.5 Concrete walls and ceilings: Surface mount set in poured concrete with a minimum size of 41 x 41 mm, 2.5 mm thick of U-shape type.

3.4 Contract Closeout

.1 Provide in accordance with Section 01 78 00 - Closeout Submittals.

END OF SECTION

SPLITTERS, JUNCTION, PULL BOXES, AND CABINETS

1. GENERAL

1.1 Section Includes

.1 Materials and components for splitters, junction, pull boxes and cabinets.

1.2 References

.1 Canadian Standards Association (CSA International):

.1 CSA C22.2 No. 0, General requirements – Canadian Electrical Code, Part II.

.2 CSA C22.2 No. 0.4, Bonding of electrical equipment.

.3 CSA C22.2 No. 14, Industrial control equipment.

.4 CSA C22.2 No.76, Splitters.

.5 CSA C22.2 No. 30, Explosion-proof equipment.

.6 CSA C22.2 No. 40, Junction and pull boxes.

.7 CSA C22.2 No. 94, Special Purpose Enclosures.

.8 CSA C22.2 No. 94.1, Enclosures for electrical equipment, non-environmental considerations (Tri-national standard with NMX-J-235/1-ANCE and UL-50).

.9 CSA C22.2 No. 94.2, Enclosures for electrical equipment, environmental considerations (Tri-national standard with NMX-J-235/2-ANCE and UL-50E).

.10 CSA C22.2 No. 286, Industrial control panels and assemblies.

.2 Electrical Equipment Manufacturers Association of Canada (EEMAC), now known as Electro-Federation Canada.

.3 Manitoba Building Code (MBC):

.1 The Buildings and Mobile Home Act amendments to the National Building Code of Canada (NBC).

.4 Manitoba Electrical Code (MEC):

.1 Manitoba amendments to the Canadian Electrical Code (CEC).

.5 National Electrical Manufacturers Association (NEMA):

.1 NEMA ICS 6, Industrial Control and Systems: Enclosures.

.6 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.7 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

.8 Underwriters Laboratories Canada (cUL):

.1 508A, Industrial Control Panels.

.2 698A, Industrial Control Panels Relating to Hazardous (Classified) Locations.

.3 1203, Explosion Proof and Dust-Ignition Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

1.3 Shop Drawings and Product Data

.1 Submit Shop Drawings and product data indicating the components and equipment/cabinets in accordance with Division 1 and Division 26.

.1 Manufacturer's data sheets for each type of junction box, cabinet, splitter, and pull box.

.2 Provide Manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size/dimensions, enclosure ratings, lug/terminal ratings, accessories/components, finish and limitations.

.1 Provide clarification in which area each type of enclosure / box will be installed, and its intended application.

.3 All materials shall be CSA certified or cUL listed and selected for the application and the environment for which it is installed in. When codes or standards require the enclosure to be certified it shall be manufactured and certified by a local panel shop. Refer to the Drawings and Division 26 for additional information on the intended CSA/NEMA/EEMAC ratings of enclosures by area.

2. PRODUCTS

2.1 Environmental Considerations

.1 Intended to be installed in dry, non-hazardous, non-corrosive process locations:

.1 To be constructed of painted, mild steel.

.2 Back-plate with offsets for installation of devices.

.3 Continuous piano hinge, gasketed seal on door with quarter turn latch and handle.

.2 Intended to be installed in wet or corrosive locations:

.1 Constructed of cast aluminum with threaded connection.

.2 Termination of underground PVC conduit system may be made into an exterior mounted, rigid PVC or Fiberglass enclosure type 4X as applicable.

.3 Utilize 316 stainless steel bolts, washers and mounting hardware.

.3 Intended to be installed in hazardous locations:

.1 Constructed of cast copper free aluminum with threaded connection.

.2 Hinged, bolt-on style aluminum cover with neoprene gasket.

.3 Factory installed aluminum mounting plate for terminals, lugs and electrical devices.

.4 Factory installed threaded openings for conduit and cable connections.

.5 Utilize 316 stainless steel bolts, washers and mounting hardware.

2.2 Junction Boxes, and Pull Boxes

.1 Materials:

.1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.

.2 Components:

.1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.

.2 Use rolled edges for surface boxes.

2.3 Splitters

.1 General:

.1 Three (3) sets of lugs for phases plus neutral, minimum, sized and suitable for conductor termination.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 Provide ground bar, with a minimum of three (3) terminals.

.2 Splitters shall include a hinged lockable cover.

.3 Do not install splitters in hazardous or corrosive areas. If required, install suitable, Class I junction boxes.

2.4 Cabinets

.1 Materials:

.1 Locks: to match panelboards.

.2 Components:

.1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.

.2 Install a back mounting plate for DIN rail mounted terminal blocks. Plate to be painted white enamel.

.3 Install metal divider in cabinets with more than one voltage.

.4 Surface or flush with trim and hinged door, latch and lock and two (2) keys, size as indicated or to suit. Keyed to match panelboard keys 19 mm.

3. EXECUTION

3.1 Installation

.1 Boxes mounted in exterior walls shall be complete with box vapour barriers and gasketing/flashing/sealing per Manitoba Building Code. Maintain wall insulation.

.2 Install in inconspicuous but accessible locations, with a minimum 1m of clearance in front of the equipment in accordance to CEC for working space, and to egress requirements per Building Code.

.1 If junction boxes are required in inaccessible location, provide a suitable access panel which allows sufficient space for opening the junction box.

.3 Junction Boxes and Pull Boxes:

.1 Supply all pull boxes and junction boxes shown on the Drawings or required for the installation.

.2 Boxes installed in party walls to be offset by a minimum of one stud space.

.3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms or storage areas.

.4 Identify with system name and circuit designation as applicable.

.5 Size in accordance with the Canadian Electrical Code, as a minimum.

.6 Terminate cables and conductors as required.

.1 For control signals install terminal block, Weidmuller WDU4 or equivalent.

.7 Make all necessary cable entry holes in junction boxes supplied by Contractor or others, regardless of material.

.4 Splitters:

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

.5 Cabinets:

.1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items.

.2 Install terminal block, Weidmuller WDU4 or equivalent.

.6 Unapproved Electrical Equipment:

.1 The Manitoba Electrical Code (MEC) allows the use of an unapproved Control Box provided all the requirements as outlined under MEC 2-204-4 are followed and provided.

.1 Clarification: Within the jurisdiction of Winnipeg the WEB 2-024 does not allow use of unapproved electrical equipment. Therefore the use any unapproved electrical equipment will be rejected and will require either complete replacement, or the contractor will provide CSA Special inspection certification and remediation of the same at no additional cost to the Contract.

3.2 Identification

.1 Provide equipment identification in accordance with Division 26.

END OF SECTION

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1. GENERAL

1.1 Work Included

.1 Provide a complete installation which includes various boxes and materials for the miscellaneous wiring and equipment as required throughout the Contract Documents.

1.2 References

.1 Canadian Standards Association (CSA):

.1 CSA C22.1: Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.

.2 CSA C22.2 No. 14, Industrial control equipment.

.3 CSA C22.2 No. 18.1, Metallic outlet boxes (Tri-national standard with ANCE NMX-J-023/1 and UL514A).

.4 CSA C22.2 No. 18.2, Nonmetallic outlet boxes.

.5 CSA C22.2 No. 18.3, Conduit, tubing, and cable fittings (Tri-national standard with ANCE NMX-J-017 and UL514B).

.6 CSA C22.2 No. 18.4, Hardware for support of conduit, tubing, and cable (Bi-national standard with UL-2239).

.7 CSA C22.2 No. 18.5, Positioning devices (Bi-national standard with UL-1565).

.8 CSA C22.2 No. 25, Enclosures for use in Class II, Division 1, Groups E, F, and G hazardous locations.

.9 CSA C22.2 No. 30, Explosion-proof equipment.

.10 CSA C22.2 No. 213, Non-incendive electrical equipment for use in Class I and II, Division 2 and Class III, Division 1 and 2 hazardous (classified) locations (Bi-national standard with ISA 12.12.01)

.2 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.3 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

.4 Underwriters Laboratories Canada (cUL):

.1 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

.2 1203, Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

1.3 Shop Drawings and Product Data

.1 Submit product data in accordance with Division 1 and Division 26.

2. PRODUCTS

2.1 Boxes/Bodies General

.1 Size boxes as required to accommodate wiring devices, and in accordance with the CEC.

.2 Boxes shall be environmentally rated and suitable for the installation location. Refer to the drawings and Division 26 for area classifications and additional requirements.

.3 A minimum 100 mm (4") square or larger outlet boxes as required for special devices.

.4 Gang boxes where wiring devices are grouped.

.5 Blank cover plates for boxes without wiring devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

.7 Knock-out covers for sealing penetration holes.

2.2 Sheet Metal Boxes – Dry Unclassified Area

.1 Hot dipped galvanized steel.

.2 All 100 mm (4") square boxes shall be minimum 40 mm deep.

.3 Deep boxes shall be installed where required.

.4 Device boxes shall be minimum 64 mm deep.

2.3 Boxes for Rigid Metal Conduit – Non-Explosionproof

.1 Materials:

.1 Surface mounting exposed: cast copper-free aluminum, ferrous for threaded rigid conduit, with attached mounting lugs, with factory-threaded hubs and plugs, two coats corrosion resistant finish, wet location rated, gasketed covers.

.2 Ceiling outlets (surface mounting):

.1 Manufacturer/Model: Eaton (Crouse-Hinds) VXF/VFT series, or approved equal.

.3 Wall outlets, Wall switches, and Device Boxes (surface mounting):

.1 For exposed mounting either indoors or outdoors.

.2 Single gang, 2-gang, 3-gang as required.

.3 Manufacturer/Model: For one or more gang, Eaton (Crouse-Hinds) FS series or FD series, or approved equal.

.4 Covers: unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

.4 Conduit Junction Boxes (surface mount):

.1 Minimum size of 100 mm (4") round.

.2 Manufacturer / Model: Eaton (Crouse Hinds) GRF or VXF series, or approved equal.

.5 Condulet Outlet Bodies:

.1 For wiring pull points.

.2 Manufacturer / Model: Eaton (Crouse Hinds) Form 7 series, (C, E, L, LB, LL, LR, T, TA, TB, X) to suit the application, or approved equal. All blank covers to be cast aluminum, gasketed wedgenut style covers.

2.4 Boxes for Rigid Metal Conduit – Explosion Proof

.1 Materials:

.1 Surface mounting exposed: cast copper-free aluminum, ferrous for threaded rigid conduit, with attached mounting lugs, with factory-threaded hubs and plugs, two coats corrosion resistant finish, wet location rated, gasketed covers.

.2 Rated for the Hazardous Location.

.2 Conduit Junction Boxes (surface mount):

.1 Minimum size of 100 mm (4") round.

.2 Manufacturer / Model: Eaton (Crouse Hinds) GUA, GUR, EAB, EAJ series, or approved equal.

.3 Condulet Outlet Bodies:

.1 For wiring pull points.

.2 Manufacturer / Model: Eaton (Crouse Hinds) OE series, LBH series, LBY series to suit the application, or approved equal.

.4 Wall outlets, Wall switches, and Device Boxes (surface mounting):

.1 Single gang, 2-gang, 3-gang as required.

.2 For exposed mounting either indoors or outdoors.

.3 Manufacturer / Model: Eaton (Crouse Hinds) EDS or EDSCM series to suit the application, or approved equal.

2.5 Fittings - General

.1 Materials and type to suit the conduit type and the installation requirements.

.2 Bushing and connectors with nylon insulated throats.

.3 Knock-out fillers to prevent entry of debris.

.4 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

.5 Double locknuts and insulated bushings on sheet metal boxes.

.6 Thread Lubricant:

.1 Use thread lubricant to prevent galling of conduit threads when threaded into a coupling, junction box etc. Maintains grounding continuity.

.2 Manufacturer / Model:

.1 Eaton (Crouse Hinds) HTL series.

.2 Emerson (Appleton) TLC series.

.3 Hubbell (Killark) LUBG/LUBT series.

2.6 Fittings for Rigid Metal Conduit – Explosion Proof

.1 Copper free aluminum, threaded fittings for explosion proof hazardous areas.

.2 Sealing fittings:

.1 Manufacturer / Model:

.1 Eaton (Crouse Hinds) EYS-SA, EZS-SA.

.2 Emerson (Appleton) type EYF-AL or EYM-AL.

.3 Hubbell (Killark) type EY or EYS.

.3 Drain sealing fittings:

.1 Manufacturer / Model:

.1 Eaton (Crouse-Hinds) type EYD-SA or EZD-SA.

.2 Emerson (Appleton) type EYDM-A.

.4 Drain / breathers:

.1 Manufacturer / Model:

.1 Eaton (Crouse Hinds) ECD series.

.2 Emerson (Appleton) type ECDB.

.5 Threaded unions:

.1 Manufacturer / Model: Crouse Hinds UNF/UNY series to suit the application, or approved equal.

.6 Sealing Compound:

.1 All sealing compounds and manufacturer specific requirements shall be followed, and shall match those listed under the CSA certificate or cUL listing.

.2 Manufacturer / Model:

.1 Eaton (Crouse Hinds) Chico sealing compound or Chico speed seal.

.2 Emerson (Appleton) Kwiko sealing compound and fiber filler.

.3 Hubbell (Killark) Killark sealing compound and fiber filler.

.7 Thread Lubricant:

.1 Use thread lubricant to prevent galling of conduit threads when threaded into a coupling, junction box etc. Maintains grounding continuity.

.2 Manufacturer / Model:

.1 Eaton (Crouse Hinds) HTL series.

.2 Emerson (Appleton) TLC series.

.3 Hubbell (Killark) LUBT series.

3. EXECUTION

3.1 Installation

.1 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.

.2 Outlets installed in partition walls to be offset by a minimum of one stud space.

.3 Confirm the direction of door swings on site, to confirm that outlet boxes for light switches are located on the latch side of the door.

.4 Provide boxes sized as required by the CEC.

.1 Extension rings shall not be utilized to accommodate conductor fill requirements.

.2 Do not use sectional boxes.

.5 Support boxes independently of connecting conduits.

.6 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of Work.

.7 Install all outlets flush and surface mounted as required for the installation.

.1 Surface mount above suspended ceilings, or in unfinished areas.

.2 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

.3 Use plaster rings to correct depth. Use 30 mm on concrete block.

.8 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

.9 Primary bushings in termination box for cable connection.

.10 Secondary bushings in termination box for bus duct connection.

.11 Control junction box.

.12 Exterior or wet, and/or corrosive areas:

.1 Boxes mounted in exterior walls shall be complete with box vapour barriers and gasketing/flashing/sealing per Manitoba Building Code. Maintain wall insulation.

.2 Install aluminum, threaded, gasketted, outlet boxes, conduit boxes, and fittings.

.13 Hazardous areas:

.1 Install aluminum, threaded, sealing fittings, conduit boxes, outlet boxes, unions, drains, expansion fittings, flexible couplings, and all other components approved for the hazardous area(s).

.2 Install fittings and seals in accordance with the Manufacturers requirements.

.3 The installation shall meet all requirements of the CEC, Section 18 and Section 22.

3.2 Identification

.1 Provide equipment identification in accordance with Division 26.

END OF SECTION

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1. GENERAL

1.1 Summary

.1 This Section provides a comprehensive list of all conduit types that may be required for the project and the applications where each type shall be used.

.2 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section. This Section supplements requirements of other Divisions.

1.2 References

.1 Canadian Standards Association (CSA):

.1 CSA C22.1: Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.

.2 CSA B137.1 Polyethylene (PE) Pipe, Tubing, and Fittings for Cold Water Pressure Services.

.3 CSA C22.2 No. 18.1 Metallic Outlet Boxes.

.4 CSA C22.2 No. 18.2 Non-metallic Outlet Boxes.

.5 CSA C22.2 No. 18.3 Conduit, Tubing, and Cable Fittings.

.6 CSA C22.2 No. 18.4 Hardware for the Support of Conduit, Tubing, and Cable.

.7 CSA C22.2 No. 18.5 Positioning Devices.

.8 CSA C22.2 No. 45.1 Electrical Rigid Metal Conduit – Steel.

.9 CSA C22.2 No. 45.2 Electrical Rigid Metal Conduit — Aluminum, Red Brass, and Stainless Steel.

.10 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.11 CSA C22.2 No. 83, Electrical Metallic Tubing (EMT).

.12 CSA C22.2 No. 211.1, Rigid types EB1 and DB2/ES2 PVC conduit.

.13 CSA C22.2 No. 211.2, Rigid PVC (unplasticized) conduit.

.14 CSA C22.2 No. 211.3, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (Bi-National standard with UL-1684).

.15 CSA C22.2 No. 227.3, Mechanical Protection Tubing (MPT) and fittings (Tri-national standard with NMX-J-855-ANCE and UL-1696).

.16 CSA C22.2 No. 327, HDPE conduit, conductors-in-conduit, and fittings.

1.3 Submittals

.1 Submit product data in accordance with Division 1 and Division 26.

.1 Include certifications to appliable standards, ratings, and manufacturer specific installation requirements.

.2 Electric metallic tubing.

.3 Rigid aluminum conduit.

.4 Rigid PVC conduit.

.5 Flexible metal, liquid tight conduit.

.6 Flexible non-metallic, liquid tight conduit.

.7 Conduit fittings, conduit couplings.

.8 Hazardous area sealing fittings, coupling and sealing compound.

.9 Conduit clamps and support systems.

.10 Submit information on where each type of conduit will be installed, prior to installation.

.11 Submit details of the cUL approved fire stop assembly for approval prior to installation.

.2 The Drawings do not show every specific conduit run. Supply and install conduit, and support systems as required for a complete installation.

.3 The materials for each conduit must meet the requirements of the area. Some areas are wet, highly corrosive; other areas have chemicals which may adversely interact with specific materials. Care must be taken in making the proper conduit selection for the particular area.

.4 Design equipment anchorage and support system for vertical and lateral loading in accordance with the MBC.

.1 Submit written certification from a Professional Engineer licensed in the Province of Manitoba stating that support systems, anchorage, and equipment are structurally sound, and have been designed according to requirements of the MBC.

1.4 Quality Assurance

.1 Electrical equipment and materials shall be new and comply with the latest codes and standards. Unless otherwise called out in the drawings, no used, re-built, refurbished and/or re-manufactured electrical equipment or materials shall be furnished on this project.

.2 Coated type conduits shall be prepared/repaired with cleaner, primer, and touch-up compound as per the manufacturers requirements.

.3 Installed conduit shall be free from dents, bruises and other damage.

1.5 Delivery, Storage and Handling

.1 Storage: Whenever possible, store the conduit indoors to prevent possible discoloration, the accumulation of dirt and to extend the life of the product. However, if conduit is stored outdoors, it should be stored in such a way as to allow air circulation and water to drain-off and shall not be directly covered in plastic.

2. PRODUCTS

2.1 Conduits and Minimum requirements

.1 Special attention to the selection of materials must take place in corrosive atmospheres where chemicals are stored, or chemical vapours may be present. Some processes utilize several different chemical types all with difference corrosive properties, if unsure of the material required for a chemical room or injection point request clarification from the Contract Administrator.

.2 Further application specific materials use have been provided throughout this document that cover a variety of rooms, areas, interior, exterior and a variety of installation types. If unsure of the material required for a specific area or installation request clarification from the Contract Administrator.

.3 Epoxy coated Conduit.

.1 Epoxy coated metal conduit is intended for hazardous areas above and below grade. The preferred metal is rigid threaded aluminum.

.2 CSA C22.2 No. 45.1, with zinc coated metal, with additional corrosion resistant epoxy finish inside and outside.

.3 CSA C22.2 No. 211.3 for rigid fibreglass reinforced epoxy conduit and associated fittings.

.4 PVC coated metal Conduit.

.1 PVC coated metal conduit is intended for hazardous areas above and below grade. The preferred metal is rigid threaded aluminum.

.2 CSA C22.2 No. 45.1, with zinc coated metal, with additional PVC coating.

.5 Rigid Aluminum, Red Brass, or Stainless Steel metal Conduit.

.1 For interior exposed applications, above grade. Rigid aluminum may be used in hazardous areas.

.2 CSA C22.2 No. 45.2, with factory applied, closed-end thread protectors.

.3 Rigid Aluminum shall meet a minimum alloy composition of Type AA6063.

.6 Flexible Metal Conduit.

.1 Intended for connections to vibrating equipment, the flexible conduit is a short length with a connection between a permanent conduit system and the equipment. Also intended for connections to instruments where periodic inspection/adjustments/ calibrations may be required.

.2 CSA C22.2 No. 56, aluminum liquid-tight flexible metal.

.3 Flexible Metal Conduit: spirally wound, interlocked zinc coated strip steel, minimum 10 mm diameter.

.4 Liquid-Tight Flexible Metal Conduit: continuous interlocked and double-wrapped steel, zinc coated inside and outside, coated with liquid-tight jacket of flexible PVC, minimum 12 mm diameter.

.5 Liquid-Tight Flexible Metal Conduit Fittings: cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings.

.7 Flexible Non-metal Conduit:

.1 Intended for connections to vibrating equipment, the flexible conduit is a short length with a connection between a permanent conduit system and the equipment. Also intended for connections to instruments where periodic inspection/adjustments/ calibrations may be required.

.2 CSA C22.2 No. 227.3, heavy duty, liquid tight, PVC.

.8 Galvanized-Steel Rigid Conduit:

.1 For exposed outdoor application above grade, or interior dry areas.

.2 CSA-C22.2 NO. 45.1 and ANSI C80.1, zinc coating steel.

.9 High Density Polyethylene (HDPE):

.1 Direct burial and horizontal directional drilling conduit applications. Used where specifically approved by the Contract Administrator.

.2 CSA C22.2 No. 327 testing requirements, for direct burial or encasement in concrete or masonry in ordinary (non-hazardous) locations.

.10 Rigid Polyvinyl Chloride (RPVC) Conduit:

.1 RPVC for interior exposed (wet or wet corrosive atmospheres) and outdoor direct burial applications. Used in above ground general location applications when embedded in concrete walls, ceilings, or floors.

.2 DB2 may be used for direct burial, and concrete encasement applications.

.3 CSA C22.2. No. 211.0 testing requirements.

.4 CSA C22.2 No. 211.1:

.1 Rigid Type EB1 PVC conduit: for encasement in masonry and concrete only.

.2 Rigid Type DB2/ES2 PVC Conduit: for direct burial and/or encasement in masonry and concrete.

.5 CSA C22.2 No. 211.2 for unplasticized conduit.

.1 Rated FT-4 for conduits trade sizes between ½" through to 6" when used in interior applications, and suitable for direct burial.

.11 Reinforced Thermosetting Resin Conduit (RTRC):

.1 For encased burial, or direct burial applications.

.2 CSA C22.2 No. 211.3

.12 Electrical Metallic Tubing (EMT):

.1 Used in lunch rooms and office spaces.

.2 EMT: to CSA C22.2 No.83

.13 Mechanical Protection of direct burial conductors, as permitted under CEC 12-012(3)(e):

.1 Polyethylene Pipe: to CSA B137.1, minimum series 75.

.2 Flexible Plastic Underground Power Cable Ducting: to CSA C22.2 No. 211.1.

2.2 Conduit Fastenings

.1 One hole stainless steel straps to secure surface conduits 50 mm and smaller.

.1 Two hole stainless steel straps for conduits larger than 50 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1 m on centre.

.4 Strap material to match conduit material.

.5 Set screw fittings are not permitted.

.6 Threaded stainless steel rods, minimum 10 mm diameter, to support suspended channels.

2.3 Conduit Spacers

.1 PVC coated malleable metal spacers, CSA approved for the purpose.

.2 Aluminum channel may be utilized where conduits are grouped; however, a non-metallic spacer must be provided between the aluminum channel and concrete.

2.4 Conduit Fittings

.1 Fittings manufactured for use with conduit specified, CSA certified, and environmentally rated for the intended area of use.

.1 Miscellaneous Fittings: locknuts, bushings, reducers, chase nipples, 3 piece unions, split couplings, plugs, and expansion fittings specifically designed for their particular application.

.2 Coating: same as conduit.

.3 Hazardous Locations: All fittings, couplings and devices shall be rated for the Hazardous Classification(s).

.2 Utilize factory made elbows for 27 mm and larger conduits.

.3 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.

.4 Flexible Metal Conduit Fittings: threadless hinged clamp type.

.5 Electrical Metallic Tubing (EMT):

.1 Fitting Material for 25 mm size Conduit and Smaller: zinc alloy or zinc coated steel.

.2 Fitting Material for Conduit Larger than 25 mm Size: zinc coated steel.

.3 Type: compression or set screw, liquid tight for wet or damp areas.

.6 Flexible metal, liquid-tight conduit:

.1 Metal insulated throat connectors with integral nylon or plastic bushing rated for 105°C.

.2 Insulated throat and sealing O-rings:

.1 Manufacturers and Products – General Locations:

.1 ABB (Thomas & Betts); Series 5331.

.2 Manufacturers and Products – Hazardous Locations:

.1 Emerson (O-Z/Gedney); Series 4Q.

.7 Flexible, non-metallic, liquid-tight conduit:

.1 Type: High strength plastic body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.

.2 Body/compression nut (gland) design to assure high mechanical pullout strength and watertight seal.

.3 Manufacturers and Products:

.1 Emerson (O-Z/Gedney); Type STN/LM/NM.

.2 ABB (Thomas & Betts); Series 6300.

.3 Carlon; Type LT.

.8 PVC type:

.1 Meet requirements of NEMA TC-3.

.2 Type: PVC, slip-on.

2.5 Expansion Fittings for Rigid Conduit

.1 All conduits entering outlet boxes and devices that are located in walls subject to movement shall be terminated by means of liquid-tight flexible conduit, approximately 450 mm in length between the conduit and the outlet box or device which is being supplied. All conduits, bus duct, wireways, etc., passing through or across expansion joints of the building shall be installed with the use of approved expansion fittings.

.2 There are structural expansion joints in the facilities – these are not specifically identified on the electrical Drawings. Review the structural Drawings and note the locations of all expansion joints. Provide expansion couplings and fittings for all conduit crossing the joints. Do not locate rigid devices (for example panels) across or on top of the expansion joints. Add expansion fittings as required to accommodate expansion joints due to temperature variations.

.3 Expansion Fitting Manufacturers and Products:

.1 Deflection/Expansion Movement – General Locations:

.1 Emerson (Appleton) type DX.

.2 Eaton (Crouse-Hinds) type XD.

.2 Expansion Movement Only – General Locations:

.1 Emerson (Appleton) type XJ.

.2 Eaton (Crouse-Hinds) type XJ.

2.6 Fish Cord

.1 Polypropylene.

2.7 Conduit Bonding

.1 All conduits shall have a bare or insulated copper bonding conductor run within. The bonding conductor shall be sized as per the CEC, table 16. The conduit itself cannot be used as the only means of bonding. Provide bond jumpers between conduit systems, and to the bond terminals on pull boxes and junctions boxes to ensure electrical continuity of all conduit

systems. Not all bond cables are shown on the Drawings or on the cables list. Provide bonds even though not explicitly indicated in other documentation.

.2 Utilize insulated grounding bushings / conduit hub at all enclosure entries for metallic conduit.

.1 Material: Cast aluminum, with integral insulated throat, rated for 150°C.

.2 Manufacturers and Products – General Locations:

.1 ABB (Thomas & Betts) Series 370AL.

.2 Emerson (O-Z/Gedney) Type AB.

.3 Emerson (O-Z/Gedney) Type ABLG.

.3 Manufacturers and Products – Hazardous Locations:

.1 Emerson (O-Z/Gedney) Type HUBG.

.2 Eaton (Meyers; Crouse-Hinds) Series STGK/SSTGK.

3. EXECUTION

3.1 Routing

.1 Locate conduits containing communication and low voltage conductors away from conduits containing power wiring.

.2 Run parallel or perpendicular to building lines. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

.3 Do not pass conduits through structural members except as specified on the Drawings, or as permitted by the Contract Administrator.

.4 Route conduits on suspended channels where possible.

.5 Avoid routes that would interfere with any potential maintenance activities.

.6 Where not specifically shown in detail on the Drawings, review proposed conduit routing with Contract Administrator prior to installation. Comply with all routing changes requested by the Contract Administrator.

.7 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

3.2 Spacing and Supports

.1 Wall spacing:

.1 Group conduits wherever possible on suspended or surface mounted channels.

.2 Install spacers as required to provide a space between the conduits and the supporting surface, with a minimum space as follows:

.1 Above grade spaces not classified as CEC Category 1 or 2:

.1 Drywall / wood surfaces: no space required.

.2 Masonry / concrete surfaces: 6 mm.

.3 Below grade spaces: 12 mm.

.2 Wet locations: 12 mm.

.2 Supports for metallic conduit:

.1 Maximum spacing between supports for metallic conduit:

.1 16 mm conduit: 1.0 m.

.2 21 mm conduit: 1.5 m.

.3 27 mm conduit 1.5 m.

.4 35 mm conduit 2.0 m.

.5 41 mm conduit and larger 2.5 m.

.3 Supports for PVC conduit:

.1 Maximum spacing between supports for rigid PVC conduit:

.1 21 mm conduit 0.75 m.

.2 27 mm conduit 0.75 m.

.3 35 mm conduit 0.75 m.

.4 41 mm conduit 1.2 m.

.5 53 mm conduit 1.5 m.

.6 63 mm conduit 1.5 m.

.7 78 mm conduit 1.5 m.

.8 91 mm conduit and larger 2.0 m.

3.3 Connections

.1 For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:

.1 Wet or corrosive areas: flexible, non-metallic liquid tight conduit.

.2 Dry and non-corrosive areas: flexible, metallic liquid tight conduit.

.3 Hazardous areas: flexible liquid tight conduit, with couplings and fittings suitable for Class I, Division 1 and 2 areas.

.4 Length: 450 mm minimum, 1500 mm maximum, sufficient to allow movement and adjustment of equipment.

.2 Luminaires in dry areas: flexible, metallic liquid-tight conduit or approved cabling.

.3 Transition from underground or concrete embedded to exposed: rigid PVC to rigid aluminum conduit.

.4 Exterior light pole foundations: rigid PVC conduit.

3.4 Bends

.1 Conduit runs shall not exceed four 90 degrees bends (for a total of 360 degrees) between pullboxes.

.2 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter. Bends are to be symmetrical.

.3 Avoid field-made bends and offsets, but where necessary, make with an acceptable bending machine. Do not heat metal raceways to facilitate bending.

.4 Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

.5 Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

.6 Use factory made elbows for conduits over 27 mm in diameter.

.7 Install concealed raceways with a minimum of bends in the shortest practical distance.

.8 PVC Conduit:

.1 Bends 30 degrees and larger: provide factory made elbows.

.2 Use Manufacturer’s recommended method for forming bends.

.9 Do not make bends that exceed allowable conductor or cable bending radius; or that significantly restrict cable pulls.

3.5 Penetrations

.1 Prior to coring, drilling or cutting through wall, roof or floor members: perform scan of the surface, mark the intended location, and confirm acceptability with the Contract Administrator.

.2 For circular penetrations, provided steel pipe (galvanized or stainless to suit the environment).

.3 Provide 88.9 mm high concrete curb around floor penetrations that are subject to regular clean up or wash down.

.4 Make at right angles, unless otherwise shown.

.5 Notching or penetration of structural members, including footings and beams, is not permitted unless specifically approved by the Contract Administrator.

.6 Firestop openings around penetrations to maintain fire-resistance rating.

.7 Apply single layer of wraparound duct band to all metallic conduit protruding through concrete floor slabs to a point 50 mm above and 50 mm below concrete surface.

.8 Concrete walls, floors, or ceilings (above ground): provide non-shrink grout dry-pack, or use watertight seal device.

.9 Entering Structures:

.1 General: seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.

.2 Exterior wall penetration:

.1 Utilize Roxtec weatherproof sealing system.

.2 Install to Manufacturer’s recommendations.

.3 Install flush with exterior of the wall.

.4 Prior to installation of seals, Contractor to submit proof of training to the Contract Administrator. Do not install the cable seal system without equipment Manufacturer training, as work will have to be re-done. Contact Roxtec for training.

.5 Prior to covering up wall penetration work, arrange for a site inspection of the work with the Contract Administrator. Proof of proper installation is required.

.3 Concrete roof or membrane waterproofed floor:

.1 Provide a watertight seal.

.2 Without concrete encasement: Install watertight entrance seal device on each side.

.3 With concrete encasement: install watertight entrance seal device on the accessible side.

.4 Securely anchor watertight entrance seal device into construction with one or more integral flanges.

.5 Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

.4 Heating, ventilating, and air conditioning equipment:

.1 Penetrate equipment in area established by Manufacturer.

.2 Connect equipment using liquid tight flexible conduit.

.5 Corrosive sensitive Areas:

.1 Seal all conduit passing through corrosive room walls.

.2 Seal conduit entering equipment panel boards and field panels containing electrical equipment.

.6 Existing or precast wall (underground): core drill wall and install a watertight entrance seal device.

.7 Nonwaterproofed floor (underground, without concrete encasement):

.1 Provide watertight entrance seal device.

.2 Fill space between raceway and sleeve with expandable watertight compound or oakum and lead joint, on each side.

.8 For exterior installations, conduit entry shall be from the bottom, unless approved otherwise by the Contract Administrator.

3.6 Installation - General

.1 Provide bonding conductor in all conduit systems. Verify bond continuity of all conduit systems.

.2 Install conduit concealed, in walls, floors, ceilings, above suspended ceilings, and underground.

.1 Unless otherwise indicated, install conduits surface-mounted on walls and ceilings. Conceal or embed conduits only where indicated.

.2 Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

.3 Conduits shall be sized in accordance with CEC requirements for wire counts installed. Conductors shall be de-rated according to code requirements. Upsize conductors as required to meet CEC and voltage drop requirements.

.1 Except where otherwise required by Canadian Electrical Code (CEC), provide conduit of types specified and sizes indicated on drawings or as specified.

.2 Where sizes are not indicated, select proper sizes to suit intended use, fulfill wiring requirements, and comply with Canadian Electrical Code (CEC).

.3 Minimum conduit size: 21 mm, unless specifically indicated otherwise on the Drawings or specifically approved by the Contract Administrator.

.4 Water/Wastewater Treatment Plant – Conduit Types by Area:

.1 Office, lunch room, and similar dry locations:

.1 EMT conduit.

.2 Chemical Rooms, Corrosive Areas (Category 2):

.1 RPVC conduit.

.3 Hazardous Locations/Areas, and Corrosive Areas:

.1 Underground, and/or in concrete.

.1 Epoxy coated metal conduit (i.e. green-guard or other product type).

.2 PVC coated metal conduit.

.2 Above-grade installations:

.1 Exposed above-grade conduits shall be rigid aluminum, liquid tight, and as required to meet the requirements of the installation. Do not use steel conduit for areas where H2S gas or other corrosive gasses or liquids are present.

.3 Use explosion proof flexible connection for connection to explosion proof motors.

.4 Install conduit sealing fittings, fill with sealing compound and fiber material. Meet all requirements of the CEC with respect to hazardous areas sealing and means and methods. Refer to CEC Section 18 and 22 for additional requirements.

.4 General Locations/Areas and Category 1 (wet), and Heat Trace Systems:

.1 Rigid Aluminum threaded conduit.

.5 General Locations/Areas and dry:

.1 Rigid Galvanized Steel conduit.

.6 Exterior and Outside, Above-grade installations:

.1 Rigid Galvanized Steel conduit.

.5 Where EMT and PVC conduit is used, provide a separate green insulated ground wire in each conduit.

.6 Use liquid tight flexible metal conduit for connection to motors/pumps, vibrating equipment, instrumentation, and luminaries.

.7 Plug conduit ends to prevent entry of dirt and moisture.

.8 Seal conduit with duct seal compound and fibreglass insulation where conduit leaves heated area and enters unheated area.

.9 Field threads on rigid conduit must be of sufficient length to draw conduits up tight and to the minimum fully engaged threads per the CEC for application and Hazardous area.

.10 Install pull cord in all empty conduits.

.11 Emergency lighting and exit signs shall be connected via a separate and dedicated conduit system.

.12 Remove and replace blocked conduit sections.

.1 Do not use liquids to clean out conduits.

.13 Dry conduits out before installing wire.

.14 All conduits exposed in finished areas are to be free of unnecessary labels and trade marks.

.15 Seal and firestop penetration around conduit with cUL approved fire stop assembly for the installation conditions.

.16 Where conduit crosses building expansion joints, install expansion fitting approved by Authority Having Jurisdiction, complete with grounding jumper. Provide bend or offset in conduit adjacent to building expansion joint where conduit is installed above suspended ceilings.

3.7 Installations in Category 1 Locations

.1 Arrange to provide drainage at frequent intervals to suitable locations.

.2 Equip with approved fittings to permit the moisture to drain out of the system.

.3 Install the conduit with a minimum of 12 mm space from the supporting surface.

.4 Every joint, coupling and fitting to be water-tight.

.5 Where conduit leaves a warm room and enters a cooler atmosphere, seal the conduit and arrange the conduit in a manner to avoid condensation accumulation at the seal.

3.8 Installations in Category 2 Locations

.1 Comply with all requirements of Category 1 locations.

3.9 Installations in Category 2 Wet Locations

.1 Comply with all requirements of Category 1 locations.

3.10 Installations in Hazardous Locations

.1 Install conduit system, complete with explosion proof conduit sealing fittings:

.1 Install cables in conduit system – maximum permitted conduit / conduit fitting fill for hazardous areas is 25%.

.2 Provide sealing fittings to suit the area classification, and to meet the CEC requirements.

.3 Install sealing compound following Manufacturer's instructions.

3.11 Installation – Metal Conduit and Tubing, Rigid Metal Conduit

.1 Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

.2 Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.

.3 Utilize insulated grounding bushings at all enclosure entries for metallic conduit.

.4 Cut conduit straight with a squared end, properly ream smooth, cut threads and brush threads clean.

.1 Remove burrs, ream and clean metal conduit before installation of conductors, wires, or cables.

.2 Metal, threaded conduit to be cut with a cutting tools that provide a 19mm taper per foot.

.5 Fasten conduit terminations in sheet metal enclosures with two locknuts and terminate with bushing. Install locknuts inside and outside enclosure.

.6 Conduit installed underground shall be painted with two (2) coats of corrosion inhibiting compound before backfilling.

.7 Threaded conduit connections shall have a minimum of 5 full threads fully engaged or greater. In general all threaded connections (for both hazardous and non-hazardous areas) shall meet or exceed the requirements set out in CEC Section 18.

.8 Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

3.12 Installation – Non-Metallic Conduit

.1 Make field bends and solvent cemented joints in accordance with manufacturer's instructions.

.2 PVC conduit sections and fittings shall be connected using watertight PVC conduit cement.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

3.13 Installation – Exposed/Surface and Semi-Concealed Conduit

.1 Run conduits adjacent to or below existing cable tray systems. Use existing strut where available, add strut and threaded rod where existing strut is not available.

.1 Group conduits wherever possible on suspended or surface mounted unistrut channels.

.2 Where conduits pass through walls, group and install through openings. After all required conduits are installed; close wall openings with material compatible with the wall construction. Perform fire stopping & sealing to ensure integrity of wall.

.3 Provide a minimum of 1 conduit diameter of space between adjacent conduit runs.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Install conduit to conserve headroom and cause minimum interference in spaces through which conduit passes.

.4 Install conduit so as not to interfere with ceiling inserts, luminaires or ventilation ducts or outlets.

.5 Alter routing to avoid structural obstructions, keeping crossovers to a minimum.

.6 Install exposed conduit and extensions from concealed conduit systems neatly, parallel with, or at right angles (perpendicular) to walls and structural members.

.7 Run conduit for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.

.8 Run conduits in flanged portion of structural steel.

.9 Do not pass conduits through structural members except as indicated. Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.14 Installation - Concealed Conduits

.1 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

.2 Where required to be concealed, install conduit neatly and close to building structure so as to minimize need for furring.

.3 Run parallel or perpendicular to building lines.

.4 Do not install horizontal runs in masonry walls.

.5 Do not install conduits in terrazzo or concrete toppings.

3.15 Installation - Conduits in Cast-In-Place Concrete (On Grade)

.1 Place conduit between bottom reinforcing steel and top reinforcing steel.

.1 Install in centre one third of slab.

.2 Ensure minimum 20 mm concrete cover.

.2 Separate conduit by not less than diameter of largest conduit to ensure proper concrete bond.

.3 Protect conduits from damage where they stub out of concrete.

.4 Install sleeves where conduits pass through slab or wall.

.5 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.

.1 Use cold mastic between sleeve and conduit.

.6 Conduits in slabs: minimum slab thickness 4 times conduit diameter.

.7 Encase conduits completely in concrete with minimum 25 mm concrete cover.

.8 Organize conduits in slab to minimize cross-overs.

3.16 Installation - Conduits in Cast-In-Place Slabs (Below Grade)

.1 Use epoxy coated rigid steel conduits.

.2 Run conduits 25 mm and larger below slab and encase in 75 mm concrete envelope.

.1 Provide 50 mm of sand over concrete envelope below floor slab.

3.17 Installation - Conduits Underground

.1 Minimum burial depths shall be as detailed on the Drawings, but in no case less than the requirements indicated in the CEC.

.2 Conduits shall have a red plastic warning tape placed above, buried at a depth of 305 mm below grade. The plastic tape is to completely cover all conduits, and overlap the width of all conduits by at least 150 mm on either side. Provide mechanical protection, planking in accordance with the U.G trenching specifications.

.3 All underground direct buried conduits shall be rigid PVC.

.4 Provide rigid PVC conduit, type DB2 for encasement in concrete for duct banks. HDPE conduit can be used only where specifically approved by the Contract Administrator.

.5 Maintain a minimum of 1200 mm horizontal clearance distance from underground structures such as buildings and equipment foundations.

.6 Maintain a minimum of 600 mm horizontal clearance distance from underground equipment such as piping and other underground conduit runs.

.7 All clearances in strict accordance with the MBC, CEC, and all other by-laws.

.8 Provide Universal GPS coordinates of all underground conduit runs at every bend, and at every 6000 mm intervals. Include coordinates on the As-Built Drawings.

.9 Provide man-holes and hand-holes as required to accommodate the conductor pull.

.10 Slope conduits away from building and enclosures entry points, to provide drainage.

.11 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

END OF SECTION

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

1. GENERAL

1.1 Description

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section. This Section supplements requirements of other Divisions.

.1 Section includes various materials for underground works that may be required for the project and the applications where each type shall be used.

1.2 References

.1 Canadian Standards Association (CSA):

.1 CSA C22.1: Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.

.2 CSA C22.3 No.7, Underground Systems.

.3 CSA Z809, Sustainable Forest Management, and Update No. 1.

.2 Forest Stewardship Council (FSC):

.1 FSC-STD-01-001 V5-2, FSC Principle and Criteria for Forest Stewardship.

.3 Sustainable Forestry Initiative (SFI):

.1 SFI Standards and Rules.

.4 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.5 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

1.3 Submittals

.1 Submit in accordance with Division 1 and Division 26.

.2 Submittals shall include, but not be limited to the following:

.1 Submit manufacturer's instructions, printed product literature and data sheets for cables and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Precast manholes and handholes.

.3 Dimension drawings and descriptive literature.

.4 Cable pulling calculations for all cables.

.5 Proposed cable pulling methodology to ensure pulling forces are within the cable Manufacturer's limits.

2. PRODUCTS

2.1 Cable Protection

.1 Wooden Protection: 38 x 140 mm planks pressure treated with copper naphthenate or 5% pentachlorophenol solution, water repellent preservative. Must be rated Permanent Wood Foundation (PWF), All Weather Wood (AWW) is not acceptable. Creosote and some other types of wood preservatives may injure the insulation of conductors and should not be used.

.2 Concrete Topping Protection: Concrete topping of conduit in trench, minimum 50 mm thick layer of concrete, dyed red, with a 150 mm overhang, past the edges of each conduit installed for the length of the trench.

.3 For underground conduits or cables, provide mechanical protection as follows:

.1 120 V or 600 V and 15 A to 90 A: mechanical protection using treated planks 600 V and below; and 100 A or greater: mechanical protection using 50 mm thick concrete topping, or concrete duct banks as directed on the Drawings.

.2 600 V to 15 kV: mechanical protection using 50 mm thick concrete toping, or concrete duct banks as directed on the Drawings.

2.2 Markers

.1 Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

.2 Cedar post type markers: 89 x 89 mm, 1.5 m long, treated with copper naphthenate or 5% pentachlorophenol preservative, with nameplate fastened near post top, on side facing cable or conduit to indicate depth and direction of duct and cable runs.

.1 Nameplate: aluminum, anodized 89 x 125 mm, 1.5 mm thick mounted on cedar post with mylar label 0.125 mm thick with words Cable, Joint or Conduit with arrows to indicate change in direction. Fasten using stainless steel screws.

.3 Warning tape:

.1 Material: Polyethylene, 4-mil gauge with detectable strip.

.2 Color: Red.

.3 Width: Minimum 150 mm.

.4 Designation: Warning on tape that electric circuit is located below tape.

.5 Identifying Letters: Minimum 25 mm high permanent black lettering imprinted continuously over entire length.

.6 Manufacturers and Products:

.1 Panduit; Type HTDU.

.2 Reef Industries; Terra Tape.

.3 W.H. Brady Inc.

.4 Wieland Electric Inc.

3. EXECUTION

3.1 General

.1 Prior to excavation or directional boring, perform a complete site survey to ensure that the installation will not conflict with existing systems. Repair of damages to existing systems will be at the cost of the Contractor.

.2 Provide Universal GPS coordinates of all underground cable or conduit runs at every bend, and at a maximum of 6000 mm intervals. Include coordinates on the As-Built Drawings.

.3 Coordinate work with other trades to ensure that the location and route of the buried systems does not conflict with the work of other trades.

.4 Refer to the Drawings for cable / trench details where applicable. Where conflict in details occurs, allow for the more onerous and costly installation method.

.5 Perform all utility and underground locates, include “Call before you dig” (now Click-before-you-dig) to ensure all utilities are located/flagged: http://clickbeforeyoudigmb.com/

.6 Clearances to be in strict accordance with the Winnipeg Electrical By-laws (WEB), CEC, and all other applicable by-laws.

3.2 Directional Drilling/Boring

.1 Perform directional boring as directed on the Drawings, or as specifically approved by the Contract Administrator. Otherwise, use open trenching installation methods.

.2 Directional boring shall utilize HDPE conduit.

3.3 Direct Burial of Cables

.1 Employ soft dig excavation methods near and around any buried electrical system. An acceptable soft dig method is Hydrovac (water based) excavation method.

.2 All cable / conduit trenches shall have a red plastic warning tape placed above, buried at a depth halfway between grade and the installation. The plastic tape is to completely cover all

conduits and overlap the width of all conduits by at least 150 mm on either side. Use multiple parallel tape runs as required.

.3 Perform excavation and trenching. Provide sand bed in trench, and lay in cables, maintaining separation between cable runs. Maintain a minimum of 75 mm of clearance from each side of trench to the nearest cable. Do not pull cable into trench.

.4 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.5 Minimum permitted radius at cable bends for rubber or plastic cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or greater in accordance with the Manufacturer's instructions. For communications cables minimum permitted radius is 15 the diameter of the cable or greater in accordance with the Manufacturer's instructions.

.6 Underground cable splices are not acceptable.

.1 Make terminations and splices (splices - only where specifically approved by the Contract Administrator) leaving 0.6 m of surplus cable in each direction. Terminations and splices shall be performed with approved kits, and in accordance with the Manufacturer's instructions and with specific training.

.7 Maintain a minimum of 150 mm horizontal separation between power cabling, increase to 190 mm separation if cabling is 1/0 or larger. For cables of different circuits add an additional 75 mm minimum separation.

.1 Maintain a minimum of 300 mm horizontal separation between power cabling and communication cabling.

.2 Maintain 300 mm (190 mm only where specifically approved by the Contract Administrator) minimum separation between power cabling from different sources/transformers.

.3 Maintain 300 mm minimum horizontal separation between low voltage (<100 0V) and medium voltage cables (>1000 V).

.4 Where possible, communication cables should have a minimum horizontal separation of 1000 mm from water and sewer lines and other deep services.

.8 Cable Crossing:

.1 Cable crossing shall be made at right angles (or as close to right angles as possible), with mechanical protection.

.2 Minimum burial depths shall be maintained per CSA C22.1 (Table 3) and CSA C22.3 No. 7 (Table 1). Increase the depth of cabling systems in a crossing to maintain minimum vertical separation, and minimum burial depth. Provide mechanical protection(s) as required.

.3 Provide sand bed over cables, after the cables are laid into the trench. Minimum sand bedding below cables is 75 mm. Minimum sand bedding above cables is 75 mm. Supply

and install mechanical protection of cables above sand bedding. Use clean fill, devoid of rocks or materials which can damage or deform the cable trench.

.4 When low voltage cables (<1000 V) cross medium/high voltage cables (>1000 V) maintain 300 mm vertical separation with low voltage cables in upper position.

.1 When mechanical protection is provided, maintain a minimum 75 mm vertical separation between low voltage cables and 150 mm between medium/high voltage cables.

.5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control, cables when crossing other cables, with fire alarm and control cables in upper position.

.6 The Contractor must meet the minimum code clearance requirements when crossing of any other systems, such as mechanical or utility services.

.9 Mechanical Protection:

.1 Install pressure treated wood (PTW) planks on lower cables 600 mm horizontally in each direction at crossings.

.2 When intersecting other utilities and watermain (WM) works, provide horizontal mechanical protection between the services (i.e. if the WM is deeper, provide horizontal mechanical protection below the electrical service (i.e. sand layer). If the intersecting utility is above the electrical installation then the additional mechanical protection shall be provided above the electrical installation.

.3 Provide horizontal mechanical protection above conduits/cables for any location less than 1 m in burial depth. When horizontal protection is used above cabling systems it shall be provided at a minimum depth of 300 mm below finished grade. The minimum depth for the electrical installation when mechanical projection is provided above shall be buried 0.7 m below finished grade. Provide PTW a minimum of 100 mm thick.

.4 Provide vertical mechanical protection between trenches for any location where the horizontal distance between trench or other utility/services is less than 1 m (300 mm min with protection), or horizontal distance between a trench and light/utility pole or tree is less than 2 m (1.5 m min with protection), or horizonal distance between the trench and under ground structure (building or equipment foundation) is less than 1.2 m (300 mm min with protection). The minimum vertical height shall equal or exceed the sand layer when adjacent to utility/services, however, when adjacent to a light/utility pole it shall extend the height of the trench.

.1 Clarification: Reduction of horizontal separation between the trench and utility/services shall be coordinated with the utility/service prior to reducing separation distance. In some cases reduction may be approved by the utility/service, in other cases the full separation distance must be adhered to.

.10 Backfill:

.1 Use clean backfill, free of rocks and debris. Return excavation area to the original condition.

.2 Photograph all open trenches, with cabling, conduit, supports and spacers installed.

.3 Do not cover cabling or backfill until inspected by the Authority Having Jurisdiction (AHJ), and Contract Administrator. Do not close up trench without approval.

3.4 Cable Installation in Ducts

.1 Do not pull spliced cables inside ducts.

.2 Inspect and clean ducts prior to installing cables.

.3 Group raceways installed in same area.

.4 Utilize conductors that are rated for underground direct earth burial in underground ducts.

.5 Before pulling cable into ducts and until cables properly terminated, seal ends of cables with moisture seal tape.

.6 Install multiple cables in duct simultaneously.

.7 Use CSA-approved lubricants of type compatible with cable jacket to reduce pulling tension.

.8 Install cables as indicated in ducts.

.9 Provide expansion fittings that allow minimum of 100 mm of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure. Provide slack loops in cable, compatible expansion fittings.

.10 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.

.11 After installation of cables, seal duct ends with duct sealing compound.

.12 Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

.13 Install watertight fittings in outdoor, underground, or wet locations.

3.5 Markers

.1 Mark cable every 30 m along cable or duct runs and changes in direction or as indicated on the Drawings.

.2 Where markers are removed to permit installation of additional cables, reinstall existing markers.

3.6 Field Quality Control

.1 Perform tests in accordance with Section 26 08 05 - Acceptance Testing - Electrical.

.2 Check phase rotation and identify each phase conductor of each feeder.

.3 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.4 If Voltage Drop (VD) measurements are taken for any reason during construction for any cabling that is part of an underground system, the value shall only be deemed valid in summer at a minimum ground temperature of 25°C.

.5 Pre-acceptance test.

.1 After installing power cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.3 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.

.4 Remove and replace entire length of cable if cable fails to meet any of test criteria.

3.7 Clean-up

.1 Repair damage to adjacent materials caused by cables installation.

.2 Repair surface to previous existing condition, or to new conditions specified on the Drawings, and in the Specifications.

END OF SECTION

HEAT TRACING

1. GENERAL

1.1 Description

.1 Provide electrical heat trace system as part of piping and insulation system furnished under other sections. Typical coordination involves Division 40 for new and existing (where applicable) piping systems to prevent freezing.

.1 Work shall be performed in cooperation with other trades on the project and so scheduled as to allow efficient completion of the project. Materials and equipment shall be installed as fast as conditions will permit and installed properly.

.2 The Work of this Section shall include all labor, materials, tools, equipment and appurtenances, and performing all operations necessary to furnish and install complete systems in accordance with this Section of these Specifications, the Drawings, and the codes and standards listed herein.

.3 Attend regular coordination and job progress meetings required.

.2 Comply with all laws, ordinances, rules, codes, standards, regulations, bulletins, by-laws, and orders of all authorities having jurisdiction relating to this work, and enforced in the locality of jobsite. If otherwise specified herein the bare minimum of the code(s) and requirements shall first be met, and specified requirements shall be in addition to the code(s) and requirements.

.1 Supply and install all material, equipment, wiring, and labour necessary for the installation of the systems detailed on the Drawings in accordance with the latest edition of the Canadian Electrical Code, Manitoba Electrical Code, and building codes.

.3 The General Conditions, Supplementary Conditions, and Division 1 are a part of this Specification and shall apply to this Division.

.1 The intent of the Drawings and Specifications is to include all labour, products, and services necessary for complete Work, tested and ready for operation.

.2 These Specifications and the Drawings and Specifications of all other Divisions shall be considered as an integral part of the accompanying Drawings. Any item or subject omitted from either the Specifications or the Drawings, but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided.

.3 If discrepancies or omissions in the Drawings or Specifications are found, or if the intent or meaning is not clear, advise the Contract Administrator for clarification before submitting Bid.

.4 Responsibility to determine which Division provides various products and Work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of Specifications.

HEAT TRACING

1.2 Summary

.1 The Scope of Work for this Section includes, but is not limited to, the following:

.1 Materials and procedures for the provision and installation of thermal insulation and heat tracing for process piping systems as indicated in the Drawings.

.2 Furnish and install a complete system of heaters, components, materials, and controls to prevent piping from freezing.

1.3 References

.1 Except as specified herein, the latest edition of the standards listed below form a part of this Specification to the extent referenced in this Section. Where earlier editions of standards are adopted as referenced in applicable codes, those shall govern. The publications are referred to within the text by the basic designation only.

.2 In each of the standards referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

.3 American Society for Testing and Materials (ASTM):

.1 A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.2 A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

.3 B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.4 C441, Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction.

.5 C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

.6 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.4 Canadian Standards Association (CSA):

.1 C22.1, Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.

.2 C22.2 No. 130, Requirements for electrical resistance trace heating and heating device sets.

.5 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE 844.2 (CSA C293.2), Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures – Application Guide for Design, Installation, Testing, Commissioning, and Maintenance

.6 National Electrical Manufacturers Association (NEMA):

.1 250, Enclosures for Electrical Equipment (1000 volts maximum).

.7 National Fire Protection Association (NFPA):

.1 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

.8 Underwriters Laboratories Ltd (cUL):

.1 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.4 Definitions

.1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these Specifications, and on Drawings, are those defined by IEEE SP1122.

.2 All terminologies, abbreviations, and acronyms used in this Document are as listed in the various Standards, Codes, Rules, and Bulletins used herein.

.3 Where the word *install* is used, unless specifically specified, is also meant to include the supply of the equipment.

.4 The term “Shop Drawing” means drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work. Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the Section under which the adjacent items will be supplied and installed. Indicate cross references to Design Drawings and Specifications.

1.5 System Description

.1 Provide heat tracing system for other piping systems, as specified by other Divisions.

.2 Design Requirements:

.1 Provide pipe tracing cable system capable of maintaining pipe contents at a temperature deemed acceptable by the Division responsible for furnishing the piping and insulation system. At a minimum the pipe tracing cable system capable of maintaining pipe contents at temperature of 4˚C when outside ambient temperature is -40˚C with 32 km/hr wind.

.1 The “temperature deemed acceptable” shall be referred to hereinafter as the “specified temperature”

.2 Verify heating requirements with Division responsible for furnishing the piping and insulation system.

.3 The design, equipment, and installation shall meet all codes, regulations, and manufacturers requirements. Where manufacturer requirements for certification or installation are above the minimum requirements of the code the more stringent shall apply.

.3 Environment:

.1 All heat trace boxes, connections, and control enclosures shall be rated for the environment in which they are installed. The installation method shall always assume moisture can be present which may affect the heat trace element and its connections, therefore no connection shall take place below grade where the potential to submerge the connection due to groundwater.

.2 Water-tight fittings/connections alone will not be considered suitable for submergence due to groundwater and will be rejected.

.3 Normal Locations (Indoor or Outdoor).

.1 Where heat trace is required in normal locations the system shall be designed for use in Category 1 locations.

.4 Hazardous Areas (Zone 0, Zone 1, Zone 2) (Indoor or Outdoor):

.1 Where heat trace is required in hazardous locations the system shall be designed for the Gas groups present and for use in Category 2 locations. Gas Groups at minimum shall include Group IIA & IIB gases unless additional requirements are called out on the Hazardous Classification diagram or drawing.

.2 Where equipment does not come with the maximum surface temperature rating the system shall be deemed at maximum of 100˚C in accordance with CEC 18-054.

1.6 Submittals

.1 Submit the following Shop Drawings in accordance with Division 1.

.2 The Contractor shall have Shop Drawing Submissions prepared for all aspects of the work relating to the design and construction of heat trace cables and/or controllers, including heat trace calculations to accommodate the proposed materials. The Shop Drawing Submission shall be in sufficient detail to permit review of materials for compliance with this Specification and facilitate assembly in the field complete with all necessary connection details.

.1 Complete manufacturers material/product data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

.2 Show isometric layout of pipe tracing cables over piping layout.

.3 Include installation details and connection diagrams sufficient to install pipe tracing cable system.

.3 Furnish to all other trades advance layout information and Shop Drawings necessary to permit other trades affected by the Work to install their work properly coordinated and without delay.

.4 Include heat trace calculations for the materials and application. Refer to the Schedules provided later in this section for minimum typical values should preliminary material selection not be available to assist with preliminary calculation review.

1.7 Shipment, Protection and Storage

.1 Deliver material to Site in original non-broken factory packaging, labeled with Manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.8 Quality Assurance

.1 Comply with the requirements specified in Division 1.

.2 Install insulation employing skilled workers regularly engaged in this type of Work.

.3 Materials shall meet or exceed fire and smoke hazard ratings as stated in this Section and defined in applicable building codes.

.4 All items/equipment provided under this section shall come with appropriate certificates/markings for use in Manitoba, for the environment for which it’s installed, meet all applicable electrical codes, and conform with Division 26.

.5 All work shall be performed in accordance with the latest edition of the Canadian Electrical Code, with amendments from the Manitoba Electrical Code. Install all material, equipment, wiring, and labour necessary for the installation. The installation shall also be performed to all manufacturer installation requirements.

.6 With the acceptance of the Contract Administrator and without extra cost to the City, make reasonable modifications in Work specified under this Section of the Specifications required to coordinate with normal structural interference's, or for proper execution of specified work.

.7 If Work is installed before coordinating with other trades so as to cause interference with the work of such trades, make all necessary changes in Work under this Section of the Specifications at no additional cost to the City.

.8 Protect all materials and work of other trades from damage that may be caused by the Work required under this Section of the Specifications and be responsible for repairing any damages caused by such work without any additional cost to the City.

HEAT TRACING

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 Urecon Ltd.

.2 Raychem.

.3 Or approved equal**.**

2.3 Electric Heat Tracing

.1 Provide proper fittings and all appurtenances for a complete and working system. For the field connections through conduit systems, and interconnection wiring without need for procurement of special fittings or wiring devices.

.2 Heat tracing conduits:

.1 From the controller box use rigid galvanized conduit for the heater element cables, and a separate RVPC conduit for the sensor cable. The conduit wall penetrations shall be sealed to prevent water and gas ingress to the facility.

.2 Consisting of extruded plastic moulding and applied to pipe prior to application of insulation.

.3 Fasten securely to pipe and seal to prevent ingress of foam during insulation.

.4 Check conduit after insulating to ensure they are not plugged.

.5 Seal ends prior to shipping to prevent foreign material from entering conduit while in transit or during installation.

.6 Conduit shall be provided between the control box and the point of heat trace. Provide suitable strain reliefs to transition the heat trace element and sensor to the piping.

.1 One conduit and strain relief will be the heat trace cable feed.

.2 One conduit and strain relief will be used for the heat trace return (where duplex heat tracing is used).

.3 One conduit and strain relief will be for the sensor.

.4 Strain reliefs shall be rated for the environment for which they’re installed.

.7 Manufacturer to ensure that specified electric tracing cable and heat tracing conduit size are compatible, so that cable may be pulled in with relative ease.

.8 For plastic pipe:

.1 Aluminum tape (AT180) shall be applied between the heater element and piping wall where channel is not provided, or in areas where channel does not bridge gaps. The

heater element cable shall be supported with Fiberglass tape onto the piping in intervals recommended by the manufacturer.

.2 In applications where a channel is provided the channel shall be D-shaped and in direct contact with the piping, the heater element shall be inserted into the channel.

.9 To provide a good ground path where none exists and to enhance the heater's ruggedness, the heater shall have a metallic grounding overbraid of sufficient conductivity to carry fault current made of tinned-copper and an outer jacket of modified polyolefin or secondary Fluoropolymer extruded overjacket.

.10 In order to provide energy conservation and to prevent overheating, the heater shall have a self-regulating factor of a least 90%. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 4ºC (40ºF) pipe temperature operation to 65ºC (150ºF) pipe temperature operation.

2.4 Cable Design

.1 Voltage: 120 volts, 1PH, 60 Hertz, as shown on Drawings for electrical connection.

.2 Parallel design, current flow across cable.

.3 Heat output: 15 watt/m constant (1 w/ft = 3.28 watt/m), independent of length.

.4 Self-regulating heat output, resistive parallel circuit type, constant watt rated.

.1 The cable shall be CSA Certified for use on plastic pipe and the manufacturer will be required to provide documentation of same.

.2 Provide duplex heat tracing or single heat tracing as noted on Drawings.

.3 The heat trace cable shall be continuous with the only terminations taken place within the junction box above grade (all splicing, sealing, and connections are to conform to the manufacturer's requirements; the heater elements shall only be terminated within the junction box). Termination boxes shall be rated for the environment for which they're installed.

.4 The self-regulating heater element shall at a minimum consist of two (2) 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating (hot spots), to be used with plastic pipe, and to be cut to length in the field. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket, and suitable for cutting to length in field.

2.5 Controllers (Control Box)

.1 Provide an adjustable setpoint controller with solid state switching circuitry suitable for use with RTD type temperature sensors. Controllers in the Contract are intended for control of the heat trace cable on the pre-insulated piping, at the locations noted on the Construction Drawings. Controllers shall conform to the following design features:

HEAT TRACING

.1 Suitable for control of the cable specified for use on plastic pipe.

.2 Thermostatic ambient sensing control on each tape set to the desired temperature for the pipe contents, as specified by other Divisions. Where not specified, the Thermostatic ambient sensing control on each tape shall be set at 5˚C (41˚F).

.1 Provide non-adjustable thermostats, calibrated and tested at factory to operate pipe heating system when temperature of pipe drops to the specified temperature.

.2 Provide non-adjustable thermostats, calibrated and tested at factory to close alarm contacts when temperature of pipe drops to 2˚C at coldest location.

.3 RTD Sensors and monitoring circuitry to have repeatability and maximum temperature differential of 1°C (2°F).

.3 Ordinary Locations (unclassified):

.1 Set Hi-temperature cut out trip/alarm to: 29°C (84°F).

.2 Provide thermostats with a minimum CSA/NEMA 4X enclosures or as required to suit environment.

.3 Control Box: minimum CSA/NEMA 4X, weatherproof.

.4 Hazardous Locations:

.1 Set Hi-temperature cut out trip/alarm to: 20°C (68°F).

.2 All components shall be rated for the hazard. Installation means and methods shall follow CEC Section 18 & Section 22.

.5 Set Low-temperature alarm when the temperature of the pipe drops below: 2°C (35°F).

.6 Electric heat tracing voltages shall be selected as indicated on the Drawings.

.7 Minimum Circuit Breaker Typical Sizes (See drawings panelboard schedule). Should the Controller (Control Box) not inherently have built in GFCI protection provide GFCI type breakers at the panelboard:

.1 30A, 2 pole, single throw for 152 mm watermain.

.2 15A, 1 pole for 25 mm water service.

.3 15A, 1 pole for 32 mm sewer line.

.8 Controller to have option for manual bypass (48-hour) of controls and to include indicators lights to indicate Power on, Heater on, High Temp alarm trip. Controller shall also come with Ground Fault monitor/trip (GFCI protection).

.9 Controller to be installed and positioned for easy viewing and maintenance. Install location as indicated on the Drawings.

HEAT TRACING

.1 Entry holes for wiring:

.1 2 x 1" top and bottom: power in, heater out.

.2 1 x 1/2" on the side for sensors.

.2 Electrical Fittings:

.1 Electrical fittings such as splice kits, end seals, etc. shall conform to the product supplied by the manufacturer of the heat trace cable and shall conform to the applicable CSA Standards for manufacture and installation.

.2 Provide proper fittings and appurtenances for field connection of system to conduit and wiring without need for procurement of special fittings or wiring devices.

.3 Terminal end seal kits: certified for installation in damp conditions and consisting of:

.1 Constant watt.

.2 End connector.

.3 900 mm of Teflon tape.

.4 Adhesive-lined heat shrink end cap.

.4 Power connection kits: connect to pipe.

.1 Constant watt.

.2 Flexible conduit.

.3 End caps.

.4 12 AWG hook-up wire.

.5 Splices.

.6 Heat shrink sleeves.

.5 Each controller to be labelled as per use with lamacoid and 1 cm high letters, plus the lamacoid shown below:

HEAT TRACE
TO BE ENERGIZED FROM
OCTORBER 1 TO MAY 31

2.6 Insulation

.1 Insulation Materials, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives.

.1 Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed rating when tested in accordance with CAN/ULC S102, NFPA 255 or ASTM E84.

.2 Provide insulating materials and accessories that withstand service temperatures without smouldering, glowing, smoking, or flaming when tested in accordance with ASTM C441.

.3 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labeled.

.4 Insulation (Except Flexible Cellular and Calcium Silicate Insulation):

.1 Place sections of insulation around pipe and joints tightly butted into place. Draw jacket tight and smooth. Secure jacket with fire resistant adhesive, factory-applied self-sealing lap, or stainless steel outward clinching staples spaced not over 4 inches (101.6 mm) on center and 12.7 mm (1/2-inch) minimum from edge of lap. Cover circumferential joints with butt strips, not less than 76.2 mm (3 inches) wide, of material identical to jacket material. Overlap longitudinal laps of jacket material not less than38.1 mm (1-1/2 inches). Adhesive used to secure butt strip shall be same as that used to secure jacket laps. Apply staples to both edges of butt strips.

.2 Vapor Barrier Jacket: When a vapor barrier jacket is required, on ends of sections of insulation that butt against flanges, unions, valves, fittings, and joints, provide a vapor barrier coating, or manufacturer's weatherproof coating for outside service, unless pipe insulation is supplied with factory-applied self-seal lap. Apply vapor barrier coating at longitudinal and circumferential laps. Patch damaged jacket material by wrapping a strip of jacket material around the pipe and cementing, stapling, and coating as specified for butt strips. Extend patch not less than 38.1 mm (1-1/2 inches) past the break in both directions. At penetrations by pressure gages, thermometers, etc. fill voids with vapor barrier coating (for outside service). Seal with a brush coat of the same coating. (Do not use staples to secure jacket laps on pipes carrying fluid medium at temperatures below 1.7°C (35°F).)

.3 Roof: Where pipe penetrates the roof, insulate piping to a point flush with top of flashing and seal with vapor barrier coating. Butt top of flashing and interior insulation tightly to exterior insulation. Extend exterior metal jacket 50.8 mm (2 inches) to fold down beyond end of insulation. Seal flashing and counterflashing underneath with vapor barrier coating.

.5 Flexible Cellular Insulation (Do not use for pipes in pipe chases and fire walls):

.1 Do not use flexible cellular insulation for pipes in fire rated chases and inside fire walls.

.2 Bond cuts, butt joints, ends, and longitudinal joints with adhesive. Miter 90-degree turns and elbows, tees, and valve insulation. Where pipes penetrate fire walls, provide rated insulation inserts and metal jackets. Insulate flanges, unions, valves, and fittings in accordance with manufacturer's published instructions. Apply two (2) coats finish as

recommended by insulation manufacturer to flexible unicellular insulation in outside locations. Do not use vinyl lacquer finish or equivalent. Provide flexible cellular insulation for outdoor use with ultraviolet (UV) resistant coating.

.6 Hangers and Anchors:

.1 Pipe insulation shall be continuous through pipe hangers. Where pipe is supported by insulation, provide galvanized steel shields or protection saddles as indicated.

.2 Where shields are used on pipes 50.8 mm (2 inches) and larger, provide insulation inserts at points of hangers and supports. Insulation inserts shall be of calcium silicate, cellular glass, molded glass fiber, rigid foam or other acceptable material, all minimum 15 psi (103 kPa) compressive strength, of the same thickness as adjacent insulation. Insulation inserts shall cover bottom half of pipe circumference and be not less in length than the protection shield. Vapor-barrier facing of insert shall be of same material as facing on adjacent insulation. Seal inserts into insulation with vapor barrier coating or weatherproof coating as applicable.

.3 Where protection saddles are used, fill voids with same insulation material as used on adjacent pipe. Protection saddles shall not be used on piping carrying medium less than 15.6°C (60°F) unless otherwise indicated.

.4 Where anchors are secured to piping carrying medium less than 15.6°C (60°F) that is to be insulated, insulate anchors same as piping for a distance not less than four times the insulation thickness to prevent condensation. Vapor seal insulation around anchors.

.7 Flanges, Unions, Valves and Fittings for Piping:

.1 Factory fabricated removable and reusable insulation covers may be used except with flexible cellular insulation. When nesting size insulation is used, overlap 50.8 mm (2 inches) or one pipe diameter, whichever is larger. Use insulating cement to fill voids. On pipe sizes larger than 63.5 mm (2-1/2 inches), elbows insulated using insulation segments shall not have less than three segments per elbow. Place and join segments with manufacturer's recommended water-vapor resistant, fire retardant adhesive appropriate for the temperature limit of the service. Overlap tape seams 25.4 mm (1 inch). Total dry film thickness shall be not less than 1.59 mm (1/16-inch). Unions are not to be insulated; taper insulation to union at a 45 degree angle. Provide finish coating as follows:

.2 Coating with Embedded Glass Tape: Coat insulation and all purpose jacket with two coats of lagging adhesive and with glass tape embedded between coats. Total dry film thickness shall not be less than 1.59 mm (1/16 inch). For cold piping, seal insulation and jacket with two coats of vapor barrier coating with glass tape embedded between coats. Insulate anchors attached directly to cold pipe for a sufficient distance to prevent condensation but not less than 152.4 mm (6 inches) from insulation surface.

.3 PVC Fitting Covers: Factory premolded one-piece PVC fitting covers may be provided in lieu of Coating with Embedded Glass Tape. Provide factory premolded field-fabricated segment or blanket insert insulation under fitting covers. Install factory premolded one-piece PVC fitting covers over insulation. Secure covers with stapling, taping with PVC vapor barrier tape, or with metal or plastic tacks made for securing PVC fitting covers. Do

not provide PVC fitting covers where exposed to weather. Provide PVC fitting covers only in ambient temperatures below 65.6°C (150°F).

.8 Piping Exposed to Weather:

.1 Metal Jackets: Provide over insulation. Machine cut jacket to smooth edge of circumferential joints. Overlap jacket not less than 50.8 mm (2 inches) at longitudinal and circumferential joints and secure with metal bands at not more than 229 mm (9 inches) centers. Overlap longitudinal joints down to shed water. Seal joints with a coating recommended by insulation manufacturer for weatherproofing.

.2 Flanges, Unions, Valves, Fittings, and Accessories: Insulate and finish as specified hereinbefore for applicable service. Apply two (2) coats of an emulsion type weatherproof mastic for hot service and vapor barrier mastic for cold service recommended by insulation manufacturer. Embed glass tape in the first coat. Overlap tape not less than one inch (25.4 mm) and the adjoining metal jacket not less than 50.8 mm (2 inches).

.9 Insulate fittings and valve bodies with preformed removable insulated fittings.

.10 Cold piping interior: semi-rigid, pre-formed fibreglass or formed rigid mineral fibre pipe insulation, with factory applied paintable canvas vapour barrier jacket, factory moulded to conform with piping, "K" value: maximum 0.035 W/m°C at 24°C. Service temperature: minus 40°C to 150°C.

.11 Cold piping exterior: foamglass insulation with factory applied aluminum vapour barrier jacket, factory moulded to conform with piping. “K” value: maximum 0.035 W/m°C at 24°C. Service temperature: -40°C to 150°C.

.12 Recovery jackets: 0.9 mm smooth aluminum sheet or paintable canvas for all new insulated piping.

.13 Vapor Barrier Coating: Provide in accordance with insulation manufacturers’ recommendations.

.14 Vapor Barrier Materials: ASTM C1136. Resistant to flame, moisture penetration, and mold growth, color white.

.15 Weatherproof Coating: For outside applications, provide in accordance with insulation and jacket manufacturer’s recommendations.

.16 PVC Pipe Fitting Cover and Its Vapor Barrier Tape: Provide PVC fitting covers with insulation inserts of same material and thickness as pipe insulation.

2.7 Buried Piping

.1 Provide insulation for all buried piping with a soil cover of less than 2600 mm in grassed areas or less than 3000 mm below roads, walkways, and access pads.

.2 The required insulation shall conform to current CAN/ULC S701 with a minimum compression strength of 175 kPa.

.3 Acceptable Manufacturer:

.1 DOW Chemical HI-40 (blue in colour).

.2 Owens Corning Foamular (400).

.3 Or approved equal.

2.8 Above-ground Piping

.1 Provide insulation for all pipe and equipment with an operating surface temperature in excess of 50°C. Use a minimum thickness of 25 mm. Use greater thicknesses as required to lower the outer skin temperature to below 40°C.

.2 Provide insulation for all piping where heat retention is required, at the locations indicated on the Drawings and for other piping systems where insulation is indicated on the Drawings.

.3 Provide insulation at pipe hangers and supports with factory applied vapour jacket and a self-sealing lap, manufactured specifically for use at support locations. It shall be a minimum of 200 mm long and of the same thickness as adjacent pipe insulation.

.4 Provide a suitable bonding agent to join the preformed sections.

.5 On exterior piping, provide aluminum jacketing with a minimum thickness of 0.9 mm, unless indicated otherwise.

.6 Provide aluminum banding, 12 mm wide by a minimum thickness of 0.5 mm with matching seals.

.7 Provide polypropylene jacketing at elbows, tees or other changes of direction and where indicated. Use the heat-shrink type jacketing, with a minimal thickness of 0.1 mm.

.8 On interior piping, provide paintable canvas jacketing, ULC listed (cUL), 0.27 kg/m^2 minimum.

2.9 Piping Insulation Jackets:

.1 All-Purpose Jackets:

.1 Insulation manufacturer's standard reinforced fire retardent jacket with or without integral vapor barrier as required by the service. Provide jackets in exposed locations with a white surface suitable for field painting.

.2 Metal Jackets:

.1 Aluminum Jackets: ASTM B209, Temper H14, minimum thickness of 27 gage (0.016 inch), with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside diameters less than 200 mm (8 inches). Provide corrugated surface jackets for jacket outside diameters 200 mm (8 inches) and larger. Provide stainless steel bands, minimum width of 12.7 mm (1/2-inch). Provide factory prefabricated aluminum covers for insulation on fittings, valves, and flanges. Covers shall be same thickness and material as jackets on adjacent piping.

.2 Stainless Steel Jackets: ASTM A167 or ASTM A240; Type 304, minimum thickness of 33 gage 0.254 mm (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 12.7 mm (1/2-inch). Provide factory prefabricated stainless steel covers for insulation on fittings, valves, and flanges. Covers shall be same thickness and materials as jackets on adjacent piping.

3. EXECUTION

3.1 Examination

.1 Examine areas and conditions under which pipe tracing cables to be installed and notify Contract Administrator, in writing, of conditions detrimental to proper and timely completion of Work.

.2 Do not install insulation and recovering before piping and equipment has been tested and approved.

.3 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 Install in accordance with manufacturer's written instructions. Coordinate installation with pipe insulation application.

.2 Distribute and fasten cable evenly on piping using pipe strap, cable ties, or fibreglass tape at maximum spacing 0.5 m. Ensure that heating cables do not touch or cross each other at any point. Run only cold leads in conduit and ensure sensing bulb does not touch cable. Ground shield to building ground. Coordinate cable installation with insulation application. Loop additional cable at fittings, valves, and flanges.

.3 Provide power connections, end seals, tee kits and all other components required for a complete operating system.

.4 Ensure insulation is continuous through inside walls and floor penetrations. Pack around pipes with fireproof, self-supporting insulation material, properly sealed.

.5 Insulate piping and fittings as noted in the schedule below. Insulate valves unless otherwise noted. Do not insulate unions, flanges (except on flanged valves if valve must be insulated), Victaulic couplings, strainers, (except on chilled water lines), flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.6 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.7 Cover all insulated piping throughout with aluminum or paintable canvas recovery jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres, unless otherwise noted. Lap the joints a minimum of 75 mm. Align longitudinal seams in aluminum recovering to shed water. All bands and screws are to be accessible for service and removal.

HEAT TRACING

.8 Cold piping: seal lap joints with 100% coverage of vapour barrier adhesive. Seal butt joints with 50 mm wide strips of vapour barrier sealed with vapour barrier adhesive. For fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells, seal all laps and joints.

.9 Unless indicated otherwise, do not insulate water body valves.

.10 Terminate insulation 100 mm on each side of all flanges and grooved joint couplings.

.11 Finish insulation neatly on hangers, supports, and other protrusions.

.12 Coordinate circuit connection points and voltages with Drawings, make power and control connections.

.13 Apply "electrically traced" signs to outside of thermal insulation as latest CEC Section 62.

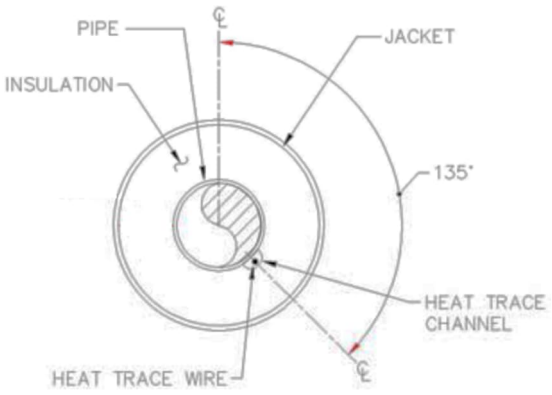
.1 Install heat tracing cable according to circuit length and geometry on approved Shop Drawings. Installation of cable shall conform to the manufacturer's instructions and the applicable requirements of the Canadian Electrical Code (CEC). Under no circumstances should the length of pull exceed the maximum recommended by the manufacturer.

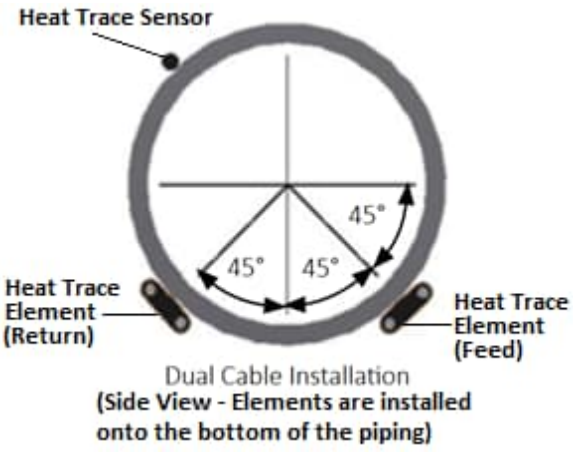
.2 Written approval of the manufacturer shall be provided in regard to the installation and testing (as outlined herein) of all heat trace cable.

.3 Splicing, branching and terminating of heating cable shall be performed using approved specialized heat shrink kits specifically designed for that purpose and meeting the requirements of the manufacturer.

.4 Install approved end seal kits at cable circuit ends as per the manufacturer's instructions.

.5 Sensors shall be installed on services during construction. Location of sensor must be identified on Shop Drawing submission and consistent with detail drawing of typical hook-up. Must be installed at location representative of ambient temperature on circuit. Location of sensor on pipe should be 180 degrees from heat trace cable (i.e. opposite side of pipe) for single heater element installations. Examples of single and dual elements are shown below for clarity.





.6 Heat trace cable and electrical appurtenances shall be installed in such a manner as to maintain the integrity of and prevent damage to the water pipe, insulation, and the cable itself and its appurtenances.

.7 To facilitate future connections, the Contractor is to provide sufficient length of heat trace cable and thermistor wire in his installations to enable a complete and functional connection.

3.3 Field Quality Control

.1 Examine material at initial install, and again at final installation for damage and defects in workmanship prior to start-up.

.2 Prior to installation of insulation, start pipe tracing system and check for temperature increase over full length of each tracing cable.

.1 A representative of the manufacturer shall megger each circuit of sufficient voltage to confirm whether the circuit will function in its intended manner and is without deficiency. All tests to be witnessed by the Contract Administrator. Each circuit shall be tested before, during and after installation, and the results recorded.

.2 Use 2500 V megger to test cables for continuity and insulation value and record readings before, during and after installation.

.3 Should the resistance drop be in excess of that recommended by the manufacturer of the cable, the Contractor shall determine the cause, rectify same, and re-test the circuit.

.1 Where resistance of 50 megohms or less is measured, stop work and advise Contract Administrator.

.3 Records for the Heat Trace Installation:

.1 The Contractor shall provide the Contract Administrator the following records with respect to the construction of the heat trace system and its related controllers:

.1 A Record Drawing of the completed installation showing the location of all terminations, splices, etc. in sufficient detail and accuracy for the Contract Administrator to locate these features in the future. All terminations, splices, etc. shall be tied to a readily identifiable surface feature such as a hydrant, valve, or building face.

.2 A record of each circuit in the heat trace system complete with the appropriate data on circuit length, cable type, and tabulated results of all megger testing.

.3 Submit Operation Manual prepared by the manufacturer(s) of the heat trace system and controls complete with detailed literature on components installed and recommended Operation and Maintenance procedures for the system

3.4 Closeout Activities

.1 Provide in accordance with Section 01 78 00 - Closeout Submittals.

3.5 Typical Schedules

.1 Refer to the mechanical and process divisions and the drawings for specific requirements. Only when not specified or shown on the drawings carry the minimum materials and requirements as provided in the below Schedules.

SCHEDULE 26 05 95-1, HEAT TRACE APPLICATIONS *

Application	Process Fluid, or Piping Size	Insulation Thickness (fibreglass) mm	Insulation (closed cell phenolic foam)	Flow Rate
Clean Water	Liquid		76 mm (3”)	(0.03-USgpm)
Insulated Process Piping, as shown on Drawings	15 to 50 mm (0.6 to 2”)	25 mm * (1”)	25 mm * (1”)	-
Insulated Process Piping, as shown on Drawings	Over 50 mm (2“)	50 mm * (2”)	50 mm * (2”)	-

SCHEDULE 26 05 95-2, INSULATION MATERIAL FOR PIPING *

Service	Material	Spec	Type	Class	Vapor Barrier Required
Chilled Water (Supply & Return, Dual Temperature Piping, 40°F (4.4°C) nominal)	Cellular Glass	ASTM C 552	II	2	No
	Urethane	ASTM C 591			Yes
	Mineral Fiber	ASTM C 547		1	Yes
	Flexible Cellular	ASTM C 534	I		No
	Faced Phenolic Foam	ASTM C 1126	III		Yes
Brine Systems Cryogenics (Minus 30 to Zero deg F) (-34.4 to 17.8°C)	Cellular Glass	ASTM C 552	II	2	No
	Flexible Cellular	ASTM C 534	I		No
	Faced Phenolic Foam	ASTM C 1126	III		Yes
Brine Systems Cryogenics (Zero to 34 deg F) (-17.8 to 1.1°C)	Cellular Glass	ASTM C 552	II	2	No
	Flexible Cellular	ASTM C 534	I		No
	Faced Phenolic Foam	ASTM C 1126	III		Yes

*** Unless stated otherwise elsewhere in the Specifications or on Drawings the values provided here are minimum and considered for information only for preliminary heat tracing estimates. Should other divisions provide more stringent requirements, the more stringent shall govern.**

SCHEDULE 26 05 95-3, PIPING INSULATION THICKNESS (INCH) (MM) *

		Tube and Pipe Size DN (MM)				
Service	Material	1/4 - 1 ¼ (8–32)	1 1/2-3 (40-80)	3 1/2-5 (90-130)	6-10 (150-250)	11-36 (280-900)
[Chilled Water (Supply & Return & Dual Temperature Piping) (40°F (4.4°C) Nominal)]	Cellular Glass	1.5 (38.1)	2 (50.8)	2 (50.8)	2.5 (50.8)	3 (76.2)
	Faced Phenolic Foam	1 (25.4)	1 (25.4)	1 (23.4)	1.5 (38.1)	1.5 (38.1)
	Mineral Fiber	1 (25.4)	1 (25.4)	1.5 (38.1)	1.5 (38.1)	1.5 (38.1)
	Urethane	0.75 (19.1)	0.75 (19.1)	0.75 (19.1)	1 (25.4)	1 (25.4)
	Flexible Cellular	0.75 (19.1)	0.75 (19.1)	0.75 (19.1)	1 (25.4)	1 (25.4)

HEAT TRACING

SCHEDULE 26 05 95-3, PIPING INSULATION THICKNESS (INCH) (MM) *						
		Tube and Pipe Size DN (MM)				
Service	**Material**	**1/4 - 1 ¼ (8–32)**	**1 1/2-3 (40-80)**	**3 1/2-5 (90-130)**	**6-10 (150-250)**	**11-36 (280-900)**
Brine System Cryogenics (Minus 30 to Zero°F)	Cellular Glass Flexible Cellular Faced Phenolic Foam	2.5 (63.5) 1 (25.4) 1.5 (38.1)	2.5 (63.5) 1 (25.4) 1.5 (38.1)	3 (76.2) N/A 2 (50.8)	3 (76.2) N/A 2 (50.8)	3.5 (88.9) N/A 2 (50.8)
Brine Systems, Cryogenics (Zero to 34°F)	Cellular Glass Flexible Cellular Faced Phenolic Foam	2 (50.8) 0.75 (19.1) 1 (25.4)	2 (50.8) 1 (25.4) 1 (25.4)	2 (50.8) 1 (25.4) 1 (25.4)	2.5 (63.5) 1 (25.4) 1.5 (38.1)	3 (76.2) 1 (25.4) 1.5 (38.1)

SCHEDULE 26 05 95-4, INSULATION THICKNESS FOR EQUIPMENT *	
Equipment	**Recommended Thickness**
Expansion Tanks or Pneumatic Water Tanks	1/2" (50.8 mm)
Air Separators	2" (50.8 mm)
Pumps	2" (50.8 mm)
*Chilled Water Tanks 35 to 55°F (1.7 to 12.8°C)	1" (25.4 mm)
*Cryogenic Equipment Minus 30 to 1°F (-34.4 to -17.2°C)	4" (101.6 mm)
NOTE: *indicates where vapor barrier is required.	

*** Unless stated otherwise elsewhere in the Specifications or on Drawings the values provided here are minimum and considered for information only for preliminary heat tracing estimates. Should other divisions provide more stringent requirements, the more stringent shall govern.**

END OF SECTION

ACCEPTANCE TESTING

1. GENERAL

1.1 References

.1 NETA Acceptance Testing Specifications, 2009 (ATS-2009).

.2 CSA C282, Emergency Electrical Power Supply for Buildings.

.3 City of Winnipeg inspection.

1.2 Submittals

.1 Submit:

.1 Test equipment to be utilized with last calibration date.

.2 Qualifications of lead electrical inspections technician.

.3 Test forms that will be utilized. These will be based on the City of Winnipeg test form format.

1.3 Qualification

.1 Provide competent lead electrical inspection technician thoroughly familiar with all aspects of electrical testing. It is expected that the technician will have a CET, Journeyman Electrician's certificate, or other equivalent designation. The designated technician is to be on-site and lead all electrical testing.

.1 The Contract Administrator reserves right to approve the lead electrical inspection technician and request an alternate technician if deemed to be unqualified.

.1 The Contract Administrator reserves the right to request documentation and proof from the Contractor that their lead electrical inspections technician is qualified to perform the work. The documentation and proof can include the following:

.1 A request for references from past previous projects.

.2 A request for a list of past previous projects.

.2 In the circumstance where the Contract Administrator rejects the lead inspection technician, the Contractor will be responsible for providing a suitably qualified individual to perform the work, at no additional cost to the City of Winnipeg. Qualifications will be specifically analyzed by the Contract Administrator, based on the following:

.1 The qualified lead electrical inspection technician will have performed similar work at other similar installations.

.2 The qualified lead electrical inspection technician will be trained in using the instruments and measuring devices; and adjusting the settings or programming the devices.

.3 The qualified lead electrical inspection technician will have experience in analyzing the results obtain from the instruments or measuring devices.

.4 The qualified lead electrical inspection technician will have sufficient experience to immediately recognize erroneous measurements based on past work experience and expected results.

.5 The qualified lead electrical inspection technician will be familiar with the settings and methodologies required to perform the Work.

.3 In the circumstance where the Contractor cannot provide a competent lead electrical inspection technician, the Contract Administrator reserves the right to hire a qualified individual separate from this Contract and to back charge the Contractor for services and costs performed in order to complete the Work.

1.4 Testing Equipment

.1 All test equipment shall be in good mechanical and electrical condition.

.2 Accuracy of metering in test equipment shall be appropriate for the test being performed.

.3 Wave shape and frequency of test equipment output waveforms shall be appropriate for the test and the tested equipment.

.4 The test equipment shall be calibrated as specified below:

.1 The testing organization shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.

.2 The testing organization will have calibration certifications for test equipment, and a copy will be made available to the Contract Administrator.

.3 The firm providing calibration service shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.

.4 Instruments shall be calibrated in accordance with the following frequency schedule:

.1 Field instruments: Analog, 6 months maximum. Digital, twelve (12) months maximum.

.2 Laboratory instruments: Twelve (12) months maximum.

.3 Leased specialty equipment: Twelve (12) months maximum.

.4 Dated calibration labels shall be visible on all test equipment.

.5 Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.

.6 Calibrating standard shall be of higher accuracy than that of the instrument tested.

.5 Specific requirements of insulation resistance meters.

.1 Must be digital units.

.6 All test equipment to have valid calibration stickers displayed on the equipment.

.7 AC High Voltage (dielectric strength) Units:

.1 Use AC High voltage units for insulation tests and other tests as indicated, at voltage levels indicated, or required by Manufacturers recommendations.

.8 Low Resistance Test Units (Ductor):

.1 Low resistance test units to have 10 A output.

.2 Digital display and accuracy to 1 micro-ohm, with a range from 1 μΩ to 1000 Ω. Standard electrician multimeters will not be accepted.

.9 Insulation Resistance Tests (Megohmmeter/Megger):

.1 Use a megger with 20,000 M-ohm resolution for megger tests.

.2 Output voltages on DC megger units to be 250 V, 500 V, 1000 V, 2500 V or other as required.

.3 Record ambient temperature and adjust the measured M-ohms to 20°C ambient.

.4 Use 2.5 kV megger for 5 kV and15 kV equipment and 1000 V megger range for power equipment of 600 V and below.

.5 For 10-minute megger tests, record M-ohm values in M-ohm at 30 seconds, 60 seconds, 5 minutes and 10 minutes. Plot M-ohm against time for each connection, calculate and record the ratio of measured M-ohm as follows:

.1 60 sec M-ohm/30 sec M-ohm = dielectric absorption.

.2 10 min M-ohm/1 min M-ohm = polarization index.

.3 Report the 1 minute M-ohm as the insulation resistance value.

.6 Submit tabulated measure M-ohm figures for 10-minute insulation tests, submit a graph.

.7 Apply megohmmeter dc voltage in accordance with the equipment Manufacturer's recommendations or NETA ATS-2009 Table 100.1.

.10 VLF Test:

.1 Use a VLF tester capable of 40 kV peak that is capable of testing 1.1uF of cable load at 0.1 Hz up to 5.5 uF at 0.2 Hz.

.11 Ground Resistivity Tester:

.1 Ground resistivity tester to measure earth impedance in variable distances from the source.

.2 Unit to be capable of plotting ground resistivity from 0.1 ohms and up.

.12 Other test equipment as required in order to satisfy the requirements of this section as detailed herein.

1.5 Testing Report

.1 Prepare an overall inspection and test report that details all investigations and tests.

.2 The Contractor shall provide final report.

.1 The electronic copy of the report, including the test forms, shall be provided in PDF format.

.2 Sample City test forms are included for reference. The Contractor shall modify the forms, and create new forms as needed to meet all the test requirements described herein.

.3 A Microsoft Word version of the all completed test forms provided to the City shall also be included on the CDs.

.3 The report shall be neat and organized. Any omissions, inconsistencies, or incomplete work identified by the Contract Administrator shall be corrected and incorporated into the report in the appropriate section, and completely resubmitted.

.4 A draft of each report shall be completed and sent to the Contract Administrator for review a maximum of one (1) month after the completion of the inspections at the Site.

.5 The final report shall be submitted a maximum of two (2) weeks after the Contractor receives the mark-up of the draft report from the Contract Administrator.

.6 The report shall include the following:

.1 Summary of project.

.2 Testing Equipment.

.3 Detail the type, manufacturer, model, last calibration date and test certificate for all testing equipment used.

.4 Description of equipment tested.

.5 Description and methodology of all tests performed.

.6 Typed inspection forms including:

.1 Identification of the testing organization.

.2 Equipment identification.

.3 Humidity, temperature, and other conditions that may affect the results of the tests/calibrations.

.4 Date of inspections, tests, maintenance, and/or calibrations.

.5 Identification and signed initials of the testing technician.

.6 Indication of inspections, tests, maintenance, and/or calibrations performed and recorded, along with charts, and graphs as applicable. All measurements and readings taken shall be noted for inclusion in the report. Where repairs are made, measurements and readings before and after the repair shall be included.

.7 Indication of expected results, when calibrations are to be performed.

.8 Indication of “as-found” and “as-left” results, as applicable.

.7 Itemized list of all repaired deficiencies which shall include:

.1 Detailed description of the deficiency.

.2 Detailed description of the deficiency repair.

.8 Itemized list of all un-repaired deficiencies encountered which shall include:

.1 Detailed description of the deficiency.

.2 Recommended action to be taken to repair the deficiency.

.3 Reason for not performing the recommended repair (such as equipment or component not available).

.4 Schedule and subsequent follow up and documentation of the repair of the deficiency.

2. PRODUCTS

2.1 Equipment

.1 Provide all tests results with typed test reports and signed field test sheets.

.2 All test sheets to include equipment nameplate data, customer identification, time and date of tests, environmental conditions during tests, and test results.

.3 Provide testing equipment, lifts, man-baskets, temporary connections, cabling, lugs, leads, clips, and all other devices and equipment as required to perform the required tests and complete the required documentation.

3. EXECUTION

3.1 Test Plan

.1 Prior to performing testing, the lead electrical inspection technician shall submit written test procedures indicating details of the work to be performed to the Contract Administrator for review and approval prior to proceeding.

.2 As a minimum, the test plan shall include the following:

.1 Type of tests.

.2 Equipment being used to perform the test.

.3 Equipment settings for each test.

.4 Test sheets.

.5 Safety checks and safety plan.

.6 An indication of expected results.

.3 The cost of any damage to equipment due to improper test methods or procedures will be borne by the Contractor performing the tests.

3.2 Scope of Testing

.1 Perform testing and Commissioning of electrical devices, in accordance with the Drawings and Specifications to suit the actual project. Scope of work for testing includes the following devices:

.1 Panel boards and distribution panels, greater than 225A, including:

.1 Surge Protector.

.2 Power Meter.

.3 Voltage Monitor.

.4 CTs.

.5 PTs.

.6 Branch Circuit Breakers.

.2 Molded case circuit breakers, greater than or equal to 250 A frame.

.3 Dry type transformers, 15 kVA and greater.

.4 Oil filled transformers.

.5 Motors, 0.5 HP and greater.

.6 Battery systems.

.7 Surge arrestors.

.8 Cables:

.1 Test all 120 / 208 V / 240 V / 600 V power cables and wires No. 10 AWG or larger (except for lighting and 15 A duplex receptacle circuits).

.2 Test all 15 kV cables.

.9 Grounding system.

.10 Perform harmonics measurements and analysis at all main distribution panels, at all available voltage levels at the Facility.

.2 All equipment which fails the tests shall be replaced, repaired and corrected at no additional charge. These items are deemed to be under warrantee, and the warrantee shall not be affected or voided as a result of the testing performed.

.3 The calibration, check out, testing and Commissioning activities specified in other sections, of the overall Specifications are to be considered as supplemental to the requirements of this section. Those requirements are to be completed for each particular part of the work described prior to the execution of the overall requirements described herein. Where any duplication in requirements may exist the more stringent requirement will take precedent.

.4 Perform Commissioning of all systems, to ensure a complete and functional installation.

3.3 Inspection, Testing and Maintenance Procedures

.1 General:

.1 All tests are based on NETA (National Electrical Testing Association) standard ATS-2009. Where Manufacturer's Specifications, tolerances, and/or published data are not available, refer to the appropriate tables in ATS-2009. Confirm with the equipment Manufacturer that the test will not damage the equipment or void the warrantee prior to proceeding with tests.

.2 Torque all accessible bolted electrical connections. Additional requirements apply as specified.

.3 Utilize the Drawings for reference while performing the specified electrical inspection work. Where the existing installation deviates from that shown on the Drawings, mark-up the Drawings with red pen as required to reflect the installation. Include the marked-up Drawings in the report.

.4 The scope of required Drawing checks is limited to the equipment and components that are part of the electrical inspection work.

.5 Any repairs made that affect the accuracy of the Drawings shall be marked up on the Drawings.

.6 All inspection values, readings, corrections, and assessments shall be clearly recorded for inclusion within the report.

.7 Where corrections or repairs are made, record both as found/as left test readings on the inspection sheet. If space is not provided on the inspection form, record the readings in the Note fields or on a separate sheet.

.2 Inspection Forms:

.1 The inspection forms are to be provided, and completed by the Contractor. These shall be typewritten (in Microsoft Word or Excel format) and submitted the Contract Administrator for format approval.

.2 Make appropriate print-outs of the inspection forms and utilize for entry of data and test results on Site.

.3 Utilizing the Microsoft Word form templates, enter the data recorded manually into the forms electronically.

.4 Complete the inspection forms in their entirety and include them in the report.

.5 Submit electronic PDF copies of the inspection forms.

.6 The scope of Work required in the Specifications is in no way limited by the inspection forms, or spaces provided. Provide additional pages, documents, and forms as required to provide a complete report.

.7 The inspection forms may be updated during the by the Contract Administrator. Utilize the latest forms.

.8 Perform insulation resistance temperature correction.

3.4 Cables (Also Feeders In Conduit), Up To 600 V

.1 Perform inspection and tests on cables prior to installing sealing compound in the conduit system. This applies to hazardous areas and to weatherproof penetration sealant.

.2 Inspection and testing shall be comprised of the following:

.1 For cables/wires 4/0 AWG or larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate and correct values which deviate from those of similar bolted connections by more than 50%of the lowest value.

.2 Torque all accessible bolted electrical connections.

.3 Inspect compression applied connectors for correct cable match and indentation.

.4 Inspect grounding and cable/conduit support.

.5 Verify that visible cable bends meet or exceed the minimum allowable bending radius.

.6 Measure length of cable/conduit and record in meters. Record and adjust all cable lengths included in the cable schedules. Other building base building cabling such as lighting, fire alarm, public address, 15A duplex receptacles do not need to be recorded. Record cable lengths based on conductor distance markings where ever possible, for accurate lengths.

.7 If cables/wires are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

.8 Perform an insulation-resistance test on each conductor. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 1 Gigohms for power cabling. The voltage applied shall be 1000 VDC for 600 V or 1000 V rated cables.

3.5 Cables, Medium Voltage (5 kV and 15 kV)

.1 Inspection and testing shall be comprised of the following:

.1 Inspect exposed sections of cables for physical damage and evidence of overheating and corona.

.2 Proper connections in accordance with single-line diagram.

.3 Proper circuit and phase identification.

.4 Inspect terminations and splices for physical damage and evidence of overheating and corona.

.5 Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50% of the lowest value.

.6 Inspect compression applied connectors for correct cable match and indentation.

.7 Check for proper lug installation.

.8 Confirm bolt torque levels are in accordance with Manufacturer’s recommendation.

.9 Inspect shield grounding and cable support.

.10 Verify that visible cable bends meet or exceed the minimum allowable bending radius.

.11 Measure and record the length of cable.

.12 If cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

.13 Perform a shield-continuity test on each power cable by ohmmeter method. The shielding must exhibit continuity. Investigate resistance values in excess of 10 ohms per 1000 feet of cable.

.14 Perform an insulation-resistance test on each conductor utilizing a megohm-meter:

.1 Utilize 2,500-volt megohmmeter for 5 kV, 8 kV, 15 kV conductors in accordance with NETA standards.

.2 Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 5 Gig-ohms for 5 kV cable, and 15 Gig-ohms for 15 kV.

.15 Perform a Very Low Frequency (VLF) ac high-potential test on cables. Adhere to all precautions and limits as specified in the applicable NEMA / ICEA Standard for the specific cable. Perform tests in accordance with IEEE Standard 400.2. Test procedure shall be as follows, and the results for each cable test shall be recorded as specified herein. The test voltage shall be sinusoidal with a frequency of 0.1 Hz, and shall not exceed cable Manufacturer's test values or IEEE 400.2 values as indicated:

Cable rating phase to phase (RMS)	**Acceptance test phase to ground**	**Maintenance test phase to ground**
5 kV RMS	10 kV RMS (14 peak)	7 kV RMS (10 peak)
15 kV RMS	20 kV RMS (28 peak)	16 kV RMS (22 peak)

.1 If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the over-potential test, the test specimen is considered to have passed the test.

.2 Ensure that the input voltage to the test set is regulated.

.3 Current-sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.

.4 Record wet and dry-bulb temperatures or relative humidity and temperature.

.5 Test each section of cable individually.

.6 Individually test each conductor with all other conductors grounded. Ground all shields.

.7 Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable methods as necessary.

.8 Ensure that the maximum test voltage does not exceed the limits for terminators specified in IEEE Standard 48 or Manufacturer's Specifications.

.9 Raise the conductor test voltage to the specified maximum test voltage and hold for five minutes. Record leakage current.

.10 Apply grounds for a time period adequate to drain all insulation-stored charge.

.16 Perform a Dissipation Factor (Tangent Delta) test on all cables.

.1 Perform tests in accordance with IEEE Standard 400.2.

.2 The test voltage applied shall be a 0.1 Hz sinusoidal waveform.

.3 The dissipation factor shall be calculated for an applied voltage of 1 Uo RMS.

.4 Provided that the dissipation factor does not rise significantly while raising the voltage, the dissipation factor shall also be calculated for an applied voltage 2 Uo RMS.

.5 In the event of a cable failure discovered during testing, replace the cable.

3.6 Circuit Breakers, Insulated-Case/Molded Case, up to 600 V

.1 Inspection and testing shall include the following:

.1 Note the equipment nameplate data for inclusion in the report.

.2 Record all adjustable settings.

.3 Inspect physical and mechanical condition.

.4 Inspect anchorage and alignment.

.5 Clean the unit.

.6 Torque all accessible bolted power connections.

.7 Operate the circuit breaker to insure smooth operation.

.8 Test all breakers utilizing the “Push-To-Trip” button, if equipped.

.9 Move operating handle to the off and on position.

.10 Restore breaker position to original position.

.2 For cables 4/0 AWG and larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50% of the lowest value.

.3 For breakers with a frame size greater or equal to 250 A, or as specified elsewhere in the Specification:

.1 Perform an insulation resistance test.

.2 Breakers rated less than 600 V, test voltage is to be 500 VDC.

.3 Breakers rated at 600 V, test voltage is to be 1000 VDC.

.4 Perform a contact/pole-resistance test.

3.7 Air Circuit Breakers

.1 Visual and Mechanical Inspection:

.1 Proper cell fit and element alignment.

.2 Proper operation of cubicle shutters and racking mechanism.

.3 Bolt torque level in accordance with Manufacturer's recommendations and NETA ATS-2009, Table 100.12. Where conical washers (Belleville or other) are used, consult with the Contract Administrator prior to tightening or applying pressure to connections.

.4 Proper contact condition.

.5 Perform mechanical operator and contact alignment tests on breaker and it's operating mechanism in accordance with Manufacturer's instructions.

.6 Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operations are correct.

.7 Ensure that maintenance devices are available for servicing and operating breaker.

.8 Check for adequate lubrication on contact, moving, and sliding parts.

.9 Check condition of brushes and limit switches on charging and lifting motors.

.10 With Breaker in TEST Position:

.1 Trip and close breaker with control switch.

.2 Trip breaker by manually operating each protective relay.

.11 Perform breaker travel and velocity analysis in accordance with Manufacturer's instructions; values shall be in accordance with Manufacturer's acceptable limits.

.2 Electrical Tests:

.1 Insulation Resistance Tests:

.1 Utilize:

.1 1,000 volt megohmmeter for 600 V circuit breakers.

.2 Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

.3 Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

.4 Test values to comply with NETA ATS-2009 Table 100.1.

.2 Contact Resistance Tests:

.1 Contact resistance in microhms across each pole.

.2 Investigate deviation of 50% or more from adjacent poles and similar breakers.

.3 Dieletric Withstand Tests:

.1 Maximum applied voltage for equipment in accordance with NETA ATS-2009, Table 100.2 and Table 100.19.

.2 Each pole-to-ground with other poles grounded and contacts closed.

.3 Test results evaluated on pass/fail basis.

.4 Minimum pickup voltage tests on trip and close coils.

3.8 Vacuum Circuit Breakers

.1 Visual and Mechanical Inspection:

.1 Check for proper element alignment.

.2 Check for proper operation of cubicle shutters and racking mechanism.

.3 Bolt torque level in accordance with Manufacturer's recommendations and NETA ATS-2009, Table 100.12. Where conical washers (Belleville or other) are used, consult with the Contract Administrator prior to tightening or applying pressure to connections.

.4 Perform mechanical operational tests on breaker and it's operating mechanism in accordance with Manufacturer's instructions, plus check:

.1 Pull rod adjustment.

.2 Trip latch clearance.

.3 Overtravel stops.

.4 Wipe and gap setting.

.5 Perform breaker travel and velocity analysis in accordance with Manufacturer's instructions; values shall be in accordance with Manufacturer's acceptable limits.

.6 Check contact erosion indicators in accordance with Manufacturer's instructions.

.7 With Breaker in TEST Position:

.1 Trip and close breaker with control switch.

.2 Trip breaker by manually operating each protective relay.

.2 Electrical Tests:

.1 Insulation Resistance Tests:

.1 Utilize 2,500-volt dc megohmmeter for 5 kV and 15 kV circuit breakers.

.2 Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

.3 Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

.4 Test values to comply with NETA ATS-2009, Table 100.1

.2 Contact Resistance Tests:

.1 Between the line and load stab of closed contact resistance in microhms across each pole.

.2 Investigate deviation of 50% or more from adjacent poles and similar breakers.

.3 Dielectric Withstand Tests:

.1 Maximum applied voltage in accordance with NETA ATS-2009, Table 100.19.

.2 Each pole-to-ground with other poles grounded and contacts closed.

.3 Test results evaluated on pass/fail basis.

.4 Minimum pickup voltage tests on trip and close coils.

3.9 Control Power Transformers, up to 600 V

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the report.

.2 Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

.3 Verify that primary and secondary fuse ratings or circuit breakers match available Drawings. Where Drawings are not available, note fuses that appear to be sized incorrectly, based upon application of the Canadian Electrical Code. Mark fuse sizes and type on the Drawings, where not shown.

.4 Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be:

.1 windings less than 250 V: 500 VDC.

.2 windings greater than 250 V: 1000 VDC.

3.10 Grounding System

.1 Inspection and testing shall be comprised of the following:

.1 Perform resistance tests between the main grounding electrode and grounded points in the electrical distribution system located in the main panel and transformers Investigate and correct connections with a resistance greater than 0.5 milliohms.

3.11 Panel Boards, up to 600 V

.1 Inspection and testing shall be comprised of the following:

.1 Note the equipment nameplate data for inclusion in the report.

.2 Inspect physical and mechanical condition.

.3 Inspect anchorage, alignment, and grounding.

.4 Clean the unit.

.5 Inspect breakers and verify mechanical operation by exercising all circuit breakers.

.1 Record breaker data on the inspection form.

.2 Test all breakers utilizing the “Push-To-Trip” button, if equipped.

.3 Move operating handle to the off and on position.

.4 Restore breaker position to original position.

.6 Test with current injection, main and feeder/load breakers with a frame size greater than or equal to 250A, or with long, short, or ground fault settings and complete a separate inspection form for each.

.7 Torque all accessible bolted power connections including incoming, load neutral and ground connections.

.8 Perform insulation-resistance tests on each bus phase with all other phases grounded.

.1 The main breaker, if present, is to be open for the test. If no main breaker is present, disconnect the supply conductors.

.2 Open all load breakers.

.3 Test voltage for all 600/347 V panelboards to be 1000 VDC.

.4 Test voltage for all 120/208 V panelboards to be 500 VDC.

.9 Perform insulation-resistance test on insulated bearings in accordance with Manufacturer's published data, if applicable.

.10 Perform resistance tests on resistance temperature detector (RTD) circuits. RTD circuits should conform to design intent and/or machine protection device Manufacturer's Specifications.

3.12 Transformers, Dry-Type, up to 600 V

.1 Inspection and testing shall be comprised of the following:

.1 Note the equipment nameplate data for inclusion in the report.

.2 Inspect physical and mechanical condition.

.3 Inspect anchorage, alignment, and grounding.

.4 Clean the unit.

.5 Torque all accessible bolted power connections.

.6 Record the tap setting.

.7 Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Duration of the test is to be one minute. Calculate the dielectric absorption ratio.

.1 600 V windings shall be tested at 1000 VDC.

.2 120/208 V windings shall be tested at 500 VDC.

3.13 Transformers, Dry-Type, Medium Voltage

.1 Inspection and testing shall be comprised of the following:

.1 Note the equipment nameplate data for inclusion in the report.

.2 Inspect physical and mechanical condition.

.3 Inspect anchorage, alignment, and grounding.

.4 Clean the unit.

.5 Verify that alarm settings on temperature indicators are as specified and operate within Manufacturer's recommendations for specified settings.

.6 Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50% of the lowest value.

.7 Record tap setting. Confirm the tap setting appears reasonable by measuring the voltage during normal Facility operation.

.8 Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Calculate polarization index. Minimum insulation-resistance values of transformer insulation should be 1000 megohms for the 4160 V windings and 100 megohms for the 600 V windings. Values of insulation resistance less than the values stated should be investigated. The polarization index should not be less than 1.0.

.1 The test duration shall be 10 minutes for each winding.

.2 4160 V windings shall be tested at 2500 VDC.

.3 600 V windings shall be tested at 1000 VDC.

.9 Perform turns-ratio tests at the designated tap position. Turns-ratio test results should not deviate more than one-half percent from either the adjacent coils or the calculated ratio.

.10 Measure the resistance of each winding at the designated tap position.

.11 Measure core insulation resistance at 500 VDC if the core is insulated and if the core ground strap is removable.

.12 Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading. Phase-to-phase and phase-to-neutral secondary voltages should be in agreement with nameplate data.

3.14 Grounding Systems

.1 Visual and Mechanical Inspection:

.1 Equipment and circuit grounds in motor control center, panelboard, switchboard, and switchgear assemblies for proper connection and tightness.

.2 Ground bus connections in motor control center, panelboard, switchboard, and switchgear assemblies for proper termination and tightness.

.3 Effective transformer core and equipment grounding and bonding.

.4 Accessible connections to grounding electrodes for proper fit and tightness.

.5 Accessible exothermic-weld grounding connections to verify that moulds were fully filled and proper bonding was obtained.

3.15 Ground Fault Systems

.1 Inspection and Testing Limited To:

.1 Zero sequence grounding systems.

.2 Residual ground fault systems.

.2 Visual and Manual Inspection:

.1 Neutral Main Bonding Connection to Assure:

.1 Zero sequence sensing system is grounded ahead of neutral disconnect link.

.2 Ground strap sensing system is grounded through sensing device.

.3 Neutral ground conductor is solidly grounded.

.2 Verify that control power has adequate capacity for system.

.3 Manually Operate Monitor Panels For:

.1 Trip test.

.2 No trip test.

.3 Nonautomatic rest.

.4 Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.

.5 Relay check for pickup and time under simulated ground fault conditions.

.6 Verify nameplate identification by device operation.

3.16 Thermographic Inspection

.1 Camera:

.1 Minimum IR resolution: 320 x 240 pixels.

.2 Minimum visible resolution: 640 x 480 pixels.

.2 Thermographic inspections and photographs shall be completed in accordance with the recommendations of the Standard for Infrared Inspection of Electrical Systems and Rotating Equipment published by the Infraspection Institute.

.3 Provide a thermographic survey of connections associated with incoming service conductors, bus work, and branch feeder conductors and larger at each:

.1 Medium voltage switchgear.

.2 Low voltage switchgear, greater than 225 A.

.3 Panelboards greater than 225 A.

.4 All other equipment specified herein which requires a thermographic survey.

.4 Inspection and testing shall be comprised of the following:

ACCEPTANCE TESTING

.1 Remove all necessary covers prior to thermographic inspection.

.2 Equipment to be inspected shall include all current-carrying devices.

.3 Test Parameters:

.1 Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.

.2 Equipment shall detect emitted radiation and convert detected radiation to a visual signal.

.3 Thermographic surveys should be performed during periods of maximum possible loading but not less than 40% of rated load of the electrical equipment being inspected. Coordinate with City as required.

.4 Note all temperature differences larger than 1°C. Investigate all temperature differences larger than 4°C.

.5 Re-inspect deficient areas with the thermographic camera following repairs and corrections, for deficient areas identified.

.5 Provide a report which shall include the following:

.1 Description of the equipment tested.

.2 Discrepancies found.

.3 Temperature difference between the area of concern and the reference area. Probable cause of temperature difference. Identify any repairs made during the thermographic inspection. If no repairs were made, provide recommended action for repair.

Areas inspected. Identify inaccessible and / or unobservable areas and / or equipment.

.4 Identify load conditions at time of inspection.

.5 Provide photographs and thermograms of all areas investigated, with deficient areas identified. Visible light photographs and thermograms shall align in a manner to allow for easy identification of the components shown on the thermograms.

.6 Provide thermograms of all deficient areas corrected and identify the load conditions at the time of re-inspection.

END OF SECTION

DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

1. GENERAL

1.1 Related Sections

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section. This section supplements requirements of other Divisions.

.1 Section includes various equipment and testing requirements that may be required for the project and the applications where each type shall be used.

1.2 Description

.1 This Section covers the furnishing of all materials, equipment and services for the design, fabrication, supply and delivery, installation/labour, and testing of indoor transformers, or outdoor pad-mounted transformers.

.2 This Specification outlines only general performance and minimum requirements; it is not intended to relieve the Vendor of responsibility for the design of equipment in accordance with the latest applicable codes and standards.

.3 The intent of this Specification is to convey minimum requirements for complete, operable, safe, effective and approved equipment delivered to the Site ready for installation.

1.3 References

.1 American National Standards Institute (ANSI):

.1 C57. 12.90: Test Code for Distribution and Power Transformers.

.2 Canada Energy Efficiency Act and Energy Efficiency Regulations:

.1 National Resources Canada (NRCan).

.3 Canadian Standards Association (CSA):

.1 CSA C9, Dry-Type Transformers.

.2 CSA C22.1, Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.

.3 CSA C22.2 No.47, Air-Cooled Transformers (Dry Type).

.4 CSA C22.3 No.7, Underground Systems.

.5 CSA C802.2, Minimum Efficiency Values for Dry Type Transformers.

.4 Institute of Electrical and Electronics Engineers (IEEE):

.1 C57.12.28: Standard for Pad-Mounted Equipment - Enclosure Integrity.

.5 Manitoba Energy Code for Buildings (MECB):

.1 Manitoba amendments to the National Energy Code of Canada for Buildings.

.6 National Electrical Testing Association (NETA):

.1 ATS – Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.7 National Electrical Manufacturers Association (NEMA):

.1 ST 20, Dry Type Transformers for General Applications.

.8 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.9 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

1.4 Warranty

.1 As a minimum, the Vendor shall include a warranty for twelve (12) months of operation or eighteen (18) months after arrival on Site, whichever is less. The Vendor shall state their standard warranty for the Transformer specified.

1.5 Submittals

.1 Submit in accordance with Division 1 and Division 26.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature, specifications, and data sheets for dry type transformers and include product characteristics, performance criteria, physical size, impedance, finish and limitations. Include transformer weight.

.3 For wall-mount installations coordinate the support structure with other Divisions and submit for review.

.4 Closeout Submittals:

.1 Operation and Maintenance Data: For transformers to include in operation and maintenance (O&M) manuals.

.2 Applicable wiring diagrams, including any modifications.

.3 Performance Validation Report and other completed factory and site testing reports.

.5 Outdoor installations:

.1 Submit catalogue cuts for transformer pads, including anchoring method and dimensioned foundation template. Provide dimensioned cable entry locations.

1.6 Responsibility

.1 Install transformers, factory-supplied materials, accessories, and options, furnished by the transformer manufacturer.

1.7 Quality and Environmental Assurance

.1 On-Site Testing Qualifications: Accredited by NETA.

.2 Certified ISO 9001 Quality Management System.

.3 Certified ISO 14001 Environmental System.

2. PRODUCTS

2.1 General

.1 General: dry type, air-cooled, self-ventilated, code gauge steel, complete with ventilation openings, removable access panels, mounting brackets, and solderless primary and secondary cable connectors. Enclosures to have zinc chromate prime coat and enamel finish coat per Division 26. Transformers to be single- or 3-phase as noted on the Drawings.

.2 Design:

.1 Type: Air Natural Convection Cooling (ANN).

.2 CSA/NEMA Environmental Rating: minimum 3R, with removable metal front panel.

.1 When installed Indoors suitable for an ambient temperature of: 5˚C to 30˚C, ventilated.

.2 When installed Outdoors suitable for an ambient temperature of: -40˚C to 40˚C, of fully enclosed non-ventilated design, or shielding plates to prevent ingress from snow drifts.

.3 3-phase, kVA and voltages as indicated on the Drawings, 60 Hz.

.4 Voltage primary taps: 2.5% full capacity above and below normal.

.5 Insulation: Class H.

.6 Basic Impulse Level (BIL): 10 kV B.I.L.

.7 Hipot: 4 kV.

.8 Low-Sound-Level Requirements: Maximum sound levels when factory tested according to NEMA ST 20, applied to all transformers, including those with K-factor ratings up to 20, as follows:

.1 9.00 kVA and Less: 40 dBA.

.2 9.01 to 30.00 kVA: 42 dBA.

.3 30.01 to 50.00 kVA: 42 dBA.

.4 50.01 to 150.00 kVA: 47 dBA.

.5 150.01 to 300.00 kVA: 52 dBA

.6 300.01 to 500.00 kVA: 57 dBA.

.7 500.01 to 700.00: 59 dBA.

.8 700.01 to 1000.00: 61 dBA.

.9 1000.01 to 1500.00 kVA: 64 dBA.

.9 Factory Sound-Level Tests: Conduct sound level tests on equipment. Provide data for each serial number upon request.

.10 Test each transformer for required noise limit. Type testing is not acceptable.

.11 Impedance at 170°C: 6.0% maximum up to 112.5 kVA; 5.5% maximum above 112.5 kVA.

.12 Finish: In accordance with Division 26.

.13 Three Phase Windings: arrange with three primary windings connected in delta and three secondary windings connected in wye.

.14 Max. Winding Temperature:

.1 Indoor applications: 150°C rise with temperature continuous full load.

.2 Outdoor applications: 115˚C rise with temperature continuous full load.

.3 Max. Lead Connection: 55°C rise with temperature continuous full load.

.15 Copper winding.

.16 All connections are front accessible only and taps.

2.2 Equipment Identification

.1 Provide equipment identification in accordance with Division 26.

.2 Label size: 7.

2.3 Delivery, Storage, and Handling

.1 Deliver, store, and handle materials in accordance with Manufacturer’s written instructions.

.2 Requirements:

.1 Store and protect dry type transformers from nicks, scratches, and blemishes.

.2 Replace defective or damaged materials with new.

.3 Provide lifting hooks for complete transformer assembly.

.4 Do not use permanent distribution system dry type transformers for temporary power distribution without permission from the Contract Administrator.

3. EXECUTION

3.1 Installation

.1 Remove shipping supports only after transformer is installed and just before putting into service. Remove shipping bolts, blocking, and wedges.

.2 Coordinate installation of floor, wall-mounted, and structure-hanging supports with actual transformer provided.

.1 Mounting: up to 45 kVA suitable for wall or floor mounting; and above 45 kVA suitable for floor mounting unless otherwise shown.

.2 Install transformers in level upright position.

.3 Indoor Installation – floor mount:

.1 Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

.2 Proceed with installation only after unsatisfactory conditions have been corrected.

.3 Ensure adequate clearance around transformer for ventilation.

.4 Construct concrete bases and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.

.5 Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

.6 Secure transformer to concrete base according to manufacturer's written instructions.

.7 Do not install dry type transformers indoors in Category 1 or Category 2 areas.

.8 Examine concrete bases for suitable mounting conditions where transformers will be installed. Install transformers level and plumb on a concrete base with vibration-dampening supports.

.9 Secure transformer to concrete base, rigid, plumb and square according to manufacturer's written instructions.

.4 Loosen isolation pad bolts until no compression is visible.

.5 Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure. Connections to transformers shall be in flexible conduit and shall enter the enclosure below the coils. Make conduit entry into bottom 1/3 of transformer enclosure.

.6 Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

.7 Mount transformers as indicated on Drawings and connect primary, secondary, neutral and ground conductors in accordance with wiring diagrams. Provide brackets and bolts for wall mounted transformers. Ensure all transformers have good ventilation.

.1 Rear Clearance: Provide a minimum of 51 mm (2 inches) clearance from wall, increase with clearance indicated where indicated on nameplate or manufacturers literature.

.2 Ensure adequate clearance around transformers for ventilation and heat radiation.

.8 Mount transformers to reduce direct and transmitted noise. Mount core and coils of transformers on vibration and sound absorbing pads. Install vibration insulators between unit and floor/wall where applicable. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

.9 Install transformer nameplates with specific transformer data. Provide nameplates and label products.

.10 Verify that ground connections are in place and requirements in Section 26 05 28 - Grounding - Secondary have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

.11 Before energization, keep transformers in electrical room or storage room above 10°C ambient. Energize transformers after installation is complete.

3.2 Grounding

.1 Transformer shall have all noncurrent-carrying metal parts connected to a solid earth grounding system.

3.3 Protection

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by dry type transformers installation.

3.4 Distribution Transformers – Non-Harmonic mitigation Type

.1 Provide primary and secondary voltages, and kVA or MVA capacity as shown on the drawings.

.2 Winding Material: Copper.

.3 Primary Winding: 3-wire delta.

.4 Secondary Winding: Wye

.5 Continuous Duty Overload Capacity: 120% of nominal kVA Rating.

.6 Efficiency: Exceed minimum efficiency requirements for CSA C802.2 and MECB requirements.

.7 Supports NFPA 70E/CSA-Z462 arc flash standard to provide operating data without opening transformer enclosure.

.8 Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 00 - Common Work Results - Electric.

.9 Nameplates: Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 26 05 00 - Common Work Results – Electric.

3.5 Field Quality Control

.1 Perform visual Electrical and Mechanical Inspection.

.2 Report: Prepare a written report recording voltages on the primary and secondary sides, and tap settings. Record and include all tests and their results regardless of type (i.e. include resistances, voltages, current etc.), include equipment used during testing and their calibration data, etc. All test sheets shall signed and provided to the Contract administrator for review.

.3 Vacuum dirt and debris; do not use compressed air to assist in cleaning.

.1 Electrical Tests:

.1 Measure resistance at each winding, tap, and bolted connection.

.2 Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5.

.3 Record secondary voltage when transformers are carrying approximately 75% of full load. Adjust tap connections to give a continuous secondary voltage of 120 V phase to neutral. Set tap connections for above 120 V rather than below.

DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

3.6 Acceptable Manufacturers

.1 The manufacturers listed can provide dry type transformers, but only a few of the listed manufacturers have full capability to provide harmonic and specialty type transformers. It is the contractors responsibility to coordinate the application specific requirements with the appropriate manufacturer where required.

.2 Marcus Transformer.

.3 Powersmiths International Corp.

.4 Hammond Manufacturing Co. Inc.

.5 Eaton.

.6 Schneider Electric.

.7 Or approved equal.

3.7 Closeout Activities

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Provide operation and maintenance data for incorporation into manual specified in Section 01 73 00 - Operation and Maintenance Manual.

.3 Include insulating liquid maintenance data.

END OF SECTION

PANELBOARDS – BREAKER TYPE

1. GENERAL

1.1 Related Sections

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section. This section supplements requirements of other Divisions.

.1 Section includes various equipment and testing requirements that may be required for the project and the applications where each type shall be used.

1.2 References

.1 Canadian Standards Association (CSA):

.1 CSA C22.1, Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.

.2 C22.2 No.29, Panelboards and Enclosed Panelboards.

1.3 Action and Informational Submittals

.1 Submit in accordance with Division 1.

.2 Product Data and Literature:

.1 Submit manufacturer's instructions, printed product literature and data sheets for panelboards and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Include on drawings:

.1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

.2 Ensure specialty breaker types are identified for branch circuits where Ground Fault Circuit Interrupter (GFCI) capacity, or Arc Fault Circuit Interrupter (AFCI) capacity are required.

2. PRODUCTS

2.1 Panelboards

.1 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

PANELBOARDS – BREAKER TYPE

.2 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.3 Product of one Manufacturer.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.4 Panelboard Ratings:

.1 CSA or cUL approved short circuit current rating (SCCR) to meet the minimum rating as shown on the Drawings.

.2 If minimum SCCR is not shown on the drawing for panelboards up to 240 V provide 25,000 RMS symmetrical amp minimum bracing.

.3 If the minimum SCCR is not shown on the drawings for panelboards up to 600 V provide 50,000 RMS symmetrical amp minimum bracing.

.4 Series rated breakers not acceptable.

.5 Bussing:

.1 Distributed phase sequence type.

.2 Tin plated copper bus with neutral of same ampere rating of mains.

.3 Behind usable space, with mounting hardware.

.4 Isolated ground bus, with minimum three (3) terminals for bonding conductors equal to breaker capacity of the panelboard.

.5 Mains: suitable for bolt-on breakers (Anti-turn solderless type).

.6 Main breaker or main lugs only, as detailed on Drawings.

.7 Surge Protection Device (SPD), Type 2, with rated isolation breaker.

.6 Enclosure Construction:

.1 Gutters adequate for wire size used, 4 inch (100 mm) minimum.

.1 Code gauge galvanized steel, without knockouts.

.2 Dead front safety type, lockable, with two (2) keys for each panelboard all keyed alike.

.3 Flush stainless steel cylinder tumbler type locks (rain and ice resistant) with spring loaded door pulls.

.4 Trim and door finish: Rust inhibiting primer, baked enamel finish.

.5 Trim with concealed front bolts and hinges.

.6 Enclosure to be 508 mm wide minimum.

2.2 Breakers

.1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Lock-out Tag-out (LOTO): Provide Spare Lock-on device for one 1P and one 3P breakers. Turn over unused lock-on devices to City.

.5 Provide Lock-on devices for

.1 Fire alarm circuit (paint this circuit red) and lock in the “On” position.

.2 Emergency circuits.

.3 Security System circuits.

2.3 Equipment Identification

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Nameplate for each panelboard size 4 engraved or as indicated.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved or as indicated.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in clear plastic envelope at inside of panel door.

2.4 Manufacturers

.1 Schneider (Square D).

.2 Eaton (Cutler-Hammer).

.3 Siemens.

.4 Or approved equal.

3. EXECUTION

3.1 Installation

.1 Mount panelboards to height specified in Division 26, or as indicated on the Drawings.

.2 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.3 Connect loads to circuits.

.4 Connect neutral conductors to common neutral bus with respective neutral identified.

3.2 Protection

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by panelboards installation.

END OF SECTION

WIRING DEVICES

1. GENERAL

1.1 Section Includes

.1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 References

.1 National Electrical Manufacturers Association (NEMA):

.1 NEMA 250-2014, Enclosures for Electrical Equipment (1000 Volts Maximum).

.2 NEMA ICS 6:1993 (R2011), Industrial Control and Systems: Enclosures.

.2 Canadian Standards Association (CSA):

.1 C22.2 NO. 42-10 (R2015) - General use receptacles, attachment plugs, and similar wiring devices.

.2 C22.2 NO. 42.1-13 - Cover plates for flush-mounted wiring devices (Bi-national standard, with UL 514D).

.3 C22.2 NO. 55-15 - Special use switches.

.4 C22.2 NO. 111-10 (R2015) - General-use snap switches (Bi-national standard, with UL 20).

1.3 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 26 05 00 - Common Work Results - Electrical.

1.4 Submittals

.1 Submit Shop Drawings in accordance with Section 01 33 00 - Submittal Procedures.

2. PRODUCTS

2.1 Manufacturer

.1 Acceptable Manufacturers:

.1 Crouse-Hinds (Eaton).

.2 Hubbell Inc.

2.2 Switches

.1 Switches to be of one manufacturer throughout project.

.2 Manually - operated general purpose AC switches shall have the following features:

.1 Terminal holes approved for AWG # 10 wire.

.2 Silver alloy contacts.

.3 Urea or melamine molding for parts subject to carbon tracking.

.4 Suitable for back and/or side wiring.

.3 Toggle-operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

2.3 Receptacles

.1 Receptacles to be of one manufacturer throughout project.

.2 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA-C22.2 No.42 with following features:

.1 Ivory urea molded housing.

.2 Suitable for # 10 AWG for back and side wiring.

.3 Eight (8) back wired entrances, four (4) side wiring screws.

.4 Break-off links for use as split receptacles.

.5 Triple wipe contacts and riveted grounding contacts.

.3 Duplex 15 A, 120 V, 3 wire, U-ground ground fault receptacle.

.4 Other receptacles with ampacity and voltage as indicated.

.5 Receptacles located in the wet areas and on the exterior of the building to be weatherproof construction.

2.4 Cover Plates

.1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.

.2 Cover plates to be of one manufacturer throughout project.

.3 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.

.4 Use stainless steel 1 mm thick cover plates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.

.5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for single receptacles or switches.

.6 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

.7 Sheet metal cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

3. EXECUTION

3.1 Installation

.1 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.

.2 Mount wiring devices at height in accordance with Section26 05 00 - Common Work Results – Electrical. Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by Contract Administrator at the Site. The above shall be used as a guide but shall be subject to final verification prior to installation.

.3 Switches:

.1 Install single throw switches with handle in the "UP" position when switch closed.

.2 Install switches vertically in gang type outlet box when more than one switch is required in one location.

.3 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on Drawings.

.4 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results - Electrical.

.4 Receptacles:

.1 Install receptacles in a gang type outlet box when more than one receptacle is required in one location.

.2 Where split receptacle has one portion switched, mount vertically, and switch upper portion.

.3 Mount lighting fixture receptacles local to fixtures.

.4 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results - Electrical.

.5 Cover Plates:

.1 Protect cover plate finish with paper or plastic film until all painting and other Work is finished, and then remove protective covering.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not distort plates by tightening screws excessively.

.4 Do not use cover plates meant for flush outlet boxes on surface mounted boxes.

END OF SECTION

MOULDED CASE CIRCUIT BREAKERS

1. GENERAL

1.1 Section Includes

.1 Materials for moulded-case circuit breakers, circuit breakers, and ground-fault circuit-interrupters.

1.2 References

.1 Canadian Standards Association (CSA):

.1 Latest approved edition of CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

.2 CSA C22.2 No. 5-02, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.3 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 26 05 00 - Common Work Results - Electrical.

1.4 Submittals

.1 Submit Shop Drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include time-current characteristic curves for breakers with minimum symmetrical (rms) interrupting capacity as shown and over at system voltage.

2. PRODUCTS

2.1 Breakers General

.1 Moulded case circuit breakers, arc-fault circuit-interrupters, and ground-fault circuit interrupters: to CSA C22.2 No. 5.

.2 Bolt-On Moulded Case Circuit Breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.

.3 Common-Trip Breakers: with single handle for multi-pole applications.

.4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from three (3) to eight (8) times current rating.

.5 Circuit breakers with interchangeable trips as indicated.

.6 Circuit breakers shall clearly indicate fault current withstand ratings.

.7 Lock-on devices shall be provided for the following systems:

.1 Egress and Emergency Lighting.

.2 Any other breakers as indicated on the Drawings.

2.2 Thermal Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

3. EXECUTION

3.1 Installation

.1 Install circuit breakers as indicated.

END OF SECTION

DISCONNECT SWITCHES FUSED AND NON-FUSED UP TO 600 V PRIMARY

1. GENERAL

1.1 Section Includes

.1 Provide disconnect switches for 600 V and 120/240 V distribution as indicated on the Drawings.

1.2 References

.1 National Electrical Manufacturers Association (NEMA):

.1 NEMA 250 - 2014, Enclosures for Electrical Equipment (1000 Volts Maximum).

.2 NEMA ICS 6: 1993 (R2011), Industrial Control and Systems: Enclosures.

.2 Canadian Standards Association:

.1 CAN/CSA C22.2 No.4-M89, Enclosed Switches.

.2 CSA 22.2 No.39-M89, Fuseholder Assemblies.

1.3 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 26 05 00 - Common Work Results - Electrical.

1.4 Submittals

.1 Submit Shop Drawings in accordance with Section 01 33 00 - Submittal Procedures.

2. PRODUCTS

2.1 Disconnect Switches

.1 Ratings: Ampere ratings as shown on the Drawings or to suit load requirements. For motors, use disconnects switches with HP ratings at least equal to motor HP.

.2 Provide ON-OFF switch position indication on switch enclosure cover.

.3 NEMA Type according to Section 26 05 00 - Common Work Results - Electrical.

.4 Finish: one (1) primer coat and one (1) finish coat on all metal surfaces, colours as per Section 26 05 00 - Common Work Results - Electrical.

.5 Switch mechanisms: quick-make and quick-break action with self-wiping contacts, solderless pressure lug connectors.

.1 For switches 100 A and over, provide non-tracking arc shrouds.

.2 All switch poles to operate together from a common operating bar.

.6 Provide for padlocking disconnect switches in OFF position by three (3) locks. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handle in ON position.

.7 Where required (namely for VFDs) provide an auxiliary contact on the disconnect such that the contact breaks prior to main contacts. Interlock auxiliary contact with emergency stop of associated motor.

.8 Neutral Bars: where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.

.9 Fuse Holders: to CSA C22.2 No.39 relocatable and suitable without adaptors, for type and size of fuse indicated.

.10 Approved Manufacturers:

.1 Eaton.

.2 Schneider Electric.

.3 Siemens.

2.2 Fuses

.1 Size as indicated.

.2 Fuses feeding motors to be of the time delay type.

.3 Provide one (1) full set of spare fuses, three (3) for each different ampere rating used, stored in suitable enclosure.

2.3 Equipment Identification

.1 Identification: provide lamacoid plate in accordance with Section 26 05 00, on each switch showing voltage, source of supply and load being fed, for example:

DOOR CONTROLLER 120/240 V FED FROM PPA

.2 Indicate name of load controlled on size 4 nameplate.

3. EXECUTION

3.1 Installation

.1 Install disconnect switches complete with fuses if applicable.

DISCONNECT SWITCHES FUSED AND NON-FUSED UP TO 600 V PRIMARY

.2 Mounting: provide supports independent of conduits. Wall-mount where possible, otherwise provided Unistrut frame support. Where switches are grouped mount in uniform arrangement.

.3 Wiring: connect line and load cable to all switches.

.4 Fuse Rating: install so that rating is visible.

END OF SECTION

LIGHTING

1. GENERAL

1.1 Codes and Standards

.1 Canadian Standards Association.

.2 Underwriters Laboratories of Canada (ULC).

.3 IES LM79 & LM80.

1.2 Submittals

.1 Product Data:

.1 Submit Manufacturer's printed product literature, specifications and datasheets and include product characteristics, performance criteria, and limitations.

.2 Include equipment catalog numbers and fixture type on all submitted Shop Drawings.

1.3 Quality Assurance

.1 All equipment and materials are to be new and CSA approved.

2. PRODUCTS

2.1 General

.1 Luminaires to be CSA approved.

.2 Provide supporting devices, plaster frames, junction boxes and outlet boxes where required.

.3 Where soffits or ceilings have thermal insulation, provide fixtures which are CSA approved for such use.

.4 Luminaire types shall be as indicated on the Drawings. In general, the Facility shall have several different luminaire types, which include fluorescent as well as LED. A request for equal from a different luminaire Manufacturer/vendor shall be submitted and approved (if deemed to be equal by the Contract Administrator) in accordance with the Contract Documents prior to tender close.

.5 Refer to the Drawings for the fixture types, manufacturer, and model numbers.

2.2 LED Lighting

.1 Refer to luminaire schedule on the Drawings for acceptable products.

.2 General Requirements:

.1 Voltage Rating: 120 VAC

.2 Power rating: As indicated on Drawings.

.3 Input Frequency: 60 Hz.

.4 Correlated Color Temperature (CCT): minimum 4000K.

.3 Outdoor Lighting:

.1 L70 at 54 000 hours.

.2 22K – 25K Lumen output

.3 Color Rendering Index (CRI): >= 70.

.4 Ambient Operating Temperature: -40°C -55°C.

.5 Housing: Die-Cast Aluminum

.6 Lens: Polycarbonate, anti-vandalism protection

.7 Finish colour: Black

.8 IP rating: IP65

2.3 Finish

.1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

3. EXECUTION

3.1 Manufacturer’s Instruction

.1 Comply with the Manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 Installation

.1 General:

.1 The Contractor is responsible for upsizing conductors to account for voltage drop. Conductor sizes as described on the Drawings, cable schedules and elsewhere are minimum size, and are highly dependent on specific cable routing. The contractor shall upsize wiring as required to meet the requirements herein, and to comply with CEC requirements.

.2 Calculate voltage drop based on 80% of the breaker rating.

.2 Locate and install luminaires as indicated on Drawings.

.3 Luminaires shall be installed in accordance with the Manufacturer's recommendations and the requirements herein. Each luminaire shall be solidly and rigidly installed so that the fixture does not move or swing. Acceptable means of support include:

.1 Rigid Aluminium Conduit/Pipe.

.2 Threaded Rod.

.3 Cantruss.

.4 Wire and connect fixtures using 12 AWG or larger, RW90 run in conduit. Conduit to be as specified in Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

.5 Short flexible connections less than 2 m in length to luminaires may be HL rated TECK90 cable.

.6 Drawings do not show conduit routing or conduit sizes and wire counts. Supply and install a complete system of conduit and wire for the lighting system. Make all connections and install all conductors for the switching and branch circuiting indicated and required.

.7 Conduits shall be sized in accordance with CEC requirements for wire counts installed. Conduit size shall be 21 mm or greater. Conductors shall be de-rated according to code requirements. Upsize conductors as required to meet CEC and voltage drop requirements.

.8 Install a permanent label or lamacoid for all luminaires indicating the circuit(s) connected.

3.3 Luminaire Supports

.1 Provide adequate support to suit ceiling or wall mounted luminaires.

3.4 Control

.1 As indicated on Drawings.

3.5 Field Quality Control

.1 Operate each fixture after installation and connection. Each fixture shall be inspected for proper connection and operations.

.2 Perform testing of all lighting systems.

.3 Completely clean the exterior, interior, lamps, lenses, etc. of all luminaires after construction and prior to turning over to the City.

3.6 Protection

.1 Lighting fixtures, once installed, shall be protected from damage during the remainder of the construction period. Make good and replace any damages occurring during construction.

LIGHTING

.2 Damage to luminaires occurring during construction shall be replaced by the Contractor at the Contractor's expense. The decision as to what constitutes a damaged fixture which requires replacement is at the discretion of the Contract Administrator.

END OF SECTION

PILE FOUNDATIONS, GENERAL REQUIREMENTS

1. GENERAL

1.1 Action and Informational Submittals

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Soils Investigation Report(s): when Site conditions differ from those indicated, submit written notification to the Contract Administrator and await further instructions.

1.2 Waste Management and Disposal

.1 Divert all construction waste off Site.

1.3 Soils Investigation Report

.1 Further to C3.1, soils investigations were undertaken for CPKC Railway utility under crossings, Phase 2 ESA on Parcel B, and general soils conditions on Parcel C. Geotechnical Data is found in Appendices A1, A2, A3 and D1, D2, D3, and D4.

2. PRODUCTS

2.1 Materials

.1 Material requirements for piles are specified in Section 31 63 23 - Bored Concrete Piles.

.2 Supply or fabricate full length piles as indicated and provide equipment to handle full length piles without cutting and splicing.

2.2 Equipment

.1 Drilling equipment and crane: provide manufacturer's name, type, specification, capacity, leads, drill head for down hole hammer (if required).

.2 Drilling equipment shall have sufficient power to drill the piles into the glacial till/boulders/cobbles and clay layers.

3. EXECUTION

3.1 Preparation

.1 Protection:

.1 Protect adjacent structures, services and work of other sections from hazards due to pile installation operations and shoring work.

.2 Arrange sequencing of pile and shoring installation operations and methods to avoid damages to adjacent existing structures and elements.

.3 When damages occur, remedy damaged items to restore to original or better condition at own expense.

.2 Ensure that ground conditions at pile locations are adequate to support pile installation operation.

.1 Make provision for access and support of piling equipment during performance of Work.

3.2 Installation

.1 Installation of each pile will be subject to review by the Contract Administrator. The Contract Administrator will be sole judge of acceptability of each pile.

3.3 Obstructions

.1 Where obstruction is encountered that causes sudden unexpected change in penetration resistance, proceed as directed by the Contract Administrator.

3.4 Repair and Restoration

.1 No extra compensation will be made for replacing or other work made necessary through rejection of defective piles.

.1 Defective piles are piles that are incorrectly formed and/or do not meet the placement and tolerance criteria of the vehicle gate manufacturer's requirements.

3.5 Cleaning

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

BORED CONCRETE PILES

1. GENERAL

1.1 References

.1 2024 National Building Code and the Manitoba Amendments.

.2 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.3 CAN/CSA-A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

.4 ACI 306R, Guide to Cold Weather Concreting.

.5 ASTM C 260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.

.6 ASTM C494/C494M, Standard Specification for Chemical Admixtures for Concrete.

.7 The latest edition of all Reference Standards shall be the latest edition at the time of Contract award.

1.2 Submittals

.1 Submit the in accordance with Section 01 33 00 - Submittal Procedures.

1.3 Quality Control

.1 Perform the work by a Piling Subcontractor with minimum fifteen (15) years of proven, satisfactory and successful piling experience on projects of similar size and nature.

.2 The Contractor shall be fully responsible for quality control of all aspects of the piling Works.

.3 Submit and implement a Quality Control Plan a minimum of four (4) weeks prior to first scheduled piling; the Quality Control Plan shall include:

.1 Identify the Quality Control Manager.

.2 Qualifications of construction supervisory personnel.

.3 Pre-placement procedures, and checklists.

.4 During placement contingency plans and procedures.

.5 Post-placement procedures and checklists for concrete.

.4 Submit for review by the Contract Administrator copies of pile records.

1.4 Waste Management and Disposal

.1 Divert all construction waste off Site.

BORED CONCRETE PILES

2. PRODUCTS

2.1 Materials

.1 Concrete mixes and materials: in accordance with the CW3310, Mix Type 1.

.2 Reinforcing steel: in accordance with CW3310.

3. EXECUTION

3.1 Examination

.1 Before starting piling, examine other Work that may affect this Work.

.2 Coordinate pile locations with Section 32 31 33 - Cantilevered Access Gates reviewed Shop Drawing(s) and related documents.

.1 Contractor to establish top of concrete pile to suit finished gate and Section 32 31 33 - Cantilevered Access Gates documents.

.3 Notify the Contract Administrator of any conditions that would prejudice proper installation of this Work.

3.2 Installation

.1 The Contractor shall take all precautions to prevent damage to structures and adjacent properties during or as a consequence of pile installation operations. In the event of damage, the Contractor will be held liable, and shall be required to provide appropriate restoration and repairs at his cost, to the satisfaction of the Contract Administrator.

.2 Pile Installation:

.1 Bore holes to diameters and depths as indicated by the Contract Documents.

.2 The drilling and installation of concrete piles shall be carried out only by qualified operators, using suitable equipment, with a proven record of competence and experience in this type of installations. The Contractor should familiarize himself with the subsurface ground conditions and select drilling techniques that are suitable for drilling into clay materials.

.3 The Contractor shall clean the bottom of all piles to ensure all loose material has been removed from the hole.

.4 Pile concrete shall be placed through a concrete hopper with internal funnel, and 200 mm diameter long hose extension positioned over the centre of each pile.

.5 Centre line tolerance for piles below vehicle gates:

.1 To suit alignment criteria by vehicle gate supplier.

.2 Tolerances are not cumulative.

.6 Dispose of excavated materials off Site.

.7 Install steel reinforcement as indicated.

.8 Fill pile excavations with concrete to elevations as to suit vehicle gate and related appurtenances. Extend casting above finished grade with purpose made sonotube. Sonotube shall be removed in its entirety following general curing of concrete.

3.3 Field Quality Control

.1 Field Records: maintain piling records, including depth of pile, diameter, pile sequence number and vibration monitoring data.

3.4 Cleaning

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

CANTILEVERED ACCESS GATES

1. GENERAL

1.1 System Description

.1 Modular automated cantilevered gate for closure of vehicular access routes and regulation of traffic flow. Section includes the following components:

.1 Aluminum cantilever sliding gate.

.2 Electric gate operator.

.3 Gate support posts (structural portals) and rolling hardware.

.4 Gate operator accessories including safety and reversing devices. Excluding access controls.

1.2 Submittals

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Manufacturer experience.

.3 Installers experience.

.4 Product Data:

.1 Gates and hardware.

.2 Gate operator including operating instructions, motor name plate data, ratings, characteristics, and mounting arrangement.

.5 Shop Drawings:

.1 Submit Shop Drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.

.3 Provide detailed diagrams of all gate components.

.6 Test reports:

.1 If requested by the Contract Administrator, submit affidavits from the manufacturer demonstrating that the gate mechanism has been tested to 200,000 cycles without breakdown.

.2 ISO 9001 Compliant manufacturer.

CANTILEVERED ACCESS GATES

1.3 Quality Assurance

.1 Manufacturer: A company specializing in the manufacturer of gates and electric gate operators of the type specified, with a minimum of ten (10) years experience.

.2 Installer Qualifications: an experienced installer who has completed automated gate installations similar in material, design, and extent to those indicated for this project. Installer to have a minimum five (5) years experience in similar commercial gate installations.

.3 Source limitations for gate operators and gates: obtain each color, grade, finish, type, and variety of components for gate and gate operator from one (1) source.

.4 Electrical Components, Devices, and Accessories: listed and labelled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for UL Standard: Provide gate operators, tested and listed by a nationally recognized testing laboratory to comply with UL 325 6th edition. Electrical components shall be CSA certified.

.5 Emergency Access Requirements: comply with requirements of local authorities having jurisdiction for automatic gate operators serving as a required means of access, including fire fighting vehicles.

1.4 Operation and Maintenance

.1 Submit an Operation and Maintenance manual in accordance with Section 01 73 00 - Operation and Maintenance.

.2 Provide Operations and Maintenance manuals for all equipment in Operating and Maintenance Manual and the below:

.1 Including but not limited to all product brochures, technical data, illustrations, parts lists, reviewed Shop Drawings, and any design Drawings and Specifications.

1.5 Commissioning

.1 Submit a commissioning plan in accordance with Section 01 65 00 - Facility Start-Up/Commissioning.

.2 All access gate and related appurtenances are to be fully commissioned by qualified personnel and verified to be operational.

.1 Operation, post commissioning, is to be demonstrated to the City or their Representative. Failures at the demonstration phase shall require partial or complete recommissioning at the Contractor’s expense.

1.6 Operator Training

.1 Provide on-site, hands on training in accordance with Section 01 78 00 - Closeout Submittals.

CANTILEVERED ACCESS GATES

2. PRODUCTS

2.1 Cantilevered Access Gate

.1 Manufacturer:

.1 Design standard: Wallace Perimeter Security:

.1 Model: Alpha Gate with Kinetic gate operator or approved equal.

2.2 Materials

.1 Electrical components: CSA/UL approved.

.2 Power Supply: 208V, single phase.

.3 All components to be temperature rated from -40°C to +40°C.

2.3 Components

.1 Cantilevered Gate:

.1 Gate:

.1 Modular design, featuring field replaceable components.

.2 Site tensioned beam comprising an immensely strong 205 mm x 285 mm section, corrosion resistant, aircraft grade hollow aluminum extrusion of unique profile, incorporating high-tensile steel tensioning rods.

.3 Pre-galvanized pickets OD 26 mm x 1.5 mm are inserted vertically through the main beam and secured to top and bottom rails with roll pins at each picket.

.4 Galvanized 8 mm diameter internal tension rods.

.5 Serrated–anti climb, aluminum top strip 60 mm x 30 mm.

.6 3.4 mm (9) gauge chain link infill.

.2 Standard gate widths are:

.1 6100 mm clear opening.

.3 Standard gate heights are:

.1 2400 mm plus 304 mm, 3 strands of barbed wire.

.4 Guides:

.1 Welded structural gate posts (portals) with top rail guide wheels and cantilever wheels.

.2 Galvanized after fabrication to ASTM 123M.

.3 60 mm x 80 mm x height to suit, support posts, connected at the top, form rigid frames to support the gate. Flanged for securing to foundation.

.4 Sealed bearing, nylon polyamide 160 mm maintenance free, guarded cantilever roller sets.

.5 Catch post (portal) with run-on plate for secure closure.

.6 Gate support posts feature integral mount for gate operator, ensuring correct alignment for the life of the system.

.7 Included standard “reach through guards” per ASTM F2200.

.5 Fasteners: Concealed, stainless steel.

.2 Kinetic electronic gate drive:

.1 Electric microprocessor controller unit with many standard logic sequences, provisions for dedicated, labeled accessory inputs and outputs. Alert, Fault, Error logging for simplified troubleshooting and remote diagnostics.

.2 Limit Switches: motor output shaft embedded encoder with 1/32nd resolution to determine gate full open, full close, partial open, acceleration and deceleration points.

.3 Variable Speed (field selectable speed +/- 76 mm per second) rack and pinion drive mechanism with nylon polyamide drive gear/rack hardware. Provide 610 mm per second gate travel speed.

.4 Integrated un-interruptible power supply (U.P.S.)

.5 Field selectable, fail safe or fail secure operation upon AC power loss.

.6 Field selectable, 110V/240V single phase input power.

.7 Super energy efficient design, optimized for solar applications.

.8 Adaptive inherent entrapment sensor with “ice breaker mode”.

.9 Built-in multi-level power surge and lightning strike protection using opti-isolation technology.

2.4 Accessories & Options

.1 Safety Devices:

.1 Through-Beam photocells.

.2 Radio transmitting 7620 mm gate contact edge and radio receiver.

.2 Notification or instructive device:

.1 Provide only a strobe or flashing light indicating gate in motion or pending motion.

.3 Access control devices:

.1 Contractor to provide Model 48-9C pedestal as manufactured by Gooseneck Stands or approved equal. Nominal 1220 mm high (base to top of horizontal leg), complete with 330 mm horizontal leg, polyester powder coated steel pedestal with baseplate. Provide stainless steel anchors to concrete substrate.

.2 Contractor to provide Model HOOD-CS-4.5x8 pedestal head or approved equal. Nominal 115 mm wide x 200 mm high x 76 mm deep polyester powder coated steel pedestal head.

.3 Contractor to provide gate activation device: Model CM-550SK as manufactured by Camden Door Controls or approved equal.

.4 Gate panel options:

.1 Substitute 3 strands of non-barbed wire top.

2.5 Finishes

.1 Visible surface color: Aluminum beam and rails with galvanized steel components.

3. EXECUTION

3.1 Installation

.1 Coordinate gate installation with gate bored concrete pilings.

.2 Install structural post (portals) on concrete foundations; completely level both horizontally and vertically.

.3 Install cantilevered sliding access gate to manufacturer's written instructions.

.4 Test and adjust complete system for proper function and leave in complete working order.

.5 Supply and install other electrical wiring, conduit junction boxes, transformers, circuit breakers and auxiliary components required for complete operable system.

3.2 Cleaning, Maintenance and Documentation

.1 Perform cleaning and maintenance procedures in strict accordance with manufacturer’s written instructions.

END OF SECTION

PROCESS CONTROL DESCRIPTIONS

1. GENERAL

1.1 Description

.1 Provide control system programming and configuration services to achieve the operational functionality generally as described in the control descriptions provided in this Section and in compliance with Contract Documents.

.2 This Section outlines the proposed operation and control strategies for the new lift station.

.3 It should be noted that these control descriptions are provided as a guide to the intent of the main control strategies and do not purport to describe every detail and nuance of the completed programs. The control system integrator and Contractor must study Contract Documents and take into consideration the City of Winnipeg standard practices for control program design, graphics objects characteristics, screen layouts, and operator interface features as applicable.

.4 All aspects of the new control sequences, operator interface, and remote monitoring must be thoroughly tested in cooperation with the City and the Contract Administrator to demonstrate correct functioning of all control system features and to verify that all interlocks and alarms are functioning properly.

1.2 References

.1 International Society of Automation (ISA):

.1 S5.1: P&IDs and Tagging.

.2 S5.4: Instrument Loop Diagrams.

.3 S7: Instrument Air.

.4 S12: Electrical Equipment for Hazardous Locations.

.5 S18.2: Alarm Management.

.6 S20: Instrument Specifications.

.7 S50: Electrical Control Signals.

.8 S75: Control Valve Design, Specification and Testing.

.9 S96: Valve Actuators.

.10 S99: Control System Cyber Security.

.11 101: Human-Machine Interfaces.

.2 Related Project Documents:

.1 The following project documents are listed to assist the reader in comprehension of this document. Refer to Division 26, Division 40, and other Divisions referenced throughout this document for the complete scope of work.

.2 Specifications:

.1 Section 40 72 00 - Level Measurements

.2 Section 43 21 39 - Lift Station

.3 Section 43 21 39A - Lift Station - Pumps Data Sheet

.3 Drawings:

.1 Drawing YC2-C501 - Lift Station - Plan and Section

1.3 Submittals

.1 Submit Shop Drawings in accordance with Section 01 33 00.

1.4 Quality Assurance

.1 Comply with the requirements related to quality control procedures.

2. NARRATIVE

2.1 General

.1 All equipment will be able to be run manually by the operators from the control panel.

.2 Wells with level monitoring will have a high level warning, a high-high level alarm, a low level warning, and a low level alarm.

.3 All equipment will raise alarms when a fault is generated or abnormal operating conditions are detected. See equipment specifications and manufacturer's ratings for operating condition limits.

.1 Faulted equipment shall require manual intervention to remove the fault and restart. Equipment shall not automatically restart after it has faulted.

2.2 Overview

.1 Control Intent:

.1 A new concrete barrel will be installed and connected to the new gravity sewer system and forcemain. Two (2) new submersible pumps and associated instrumentation will be installed in the new barrel. The pumps will alternate between lead and lag duty via an alternating relay.

.2 The Work involves the following control components:

.1 Four (4) new float switches:

.1 LSLL, (level switch low-low),

.2 LSL, (level switch low),

.3 LSH, (level switch high),

.4 LSHH, (level switch high-high),

.5 LSHHH, (level switch high-high-high),

.6 LSHHHH, (level switch high-high-high-high), and

.7 an additional spare float.

.2 Two (2) new submersible pumps:

.1 P-1; and

.2 P-2.

.3 Alarm, strobe and horn (beacon) located on the lift station control panel.

2.3 Control Scheme

.1 LAH shall be triggered by the float LSH. Upon rising level activated by LAH, the lead pump will start and run at full speed.

.2 LAHH shall be triggered by the float LSHH. If the water level continues to rise, and activates LAHH, the lag pump will start and run at full speed.

.3 On activation of LSHHH, LAH will set and a strobe light and buzzer will sound. LAH will remain set until the water level decreases and the LSHHH is no longer active. A button permits the operators to silence the horn but the strobe will continue to flash.

.4 On activation of LSHHHH, LAHH will set and a strobe light and buzzer will sound. LAHH will remain set until the water level decreases and the LSHHHH is no longer active. A button permits the operators to silence the horn but the strobe will continue to flash.

.5 On deactivation of LSL, all pumps shall stop. At this point, the alternating relay will trigger such that the lead pump and lag pump trade duty assignments.

.6 If the lead pump is set to off, and the water level triggers LAH, the lag pump will start immediately.

.7 If water level drops to LSLL, all pumps will stop, alternating relay will trade P-1 and P-2 duty assignments and LAL will set and a strobe light and buzzer will sound. LAL will remain set until the water level increases and the LSLL is no longer active. A button permits the operators to silence the horn but the strobe will continue to flash.

.8 The controller shall start, stop and alternate the pumps at the respective pumping station and shall include a 15 second time delay between consecutive starts and provide delay of second pump start due to a call for both pimps to start following the return of power after a power failure.

.9 Each pump will have local indicator lights on the control panel for run and fault statuses, as well as an elapsed time meter.

.1 When a pump faults (either through overload, high temperature, or leakage detection), the fault indicator light will illuminate.

.2 When a pump is running, its run indicator light will illuminate and its elapsed time meter will resume counting.

.10 If one pump is faulted, or the running pump is set to off, the remaining pump shall start and run.

2.4 Setpoints

.1 Refer to Drawing YC2-C501 for setpoints.

2.5 Alarms

Alarm Name	Trigger
LAL	Water level below low level setpoint, triggered by LSLL
LAH	Water level above high level setpoint, triggered by LSHHH
LAHH	Water level above high level setpoint, triggered by LSHHHH
P1 Fault	P1 starter overload, motor overtemperature, or leakage detected in motor
P2 Fault	P2 starter overload, motor overtemperature, or leakage detected in motor
Station alarm	P1 Fault, P2 Fault, LAHH, LAHHH, LAL, both pumps set to OFF, or surge protective device alarm

END OF SECTION

LEVEL MEASUREMENT

1. GENERAL

1.1 Reference

.1 International Society of Automation (ISA):

.1 S5.1: P&IDs and Tagging.

.2 S5.4: Instrument Loop Diagrams.

.3 S7: Instrument Air.

.4 S12: Electrical Equipment for Hazardous Locations.

.5 S18.2: Alarm Management.

.6 S20: Instrument Specifications.

.7 S50: Electrical Control Signals.

.8 S75: Control Valve Design, Specification and Testing.

.9 S96: Valve Actuators.

.10 S99: Control System Cyber Security.

.11 101: Human-Machine Interfaces.

2. PRODUCTS

2.1 Level Switch, Float

.1 Float level switches provided for this project shall all be sourced from the same manufacturer and in compliance with this Specification.

.1 Float switches shall have SPDT output contacts rated for pilot duty.

.2 Provide polypropylene float casing with pre-terminated signal cable. Float switch density shall be selected for optimal performance in the specified process liquid.

.2 Extension cable shall be three (3) conductor, of sufficient length to reach the ventilated trough without strain and providing adequate slack. A minimum of 15 m of cable shall be provided.

.3 General:

.1 Approvals: CSA or ULC.

.4 Function: Actuate contact at preset liquid level.

.5 Type: Direct-acting float with an enclosed switch and integral cable.

.6 Service: Wastewater, unless otherwise noted.

.7 Performance:

.1 Set Point: As noted.

.2 Temperature: -40°C to 50°C.

.8 Features:

.1 Entire Assembly: Watertight and impact-resistant.

.2 Float Material and Size: Polyethylene/foam filled; 114 mm diameter max.

.9 Signal Interface:

.1 Switch Type: Mercury free.

.2 Switch Contacts: Form C Dry Contact rated 4.5 A continuous at 120 VAC.

.10 Accessories required for each float:

.1 Float sway control ring.

.2 Hook for cable suspension suitable for anchoring in concrete manhole top slab.

.3 Kellems cable grip to support cable from hook.

.11 Manufacturer:

.1 Xylem ENH-10.

.2 Or approved equal.

3. EXECUTION (NOT USED)

END OF SECTION

LIFT STATION

1. GENERAL

1.1 Description

.1 This Section specifies the supply, installation, testing and commissioning of duplex submersible sewage pumps, complete with electric motor, lifting chain, exterior control panel, concrete barrel, piping as well as all accessories required for the Lift Station.

1.2 Related Work

.1 Electrical – See Division 26.

.2 CW 2030 Gravity Sewers.

.3 Part E Specification E23 Sewage Forcemain.

1.3 Scope

.1 The Work under this Contract includes installation of a new sewage lift station consisting, but not necessarily limited to, the following Work:

.1 Installation of a new 2700 mm concrete barrel and connection to the new forcemain and gravity sewer lines.

.2 Supply and installation of duplex submersible sewage pumps.

.3 Supply and installation of control panel.

.4 Supply and installation of all necessary valves, fittings and instruments.

.5 Supply of portable manual equipment and personnel lifting davits.

.6 Implement vendor instructions / advice regarding installation.

.7 Support vendor field commissioning services:

.1 Pump Start-up and run-in.

.2 Performance verification.

.3 Control panel and pumps training.

1.4 Sustainability Requirements

.1 Pumps shall last at least twenty (20) years.

.2 Controller shall be capable of controlling pumps of 1.5 times the kilowatts at same voltage and remaining serviceable for thirty (30) years.

LIFT STATION

1.5 Submittals

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 All equipment shall be metric – SI Standard.

.3 Product Data:

.1 Submit manufacturer's printed product literature, specifications and data sheet for fixtures and equipment.

.2 Record of similar installations, still in service, and their lifetime maintenance requirements. All installations shall be over five (5) years old.

.4 Shop Drawings.

.1 Equipment, including connections, fittings, valves, control assemblies and ancillaries. Identify whether factory or field assembled.

.2 Dimensions and recommended installation layout.

.3 Pump performance and efficiency curves.

.5 Certificates: submit certificates signed by manufacturer(s) certifying that materials comply with specified performance characteristics and physical properties.

.6 Instructions: Submit manufacturer's installation instructions.

1.6 Identification

.1 Any component of the lift station shall be identified with a label bearing the same code or name described on the Drawing. All wiring shall be numbered and identified at both ends to facilitate service and troubleshooting.

2. PRODUCTS

2.1 Submersible Pumps

.1 Duplex pump system, factory assembled, tested and adjusted, ready for Site piping and electrical connections.

.1 Vendor to assemble in shop and test before shipment.

.2 Pump Capacity: 3.13 L/s at 4.65 m head (excluding losses internal to the pumps), each:

.1 Suitable for domestic sewage and surface runoff carrying grit, sand and organic materials.

.2 Lower flow shall be on the steep part of the pump curve and above 50% pump flow capacity.

.3 Acceptable manufacturer: Flygt NP 3085 SH 3~ Adaptive 455 or approved equal.

.3 Pump Construction: CSA approved vertical single stage centrifugal, designed to reliably and repeatedly pump solids up to 75 mm diameter and any trash or rags which pass through a 300 mm sewer service. Housing to be epoxy coated cast iron, stainless steel shaft, non-clog bronze or cast iron impeller open or semi-open dynamically balanced, mechanical shaft seal. Replaceable pump casing wear rings and impeller wear rings to be corrosion and wear resistant.

.4 Accessories:

.1 Pump coupling for submersible sewage pump discharge to be 75 mm floor mounted discharge elbow connection with stainless steel anchor bolts. Couplings to have self-cleaning, non-clogging closing action. The couplings shall permit removal of a pump and its return to service without entering the pumpwell to unbolt or unlock the connection between the pump and piping.

.2 Stainless steel lift chains for pumps including intermediate hook attachments and terminal clevis, to manufacturer's requirements.

.5 Submersible Motors:

.1 Motor: 1.6 kW (2.2 hp) 208 VAC, 3 phase, 60 Hz, 28.75 RPS, hermetically sealed or as required to meet pump capacity.

.2 Refer to Division 26 for additional requirements.

2.2 Valves & Piping

.1 Check valves shall be ball type valves, providing 100% opening area when open. Valves housing shall be cast iron type GGG40/ASTM 65-45-12/SAE D4512. Valves to be flanged. Approved supplier: Flygt or approved equal.

.2 Sewage Air / Vacuum Release Valve:

.1 Compact tubular design in Stainless Steel body, hollow direct acting float with solid large orifice in HDPE.

.2 Seals are EPDM rubber on EPDM seats.

.3 Shall have integral anti-surge orifice mechanism to limit pressure due to transient pressure rise induced by closure to less than 1.5 times valve rated pressure.

.4 Intake orifice equal to large discharge orifice shall be sized as noted on Drawings.

.5 Connection to the valve inlet shall be ANSI 50 mm NB Class 125.

.6 Nuts and washers in 316 SS to be supplied by Contractor.

.7 Minimum pressure rating 1 MPa (145 psi).

.8 Acceptable Material:

.1 Vent-O-Mat RGXv (Air / Vacuum).

.2 RGX (combination type.

.3 Eccentric Plug Valve:

.1 Manufacturers:

.1 DeZurik.

.2 Milliken.

.3 Val-Matic.

.2 Type: Non-lubricated, eccentric.

.3 Body Working Pressure:

.1 Cast Iron, ASTM A126 Class B or Ductile Iron, ASTM A536, Grade 64-45-12.

.2 1220 kPa (175 psi).

.4 Valve Ports:

.1 Provide rectangular ported valves, circular ports are not acceptable.

.2 All valves100% port.

.5 Valve Seats:

.1 Coat plug with seat material specified. Bolted systems are not acceptable.

.2 Seat Material:

.1 Neoprene or Buna-N synthetic rubber.

.3 Provide valves with one piece coated plugs with mating seats of 90%, minimum, pure nickel 3 mm (1/8-inch) welded into the body of valves.

.6 Upper and Lower Plug Journal Bearings:

.1 Removable, permanently lubricated stainless steel bushings for valves 500 mm (20-inch) and smaller.

.2 Bronze bearings with Type 316 stainless steel bushings for valves 600 mm (24-inch) and larger.

.3 Provide grit seals for upper and lower plug shafts for all valves.

.7 Stem Seals:

.1 Adjustable multiple V-packing.

.2 Replaceable and adjustable without valve disassembly.

.8 Shop Testing:

.1 Provide all plug valves tested and certified bubble tight in both directions at the full rated working pressure as specified herein.

.9 Shop Painting:

.1 Provide epoxy painting as specified herein.

.2 Provide fusion bonded epoxy, 12 mils (305 micrometres) inside and out.

.4 Piping to be 316 SS within station with flanged connections at pumps and valves. Piping to be rated for 150 psi working pressure and to be securely supported within station.

.1 Pipe:

.1 Schedule 40, 304 L Stainless Steel pipe, to ASTM A312, ANSI B36.19.

.2 Flanges Slip-on, Threaded or weld neck, ASTM 181.

.3 Gaskets 1.6 mm Full Face, Neoprene.

.2 Boltings Hex-head and Heavy Hex nuts, ASTM A 307 Gr. B 316 Stainless Steel.

.5 Pipe penetrations:

.1 Pipe penetrations through the lift station wall shall use a waterproof wall seal designed for underground applications, such as Link Seal Model C (EPDM), NPC Kor-N-Seal pipe-to-manhole connector or similar.

3. EXECUTION

3.1 Pump Manufacturer's Instructions

.1 Supplier/Manufacturer's will supply written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet(s). Contractor to follow these instructions.

.2 Provide assistance to the Contractor during installation.

3.2 Installation

.1 Install a new 2700 mm concrete barrel as indicated on the Drawings.

.2 Make piping and electrical connections to pump and motor assembly and controls as indicated by manufacturer.

.3 Ensure pump and motor assembly do not support piping.

.4 Align vertical pit mounted pump assembly after mounting and securing discharge elbow.

.5 Connect to the new 75 mm HDPE forcemain line and gravity sewer line(s) as shown on the Drawings.

3.3 Field Quality Control

.1 Site Tests/Inspection:

.1 Check power supply.

.2 Check starter protective devices.

.2 After all piping completed: fill sump with fire water, start-up, check for proper and safe operation.

.3 Check settings and operation of manual-off-auto selector switch, operating, safety and limit controls, audible and visual alarms, overloads and other protective devices.

3.4 Commissioning

.1 Conduct General: Procedures:

.1 Check power supply.

.2 Check starter overload settings.

.3 Start pumps, check impeller rotation.

.4 Check for safe and proper operation.

.5 Check settings, operation of operating, limit, safety controls, audible / visual alarms and other protective devices.

.6 Test operation of manual-off-auto switch.

.7 Test operation using generator.

.8 Check base for free-floating, no obstructions under base.

.9 Run-in pumps for twelve (12) continuous hours. Return water to sump.

3.5 Performance Verification

.1 Support vendor in execution of field Performance Verification.

.2 Application tolerances:

.1 Flow: plus 10%; minus 0%.

.2 Pressure: plus 10%; Minus 5%.

.3 Procedures:

.1 Fill sump at rate slower than capacity of pump #1.

.2 Record levels at which pump #1 starts and stops. Determine flow rate by observing time taken to down water level.

.3 Fill sump at rate faster than capacity of pump #1 but slower than capacities of pumps #1 and #2 operating in parallel.

.4 Record levels at which pumps start and stop - water level rising and water level falling.

.5 Verify operation using generator.

.6 Adjust water level controls as necessary and repeat items 1 to 4.

.7 Adjust level controls as necessary.

.8 Check level at which high water level alarm starts and stops. Adjust as necessary.

.4 Check removability of pumps for servicing without interfering with operation of other pump.

.5 Verify non-clog capability and maximum size of solids, using procedures recommended by manufacturer.

3.6 Reports

.1 Receive and Include:

.1 Performance Verification results on approved PV Report Forms.

.2 Product Information report forms.

.3 Pump performance curves with final point of actual performance.

3.7 Training

.1 In accordance with Section 01 78 00 - Closeout Submittals supplemented as specified.

.2 Minimum two (2) hours on pump maintenance procedures.

.3 Minimum two (2) hours on control panel operation and maintenance procedures.

END OF SECTION

EQUIPMENT DATA SHEET

Description:	Raw Wastewater Pump 1 & 2
Number:	2
Design Conditions:	
Liquid:	Raw Wastewater
Liquid temperature:	5-30ºC
Solids content:	0-1000 mg/L
Minimum solids passing:	75 mm
Pump Location	Raw Wastewater Pump Station
Rating Point:	
Rated Flow (one pump running):	3.13 L/s
Rating Point TDH (excludes losses internal to pump):	4.65 m
Construction:	
Flange Rating:	Class 125
Impeller Material:	Hard Iron
Casing Material:	Grey Cast Iron
Driver:	
Drive Type:	Submersible
Motor Type:	Fixed Speed
Phases/Voltage/Frequency:	3-phase/208 V/60 Hz
Motor Speed:	28.75 rps
Minimum Motor Size:	1.6 kW (2.2 hp)
Classification:	Class 1 Division 1
Accessories:	8 m stainless steel lifting cable
	Auto connect discharge seat
Acceptable Manufacturers:	Flygt
	KSB
	Grundfos
	Or approved equal

END OF SECTION