

CONSTRUCTION PROGRESS SCHEDULES (SMALL PROJECTS)

1. GENERAL

1.1 Description

- .1 Section includes administrative and procedural requirements for planning, monitoring and documenting the progress of construction during performance of the Work.
- .2 Contractor shall prepare and submit to Contract Administrator for review within fourteen (14) days after Notice to Proceed, a construction progress schedule.
- .3 No work shall be done between 4:00 p.m. and 7:00 a.m. nor on Sundays, Saturdays, or legal holidays without written permission of City. However, emergency work that may result in injury or damage to the equipment or facilities if not addressed may be done without prior permission. The Contract Administrator is to be informed when starting emergency work.
- .4 The Contractor has the obligation and responsibility at all times to plan and monitor all of its activities, anticipating and scheduling its staff, materials, plant and Work methods in a manner that is likely to ensure completion of the Work in accordance with the terms and conditions of the Contract and at a rate that will allow it to be completed within the Contract Time.

1.2 Form of Schedules

- .1 Prepare schedules in form of a horizontal bar chart.
 - .1 Provide separate horizontal bar for each trade or operation.
 - .2 Horizontal Time Scale: Identify first work day of each week.
 - .3 Scale and spacing to allow space for notations and future revisions.
- .2 Format of Listings: Chronological order of start of each item of work.
- .3 Identification of Listings: By major specification section numbers.
- .4 Computer scheduling software: Use Microsoft Project.

1.3 Content of Schedules

- .1 Construction Progress Schedule:
 - .1 Show complete sequence of construction by activity.
 - .2 Show dates for beginning and completion of each major element of construction and installation dates for major items of equipment. Elements shall include, but not be limited to, the following:
 - .1 Shop Drawing receipt from supplier/manufacturer submitted to Contract Administrator, review and return to supplier/manufacturer.
 - .2 Material and equipment order, manufacturer, delivery, installation, and checkout.

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- .3 Performance tests and supervisory services activity.
 - .4 Wiring installation.
 - .5 Panel installation
 - .6 Backfilling, grading, seeding, sodding, landscaping, fence construction, and paving.
 - .7 Electrical work activity.
 - .8 Subcontractor's items of work.
 - .9 Functional Testing.
 - .10 Start-up.
 - .11 Commissioning.
 - .12 Performance testing.
 - .13 Training.
 - .14 Final cleanup.
 - .15 Allowance for inclement weather.
 - .16 Demolition.
- .3 Show projected percentage of completion for each item as of first day of each month.

1.4 Schedule Revisions

- .1 Every thirty (30) calendar days the Contractor shall revise construction schedule to reflect changes in progress of work.
- .2 Indicate progress of each activity at date of submittal.
- .3 Show changes occurring since previous submittal of schedule.
 - .1 Major changes in scope.
 - .2 Activities modified since previous submittal.
 - .3 Revised projections of progress and completion.
 - .4 Other identifiable changes.
- .4 Provide a narrative report as needed to define:
 - .1 Problem areas, anticipated delays, and impact on schedule.

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- .2 Corrective action recommended and its effect.
- .3 Effect of changes on schedules of other Contractors.
- .5 Recovery Schedule:
 - .1 When periodic update indicates the Work is fourteen (14) or more calendar days behind the current accepted schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
 - .2 If, at any time, the Work is behind schedule with respect to the progress schedule currently in force, and if the Contract Administrator believes there is a risk of the Work not being completed within the Contract Time as a result of such delay, the Contractor shall take all necessary measures to make up for such delay either by increasing staff, plant or facilities, or by amending its Work methods, whichever is applicable, with no change to the Contract Price.

1.5 Submittal Requirements

- .1 For initial submittal of construction schedule and subsequent revisions thereof, furnish six copies of schedule at the next Progress Meeting. Provide electronic copies to the Contract Administrator upon development.
- .2 Format for Submittals: Submit required submittals in the following format:
 - .1 Working electronic copy of schedule file, where indicated.
 - .2 PDF electronic file.

1.6 Contractor's Look-Ahead Schedules

- .1 The Contractor shall provide short interval "look ahead" schedules bi-weekly, identifying Work that has been performed during the past two weeks and activities that are planned for the next four (4) weeks. The short interval schedule shall be consistent with the progress schedule currently in force.
- .2 The Look-Ahead Schedules shall generally reflect the Work associated with the Detailed Progress Schedule. The activities in the Look-Ahead Schedules shall be identified by the same number coding as the Detailed Progress Schedule and revised as necessary.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

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1.1 Description

- .1 Submit to Contract Administrator submittals listed for review. Submit promptly and in 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.
 - .1 Allow ten (10) Working Days for review of submittals by the Contract Administrator.
- .2 Do not proceed with Work affected by submittal until review is complete.
- .3 Present Shop Drawings, product data, samples and mock-ups in SI Metric units.
- .4 Where items or information is not produced in SI Metric units converted values are acceptable.
- .5 Review submittals prior to submission to Contract Administrator. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .6 Notify Contract Administrator, in writing at time of submission for review, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .7 Verify field measurements and affected adjacent Work are co-ordinated.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Contract Administrator's review of submittals.
- .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Contract Administrator review.
- .10 The Contractor shall make any corrections required by the Contract Administrator and shall resubmit the required number of corrected copies of Shop Drawings. The Contractor shall direct specific attention in writing or on resubmitted Shop Drawings to revisions other than the corrections requested by the Contract Administrator on previous submission.
- .11 After Contract Administrator's review and return of copies, distribute copies to sub-trades as appropriate. Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "Shop Drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 The Contractor shall arrange for the preparation of clearly identified Shop Drawings as specified or as the Contract Administrator may reasonably request. Shop Drawings are to clearly indicate materials, weights, dimensions, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information

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necessary for completion of the Work. Where articles or equipment attach or connect to other articles or equipment, clearly indicate that all such attachments and connections have been properly coordinated, regardless of the trade under which the adjacent articles or equipment will be supplied and installed. Shop Drawings are to indicate their relationship to design Drawings and Specifications. Notify the Contract Administrator in writing of any deviations in Shop Drawings from the requirements of the Contract Documents.

- .3 Have Shop Drawings stamped, signed and dated by a Professional Engineer licensed to practice in the Province of Manitoba where required in the Specifications or by the Contract Administrator.
- .4 The Contractor shall examine all Shop Drawings prior to submission to the Contract Administrator to ensure that all necessary requirements have been determined and verified and that each Shop Drawing has been checked and coordinated with the requirements of the Work and the Contract Documents. Examination of each Shop Drawing shall be indicated by stamp, date and signature of a responsible person of the sub-contractor for supplied items and of the General Contractor for fabricated items. Shop Drawings not stamped, signed and dated will be returned without being reviewed and stamped "Re-submit". Ensure that the following are verified:
 - .1 Field measurements.
 - .2 Field construction criteria.
 - .3 Catalogue numbers and similar data.
 - .4 Submittals shall be one electronic PDF copy.
- .5 Shop Drawing reviews by the Contract Administrator is solely to ascertain conformance with the general design concept. Responsibility for approval of detail design inherent in Shop Drawings rests with the Contractor and review by the Contract Administrator shall not imply such approval.
- .6 Shop Drawings will be returned to the Contractor with one of the following notations:
 - .1 When stamped "REVIEWED" or "NO EXCEPTIONS TAKEN", distribute additional copies as required for execution of the Work.
 - .2 When stamped "REVIEWED AS MODIFIED" or "MAKE NOTED CORRECTIONS", ensure that all copies for use are modified and distributed, same as specified for "REVIEWED".
 - .3 When stamped "REVISE AND RESUBMIT", make the necessary revisions, as indicated, consistent with the Contract Documents and submit again for review.
 - .4 When stamped "NOT REVIEWED" or "REJECTED", submit other Drawings, brochures, etc., for review consistent with the Contract Documents.
 - .5 Only Shop Drawings bearing "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS", or "REVIEWED AS MODIFIED" shall be used on the Work unless otherwise authorized by the Contract Administrator.

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- .7 After submittals are stamped "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS" or "REVIEWED AS MODIFIED", no further revisions are permitted unless re-submitted to the Contract Administrator for further review.
- .8 Any adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as such in writing prior to proceeding with fabrication and installation of Work.
- .9 Make changes in Shop Drawings, which the Contract Administrator may require, consistent with Contract Documents. When re-submitting, notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.
- .10 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 Contractor's Progress Certificates.
- .11 Accompany submissions with transmittal letter, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each Shop Drawing, product data and sample.
 - .5 Specification Section, Title, Number, and Clause
 - .6 Other pertinent data.
 - .7 Date and revision dates.
 - .8 Project title and Bid Opportunity number.
 - .9 Name of:
 - .1 Contractor
 - .2 Subcontractor
 - .3 Supplier
 - .4 Manufacturer
 - .5 Separate detailer when pertinent
 - .6 Identification of product of material.
 - .7 Relation to adjacent structure or materials.
 - .8 Field dimensions, clearly identified as such.

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- .9 Specification section name, number and clause number or drawing number and detail/section number.
- .10 Applicable standards, such as CSA or CGSB numbers.
- .11 Contractor's stamp, initialled or signed, certifying review of submission, verification of field measurements and compliance with Contract Documents.

1.3 PROCEDURES

- .1 The Contractor shall, if required by the Contract Administrator, submit for the review of the Contract Administrator method statements which describe in detail, supplement with Drawings where necessary, the methods to be adopted for executing any portion of Work.
- .2 These statements shall also include details of constructional plant and labour to be employed. Acceptance by the Contract Administrator shall not relieve the Contractor of any of his responsibilities, nor shall reasonable refusal to approve entitle the Contractor to extra payment or an extension of time.
- .3 Other Considerations :
 - .1 Fabrication, erection, installation or commissioning may require modifications to equipment or systems to conform to the design intent. Revise pertinent Shop Drawings and resubmit.
 - .2 Material and equipment delivered to the site of the works will not be paid for at least until pertinent Shop Drawings have been submitted and reviewed.
 - .3 Incomplete Shop Drawing information will be considered as stipulated deductions for the purposes of progress payment certificates.
 - .4 No delay or cost claims will be allowed that arise because of delays in submissions, re-submissions and review of Shop Drawings.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

QUALITY REQUIREMENTS

1. GENERAL

1.1 Description

- .1 This Section covers Quality Assurance and Quality Control requirements for this Contract.
- .2 The Contractor is responsible for controlling the quality of work, including work of its subcontractors, and suppliers and for assuring the quality specified in the Technical Specifications is achieved.

1.2 Summary

- .1 Allow Contract Administrator access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Contract Administrator instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 The Contract Administrator will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, the City shall pay.

1.3 Independent Inspection Agencies

- .1 Independent Inspection/Testing Agencies may be engaged by the City for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by the City. Costs of additional tests required due to defective Work shall be paid by the Contractor.
- .2 All equipment required for executing inspection and testing will be provided by the respective agencies.
- .3 Employment of inspection/testing agencies does not relieve or relax responsibility to perform Work in accordance with Contract Documents. If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by the Contract Administrator at no cost to the City. Pay costs for retesting and re-inspection.

1.4 Submittals

- .1 Submit draft inspection and test reports to Contract Administrator, prior to inclusion with the O&M manuals, in accordance with Section 01 33 00 - Submittal Procedures.

1.5 Access to Work

- .1 The City, the Contract Administrator, and other authorities having jurisdiction shall have access to the work.

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1.6 Rejected Work

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by the Contract Administrator as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of the Contract Administrator it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, the City will deduct from Contract Price difference in value between Work performed and that called for by Contract

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

TEMPORARY FACILITIES

1. GENERAL

1.1 Scope of Work

- .1 The Contractor shall provide all temporary facilities for the proper completion of the work, as required and as specified.
 - .1 Section Includes:
 - .1 User Charges:
 - .1 Electric.
 - .2 Temporary heat.
 - .2 Project identification.
 - .3 Temporary Facilities:
 - .1 Field offices and trailers as required.
 - .2 Office for Contract Administrator.
 - .3 Site meeting room that can accommodate the Contractor's representative, three (3) members from Contract Administrator and three (3) members from the City.
 - .4 Equipment.
 - .5 Support facility installation.
 - .6 Security and Protection:
 - .7 Operation, termination, and removal.

1.2 References

- .1 American National Standards Institute (ANSI):
 - .1 A 117.1: Accessible and Usable Buildings and Facilities.
- .2 American Society for Testing and Materials (ASTM):
 - .1 E84: Standard Test Method for Surface Burning Characteristics of Building Materials
 - .2 E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 deg. C.
 - .3 Canadian Electrical Code.

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1.3 Use Charges

- .1 General: Costs for installation, removal and use of temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, City's construction forces, Contract Administrator, occupants of Project, testing agencies, and authorities having jurisdiction.
- .2 Sewer Service: Provide a portable washroom for usage by all entities for construction operations.
 - .1 The Contractor shall provide adequate sanitary facilities for the use of those employed on the Work. Such facilities shall be made available when the first employees arrive on the site of the Work, shall be properly secluded from observation, and shall be maintained during the progress of the Work in suitable numbers and at such points and in such manner as may be required by pertinent health and safety regulations.
 - .2 The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all times and shall enforce their use. The Contractor shall rigorously prohibit the committing of nuisances on the site of the Work, on the lands of the City, or on adjacent property.
 - .1 The Contractor shall not use the City's sanitary facilities.
- .3 Potable Water Service: Provide potable water for usage by all entities for construction operations.
- .4 Electric Power Service from Existing System: Electric power from City's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
 - .1 The Contractor shall make all necessary applications and arrangements for electrical energy for power and light necessary for the proper completion of the Work and during its entire progress. The Contractor shall provide and pay for all temporary wiring, switches, connections, and meters.
 - .2 The Contractor shall provide sufficient electric lighting so that all work may be done in a workmanlike manner when there is not sufficient daylight.
 - .3 Any electrical power required beyond the available power in section 3.2 shall be provided by the Contractor.
- .5 Notwithstanding the availability of potable water and effluent water services from the existing system, the Contractor shall be solely responsible for the provision of water for leakage and other testing, for concrete protection and to prevent freezing of equipment, as required by the Contract.
- .6 Temporary Heat:
 - .1 If temporary heat is required for the protection of the Work, the Contractor shall provide and install suitable heating apparatus, shall provide adequate and proper fuel, and shall maintain heat as required. Costs for temporary heating, cooling, and ventilating required to execute the Work shall be borne by the Contractor.

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- .2 Temporary heating apparatus shall be installed and operated in such manner that finished work will not be damaged thereby. After the permanent heating system has been installed, tested, and made ready for operation, the Contractor may, at his own risk and expense, use it for providing heat for protection of the Work. He shall provide and pay for all fuel and care necessary, and, when the Work is ready for acceptance, he shall, at his own expense, put the system into first-class condition, even to the extent of replacing worn or damaged parts.
- .3 If permanent natural gas piping is used for temporary heating units, the Contractor shall not modify or reroute gas piping without the prior approval of the natural gas supplier. The Contractor shall provide separate gas metering as required by the natural gas supplier.
- .4 The Contractor shall provide 24-hour monitoring of temporary heating, cooling and ventilating equipment.

1.4 Project Identification

- .1 Project Identification Sign:
 - .1 One (1) sign of construction, design, and content.
 - .2 Three sq m area.
 - .3 Content:
 - .1 Project number, title, logo and name of City as indicated on Contract Documents.
 - .2 Names and titles of authorities.
 - .3 Names and titles of Contract Administrator.
 - .4 Name of Prime Contractor.
 - .4 No other signs are allowed without City permission except those required by law.
- .2 Design sign and structure to withstand 100 km/hr wind velocity.
- .3 Finishes: Adequate to withstand weathering, fading, and chipping for duration of construction.
- .4 Maintenance: Maintain signs and supports clean, repair deterioration and damage.
- .5 Removal: Remove signs, framing, supports, and foundations at completion of Project and restore the area.

1.5 Traffic Regulation

- .1 Signs, Signals, and Devices:
 - .1 Traffic Cones as required.

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- .2 Flag Person Equipment: As required by local jurisdictions.
- .2 Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.
- .3 Haul Routes:
 - .1 Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.
- .4 Removal:
 - .1 Remove equipment and devices when no longer required.
 - .2 Repair damage caused by installation.

1.6 Submittals

- .1 Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- .2 Fire-Safety Program: Show compliance with requirements of authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- .3 Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.
 - .1 Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
 - .2 Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
 - .3 Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

1.7 Quality Assurance:

- .1 Electric Service: Comply with NECA, NEMA, and CSA standards and regulations for temporary electric service. Install service to comply with the Canadian Electrical Code.

1.8 Project Conditions

- .1 During adverse weather and against the possibility thereof, the Contractor shall take all necessary precautions so that the Work may be properly done and satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, wood and building-paper shelters, or other suitable means.
- .2 During cold weather, materials shall be preheated, if required, and the materials and adjacent structure into which they are to be incorporated shall be made and kept sufficiently

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warm so that a proper bond will take place and a proper curing, aging, or drying will result. Protected spaces shall be artificially heated by suitable means which will result in a moist or a dry atmosphere according to the particular requirements of the work being protected. Ingredients for concrete and mortar shall be sufficiently heated so that the mixture will be warm throughout when used.

2. PRODUCTS

2.1 Temporary Facilities

- .1 Field Offices, General: Mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- .2 The Contractor shall maintain a temporary field office near the work for his own use during the period of construction at which readily accessible copies of all contract documents and schedules shall be kept. The office shall be located where it will not interfere with the progress of the work. In charge of this office there shall be a competent superintendent of the Contractor as specified under "Supervision of Work" in the Tender documents.
- .3 Temporary Storage Yards: The Contractor shall construct temporary storage yards for storage of Products that are not subject to damage by weather conditions.
- .4 Temporary Storage Buildings:
 - .1 The Contractor shall provide environmental control systems that meet the recommendations of Suppliers and manufacturers of the equipment and materials stored.
 - .2 The Contractor shall arrange for a chain link partition fence to provide security of contents and ready access for inspection and inventory.
- .5 The Contractor shall store combustible materials (paints, solvents, fuels) in a well ventilated and remote building meeting all applicable safety standards.

2.2 Office For Contract Administrator

- .1 Promptly after starting work at the site, the Contractor shall provide and equip a suitable office for the exclusive use of the Contract Administrator, and the Contractor shall maintain this office thereafter until the completion of the work to be done under this contract. This office shall be a separate building located where it will not interfere with the progress of the work. An acceptable, suitably constructed and equipped trailer of adequate size and design for the purpose may be furnished as the Contract Administrator's office.
 - .1 The office and furniture shall be relatively new and in good condition.
 - .2 The equipment, supplies, and services furnished shall be acceptable to the Contract Administrator.
- .2 The Contract Administrator Office shall be of suitable height and of ample size to accommodate the furniture and equipment listed below, without crowding 50 sq. ft. of floor area). It shall be weathertight and acceptably insulated and suitably ventilated; the floor shall be tight and of sufficient construction to withstand the loads imposed upon it.

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- .1 Each room will have a door, with lock and key, and a minimum of two (2) screened windows which can be both opened and locked shut.
- .2 The office shall have one (1) exterior door, with cylinder locks and keys.
- .3 The Contractor shall furnish the following furniture, equipment, supplies, and services:
 - .1 One office chair.
 - .2 Broom and dustpan.
 - .3 One (1) desk for general office use, about 3 feet by 5 feet, all with a desk chair of the armchair swivel type.
 - .4 Plan storage cabinet and bookcase.
 - .5 Class ABC type fire extinguisher of at least four (4) pound capacity.
 - .6 Supply of drinking water in a suitable dispenser, with hot and cold supply and refrigerator space.
 - .7 Paper cups, paper towels, liquid soap, and toilet paper; each with suitable dispenser or holder.
 - .8 A waste basket for each desk, and a supply of appropriately sized plastic trash bags.
 - .9 Thermostatically controlled heating unit or system of adequate capacity to maintain a minimum temperature of not less than 20°C under all cold weather conditions. The Contractor shall provide all fuel used and service necessary.
 - .10 Thermostatically controlled, refrigerant type, air conditioner of adequate capacity to maintain a maximum temperature of not more than 20°C under all hot weather conditions. The Contractor shall provide all service necessary and provide all power used.
 - .11 The Contractor shall arrange for complete janitor service to be provided on a bi-weekly basis.
 - .12 One copying machine with supplies and service. Machine shall be capable of copying 8.5 x 11, 8.5 x 14 and 11 x 17 paper sizes. Copy rate shall be at least twenty (20) copies per minute for 8.5 x 11 paper size.
- .4 The Contractor shall provide office space and facilities until the office, furnishings, and equipment described above are ready for use, but by so doing he shall not be relieved of his obligation to provide and equip the specified Contract Administrator's office as promptly as possible.
- .5 Unless otherwise directed by the Contract Administrator, after the date of completion of the Work as stated in the final estimate, the Contractor shall remove the office and all such temporary facilities from the site, the same to become his property, and leave the premises in a condition acceptable to the Contract Administrator.

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- .6 Remove snow and ice as required to minimize accumulations.
- .7 Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - .1 Store combustible materials apart from building.

2.3 Equipment

- .1 Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

3. EXECUTION

3.1 Installation, General

- .1 Locate facilities in the green space adjacent to the Digester building where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

3.2 Temporary Utility Installation

- .1 General: Install temporary service or connect to existing service.
 - .1 Arrange with utility company, City, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- .2 Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - .1 Toilets: Use of City's existing toilet facilities is prohibited.
- .3 Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- .4 Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - .1 Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
- .5 Electric Power Service: Connect to City's existing electric power service. Maintain equipment in a condition acceptable to City.
- .6 Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - .1 Connect temporary service to City's existing power source, as directed by City. Available power: 600 Vac 30 A.

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- .7 Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

3.3 Support Facilities Installation

- .1 General: Comply with the following:
 - .1 Maintain support facilities until Contract Administrator schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to City.
 - .2 All roads within the plant are used simultaneously by vehicles and pedestrians. The speed limit of 15 km/h applies throughout the plant, including the access roads and parking lots. Failure to comply with speed limit or to operate vehicles safely will result in possible removal of the staff from the plant.
- .2 Parking: Provide temporary parking areas for construction personnel. The Contractor shall not use public roads or undesignated areas for parking.
- .3 Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction.
- .4 Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - .1 Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.5 Operation, Termination and Removal

- .1 Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- .2 Maintenance: Maintain facilities in good operating condition until removal.
 - .1 Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

END OF SECTION

DELIVERY, STORAGE AND HANDLING

1. GENERAL

1.1 General Requirements

- .1 This Section specifies the general requirements for the delivery handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.

1.2 Transportation and Delivery

- .1 Transport and handle items in accordance with manufacturer's printed instructions.
- .2 Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
- .3 Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended. All spare parts shall be cross-referenced to their applicable the Specification Section.
- .4 Carefully pack and crate equipment for shipment. Protect polished and machined metal surfaces from corrosion and damage during shipment and installation. Specially pack electrical equipment to prevent damage by moisture. Cover equipment having exposed bearings and glands to exclude foreign matter. Carefully pack machines for shipment and protect electrical equipment from moisture damage. Protect bearings, seals and glands from grit and dirt.
- .5 Identify each component with durable identifying labels or tags securely attached to each piece of equipment, crate or container.
- .6 Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.
- .7 Deliver spare parts at same time as pertaining equipment. Deliver spare parts to City after completion of Work.
- .8 Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.
- .9 Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting and installing.
- .10 Assume responsibility for equipment material and spare parts just before unloading from carrier at site.
- .11 All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.
- .12 Provide equipment and personnel to unload all items delivered to the site.

DELIVERY, STORAGE AND HANDLING

- .13 Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e. City, other Contractors), perform inspection in the presence of the Contract Administrator. Notify Contract Administrator verbally, and in writing, of any problems.
- .14 Pay all demurrage charges if failed to promptly unload items.

1.3 Storage and Protection

- .1 Store and protect products and equipment in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and may be reviewed by the Contract Administrator. Instructions shall be carefully followed and a written record of this kept by the Contractor for each product and pieces of equipment.
- .2 Arrange storage of products and equipment to permit access for inspection. Periodically inspect to make sure products and equipment are undamaged and are maintained under specified conditions.
- .3 Store loose granular materials on solid flat surface in a well-drained area. Prevent mixing with foreign matter.
- .4 All mechanical and electrical equipment and instruments shall be covered with canvas and stored in a weathertight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it shall be satisfactory to the Contract Administrator. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturer and to prevent condensation on the equipment being stored.
 - .1 Prior to acceptance of the equipment, the Contractor may have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

CLEANING UP

1. GENERAL

1.1 Summary

- .1 Execute cleaning during progress of Work and at completion of Work.
- .2 Refer to Specification Sections for specific cleaning for Products or Work.

1.2 Disposal Requirements

- .1 Conduct cleaning and disposal operations to comply with local codes, ordinances, regulations, and anti-pollution laws. Do not burn or bury rubbish or waste materials on Project site. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains. Do not dispose of wastes into streams or waterways.

2. PRODUCTS

2.1 Materials

- .1 Use only those cleaning materials which will not create hazards to property and persons or damage surfaces of material to be cleaned.
- .2 Use only cleaning materials recommended by manufacturer of surface to be cleaned.

3. EXECUTION

3.1 Cleaning During Construction

- .1 Comply with General Conditions.
- .2 At all times maintain areas covered by the contract and adjacent properties and public access roads free from accumulations of waste, debris, and rubbish caused by construction operations.
- .3 During execution of work, clean site, adjacent properties, and public access roads and dispose of waste materials, debris, and rubbish to assure that buildings, grounds, and public properties are maintained free from accumulations of waste materials and rubbish. Unneeded construction equipment shall be removed and all damage repaired so that the public and property owners will be inconvenienced as little as possible.
- .4 Wet down dry materials and rubbish to lay dust and prevent blowing dust.
- .5 Cover or wet excavated material leaving and arriving at the site to prevent blowing dust. Clean the public access roads to the site of any material falling from the haul trucks.
- .6 Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes structures, work done under this contract, or elsewhere during the course of the Contractor's operations, such material or debris shall be entirely removed and satisfactorily disposed of during the progress of the work, and the ditches, channels, drains, pipes, structures, and work, etc., shall, upon completion of the work, be left in a clean and neat condition.

CLEANING UP

- .7 On or before the completion of the work, the Contractor shall, unless otherwise especially directed or permitted in writing, tear down and remove all temporary buildings and structures built by him; shall remove all temporary works, tools, and machinery or other construction equipment furnished by him; shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter in, under, and around privies, houses, and other buildings used by him; shall remove all rubbish from any grounds which he has occupied; and shall leave the roads and all parts of the premises and adjacent property affected by his operations in a neat and satisfactory condition.
- .8 Provide on-site containers for collection and removal of waste materials, debris, and rubbish in accordance with applicable regulations.

3.2 Final Cleaning

- .1 General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
 - .1 Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - .1 Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - .2 Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - .3 Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - .4 Remove tools, construction equipment, machinery, and surplus material from Project site.
 - .5 Remove snow and ice to provide safe access to building.
 - .6 Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - .7 Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - .8 Sweep concrete floors broom clean in unoccupied spaces.
 - .9 Vacuum clean concrete/tile floors in occupied spaces.
 - .10 Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.

CLEANING UP

- .11 Remove labels that are not permanent.
 - .12 Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - .13 Vacuum inside and outside of all new and existing electrical panels, MCCs, variable speed drives, etc., which have been affected by dust or dirt due to construction activities.
 - .14 Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - .15 Leave Project clean and ready for occupancy.
- .2 Touch-up paint or repaint damaged finishes on electrical items delivered to Project with finish coat of paint. Contract Administrator will make final determination of items to be repainted or touched-up.
- .3 Prior to substantial completion, Contractor with Contract Administrator and City, shall conduct inspection of sight-exposed interior and exterior surfaces and work areas to verify Work and site is clean.

END OF SECTION

CONTRACT CLOSEOUT

1. GENERAL

1.1 Related Documents

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 Summary

- .1 Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - .1 Substantial Completion procedures.
 - .2 Final completion procedures.
 - .3 Warranties.
 - .4 Final cleaning of equipment and site.
 - .5 Repair of defective and deficient Work.

1.3 References

- .1 Canadian Electrical Code.
- .2 Manitoba Amendments to the Canadian Electrical Code.
- .3 City of Winnipeg By-laws.
- .4 Manitoba Building Code.
- .5 City of Winnipeg Automation Design Guide.
- .6 City of Winnipeg Electrical Design Guide.

1.4 Submittals

- .1 Submit Shop Drawings as required.
- .2 Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- .3 Certified List of Incomplete Items: Final submittal at Final Completion.
- .4 Certificates of Release: From authorities having jurisdiction.
- .5 Certificate of Insurance: For continuing coverage.
- .6 Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

CONTRACT CLOSEOUT

- .7 Certificate of Payment: For payment of sub-trades and release of hold-back.

1.5 Substantial Completion Procedures

- .1 Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- .2 Submittals Prior to Substantial Completion: Complete the following a minimum of ten (10) days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - .1 Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting City unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - .2 Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 - .3 Submit closeout submittals specified in individual Divisions 02 through 42 Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - .4 Submit maintenance material submittals specified in individual Divisions 02 through 42 Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Contract Administrator. Label with manufacturer's name and model number where applicable.
 - .1 Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Contract Administrator signature for receipt of submittals.
 - .5 Submit test/adjust/balance records.
 - .6 Submit changeover information related to City's occupancy, use, operation, and maintenance.
- .3 Procedures Prior to Substantial Completion: Complete the following a minimum of ten (10) days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - .1 Advise City of pending insurance changeover requirements.
 - .2 Complete start-up and testing of systems and equipment.
 - .3 Perform preventive maintenance on equipment used prior to Substantial Completion.
 - .4 Instruct City's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

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- .5 Terminate and remove temporary facilities from Project site, along with mock-ups, construction tools, and similar elements.
 - .6 Complete final cleaning requirements, including touch-up painting.
 - .7 Touch-up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- .4 Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of ten (10) days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Contract Administrator will either proceed with inspection or notify Contractor of unfulfilled requirements. Contract Administrator will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Contract Administrator, that must be completed or corrected before certificate will be issued.
- .1 Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 - .2 Results of completed inspection will form the basis of requirements for final completion.

1.6 Starting of Systems

- .1 Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.
- .2 Verify wiring and support components for equipment are complete and tested.
- .3 When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, approve equipment or system installation prior to start-up, to supervise placing equipment or system in operation, and to train the City's staff.
- .4 Submit a written report that equipment or system has been properly installed and is functioning correctly.
- .5 functioning correctly.

1.7 Demonstration and Instructions

- .1 Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with City's personnel in detail to explain all aspects of operation and maintenance.
- .2 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment.
- .3 Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

1.8 Testing, Adjusting and Balancing

- .1 Adjust operating Products and equipment to ensure smooth and unhindered operation.

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- .2 Reports will be submitted to the Contract Administrator indicating observations and results of tests and indicating compliance or non-compliance with requirements of Contract Documents.

1.9 Project Records Documents

- .1 The Contractor shall record any actual revisions to the Work and maintain one set of the following Project Record Documents on Site:
 - .1 Contract Drawings, Specifications, and Addenda.
 - .2 Change Orders, Field Orders, and other written notices.
 - .3 Shop drawings, Product data, and samples.
 - .4 Records of surveying and layout Work.
 - .5 Project Record Drawings.
- .2 The Contractor shall record information on the Project Record Documents concurrent with construction progress and store these documents separately from the documents used for construction.
 - .1 The City will supply a set of Contract Drawings. The Contractor shall mark thereon all revisions as the Work progresses in order to produce a set of as-built drawings.
 - .2 The Contractor shall note any changes made during construction by any of the Contractor's forces or those of any Subcontractors.
 - .3 The Contractor shall dimension the locations of buried or concealed Work, especially piping and conduit, with reference to exposed structures.
 - .4 The Contractor shall dimension the installed locations of concealed service lines on the Site or within the structure by reference from the centre line of the service to the structure column lines, or other main finished faces, or other structural points which are easily identified and located in the finished Work.
 - .5 Certificates of Substantial Performance and Total Performance shall not be issued until as-built drawings are complete and submitted, and the Contractor has satisfied all requirements for Substantial Performance and Total Performance of the Work.
- .3 For Project Record Documents and Record Shop Drawings, the Contractor shall legibly mark each item to record actual construction including:
 - .1 Field changes of dimensions and details.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances which are concealed in construction, referenced to visible and accessible features of the Work.

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- .4 Changes in the Work caused by Site conditions, or originated by the City, the Contract Administrator, the Contractor, Preselected Equipment Vendors, or Subcontractors and by addenda, supplemental drawings, Site instructions, supplementary instructions, change orders, correspondence, and directions of any regulatory authorities.
- .5 Record the location of concealed mechanical services and electrical main feeders, junction boxes and pullboxes.
- .4 Upon completion of the Work, the Contractor shall prepare two (2) USB drives of the Record Shop Drawings, and index, and a physical printed and bound copy.
- .5 The Record Shop Drawings CD-ROM index shall identify the City's project number, project name, and Contract number and the contents of each USB in the following format:
 - .1 The index shall include the following columns of information for each Record Shop Drawing:
 - .1 USB number.
 - .2 Specification Section number.
 - .3 Specification title.
 - .4 Shop drawing transmittal number.
 - .5 Shop drawing equipment description including Preselected Equipment Vendor and Supplier.
 - .2 The index shall be printed by the following two sorts:
 - .1 Primary sort: Specification Section number. Secondary sort: Shop Drawing transmittal number.
 - .2 Primary sort: USB number. Secondary sort: Specification Section number.
 - .3 The index shall be generated using Microsoft Excel software. A copy of the electronic file shall be furnished to the City.
 - .4 The Contractor shall remove the Architect/Engineer seal from all documents.
 - .5 The Contractor shall provide a set of Project Record Documents on a USB drive in an electronic format compatible with the plant USB drive record standards. All drawings are to be provided electronically on USB drive in both AutoCAD (latest version) and Adobe Acrobat PDF (latest version). Also provide a set of USB drives containing the software implemented on this project, including standard software and custom application software. Also provide a set of USB drives containing the various programming tools and files necessary for maintenance, editing, backing up and restoring programmable equipment implemented on this project.

CONTRACT CLOSEOUT

1.10 Equipment Inventory Spreadsheet

- .1 As part of the City's asset management program, the Contractor shall complete all fields for the equipment inventory file for each piece of equipment and device provided under this Contract, as a requirement for Substantial Performance. An electronic format of the equipment inventory spreadsheet will be provided on a CD or USB drive to the successful General Contractor.

1.11 Equipment Preventative Maintenance Spreadsheet

- .1 As part of the City's asset management program, the Contractor shall complete all fields for each piece of equipment and device provided under this Contract, as a requirement for Substantial Completion. The Contractor shall transfer all of the manufacturer's recommended preventative maintenance tasks and frequencies into the spreadsheet. An electronic format of the equipment inventory spreadsheet will be provided on a CD or USB drive to the successful General Contractor

1.12 Protecting Installed Construction

- .1 Protect installed Work and provide special protection where specified in individual Specification Sections.
- .2 Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- .3 Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- .4 Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- .5 Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- .6 Prohibit traffic from landscaped areas.

1.13 Spare Parts and Maintenance Products

- .1 Furnish spare parts, maintenance, and extra products in quantities as specified within Division 26 and Division 40 within thirty (30) days of Contract award.
- .2 Deliver to Project site and place in location as directed by the City; obtain receipt prior to final payment.
- .3 Coat parts to protect from moisture.
- .4 Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers: palletized.
- .5 Stencil on containers:
 - .1 Manufacturer/supplier name.

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- .2 Unit name.
- .3 Spare part name.
- .4 Manufacturer catalogue number.
- .5 Other identifying information.
- .6 Precautionary information.

1.14 Final Completion Procedures

- .1 Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
 - .1 Submit a final Application for Payment according to Section D.
 - .2 Certified List of Incomplete Items: Submit certified copy of Contract Administrator's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Contract Administrator. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 - .3 Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- .2 Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Contract Administrator will either proceed with inspection or notify Contractor of unfulfilled requirements. Contract Administrator will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 - .1 Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.15 List of Incomplete Items (Punch List)

- .1 Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 - .1 Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 - .2 Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 - .3 Include the following information at the top of each page:
 - .1 Project name.
 - .2 Date.

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.3 Name of Contractor.

.4 Page number.

.4 Submit list of incomplete items in the following format:

.1 MS Excel electronic file. Contract Administrator will return annotated file.

.2 PDF electronic file. Contract Administrator will return annotated file.

2. PRODUCTS

2.1 Materials

.1 Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

.1 Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

3. EXECUTION

3.1 Final Cleaning

.1 General: Perform final cleaning .

.2 Dispose of Construction Waste.

3.2 Repair of The Work

.1 Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

.2 Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

.1 Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

.2 Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.

.1 Do not paint over "CSA" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

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- .3 Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
- .4 Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

3.3 Adjusting

- .1 Adjust operating products and equipment to ensure smooth and unhindered operation.

END OF SECTION

OPERATION AND MAINTENANCE DATA

1. GENERAL

1.1 Description

- .1 This Section includes procedural requirements for providing, compiling and submitting operation and maintenance data required for this project.

1.2 Summary:

- .1 This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - .1 General contents of data.
 - .2 Specific data for each equipment and system.
 - .3 Manual for materials and finishes.
 - .4 Assembly.

1.3 Definitions

- .1 System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- .2 Subsystem: A portion of a system with characteristics similar to a system.

1.4 Submittals

- .1 O&M Manual Content: Operations and maintenance manual submittal requirements are specified in individual Specification Sections for the Products for which they must be supplied. Submit reviewed manual content formatted and organized by this Section and as defined in Section 01 33 00.
 - .1 Contract Administrator and City will comment on whether content of operations and maintenance submittals are acceptable.
 - .2 Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- .2 Initial O&M Manual: Submit draft copy of each manual as defined in Section 01 33 00. Contract Administrator and City will comment on whether general scope and content of manual are acceptable.
- .3 After acceptance, deliver electronic copies to the Contract Administrator and City. Provide the City with one (1) hardcopy and the Contract Administrator with one (1) hardcopy.

1.5 Format (Hardcopy):

- .1 Prepare data in the form of an O&M instructional manual.

OPERATION AND MAINTENANCE DATA

- .2 Binders: Commercial quality, 8-1/2 x 11-inch three-hole post type binders with hardback, 3-inch maximum binder size. When multiple binders are used, correlate data into related consistent groupings. Three ring binders are not acceptable.
- .3 Arrange contents by Specification Section numbers and sequence of Table of Contents of this Project Manual.
- .4 Provide tabbed fly leaf for each separate product and system, with printed description of product and major component parts of equipment. Insert type tab labels must be secured or bonded to prevent the labels from falling out.
- .5 Text: Manufacturer's printed data, or typewritten data on twenty (20) pound paper.
- .6 Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages and insert into clear plastic envelopes that can be secured into the three-hole post binders.

1.6 Format (Electronic Documentation)

- .1 The Contractor must provide Operation and Maintenance Manual information specific to the configuration of the project in electronic form. Documents should be formatted like a web site complete with index page and Table of Contents. The electronic format must be such that the City is able to load the files onto a server to provide online access via any standard web browser. The Contractor shall make use of HTML (for text based documents) and PDF (for CAD type drawings) file formats. The complete document shall be provided on a USB drive.
- .2 The electronic O&M data must be organized in a logical manner to aid operation in troubleshooting and information retrieval.
- .3 All PDF documents must be searchable.

1.7 Quality Assurance

- .1 Preparation of data shall be performed by personnel:
 - .1 Trained and experienced in O&M of described equipment.
 - .2 Familiar with requirements of this Section.
 - .3 Skilled as technical writers to the extent required to communicate the essential data to the Reader.
 - .4 Skilled as drafters competent to prepare any required drawings.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 General Contents of Data

- .1 Title Sheet: First page in data listing following:

OPERATION AND MAINTENANCE DATA

- .1 Title: "OPERATION AND MAINTENANCE INSTRUCTIONS".
- .2 Title of Project: As shown on Contract Documents.
- .3 Name(s) of applicable building(s) or structure(s) in which equipment is located.
- .4 Name of equipment as described in Contract Documents.
- .5 Contractor's name, address, and telephone number.
- .6 Subcontractor's name, address, and telephone number if equipment is provided by Subcontractor.
- .7 Contractor's or Subcontractor's purchase order number, manufacturer's shop order number or other such numbers required for parts and service ordering.
- .8 Manufacturer's name, address, and telephone number.
- .9 Name, address, and telephone number for local source of supply for parts and service.
- .2 Equipment List: Immediately following title sheet containing the following:
 - .1 Table of Contents: Immediately following equipment list. Arrange in logical, systematic order and shall include as minimum each tabbed divider. Each page shall be numbered.
 - .2 Tabbed Dividers: Insert tabbed section dividers between each major section
 - .1 Provide title of section on each tab.
 - .2 Provide table of contents for each tabbed section, arranged in systematic order.
 - .3 Equipment Data Sheets: Provide catalog sheets showing configuration, manufacturer's specifications, models, options, and styles of equipment and major components being provided. Product data sheets will show project specific information with inapplicable information deleted by crossing out or removal. Include in tabbed section(s).
 - .4 Text:
 - .1 Include only those sheets applicable to Project.
 - .2 Each sheet shall:
 - .1 Identify specific equipment or part installed.
 - .2 Identify text applicable to equipment or part installed.
 - .3 Do not include inapplicable information or neatly strike it out.
 - .5 Drawings:
 - .1 Supplement text with drawings to clearly illustrate following:

OPERATION AND MAINTENANCE DATA

- .1 Equipment and components.
- .2 Relations of component parts of equipment and systems.
- .3 Control and flow diagrams.
- .2 Actual drawings of equipment from manufacturer. "Typical" drawings are not acceptable.
- .6 Specially written information, as required to supplement text for particular installation.
 - .1 Provide explanation of interrelationships of equipment and components, and effects one component has on another or entire system.
 - .2 Provide overall instructions and procedures for equipment tying in instructions and procedures for separate components into unified instructional package.
 - .3 Provide glossary of any special terms used by the manufacturer if applicable.
 - .4 Organize in consistent format under separate headings for different O&M procedures.
 - .5 Provide logical sequence of instructions in order of O&M action required for each procedure.

3.2 Specific Data for Each Item of Equipment and/or System

- .1 For each item of equipment and system include:
 - .1 Description of equipment and component parts:
 - .1 Function.
 - .2 Normal operating characteristics.
 - .3 Limiting conditions.
 - .4 Performance curves.
 - .5 Engineering data.
 - .6 Test as applicable.
 - .7 Complete nomenclature and model number of replaceable parts including keyed labeled exploded diagram.
 - .8 Complete nameplate data.
 - .9 City's tag (or asset) numbers for equipment as indicated on the Contract Drawings.
 - .2 Operating Procedures:

OPERATION AND MAINTENANCE DATA

- .1 Startup and break-in.
- .2 Normal operating instructions.
- .3 Regulation and control.
- .4 Stopping and shutdown.
- .5 Emergency instructions.
- .3 Maintenance Procedures:
 - .1 Routine maintenance operations.
 - .2 Guide to troubleshooting.
 - .3 Disassembly, repair, and reassembly instructions.
- .4 Manufacturer's printed instructions regarding safety precautions for both (a) protection of personnel operating equipment and systems and (b) prevention of damage to equipment and systems.
- .5 Assembly drawings and diagrams required for maintenance.
- .6 Manufacturer's parts list and illustrations
 - .1 Predicted life of parts subject to wear.
 - .2 Items recommended to be stocked by the City as spare parts and quantities of same.
- .7 Accepted control diagrams such as ladder diagrams, instrumentation loop diagrams, and electrical schematics.
- .8 Bill of material.
- .9 Other data as required under applicable Specification sections.
- .2 Each system shall include:
 - .1 Description of System and Component Parts:
 - .1 Function.
 - .2 Normal operating characteristics.
 - .3 Limiting conditions.
 - .4 Performance curves.
 - .5 Engineering data.

OPERATION AND MAINTENANCE DATA

- .6 Rating tables.
- .7 Tests, as applicable.
- .8 Complete nomenclature and model number of replaceable parts.
- .9 Complete nameplate data.
- .10 City's Tag (asset) numbers for equipment as indicated on the Contract Drawings.
- .2 Circuit Directories of Panel Boards:
 - .1 Electrical service.
 - .2 Controls.
 - .3 Communications.
- .3 Maintenance Procedures:
 - .1 Guide to troubleshooting.
 - .2 Disassembly, repair, and reassembly instructions.
 - .3 Adjustment and checking instructions.
- .4 Manufacturer's printed instructions regarding safety precautions for both:
 - .1 Protection of personnel operating equipment and systems.
 - .2 Prevention of damage to equipment and systems.
- .5 List of original all of the manufacturer's components, spare parts with diagram, and recommended quantities to be maintained in storage by the City.
- .6 Other data as required under pertinent sections of Specifications.
- .3 Prepare and include additional data when need for such data becomes apparent during instruction of City's personnel. Differences between the equipment O&M manual and the manufacturers training session shall result in the training and/or O&M Manual being corrected.

3.3 Manual For Materials and Finishes

- .1 Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured products.
- .2 Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

OPERATION AND MAINTENANCE DATA

- .3 Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- .4 Additional Requirements: As specified in individual product specification sections.
- .5 Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

3.4 Assembly

- .1 Assemble in two (2) sets.
- .2 Remove bindings of individual manuals.
- .3 Insert index tabs labeled with the respective piece of equipment to separate individual manuals.
- .4 Provide a Table of Contents at the front of each volume showing the equipment items in the order in which they appear in the volume. Each equipment items shall include the functional name, applicable specifications section, and the plan listing, if any.
- .5 The preventive maintenance schedule shall be bound in the front of each section immediately following the index tab sheet. The schedule shall be identified with respect to the piece of equipment it is referring to.
- .6 Sheet Size: 8-1/2 x 11 sheets.
- .7 Drawings may be on 11 x 17-inch sheets folded to 8-1/2 x 11 inches.
- .8 Engrave on covers and end of binder, title OPERATIONS AND MAINTENANCE INSTRUCTIONS, name of Project, City's project number, date of Contract, and volume number with subject matter of contents, and the Contract Administrator's name.

OPERATION AND MAINTENANCE DATA

FORM 01 78 23-1 Page 1 of 5 CONTRACTOR SUBMITTAL FORM			
TO: (Contract Administrator) (Address) (City, State, Zip) (Attn:)		DATE:	
		SPECIFICATION SECTION TITLE:	
		SECTION NO.:	
		MANUFACTURER/ VENDOR:	
FROM: (Contractor) (Address) (City, State, Zip)		NO. OF COPIES SUBMITTED TO [CONTRACT ADMINISTRATOR][CM]:	
		SIGNATURE OF CONTRACTOR:	
GENTLEMEN: We have checked the O&M manual submittal dated ___, 20_, and have found it to be in accordance with the requirements of Specification Section 01 78 23 as noted below.			
FORMAT Size: 8-1/2 x 11 or 11 x 17 Paper: 20-lb minimum Text: Printed data/neatly typed Drawings: Standard size bound in text; in text-size labeled envelopes Tabbed Section Dividers Cover Label: Title Project name Building/structure ID Equipment name Specification section Binders: 3-ring			

OPERATION AND MAINTENANCE DATA

FORM 01 78 23-1 Page 2 of 5			
CONTRACTOR SUBMITTAL FORM			
Provided	Not Applicable	Page No.	
3.01 GENERAL CONTENTS			
			A. Section number - one specification only
			B. Title Page
			1. Title
			2. Project title
			3. Building/structure ID
			4. Equipment name
			5. Contractor ID
			6. Subcontractor ID
			7. Purchase order data
			8. Manufacturer ID
			9. Service/parts supplier ID
			C. Product List
			D. Table of Contents
			E. Tabbed Sections
			F. Pertinent data sheets
			1. Annotated as needed
			G. Text
			1. Pertinent to project
			2. Annotated
			H. Drawings
			1. Supplement text
			a. Illustrate product and components
			b. Relations of equipment systems
			c. Control and flow diagrams
			2. Actual drawing of project equipment

OPERATION AND MAINTENANCE DATA

FORM 01 78 23-1 Page 3 of 5			
CONTRACTOR SUBMITTAL FORM			
Provided	Not Applicable	Page No.	
3.01 GENERAL CONTENTS			
			I. Special Information
			1. Interrelationships of equipment and components
			2. Instructions and procedures provided
			3. Instructions organized in consistent format
			4. Instructions in logical sequence
			5. Glossary
			J. Warranty, Bond, Service Contract
3.02 SPECIFIC CONTENTS (EQUIPMENT/SYSTEMS ONLY)			
			A. For each item of equipment
			1. Complete Form 2 to Section 01 78 23
			2. Description of Unit and Components
			a. Equipment functions
			b. Normal operating characteristics
			c. Limiting conditions
			d. Performance curves
			e. Engineering data
			f. Test data
			g. Replaceable parts list (with numbers)
			h. Nameplate data
			i. P&ID numbers
			3. Operating Procedures
			a. Startup, break-in
			b. Routine/normal operation
			c. Regulation and control
			d. Stopping and shutdown
			e. Emergency

OPERATION AND MAINTENANCE DATA

FORM 01 78 23-1 Page 4 of 5			
CONTRACTOR SUBMITTAL FORM			
Provided	Not Applicable	Page No.	
3.02 SPECIFIC CONTENTS (EQUIPMENT/SYSTEMS ONLY)			
			3. Operating Procedures (continued)
			f. Seasonal operation
			g. Special instructions
			4. Maintenance Procedures
			a. Routine/normal instructions
			b. Troubleshooting guide
			c. Disassembly/repair/assembly
			d. Alignment, adjusting and checking instructions
			5. Servicing and Lubrication
			a. List of lubricants
			b. Lubrication schedule
			c. Maintenance schedule
			6. Safety Precautions/Features
			7. Sequence of Operation of Controls
			8. Assembly Drawings
			9. Parts List and Illustrations
			a. Predicted life
			b. Spare parts list
			10. Control Diagrams/Schematics
			11. Bill of Materials
			12. Other Data as Required

OPERATION AND MAINTENANCE DATA

FORM 01 78 23-1 Page 5 of 5			
CONTRACTOR SUBMITTAL FORM			
Provided	Not Applicable	Page No.	
3.02 SPECIFIC CONTENTS (EQUIPMENT/SYSTEMS ONLY)			
			B. Each electrical and electronic system
			1. Description
			a. Equipment functions
			b. Normal operating characteristics
			c. Performance curves
			d. Engineering data
			e. Test data
			f. Replaceable parts list (with numbers)
			g. Nameplate data
			h. P&ID numbers
			2. Circuit and Panel Board Directories
			a. Electrical
			b. Controls
			c. Communications
			3. Instrumentation
			a. Loop Diagrams
			b. Components list each circuit/loop
			4. Operation Procedures
			a. Routine/normal operating instructions
			b. Sequences required
			c. Special operating instruction
			5. Maintenance Procedures
			a. Routine/normal instructions
			b. Troubleshooting guide
			c. Disassembly/reassembly
			d. Adjusting and checking
			6. Safety Precautions/Features
			7. Spare Parts List
			8. Additional Data

OPERATION AND MAINTENANCE DATA

FORM 01 78 23-2 Page 1 of 4			
EQUIPMENT DATA FORM			
PROJECT NAME			
CONTRACT NO.			
CONTRACTOR			
EQUIPMENT NO.		ASSET NO.*	
DESCRIPTION		MAINT. NO.*	
LOCATION			
MANUFACTURER			
PURCHASED FROM			
VENDOR ORDER NO.		PURCHASE \$	
DATE OF PURCHASE			
LOCAL SUPPLIER			
ADDRESS			
PHONE NO.			
MODEL NO.			
NO. OF UNITS		SERIAL NOS.	
*By City			

OPERATION AND MAINTENANCE DATA

FORM 01 78 23-2 Page 2 of 4 EQUIPMENT DATA FORM			
NAMEPLATE DATA			
ELECTRIC MOTOR		PUMP/HVAC UNIT	
MANUFACTURER		MANUFACTURER	
TYPE	[] AC [] DC	TYPE	
HORSEPOWER		SIZE	
RPM		CAPACITY	
VOLTAGE		PRESSURE	
AMPERAGE		ROTATION	
PHASE		IMPELLER SIZE	
FRAME		IMPELLER MATERIAL	
DRIVE/REDUCER		OTHER (I&C)	
MANUFACTURER		MANUFACTURER	
TYPE	[] GEAR [] V-BELT [] CHAIN [] VARIDRIVE	TYPE	
		SIZE	
SERVICE FACTOR		CAPACITY	
RATIO		RANGE	

OPERATION AND MAINTENANCE DATA

FORM 01 78 23-2 Page 4 of 4 EQUIPMENT DATA FORM				
LUBRICANT/RECOMMENDED SPARE PARTS LIST				
EQUIPMENT NO.		ASSET NO.*		
DESCRIPTION		MAINT. NO.*		
LUBRICANT LIST				
REFERENCE SYMBOL	LUBRICANT TYPE (MILITARY STANDARD)	RECOMMENDED LUBRICANT AND MANUFACTURER		
List symbols in "Maintenance Operation" (Page 3).	List general lubricant type.	List specific lubricant name, viscosity, and manufacturer.		
RECOMMENDED SPARE PARTS LIST				
PART NO. **	DESCRIPTION	UNIT	QUANTITY	UNIT COST
ADDITIONAL DATA AND REMARKS				
* By City ** Identify parts provided by this Contract with two (2) asterisks. Note: Attach additional sheets if necessary; identify each sheet at top with equipment number and description.				

END OF SECTION

ELECTRICAL WORK – GENERAL

1. GENERAL

1.1 Description:

- .1 Provide complete and operational systems for a dual redundant fibre optic ring network as shown in the specifications and drawings, including the installation and wiring of miscellaneous equipment and devices. Perform all work, testing, and commissioning as indicated and specified.
 - .1 Provide conduit, wiring and connections for equipment furnished by others unless otherwise specified and indicated.
 - .2 Provide temporary circuits, overcurrent devices, conduit and wiring, and other equipment required during construction and as part of the modification of the existing electric system and existing network cabinets. Perform work at the convenience of the City.
 - .3 Disconnecting, removing, and relocating existing electrical equipment is a part of this Contract and this Section. Make equipment scheduled for removal free of shock hazard.
 - .4 Provide network equipment relocation work associated with the relocation of certain in-cabinet equipment for the existing network panels, including disconnecting all existing wiring and conduits and providing new wiring and conduit and connections as required to the relocated equipment. Make equipment scheduled for relocation free of electrical shock hazard.
 - .5 The equipment enclosure classification of the plant areas are indicated on the drawings. Provide all equipment, devices and material meeting the requirements for these area classifications unless otherwise noted or specified.
 - .6 Review the electrical underground system and the civil yard piping. Perform locates on all areas affected by underground works. Install the electrical underground system in a manner that avoids conflicts with manholes, catch basins, etc.
- .2 Optional Pricing:
 - .1 Option 1: Provide a dual redundant cable run between the dewatering network panel and the UV network panel following the route indicated on drawing 1-0101-AUTY-001.
 - .2 Option 2: Provide a dual redundant cable run between the dewatering network panel and the UV network panel following the route indicated on drawing 1-0101-AUTY-002.
 - .3 The requirements of section 1.1 and its subsections above will apply to the separate price options.
 - .4 The area between the new headworks building and the existing UV building will be under construction by others during the time frame of this project. Coordination will be required through shared work areas for both options. This includes but is not limited to scheduling and site safety procedures.

ELECTRICAL WORK – GENERAL

1.2 General Requirements

- .1 Refer to Division 1 for General Requirements related to the Contract Documents.
- .2 Refer to all Sections of Division 26, 40, and Drawings.
 - .1 The intent of the Specifications and Drawings is to include all labour, products, and services necessary for complete Work, tested and ready for operation.
 - .2 Symbols used to represent various electrical devices often occupy more space on the Drawing than the actual device does when installed. In such instances, do not scale locations of devices from electrical symbols. Install these devices with primary regard for usage of wall space, convenience of operation and grouping of devices. Refer to installation details where they exist.
 - .3 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 the present specifications.

1.3 References

- .1 Canadian Standards Association (CSA):
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations, most current adopted edition.
 - .2 CSA-C22.3 No. 1-20, Overhead Systems.
 - .3 CSA C22.3 No.7-20, Underground Systems.
 - .4 CSA-C22.2 No. 232, Optical Fiber Cables.
 - .5 CSA CAN3-C235-83, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE SP1122 (2007), The Authoritative Dictionary of IEEE Standards Terms.
- .3 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA 250-2014, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 Manitoba Hydro:
 - .1 Manitoba Electrical Code, most current adopted revision.
 - .2 Manitoba Hydro Inspection Notices.
- .5 City of Winnipeg:
 - .1 Automation Design Guide.

ELECTRICAL WORK – GENERAL

- .2 Electrical Design Guide.
- .3 Winnipeg Electrical By-Law.
- .4 Information Bulletins.

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

1.5 Quality Assurance

- .1 Install electrical work in conformance with latest rules and requirements of the Canadian Electrical Code, the Manitoba Electrical Code, and the Winnipeg Electrical By-law.

1.6 Qualifications of Electrical Contractor

- .1 The Electrical Contractor shall have been engaged in work of a similar nature to this contract for the past five (5) years.
- .2 The Electrical Contractor shall have a minimum of five projects of equal or greater size with the type of equipment specified under this project.
- .3 Electrical work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor licenses or apprentices in accordance with Authorities Having Jurisdiction.
 - .1 Employees registered in provincial apprenticeship program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .4 Refer to Section 40 95 00 for Qualifications of Fibre Optic Network Contractor.

1.7 Submittals

- .1 Submit the following:
 - .1 The following defines a minimum for all Division 26 Shop Drawing and data submittals:
 - .1 Submit Shop Drawings delineated by specification number with all information for one piece of equipment provided as one package.
 - .2 Partial submittals will be returned without action.
 - .3 Submit bills of material: Include a numbered list of all components, with manufacturer's name, catalog number, rating, and other identification. Place item number or similar identification on all other drawings where item appears.
 - .4 Submittal shall include:

ELECTRICAL WORK – GENERAL

- .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure coordinated installation.
- .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
- .3 Indicate on Drawings clearances for operation, maintenance, and replacement of operating equipment devices.
- .4 If changes are required, notify Contract Administrator of these changes before they are made.
- .5 Contract Administrator will not assume the responsibility for searching out deviations in the Contractor's drawings.
- .6 Shop drawings shall be first checked by the Contractor for space, dimension, performance characteristics and general conformance to the Drawings and Specifications and shall be so stamped. Shop Drawings not stamped as specified will be returned to Contractor without action. Contractor's stamp shall include name and address of Contractor, the date checked, the initials of the checker and the status of the checking, including conclusive markups.
- .7 Shop Drawings shall include manufacturer's name and address, equipment or material descriptive names, and catalog number. Shop Drawings shall indicate dimensions, voltage and current characteristics, wire sizes, test or conformance data, construction and rough-in data of all material to be used.
- .5 Submit only completed drawings showing all local and remote devices associated with each item.
- .6 Mark shop drawings and data submitted showing only items applicable to specific contract. Complete catalogues that have not been curated to the specific products submitted will be rejected.
- .7 Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new work.
- .8 Submit time-current characteristic curves for all submitted protection devices such as circuit breakers and fuses.
- .9 Submit other documentary or descriptive information as required for each assembly to demonstrate compliance with the applicable contract documents.
- .2 Shop drawings and data are required for the following list:
 - .1 Cables & Accessories.
 - .2 Cable Trays, & Installation Accessories.
 - .3 Switches, Receptacles, Heavy Duty Receptacles & Power connectors.

ELECTRICAL WORK – GENERAL

- .4 Equipment Cabinets, Racks & Consoles.
- .5 Terminal and Wire Marking System.
- .6 Equipment Identification
- .7 Field Acceptance Test Reports
- .8 Record Drawings
- .3 Submit instruction manuals for installation, operation, and maintenance of equipment, and parts list for equipment listed below. Specifically mark standard publications forming a part of this contract. Cross out, blank out, or otherwise delete non-applicable items. Submittals which do not clearly indicate items and features provided shall be rejected.
 - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
 - .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Service instructions: including a list of spare parts and replacement parts and the names and addresses of all suppliers.
 - .3 Maintenance instructions: including start-up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .4 Installation instructions.
 - .5 Safety precautions.
 - .6 Operating instructions, including procedures to be followed in event of equipment failure.
 - .7 Other items of instruction as recommended by Manufacturer of each system or item of equipment.
 - .8 List of included spare items.
 - .3 Operations and maintenance manuals to include at least the following systems:
 - .1 Fibre Installations.
 - .2 Network Panels.
- .4 Provide CSA certified equipment and material. Where CSA certified equipment and material is not available, submit such equipment and material inspection authorities for special acceptance approval before delivery to Site.

ELECTRICAL WORK – GENERAL

- .5 Drawings of Record:
 - .1 One complete set of construction drawings shall be kept on site. Records during construction will be maintained.
- .6 Submit test results of installed electrical systems and instrumentation.
- .7 Permits and fees: in accordance with General Conditions of Contract.
- .8 Submit copies of electrical permit when attained and when closed.
- .9 Submit certificate of acceptance from Authority Having Jurisdiction upon completion of Work to Contract Administrator.
- .10 Manufacturer's Field Reports: submit to Contract Administrator Manufacturer's written report, within three (3) days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in Part 3.17 Field Quality Control.

1.8 Nameplates and Labeling

- .1 Provide nameplates and labels as specified in Section 26 05 53.

1.9 Interference and Erroneous Locations

- .1 Locations of electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations shall be determined during construction.
- .2 Verify in field, all data and final locations of work installed under other sections of specifications, required for placing of electrical work.
- .3 In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials to complete the work.

1.10 Delivery, Storage, and Handling

- .1 Material Delivery Schedule: Provide Contract Administrator with schedule within two (2) weeks after award of Contract.

1.11 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling.
- .2 Collect and separate paper, plastic, polystyrene and corrugated cardboard packaging material for recycling.
- .3 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Contract Administrator. Turn over any copper materials for the City to exercise its right of first claim. Disposal of materials not claimed by the City shall be the responsibility of the Contractor.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

ELECTRICAL WORK – GENERAL

- .5 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .6 Place materials defined as hazardous or toxic waste in designated containers.
- .7 Ensure emptied containers are sealed and stored safely for disposal away from children and wildlife.
- .8 Unused sealant material must not be disposed of into sewer system, streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.
- .9 Do not dispose of preservative treated wood through incineration.
- .10 Do not dispose of preservative treated wood with other materials destined for recycling or reuse.
- .11 Dispose of treated wood, end pieces, wood scraps, and sawdust at a sanitary landfill approved by Contract Administrator.

1.12 Compliance

- .1 Failure to comply with the drawings and specifications shall be cause for rejection and the Contractor shall be required to make good at no additional cost to the City or their agents.

2. PRODUCTS

2.1 Materials and Equipment

- .1 Provide materials and equipment.
- .2 All equipment shall be manufactured by experienced manufacturers who can demonstrate in-use records for all equipment offered.
- .3 Requests for approval of alternative suppliers shall be submitted to the Contract Administrator prior to tender closing. To ensure the integrity and fairness of the tender process, unapproved alternates provided after award will be rejected.
- .4 The majority of equipment shall be supplied by a single manufacturer, particularly where technical performance is of concern. Also, for equipment that requires uniformity of looks and aesthetics, such as in power and control panels, wiring devices and luminaires.
- .5 Material and equipment to be CSA Certified. Where CSA Certified material and equipment are not available, inform the Contract Administrator and obtain special approval at no cost to the City from inspection authorities before delivery to site and submit such approval to the Contract Administrator. Include any special approvals in the Operating and Maintenance manuals.
- .6 Factory assembled control panels and component assemblies.
- .7 Clearly mark equipment, devices and material with name or trademark of manufacturer and rating in volts and amperes and other pertinent information on a nameplate.

ELECTRICAL WORK – GENERAL

2.2 Wiring Terminations

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.3 Equipment Identification

- .1 Identify electrical equipment and devices with nameplates as follows:
 - .1 Nameplates: lamacoid 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core mechanically attached with self-tapping screws.
 - .2 Sizes as follows:

NAMEPLATE SIZES

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	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 All essential power labelling to be red face nameplate with white letters.
- .3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .4 Wording on nameplates and labels to be approved by Contract Administrator prior to manufacture.
- .5 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.
- .10 All network panels requiring power, provide circuit panel designations and where fed from.

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, branch circuit wiring and neutrals.
- .2 Maintain phase sequence and colour coding throughout.

ELECTRICAL WORK – GENERAL

- .3 Colour coding: to CSA C22.1.18.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.5 Conduit and Cable Identification

- .1 Colour code conduits, boxes and metallic sheathed 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 Provide cable identification label at 3m intervals or less along all conduits. Provide labels within 1m of penetrations. Labels shall be on both sides of wall, ceiling, or floor penetrations.
- .4 Colours: 38 mm wide prime colour and 19 mm wide auxiliary colour.

Item	Prime	Auxiliary
Medium Voltage (> 750 V)	Orange	
347/600 V	Yellow	
208/120/240 V Power	Black	
UPS 208/120/240 V Power	Black	Green
Control Wiring (120 V)	Black	Orange
Fire Alarm	Red	
Low Voltage Communication/General	Blue	
Low Voltage Control Wiring (< 50 V)	Blue	Orange
Intrinsically Safe	Blue	White
Grounding	Green	
Fibre Optic Cable	Purple	

2.6 Finishes

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two (2) coats of finish enamel.
 - .1 Paint outdoor electrical equipment light gray finish.
 - .2 Paint indoor enclosures light gray or black finish.

3. EXECUTION

3.1 Installation

- .1 The complete installation shall be carried out in accordance with the latest CSA C22.1.18 - Canadian Electrical Code, except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.
- .3 All work shall be executed in accordance with the latest current codes, standards, statutes or recommendations of the following technical societies, trade organizations, and governing agencies, and shall be subject to the inspection of those departments having jurisdiction.

ELECTRICAL WORK – GENERAL

- .4 Install all equipment in accordance with the manufacturer's recommendations and in a manner that will ensure satisfactory operation upon completion.
- .5 Provide all labour and all necessary equipment including lifts, scaffolding, tools and rigging materials for installation of the equipment.
- .6 The Contractor shall be responsible for coordinating all other works, including coordinating with City operations, for the equipment being installed.

3.2 Removal and Relocation of Material and Equipment

- .1 Equipment shall only be removed or relocated upon the receipt of written approval from the Contract Administrator.
- .2 Carefully dismantle and salvage electrical equipment, switches, fixtures, conduits, cables, wiring, boxes, as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.
 - .1 Deliver material and equipment not indicated for reuse to City for his disposal.
- .3 Remove from site and dispose of material and equipment not indicated for reuse.

3.3 Workmanship

- .1 Workmanship shall be the best quality, executed by workers qualified, experienced, and skilled in the respective duties for which they are employed.
- .2 Qualified tradesman shall be used for all cable installation and terminations.
- .3 The Contract Administrator reserves the right to require the dismissal from the site of workers deemed incompetent, careless, unsafe, or otherwise objectionable.
- .4 The Contract Administrator reserves the right to require the proof of competency for the site superintendent, project coordinator, data and fiber installer and cable termination electricians. The Contractor is responsible to ensure the proper competencies for the work performed.
- .5 In cases of dispute, decisions as to the quality, fitness or workmanship rest solely with the Contract Administrator, whose decision is final.
- .6 If any of the work is such as to make it impractical to produce required results, immediately notify the Contract Administrator.
- .7 All exposed parts of the electrical wiring systems such as exposed conduits, flush plates, cabinet trim, fixtures, etc., shall be square and true with the building construction.

3.4 Drawings and Specifications

- .1 The Drawings and Specifications shall be used together, and all materials and labor mentioned in one but omitted from the other shall be considered as sufficiently specified and shall therefore be supplied and installed.

ELECTRICAL WORK – GENERAL

- .2 The location of various items on the drawings is approximate, unless specified otherwise, and is subject to slight revisions as the work is installed in order to accommodate construction conditions.
- .3 Where equipment and material dimensions are dependent upon building dimensions take field measurements, do not scale the drawings.
- .4 The construction drawings are not intended to be scaled for roughing-in measurements nor to serve as Shop Drawings.
- .5 The Contractor shall consult the existing architectural, structural, mechanical, or equipment drawings for dimensions, obstructions, and location of equipment of other trades. Any discrepancies between architectural, structural, mechanical, or equipment drawings and the work shown on the electrical drawings shall be reported to the Contract Administrator for adjustment.
- .6 The installation details, instructions, and recommendations of the manufacturer of the product used, or modified to obtain the best end result, shall be the basis of attaining installation of the products for usage on this project except where definite and specific instructions are set forth herein or details are shown on the Drawings.
- .7 Panels, cabinets, fixtures and special equipment are shown on the drawings only in a schematic manner and not necessarily in their specific location. The Contractor shall be responsible for exact locations of the outlets to form a functional and aesthetic installation either by careful review of all architectural elevations, tile patterns, surface finishes, and equipment arrangements or by consultation with the Contract Administrator and other trades involved.

3.5 Errors and Omissions

- .1 In the event of errors or discrepancies between the drawings and specifications, the contractor shall obtain a ruling before Tenders are submitted.
- .2 If a ruling has not been requested, it shall be assumed that in event of a discrepancy, the Contractor has allowed for the more expensive alternative.
- .3 Where the authority having jurisdiction has indicated that changes are required which will cause delay and/or additional costs, the Contractor shall notify the Contract Administrator of the proposed changes as soon as practicable.

3.6 Alternative Equipment

- .1 The Contractor is required to submit a base Tender for the specified equipment and show a separate price increase or reduction complete with detailed descriptions for alternative equipment.
- .2 The Contract Administrator shall review alternate equipment after Tender submissions and be the sole judge of the acceptability of alternatives. Alternate proposals shall include comprehensive details and any perceived benefits to the City.
- .3 After the award of the Contract Documents, any request for a substitution must be made in writing by the Contractor (not material supplier or subcontractor). Such request shall state

ELECTRICAL WORK – GENERAL

the name of the product specified, the name of the product proposed for substitution, the reason for requesting the substitution, and any change in Contract Amount resulting from the substitution. No such substitution shall be made until an appropriate Contract Modification has been issued and approved.

3.7 Work In Existing Structures

- .1 In general, any or all existing electrical equipment and services are to remain in operation and shall not be disturbed unless otherwise noted in these Specifications and/or on the drawings or as required for the proper execution of the work.
- .2 In each area of the work, disconnect and carefully remove the existing electrical equipment and devices so noted. With the exception of items indicated as having to be re-used, all such existing equipment and devices shall be disposed of as specified herein. If not required by the City, remove them from the premises and site. All existing electrical equipment and devices indicated as not removed or abandoned are to be maintained in operation and any circuits disturbed by the construction shall be restored.
- .3 Maintain existing electrical services and systems to and in the buildings throughout the project and all "down-time" shall be scheduled at least two (2) weeks in advance with the permission of the Contract Administrator and such scheduling shall be rigidly adhered to.

3.8 Dedicated Neutrals

- .1 Each circuit shall have its own dedicated neutral wire. Shared neutral for more than one (1) circuit shall not be permitted.

3.9 Area Category and Classifications

- .1 Refer to the drawings for building areas that have the non-ordinary electrical categories and classifications as defined in the CEC.

3.10 Enclosures

- .1 Dry/General NEMA 1
- .2 Wet/Outdoor/Corrosive/Category 1 or Category 2 NEMA 4X
- .3 Hazardous Rated for hazardous location
- .4 Transformers and CSTE NEMA 3R
- .5 Any Network Panel not installed in a control room shall be NEMA 4X.
- .6 Network panels installed in the following control rooms shall be NEMA 4X:
 - .1 Primary Clarifiers.

3.11 Nameplates and Labels

- .1 Ensure Manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

ELECTRICAL WORK – GENERAL

3.12 Conduit and Cable Installation

- .1 Trench or directional drill as required to not disturb the existing plant concrete and facilities. If a roadway is required to be shut down for any installation, provide a shutdown plan to the Contract Administrator at least three weeks in advanced for approval.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.
- .4 Do not mix wiring and/or cables from different panels within the same conduit runs or pull boxes. Provide equipment barriers where acceptable and where applicable.

3.13 Cleaning

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks, and fastenings to prevent rusting.
- .3 In addition to final cleaning in accordance with the Special Conditions and Description of the Work, clean interiors and surfaces of all electrical equipment and general work area periodically to continuously maintain a clean working environment.

3.14 Contractor's Responsibility

- .1 The Contractor shall be responsible for the equipment and work until its completion and final acceptance.
- .2 The Contractor shall replace any item which may be damaged, lost or stolen without additional cost to the City.
- .3 Install all the Work promptly and in advance of concrete pouring or similar construction.
- .4 Co-ordinate the Work with other Divisions such that all equipment, conduits and wiring will be installed in the best arrangement.
- .5 Protect finished and unfinished work from damage. Any equipment or material damaged by weather, mishandling or other incident shall be replaced with new equipment and material at the direction of the Contract Administrator and at no additional cost.
- .6 Before acceptance clean all exposed surfaces of lighting luminaries, lamps, Starters, Motor Control Panels and other electrical equipment of dust and plaster. Restore any damaged paint surfaces to factory-quality finish.
- .7 Furnish all work and materials in accordance with CSA codes, provincial and local inspection department, and local utility regulatory requirements.

ELECTRICAL WORK – GENERAL

3.15 Alignment of Electrical Components

- .1 Where there are two (2) or more equipment items (switches, outlets, panels or related equipment) are installed together, they shall be aligned vertically and/or horizontally to present a neat orderly appearance.
- .2 They shall also be aligned and symmetrical with architectural elements.

3.16 Accessibility

- .1 Install all work to be readily accessible for adjustment, operation and maintenance.
- .2 Install all devices and protective systems to be accessible as per CEC (latest revision) requirements.
- .3 Access hatches shall be installed at no additional cost to the Contract Documents in walls and ceilings to provide accessibility to electrical equipment within these areas.
- .4 Locations of such access hatches shall be of an approved type and shall be installed in a pre-approved location.

3.17 Field Quality Control

- .1 The Contractor shall conduct and pay for tests as identified in Sections 16980.
- .2 Provide a manufacturer's certificate or letter confirming that the entire installation as it pertains to each system had been installed in accordance with the manufacturers' instructions.
- .3 Carry out tests in presence of the Contract Administrator or City Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct.
- .5 Ground fault detectors shall be dynamically tested by injecting current flow into the zero sequence current sensor.
- .6 Submit test results for the Contract Administrator's review.

3.18 Spare Parts

- .1 Furnish spare parts, maintenance, and extra products in quantities specified in individual Specification Sections.
- .2 Deliver to City and place in location as directed by City; obtain receipt prior to final payment.
- .3 Coat parts to protect from moisture.
- .4 Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers.
- .5 Stencil on containers:

ELECTRICAL WORK – GENERAL

- .1 Manufacturer/supplier name.
- .2 Unit name.
- .3 Spare part name.
- .4 Manufacturer catalogue number.
- .5 Other identifying information.
- .6 Precautionary information.

3.19 Substantial Completion Inspection

- .1 Prior to Substantial Completion inspection, submit written confirmation that:
 - .1 The installation as specified is completely assembled and wired.
 - .2 All wiring devices and other equipment are operational, clean and correctly labeled.
 - .3 All systems have been tested as required and are in proper working order.
 - .4 All lamacoid nameplates have been installed.
 - .5 Factory finished equipment has been cleaned, touched up or refinished to present a new appearance.
 - .6 Communication Networks, Device Level Busses, have been setup, addressed, tested and are fully functional.
 - .7 Operation and Maintenance manuals have been submitted.

3.20 Care, Operation and Start-Up

- .1 Instruct the City's Representatives in the operation, care and maintenance of equipment.

3.21 Demolition

- .1 Survey the existing electrical systems and equipment identified for removal with representatives from the other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.
- .2 Where a piece of equipment is to be removed all associated ancillary components (e.g. solenoid valves, pressure switches, etc.) and associated wiring and conduit shall also be removed.
- .3 Equipment, building or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signal system.
- .4 Equipment scheduled to be turned over to the City shall be carefully disconnected, removed and delivered to the City where indicated. Provide labor, hoisting and transportation of the

ELECTRICAL WORK – GENERAL

- equipment. All other miscellaneous electrical materials, devices, etc., associated with the equipment being turned over shall be demolished and removed from the site.
- .5 Remove electrical work associated with equipment scheduled for demolition except those portions to remain or be reused.
 - .6 Unless otherwise specifically noted, remove unused exposed conduit and support systems back to point of concealment including abandoned circuit above accessible ceiling finishes. Removed unused wiring back to source (or nearest point of usage).
 - .7 Disconnect abandoned outlets and removed devices. Removed abandoned outlets if conduit services them is abandoned or being removed. Provide blank covers for abandoned outlets which are not removed.
 - .8 Disconnect and remove abandoned electrical equipment unless otherwise indicated or specified.
 - .9 Repair adjacent construction and finishes damaged during demolition and extension work.
 - .10 Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation.
 - .11 The electrical and process equipment to be removed or relocated under this contract has been identified on the Drawings.
 - .12 Trace out existing wiring that is to be relocated or removed and perform the relocation or removed work as required for a complete operating and safe system.
 - .13 Remove exposed conduits, wireways, outlet boxes, pull boxes and hangers made obsolete by the alterations, unless specifically designated to remain. Patch surfaces and provide blank covers for abandoned outlets which are removed.
 - .14 All equipment, materials, controls, motor starters, branch and feeder breakers, panelboards, transformers, wiring, raceways, etc. furnished and installed to the temporarily keep circuits energized shall be removed when the permanent installation is fully operational.

3.22 Protection of Electrical Equipment

- .1 Material Delivery Schedule: Provide Contract Administrator with schedule within two (2) weeks after award of Contract.
- .2 Store equipment in compliance with manufacturer's recommendations and as specified herein.
- .3 Protect electrical equipment from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction.
- .4 Do not store equipment outdoors.

ELECTRICAL WORK – GENERAL

- .5 Where equipment is installed or stored in moist areas, or unheated buildings, provide acceptable means to prevent moisture damage. Provide uniformly distributed source of heat in electrical equipment to prevent condensation and damage to electrical insulation systems.

3.23 Defective or Damaged Equipment

- .1 All equipment shall be inspected for defects or damage upon delivery, report any defects or damages to the Contract Administrator within two business days. Damaged equipment shall not be used. Equipment damaged in shipment, storage, installation or through other means shall be replaced without additional cost to the City.
- .2 All equipment showing signs of water damage shall be rejected regardless of dielectric test results.
- .3 All electrical equipment is considered “in storage” regardless of location until first energized. Manufacturer’s recommendations for storage precautions, conditions and care shall be followed.

3.24 Drawings and Specifications

- .1 Drawings and specifications are typical of work to be done and of the arrangement desired. Provide accessories and appurtenances which the Contract Administrator deems functionally necessary for a complete installation, whether or not explicitly indicated or described.

3.25 As-Built Drawings

- .1 The Contractor shall maintain a master set of as-built drawings showing the changes and deviations from the contract drawings on site and upon request provide to the Contract Administrator for review.
- .2 After commissioning the Contractor shall update all changes to a clean set of red lined drawings.
- .3 Obtain a CAD set of drawings (wiring & control diagrams) from AECOM and use professional services for CAD and transfer the “As-Built” condition for all components on those drawings.
- .4 A minimum of thirty (30) days prior to application for Final Payment, submit two sets of drawings for approval that are marked to show the as-installed equipment, devices, raceway locations and wiring. The markings on the drawings are to be neat, clean and legible.
- .5 No Substantial Performance shall be issued until final “Record Drawing” CAD files and one set of prints have been received and accepted by the Contract Administrator.
- .6 The final record drawings shall incorporate the new fibre rings as well as the existing network cabling. Refer to Figure 1, Existing Backbone Routing for the existing network. Confirm existing cables on site.

ELECTRICAL WORK – GENERAL

3.26 Guarantee / Warranty

- .1 The Contractor shall guarantee/warrant all equipment supplied by the Contractor and replace with new at the Contractor's expense any part which may fail or prove defective within a period of twelve (12) months after final acceptance.

3.27 Contract Closeout

- .1 Provide in accordance with Section 01 77 00.

END OF SECTION

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1. GENERAL

1.1 Related Sections

- .1 Section 26 05 01 - Common Work Results – Electrical

1.2 Submittals

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

1.3 Work Included

- .1 Supply and install all hangers, supports and inserts for the installation shown on the Drawings and specified herein, and as necessary to fasten electrical equipment securely to the building structure.

2. PRODUCT

2.1 Framing and Support System

.1 Materials:

- .1 Intermediate duty supporting structures shall employ 41 mm square galvanized steel 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 galvanized steel structural members.
- .3 Shall be rated for use in hazardous locations and category environments as necessary.

.2 Finishes:

- .1 Hot dipped galvanized.
- .2 Nuts, bolts, machine screws: cadmium plated.

.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 Cable tray supports shall be installed in accordance with the tray Manufacturer's recommendations and as per Section 26 05 36, whichever is more stringent.

2.2 Concrete and Masonry Anchors

- .1 Materials: hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized, except for installations in corrosive areas, which shall be stainless steel.

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- .2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four (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.

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, tray, and cables.

3.2 Installation

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T-bar ceilings. Ensure that T-bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- .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.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support two (2) or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .8 Use plastic anchors for light loads only. Use metal anchors for all other loads.
- .9 Shot driven pins may only be used with written approval of the Contract Administrator.
- .10 Use round or pan head screws for fastening straps, boxes, etc.
- .11 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.
- .12 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .13 For surface mounting of two or more conduits, refer to Section 26 05 34.
- .14 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .15 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .16 Do not 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.

END OF SECTION

SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS

1. GENERAL

1.1 References

- .1 Canadian Standards Association (CSA):
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations, most current adopted edition.
 - .2 CSA C22.2 No.76, Splitters.
 - .3 CSA C22.2 No. 30, Explosion-Proof Enclosures for Use in Class I hazardous Locations.
 - .4 CSA C22.2 No. 40, Enclosures for Electrical Equipment, Non-Environmental Considerations (Tri-National Standard, with NMX-J-235/1-ANCE-2007 and UL 50).
 - .5 CSA C22.2 No. 94, Special Purpose Enclosures.
- .2 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE SP1122 (2007), The Authoritative Dictionary of IEEE Standards Terms.
- .3 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA 250-2014, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 Manitoba Hydro:
 - .1 Manitoba Electrical Code, most current adopted revision.
 - .2 Manitoba Hydro Inspection Notices.
- .5 City of Winnipeg:
 - .1 Automation Design Guide.
 - .2 Electrical Design Guide.
 - .3 Winnipeg Electrical By-Law.
 - .4 Information Bulletins.
- .6 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA ICS 6-1993 (R2011), Industrial Control and Systems: Enclosures.

1.2 Related Sections

- .1 Section 26 05 01 - Common Work Results – Electrical.

SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS

1.3 Shop Drawings and Product Data

- .1 Submit Shop Drawings and product data for cabinets in accordance with Section 26 05 10 and Section 01 33 00.
- .2 Provide Manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

2. PRODUCTS

2.1 Splitters

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three (3) spare terminals on each set of lugs in splitters less than 600A.

2.2 Junction Boxes, Cabinets, and Pull Boxes

- .1 NEMA Type of enclosure refer to Section 26 05 10.
- .2 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.
 - .3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

2.3 Network Cabinets

- .1 Materials:
 - .1 12 gauge steel frame with integral struts.
 - .2 16 or 14 gauge steel doors and sides.
 - .3 Gland plate.
 - .4 Locks: to match panelboards.
 - .5 Finish to be pretreated coated steel in black or grey powder paint.
 - .6 Two sets of 19 inch racks for both front and rear of enclosure.

SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS

- .7 42 rack units.
- .8 Levellers and anti-tip bracket.
- .9 Dimensions as shown on drawings.
- .10 Nema 12 rating for all ordinary locations, Nema4x for hazardous or corrosive locations.
- .2 Components:
 - .1 With hinged door and return flange overlapping sides, with handle, continuous piano hinge, 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 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.
- .2 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 (1) 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.
 - .7 Make all necessary cable entry holes in junction boxes supplied by Contractor or others, regardless of material.
- .3 Cabinets:

SPLITTERS, JUNCTION BOXES, PULL BOXES AND 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 or equivalent, where indicated.
- .4 Identification:
 - .1 Provide equipment identification in accordance with Section 26 05 53.
 - .2 Install identification labels indicating panel name and fibre connections, and voltage.

END OF SECTION

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1. GENERAL

1.1 References

- .1 Canadian Standards Association (CSA), latest adopted edition:
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 18.1-13 Metallic Outlet Boxes.
 - .3 CSA C22.2 No. 18.2-06 Non-metallic Outlet Boxes.
 - .4 CSA C22.2 No. 18.3-12 Conduit, Tubing, and Cable Fittings.
 - .5 CSA C22.2 No. 18.4-15 Hardware for the Support of Conduit, Tubing, and Cable.
 - .6 CSA C22.2 No. 18.5-13 Positioning Devices.
 - .7 CSA C22.2 No. 45.1-07 Electrical Rigid Metal Conduit – Steel.
 - .8 CSA C22.2 No. 45.2-08 Electrical Rigid Metal Conduit — Aluminum, Red Brass, and Stainless Steel.
 - .9 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .10 CSA C22.2 No. 83-M1985, Electrical Metallic Tubing.
 - .11 CSA C22.2 No. 227.3-15, Mechanical Protection Tubing (MPT) and fittings.
- .2 Manitoba Hydro:
 - .1 Manitoba Electrical Code, most current adopted revision.
 - .2 Manitoba Hydro Inspection Notices.
- .3 City of Winnipeg:
 - .1 Automation Design Guide.
 - .2 Electrical Design Guide.
 - .3 Winnipeg Electrical By-Law.
 - .4 Information Bulletins.

1.2 Product Data

- .1 Submit product data in accordance with Section 26 05 10.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1.3 General Conduit Requirements

- .1 The Drawings do not show every specific conduit run. Supply and install conduit, and support systems as required for a complete installation.
- .2 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.
- .3 Design equipment anchorage and support system for vertical and lateral loading in accordance with the Manitoba Building Code.

2. PRODUCTS

2.1 Conduits

- .1 Rigid metal conduit: to CSA C22.2 No. 45.2, aluminum threaded (galvanized steel threaded).
- .2 Epoxy coated conduit: to CSA C22.2 No. 45.1, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, aluminum liquid-tight flexible metal.
- .4 Rigid PVC conduit: to CSA C22.2 No. 211.2.

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 spacing as per the Rules for the applicable conduit type as indicated in Section 12 of the CEC.
- .4 Threaded stainless steel rods, 9 mm diameter, to support suspended channels.

2.3 Conduit Fittings

- .1 Fittings: to CSA C22.2 No. 18.3, No. 18.4, and No. 18.5, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT. Set-screws are not acceptable.

2.4 Fish Cord

- .1 Polypropylene.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

3. EXECUTION

3.1 Installation

- .1 Install all conduit, conduit fittings and accessories in accordance with the latest edition of the CEC in a manner that does not alter, change, or violate any part of the installed system components or the CSA/cUL certification of these components.
- .2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .3 Conceal conduits in office area. Surface mount conduits in mechanical and electrical service rooms and in unfinished areas. RGS conduit required for exterior.
- .4 Use epoxy coated conduit underground, in concrete, and in Category 2 locations.
- .5 Install conduit sealing fittings in hazardous areas. Fill with compound rated for the application and to manufacturer's instructions.
- .6 Minimum conduit size for lighting and power circuits: 19 mm.
- .7 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter. Use bending equipment specifically intended for the purpose.
- .8 Mechanically bend steel conduit over 19 mm in diameter.
- .9 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .10 Install fish cord in empty conduits.
- .11 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .12 Dry conduits out before installing wire.
- .13 Connect conduit to equipment securely to maintain continuity for the purpose of bonding to ground.
- .14 Provide for the expansion and contraction of the conduit system.

3.2 Surface Conduits

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface mounted aluminum channels.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .5 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.
- .6 Provide stand-off conduit clamps/clips.

3.3 Conduits Underground

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

3.4 Cleaning

- .1 Proceed in accordance with Section 01 74 23.
- .2 On Completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools, and equipment.

END OF SECTION

CABLE TRAYS FOR ELECTRICAL SYSTEMS

1. GENERAL

1.1 Description

- .1 Section includes cable tray, cable tray accessories, hangers and supports.

1.2 References

- .1 ASTM International (ASTM):
 - .1 A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - .2 B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 - .3 B766: Standard Specification for Electrodeposited Coatings of Cadmium
- .2 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 elsewhere in this document shall include reference to such amendments.
 - .2 C22.2 No. 65: Wire Connectors.
 - .3 C22.2 No. 126.1: Cable Tray Systems.
 - .4 CSA HA Series M, CSA Standards for Aluminum and Aluminum Alloys.National Electrical Manufacturers Association (NEMA):
 - .1 VE 1: Metal Cable Tray Systems.
- .4 Underwriter's Laboratories, Inc., (UL):
 - .1 486A: UL Standard for Safety Wire Connectors and Soldering Lugs for Use with Copper Conductors.
 - .2 486B: UL Standard for Safety Wire Connectors for Use with Aluminum Conductors.
- .5 Canadian Standards Association (CSA), latest adopted revisions:
 - .1 CSA C22.1-18, Canadian Electrical Code (CEC), Part 1, Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 126.1 - Metal Cable Tray Systems.
 - .3 CSA C22.2 No. 126.2-02 - Nonmetallic Cable Tray Systems.
- .6 Manitoba Hydro:
 - .1 Manitoba Electrical Code, most current adopted revision.

CABLE TRAYS FOR ELECTRICAL SYSTEMS

- .2 Manitoba Hydro Inspection Notices.
- .7 City of Winnipeg:
 - .1 Automation Design Guide.
 - .2 Electrical Design Guide.
 - .3 Winnipeg Electrical By-Law.
 - .4 Information Bulletins.

1.3 Submittals

- .1 Submit Shop Drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.
- .2 Product Data for Each Component:
 - .1 Show tray types, dimensions, materials, installation details, layout, and finishes.
- .3 Shop Drawings:
 - .1 Detail fabrication and installation of cable tray, including plans, elevations, sections, details of components, and attachments to other construction elements.
 - .2 Designate components and accessories, including clamps, brackets, hanger rods, splice plates connectors, expansion joint assemblies, straight lengths, and fittings.
 - .3 Coordination drawings, including floor plans and sections drawn to accurate scale. Show accurately scaled cable tray layout and relationships between components and adjacent structural and mechanical elements.
 - .4 Prior to construction, submit design Drawings and calculations indicating all tray loading and seismic support designs have been reviewed by and bear the stamp of a Professional Engineer registered in the Province of Manitoba.
- .4 Testing:
 - .1 Factory certified test reports of specified products, conforming to NEMA VE 1 .
 - .2 Field test reports indicating and interpreting test results relative to compliance with performance requirements.

1.4 Quality Assurance

- .1 Comply with the Canadian Electrical Code, the Manitoba Electrical Code, and the Winnipeg Electrical By-law for components and installation.
- .2 Single-Source Responsibility: Cable tray components shall be product of single manufacturer.

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1.5 Sequencing and Scheduling

- .1 Coordination: Coordinate layout and installation of cable tray with other installations.
 - .1 Revise locations and elevations from those indicated as required to suit field conditions and as accepted by the Contract Administrator.

2. PRODUCTS

2.1 Materials and Finishes

- .1 Conform to NEMA VE 1 .
- .2 Cable Trays, Fittings, and Accessories: Steel, hot-dipped galvanized after fabrication conforming to ASTM A123/A123M, Class B2.
- .3 Cable Trays, Fittings, and Accessories: Steel, with polyvinyl chloride (PVC) coating applied in fluidized bed or by electrostatic spray.
- .4 Cable Trays, Fittings, and Accessories: Aluminum conforming to Aluminum Association alloy 6063-T6 for rails, rungs, and trays, 5052-H32 or 6061-T6 for fabricated parts.
- .5 Cable Trays, Fittings, and Accessories: Stainless steel, Type 304.
- .6 Protect steel hardware against corrosion by galvanizing conforming to ASTM B633 or cadmium plating conforming to ASTM B766.
- .7 Fabricate cable tray products with rounded edges and smooth surfaces.

2.2 Sizes and Configurations

- .1 Conform to NEMA VE 1 .
- .2 Ladder-Type Trays: Class 20C unless indicated.
 - .1 Width: 152 mm (6 inch):
 - .1 102 mm (4 inch) is permitted only in low clearance areas.
 - .2 Inside Depth: 76.2 mm (3 inch).
 - .3 Cross-Rung Spacing: 152 mm (6 inch) oc.
 - .4 Minimum Fitting Radius: 305 mm (12 inch).

2.3 Cable Tray Accessories

- .1 Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, manufactured with same materials and finishes as cable trays.
- .2 Covers: Solid type, of same materials and finishes as cable trays.

CABLE TRAYS FOR ELECTRICAL SYSTEMS

- .3 Covers: Louvered type, of same materials and finishes as cable trays.
- .4 Covers: Ventilated-hat type, of same materials and finishes as cable trays.
- .5 Barrier Strips: Same materials and finishes as cable trays.
- .6 Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 Firestopping

- .1 Materials: CSA listed and labeled and CSA approved for fire ratings consistent with penetrated barriers.
- .2 Materials: CSA listed and labeled for fire ratings consistent with penetrated barriers.
- .3 Sleeves: Schedule 40, welded, black steel pipe sleeves. Sizes as indicated or minimum CEC size for cable or cable group to be installed.
- .4 Sealing Fittings: Suitable for sealing cables in sleeves or core drilled holes.
- .5 Sealing Mortar: Suitable for sealing cable penetration slots/openings in fire barriers.
- .6 Sealant: One-part compound for sealing cables, sleeves, and openings in fire barriers.
- .7 Two-Part Sealant: Formed-in-place sealant.
- .8 Sealbags: Heat activated to expand and seal penetration slots/openings in fire barriers.

2.5 Warning Signs

- .1 Lettering: 40 mm (1-1/2 inch) high, black on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- .2 Materials and Fastening: Conform to Section 26 05 53.

3. EXECUTION

3.1 Examination

- .1 Examine surfaces to receive cable tray for compliance with installation tolerances and other required conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 Installation

- .1 Use cable tray of indicated types and sizes, complete with manufacturer's recommended covers, barrier strips, dropouts, fittings, conduit adapters, hold down devices, grommets, and blind ends.

CABLE TRAYS FOR ELECTRICAL SYSTEMS

- .2 Install cable tray level and plumb according to manufacturer's written instructions, rough-in Drawings, original design, and referenced standards.
- .3 Check all trays for surface smoothness prior to installation. Remove burrs and sharp edges on tray surfaces to prevent damage to cables or injury to personnel.
- .4 Fasten cable tray supports securely to building structure as specified in Section 26 05 29 unless otherwise indicated.
 - .1 Locate and install supports according to recommendations of NEMA VE 1 .
 - .2 Design supports, including fastenings to structure, to carry greater of calculated load multiplied by safety factor of 4, or calculated load plus 200 lbs (90 kg).
- .5 Suspend cable trays on rod hangers and hanger clamps or channels spaced as required by loading classification rating and not more than 3000 mm on centers. Fasten hangers to channels securely mounted to the structure.
- .6 Do not drill through wood ceiling trusses. Provide wood blocking on top of ceiling truss to anchor rod hangers and channels.
- .7 Install trays and raceways generally as indicated on Drawings. Coordinate this Work with the other trades to ensure adequate horizontal and vertical clearances.
- .8 Provide minimum vertical clearance above the trays as per the CEC or as indicated on the Drawings.
- .9 Provide minimum 600 mm horizontal clearance on one side of cable tray throughout.
- .10 Working Space: Install cable trays with sufficient space to permit access for installing cables.
- .11 Install tray systems in such a manner as to conserve head-room and minimize the use of free space through which they pass. Maintain a minimum 2100 mm clear head-room wherever possible.
- .12 When the ends on square strut channel type shelf brackets are below 2100 mm AFF in a walking area, cut flush with tray. Permanently cap the end of square strut channels, etc. with plastic caps. Suitably protect sharp corners and edges of tray to prevent personal hazard.
- .13 Install tray runs to prevent interference with process or service piping and ducting and to maintain clearance for tray access. Coordinate the exact location of tray supports and runs with the work of other Divisions.
- .14 Locate cable tray above piping except as required for tray accessibility and as otherwise indicated.
- .15 Run trays parallel to building lines unless otherwise shown on the Drawings. Where two or more trays run the same route, make parallel and ensure offsets and bends are uniform.
- .16 Where hanger rods are used, use stainless steel and not be smaller than 12 mm in diameter.

CABLE TRAYS FOR ELECTRICAL SYSTEMS

- .17 Generally run cables of different voltage classes in separate trays. Where a common tray is shown on Drawings, separate the cables for different voltage classes from each other by metal barriers as supplied by the tray Manufacturer.
- .18 Barriers: Install barriers to separate cables of different systems, such as power, communications, and data processing, or different insulation levels, such as 600 volts, 5,000 volts, and 15,000 volts.
- .19 Make connections to equipment with flanged fittings fastened to tray and to equipment. Support tray independently of fittings. Do not carry weight of tray on equipment enclosure.
- .20 Install expansion connectors in cable tray runs that exceed 90 feet (27 m). Space connectors and set gaps according to NEMA VE 1 .
- .21 Make changes in direction and elevation using standard fittings.
- .22 Make cable tray connections using standard fittings.
- .23 Firestop penetrations through fire and smoke barriers.
- .24 Firestop penetrations through fire and smoke barriers, including walls, partitions, floors, and ceilings, after cables are installed.
- .25 Sleeves for Future Cables: Install capped sleeves for future cables through firestopped cable tray penetrations of fire and smoke barriers.
- .26 Install covers after installation of cable is completed.

3.3 Cables in Cable Tray

- .1 Install cables individually.
- .2 Lay cables into cable tray. Use rollers when necessary to pull cables.
- .3 Secure cables in tray at 2 m centers, with nylon ties.
- .4 Identify cables with nameplates in accordance with Section 26 05 10.
- .5 The air space between cables shall be 100% of the largest cable diameter unless otherwise specified. Main fibre cable shall be installed on the opposite side of the tray as the redundant fibre. Where the quantity of cables results in main and fibre cables within two diameters of one another, provide metallic barrier.
- .6 Mark power and communication runs in accordance with colour coding outlined in Section 26 05 10.

3.4 Grounding

- .1 Connect cable trays to ground as instructed by manufacturer. At a minimum, every section shall have a wire ground connection to the connecting cable trays. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published

CABLE TRAYS FOR ELECTRICAL SYSTEMS

torque tightening values for equipment connectors. Solidly connect sections of tray runs to the ground bus of the local electrical room.

- .2 Electrically ground cable trays and ensure continuous electrical conductivity of cable tray system. Use tray as an equipment ground conductor for itself only, not for connected equipment.
- .3 Ensure to use materials and connectors to prevent corrosion. Use approved grounding clamps suitable for connecting tray with copper conductor.

3.5 Warning Signs

- .1 After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

3.6 Field Quality Control

- .1 Grounding: Test cable trays to ensure electrical continuity of bonding and grounding connections.
- .2 Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.7 Cleaning

- .1 Upon completion of installation of system, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches, and abrasions.

3.8 Protection

- .1 Provide final protection and maintain conditions in manner acceptable to manufacturer and Installer to ensure that cable tray is without damage or deterioration at Substantial Completion.
 - .1 Repair damage to galvanized finishes with zinc-rich paint recommended by tray manufacturer.
 - .2 Repair damage to PVC or paint finishes with matching touch-up coating recommended by tray manufacturer.

3.9 Closeout Activities

- .1 Provide in accordance with Section 01 77 00.

END OF SECTION

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

1. GENERAL

1.1 Description

- .1 Provide complete underground system as indicated and specified.
- .2 Conform to lines, grades, elevations, and dimensions. Resolve interferences with other underground conduit, piping or equipment, either new or existing with the Contract Administrator. Match components suitable for proper installation.
- .3 Provide concrete encasement of duct system where indicated. Include forms and reinforcing in installation. Perform work in accordance with Section 26 05 10.
- .4 Provide manholes and handholes complete with ground rods, windows, ladders, frames, covers, cable racks, supports, pulling irons, and other inserts. Use reinforced concrete. Perform work in accordance with Section 26 05 10.
- .5 Provide Schedule 40 polyvinylchloride (PVC) conduit for power and control circuits and furnish and install rigid galvanized steel conduits for instrumentation, communication and fire circuits.

1.2 References

- .1 Reference editions shall be the most current adopted revision by the local authorities.
- .2 Canadian Standards Association (CSA):
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations, most current adopted edition.
 - .2 CSA C22.3 No.7-20, Underground Systems.
 - .3 CSA-C22.2 No. 232, Optical Fiber Cables.
- .3 Manitoba Hydro:
 - .1 Manitoba Electrical Code.
 - .2 Manitoba Hydro Inspection Notices.
- .4 City of Winnipeg:
 - .1 Automation Design Guide.
 - .2 Electrical Design Guide.
 - .3 Winnipeg Electrical By-Law.
 - .4 Information Bulletins.

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

1.3 Submittals

- .1 Submit Shop Drawings in accordance with 26 05 10.
- .2 Submit Shop Drawings and manufacturers' product data in accordance with requirements of Section 26 05 10.
- .3 Provide "Record" drawings.

2. PRODUCTS

2.1 Manufacturer's Compliance

- .1 Manufacturer's acceptance contingent upon products' compliance with Specifications.

2.2 Manufacturers

- .1 Fiber, Conduit, Type I:
 - .1 Corning Incorporated.

2.3 Materials and Components

- .1 Conduit Spacers: Furnish conduit spacers made of plastic to maintain spacing between conduits.
- .2 Concrete: Minimum compressive strength, 3,000 psi (20 MPa).
- .3 Hot-dipped galvanized steel conduit used underground to be painted with bituminous paint.
- .4 Manhole Frames and Covers:
 - .1 Heavy duty gray cast iron.
 - .2 Conform to details indicated on the drawings and as specified.
 - .3 Provide machine-finished seat.
 - .4 Mark "COMMUNICATIONS" on cover of manhole.

3. EXECUTION

3.1 Installation of Conduits

- .1 Lay conduits, indicated to be direct buried in the ground, in trench on 190 mm (7.5 inch) bed of sand and cover with an equivalent minimum 190 mm (7.5 inch) bed of sand. Ensure that no rocks come in contact with conduit during backfilling. Dig trenches to depth and location indicated.
- .2 Provide minimum separation of power and control conduits of 75 mm (3 inch) both vertically and horizontally. Build ductbank layer by layer, backfill and compact each layer to provide support for next layer.

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

- .3 Separate power and control ducts from instrument ducts by a minimum of 12 inches (300 mm).
- .4 Backfill ductbank in layers and tamp or "puddle" as directed by the Contract Administrator. Provide yellow ductbank marker tapes, reading "Caution - Fibre Lines Below", over entire length of ductline. Locate tapes 12 inches (300 mm) below grade. Provide a tape for every 12 inches (300 mm) of width of ductline.
- .5 Install conduit, indicated to be encased in concrete with spacers and reinforcing, as specified and as indicated. Rigid galvanized steel conduits to be painted with bituminous paint.
- .6 Install conduit runs following routing on drawing and running in straight lines. Where deviation from a straight line becomes necessary, install bends of radius which allow for rodding and installation of cable.
- .7 Accomplish changes in direction of runs exceeding total of 10 degrees, either vertical or horizontal, by long sweep bends having minimum radius of curvature of 8 m. Manufactured bends can be used at ends of short runs of 30 m or less, and then only at or close to the end of run. Provide long sweep bends made up of one or more curved or straight sections and/or combinations thereof. Install manufactured bends with minimum radius of 1,000 mm where larger radius cannot be used.
- .8 Lay ductlines to minimum slope of 100 mm per 30 m and slope to manholes and handholes, as indicated. Ductlines are to slope away from buildings.
- .9 Install spacers at intervals of approximately 1200 mm and stagger between tiers of ducts to provide not less than 300 mm of longitudinal separation. Install base spacers to provide at least 75 mm between bottom of trench and underside of bottom conduits. Completely fill space with concrete. Firmly wire conduits and spacers together before concrete is placed.
- .10 Ductbanks are to be formed, unless trench conditions allow for neat placement of concrete with specified clearances.
- .11 Prior to placing of concrete, remove all dirt, sand, and any other debris from between conduits and from trench bottoms. Hold conduits in place to prevent floating or accidental movement.
- .12 Stagger joints in conduits at least 150 mm. Do not allow couplings to rest on bottom of trench. Install couplings for plastic conduit in accordance with manufacturer's recommendations.
- .13 Install concrete encasements so minimum clearance of 300 mm from concrete to parallel pipes, lines, structures, etc., is maintained. Where ducts cross, minimum clearance of 150 mm is required. Do not allow the top of concrete to be less than 750 mm below finished grade or paving. Submit special conditions which may require lesser clearances or special conditions which may require greater than 750 mm depth to Contract Administrator for acceptance.
- .14 Where a connection is made to existing ductline, bond or dowel concrete encasement to existing encasement. Use waterstop between ductpours and between manholes or buildings and ductwork as indicated.

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

- .15 Do not use power-driven vibrators for spading of concrete around ducts.
- .16 Roll and grade backfill, and restore surface to condition equal to the site finish grade, or as otherwise indicated.
- .17 Locate ductbank markers at ends of all ductbanks except at manholes or handholes, at approximately every 65 m along duct run, and at each change in direction of duct run. Place markers approximately on ductbank. Install markers 150 mm square or round section by 1 m long made of Class B concrete. Imprint the letter "D" or cast it on top of the marker. Install top of duct markers flush in paved areas, protruding no more 50 mm above finished grade in unpaved areas. In finished lawns, allow marker to protrude 12 mm.
- .18 Keep conduits clean of concrete, dirt, and other substances during the course of construction. After the ductlines have been completed, pull a standard flexible mandrel not less than 300 mm long, having a diameter approximately 6 mm less than the inside diameter of the conduit, through each conduit, after which pull a brush with stiff bristles through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line. Replace conduit runs that do not allow the passage of the mandrel at no additional cost to the City. Pneumatic rodding may be used to draw in the lead wire. Install in spare conduits a pull wire or rope, and plug and seal spare conduits after cleaning.

3.2 Manholes and Handholes

- .1 Construct manholes and handholes of 3,000 psi (20 MPa) concrete cast in place, as indicated in traffic areas. Non-traffic areas shall be fibreglass as indicated.
- .2 Install manholes with cable racks, hooks, insulators, and other features, as indicated.
- .3 Place a 150 mm crushed-stone base under each manhole and handhole.
- .4 Construct cast-in-place manholes and handholes with forms, complete with centering cores and molds, to conform to shape, form, line, and grade required and maintain sufficiently rigid to prevent deformation under load. Make all joints leakproof and arrange horizontally or vertically. Place forms on successive units for continuous surfaces and fit to accurate alignment, assuring a smooth completed surface, free from irregularities.
- .5 At convenient point close to wall, drive a ground rod into earth as indicated. Extend ground rod approximately 150 mm above finished manhole floor. After completion of manhole or handhole, connect 2 m length of No. 4 bare copper ground wire to ground rod and coil it within manhole or handhole for connection to steel supports and cover.
- .6 Size, space, and place reinforcing bars as indicated and as specified.
- .7 Set manhole and handhole frames to the required grade, in full bed of concrete mortar to make watertight connection.
- .8 Install tops of manhole and handhole covers in unpaved areas approximately 12 mm above finished grade, and in paved areas install flush with finished surface of paving.
- .9 Install galvanized corrosion-resistant channel support, with continuous slot and required fittings designed for concrete encasement.

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

- .10 Install inserts in the manholes as indicated.
- .11 Install two cable pulling irons in wall opposite each ductbank entrance into manhole, one 150 mm above floor and one 150 mm below the roof of manhole. Where indicated on drawings, install additional features such as openings in manhole walls for future conduit entrances. Seal future entrances with required courses of brick.
- .12 Where ductlines enter manholes, terminate conduits in end bells. Terminate steel conduit entering manholes and handholes in grounding bushing.

3.3 Manhole and Handhole Waterproofing

- .1 Apply two (2) coats of bituminous waterproofing material to exterior surfaces of manholes and handholes. Apply by brush or spray, in accordance with manufacturer's printed instructions. Allow time between coats to permit sufficient drying.
 - .1 Two (2) coats applied with a minimum dry film thickness of 0.30 to 0.36 mm per coat.

3.4 Record Drawings of Underground Work

- .1 Furnish one (1) set of marked copies of contract drawings, showing exact routing and depths of all underground conduit, duct handholes and manholes. Furnish scaled plot plans, showing principal outline of buildings and structures. Reference conduits, ducts, and manholes, and all bends deviating from straight line, dimensionally from fixed objects or structures.

3.5 Contract Closeout

- .1 Provide in accordance with Section 01 77 00.

END OF SECTION

ELECTRICAL IDENTIFICATION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Identification of electrical materials, equipment, and installations.

1.2 References

.1 American Society of Mechanical Engineers (ASME):

.1 A13.1: Scheme for the Identification of Piping Systems.

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

.1 ANSI/IEEE C2: National Electrical Safety Code.

.3 Manitoba Hydro:

.1 Manitoba Electrical Code, most current adopted revision.

.2 Manitoba Hydro Inspection Notices.

.4 City of Winnipeg:

.1 Automation Design Guide.

.2 Electrical Design Guide.

.3 Winnipeg Electrical By-Law.

.4 Information Bulletins.

1.3 Submittals

.1 Submit Shop Drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

.2 Submit for each type of product specified.

.3 Miscellaneous: Schedule of identification nomenclature to be used for identification signs and labels.

2. PRODUCTS

2.1 Raceway and Cable Labels

.1 Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by the City of Winnipeg Electrical Design Guide.

ELECTRICAL IDENTIFICATION

- .2 Components and installation shall comply with the Canadian Electrical Code.
- .3 Conform to ASME A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.
 - .1 Color: Black legend on orange field.
 - .2 Legend: Indicates voltage.
- .4 Adhesive Labels: Preprinted, flexible, self adhesive vinyl. Legend is over-laminated with clear, wear and chemical resistant coating.
- .5 Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color coded, acrylic bands sized to suit diameter of line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.
- .6 Colored Adhesive Tape: Self adhesive vinyl tape not less than 0.08 mm thick by 25 to 51 mm wide.
- .7 Underground Line Warning Tape: Permanent, bright colored, continuous printed, vinyl tape with following features:
 - .1 Size: Not less than 152 mm wide by 0.102 mm thick.
 - .2 Compounded for permanent direct burial service.
 - .3 Embedded continuous metallic strip or core.
 - .4 Printed Legend: Indicates type of underground line.
- .8 Tape Markers: Vinyl or vinyl cloth, self adhesive, wraparound type with preprinted numbers and letters.
- .9 Aluminum, Wraparound Marker Bands: Bands cut from 0.4 mm thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- .10 Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
- .11 Aluminum Faced Card Stock Tags: Wear resistant, 18 point minimum card stock faced on both sides with embossable aluminum sheet, 0.05 mm thick, laminated with moisture resistant acrylic adhesive, and punched for fastener. Preprinted legends suit each application.
- .12 Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 51 by 51 mm by 1.3 mm.
- .13 Comply with IEEE C2.

ELECTRICAL IDENTIFICATION

2.2 Engraved Nameplates and Signs

- .1 Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by the City of Winnipeg Electrical Design Guide.
- .2 Engraving stock, melamine plastic laminate, 1.6 mm minimum thick for signs up to 129 sq cm, 3.2 mm thick for larger sizes.
 - .1 Engraved Legend: Black letters on white face.
 - .2 Punched for mechanical fasteners.
- .3 Baked Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for application. 6.4 mm grommets in corners for mounting.
- .4 Exterior, Metal Backed, Butyrate Signs: Wear resistant, non-fading, preprinted, cellulose acetate butyrate signs with 1 mm, galvanized steel backing, with colors, legend, and size appropriate to application. 6.4 mm grommets in corners for mounting.
- .5 Fasteners for Plastic Laminated and Metal Signs: Self tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers.

2.3 Miscellaneous Identification Products

- .1 Cable Ties: Fungus-inert, self extinguishing, 1 piece, self locking, Type 6/6 nylon cable ties with following features:
 - .1 Minimum Width: 5 mm.
 - .2 Tensile Strength: 222 N minimum.
 - .3 Temperature Range: -40 to 85°C.
 - .4 Color: As indicated where used for color coding.
- .2 Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

3. EXECUTION

3.1 Installation

- .1 Install identification devices according to manufacturer's written instructions.
- .2 Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- .3 Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in Contract Documents or required by codes and standards. Use consistent designations throughout Project.

ELECTRICAL IDENTIFICATION

- .4 Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- .5 Self Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
- .6 Install painted identification as follows:
 - .1 Clean surfaces of dust, loose material, and oily films before painting.
 - .2 Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.
 - .3 Apply one (1) intermediate and one (1) finish coat of silicone alkyd enamel.
 - .4 Apply primer and finish materials according to manufacturer's instructions.
- .7 Identify Raceways and Exposed Cables of Certain Systems with Color Banding: Band exposed and accessible raceways of systems listed below for identification.
 - .1 Bands: Pre-tensioned, snap around, colored plastic sleeves; colored adhesive tape; or combination of both. Make each color band 51 mm wide, completely encircling conduit, and place adjacent bands of two (2) color markings in contact, side by side.
 - .1 Fire Suppression Supervisory and Control System: Red and yellow.
 - .2 Combined Fire Alarm and Security System: Red and blue.
 - .3 Security System: Blue and yellow.
 - .4 Mechanical and Electrical Supervisory System: Green and blue.
 - .5 Telecommunications System: Green and yellow.
- .8 Install Circuit Identification Labels on Boxes: Label externally as follows:
 - .1 Exposed Boxes: Pressure sensitive, self adhesive plastic label on cover.
 - .2 Concealed Boxes: Plasticized card stock tags.
 - .3 Labeling Legend: Permanent, water proof listing of panel and circuit number or equivalent.
- .9 Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 150 to 200 mm below finished grade. Where multiple lines installed in common trench or concrete envelope do not exceed an overall width of 400 mm, use single line marker.
 - .1 Install line marker for underground wiring, both direct buried and in raceway.

ELECTRICAL IDENTIFICATION

- .10 Color Code Conductors: Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.
 - .1 Field applied, color coding methods may be used in lieu of factory coded wire for sizes larger than 10 AWG.
 - .1 Colored, pressure sensitive plastic tape in half lapped turns for distance of 150 mm from terminal points and in boxes where splices or taps are made. Apply last 2 turns of tape with no tension to prevent possible unwinding. Use 25 mm wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
 - .2 Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 76 mm from terminal and spaced 76 mm apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.
 - .2 208/120 Volt System: As follows:
 - .1 Phase A: Black.
 - .2 Phase B: Red.
 - .3 Phase C: Blue.
 - .4 Neutral: White.
 - .5 Ground: Green.
- .11 Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.
 - .1 Legend: 6.4 mm steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 - .2 Fasten tags with nylon cable ties; fasten bands using integral ears.
- .12 Apply identification to conductors as follows:
 - .1 Conductors to Be Extended in Future: Indicate source and circuit numbers.
 - .2 Multiple Power or Lighting Circuits in Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
 - .3 Multiple Control and Communications Circuits in Same Enclosure: Identify each conductor by its system and circuit designation. Use consistent system of tags, color coding, or cable marking tape.
- .13 Apply warning, caution, and instruction signs and stencils as follows:

ELECTRICAL IDENTIFICATION

- .1 Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with accepted legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
- .2 Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch (9 mm) high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.
- .14 Install identification as follows:
 - .1 Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide single line of text with 13 mm high lettering on 38 mm high label; where two (2) lines of text are required, use lettering 51 mm high. Use black lettering on white field. Apply labels for each unit of following categories of equipment.
 - .1 Panelboards, electrical cabinets, and enclosures.
 - .2 Access doors and panels for concealed electrical items.
 - .3 Push button stations.
 - .4 Remote controlled switches.
 - .5 Dimmers.
 - .6 Control devices.
 - .7 Transformers.
 - .8 Battery racks.
 - .2 Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3.2 Contract Closeout

- .1 Provide in accordance with Section 01 77 00.

END OF SECTION

NETWORK EQUIPMENT

1. GENERAL

1.1 References

- .1 Comply with latest edition of the codes and standards applicable and/or referenced in Section 26 05 10.
- .2 Comply with latest revision of following standards that may be applicable in this Section:
 - .1 Institute of Electrical and Electronics Engineers (IEEE).
 - .1 IEEE 802.1X, Port Based Network Access Control.
 - .2 IEEE 802.1Q, Bridges and Bridged Networks.
 - .3 IEEE 802.1s, Multiple Spanning Trees.
 - .4 IEEE 802.1w, Rapid Configuration.
 - .5 IEEE 802.3u, 100BASE-TX, 100BASE-FX Ethernet at 100 Mbit/s.
 - .6 IEEE 802.3z, 1000BASE-X Gbit/s Ethernet over Fibre Optic.
 - .7 IEEE 802.3ab, 1000BASE-T Gbit/s Ethernet over twisted pair.
 - .8 IEEE 802.3az, Energy Efficient Ethernet.
 - .9 IEEE 802.3x, Flow Control.

1.2 Submittals

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

2. PRODUCTS

2.1 Ethernet Switch – Control A, Control B, Server, and Supervisory Networks

- .1 Requirements:
 - .1 Input voltage: 24 VDC, redundant dual inputs.
 - .2 Ethernet Ports:
 - .1 10/100/1000 BaseT(X), quantity as indicated on the drawings.
 - .2 100/1000 BaseSFP, quantity as indicated on the drawings.
 - .3 SFP modules:
 - .1 1000Base (1 Gigabit) SX, LC Connector, 0.5 km, minimum of four per switch, or as indicated on the drawings.

NETWORK EQUIPMENT

- .4 Console port: USB.
- .5 Supported industrial protocols:
 - .1 PROFINET.
 - .2 EtherNet/IP.
 - .3 Modbus/TCP.
- .6 Redundancy Protocols:
 - .1 RSTP.
 - .2 MSTP.
 - .3 The switch must be capable of operating in a network that has connections to parallel redundant network paths.
- .7 Management Protocols:
 - .1 RMON.
 - .2 RARP.
 - .3 DHCP Server/Client.
 - .4 DHCP Option 66/67/82.
 - .5 BootP.
 - .6 Syslog.
 - .7 LLDP.
- .8 Security Protocols:
 - .1 HTTP.
 - .2 HTTPS.
 - .3 Telnet.
 - .4 SSH.
- .9 Additional required supported protocols:
 - .1 IGMPv1/v2/v3.
 - .2 GMRP.
 - .3 GVRP.

NETWORK EQUIPMENT

- .4 TFTP.
- .5 SNTP.
- .6 SMTP.
- .7 SNMP Inform.
- .8 SNMPv1/v2c/v3.
- .9 IEEE 1588 PTPv2.
- .10 IPv6.
- .11 NTP Server/Client.
- .10 Broadcast storm protection.
- .11 Support for Port Trunking.
- .12 Fanless design.
- .13 DIN rail mount.
- .14 Alarm relay dry contact: 1 A @ 24 VDC.
- .15 IEEE 802.3x for Flow Control.
- .16 Configuration via Web Browser.
- .17 Operating temperature range: -10 to 60°C.
- .18 Ambient Relative Humidity range: 5 to 95 percent (non-condensing).
- .19 Enclosure: metal, IP30 protection.
- .2 Manufacturer and Model:
 - .1 Moxa EDS-G512E-4GSFP with a minimum of four SFP-1GSXLC modules per switch.
 - .2 Moxa EDS-G516E-4GSFP with a minimum of four SFP-1GSXLC modules per switch.
 - .3 Or approved equal in accordance with B8.
- .3 The use of Virtual Local Area Networks (VLANs) is not permitted.

2.2 Ethernet Patch Panel

- .1 Requirements:
 - .1 Maximum Port Capability: 48.

NETWORK EQUIPMENT

- .2 Dimensions: 88.9 mm x 482.6 mm x 88.9 mm (3.5" x 19" x 3.5"), 2RU.

2.3 Ethernet Patch Cables

- .1 Requirements:
 - .1 Cat-6, shielded.
 - .2 Jacket Colour: Blue.

2.4 Spare Components

- .1 Provide the following spare components:
 - .1 One (1) of each unique type of switch provided.

3. EXECUTION

3.1 Network Configuration

- .1 City of Winnipeg staff will determine IP address allocation.
- .2 Configuration of switches to be completed by others.
- .3 Provide a minimum of two (2) days duration at the Site indicated by the City for assisting personnel in the configuration of the control system network as it relates to the physical network architecture.

3.2 Testing

- .1 The installation will not be considered complete if there are errors, even if communication is occurring.

END OF SECTION

FIBRE OPTIC NETWORK

1. GENERAL

1.1 References

- .1 Comply with latest edition of the codes and standards applicable and/or referenced Section 26 05 10
- .2 The following is a list of standards that may be applicable in this Section:
 - .1 National Electrical Code (NEC) OFCR-LS; Sunlight Resistant (SUN RES).
 - .2 Institute of Electrical & Electronic Engineers, Inc. IEEE-383/IEEE-1202 flame test suitable for direct burial.
 - .3 Telecommunications Industry Association (TIA); Electronics Industry Association (EIA):
 - .1 568, Commercial Building Telecommunications Cabling Standard.
 - .2 569-D, Telecommunications Pathways and Spaces.
 - .3 607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
 - .4 Canadian Standard Association (CSA):
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations, most current adopted edition.
 - .2 CSA C22.2 No.2556, Wire and cable test methods.
 - .3 CSA C22.2 No. 230, Tray cables.
 - .4 CSA C22.2 No. 232, Optical fiber cables.
 - .5 CSA C22.2 No 262, Optical fiber cable and communication cable raceway systems.
 - .5 American National Standard (ANSI/NETA).
 - .1 ANSI/NETA ATS, Standard For Acceptance Testing Specification for Electrical Power Equipment and Systems.
 - .6 Manitoba Hydro:
 - .1 Manitoba Electrical Code, most current adopted revision.
 - .2 Manitoba Hydro Inspection Notices.
 - .7 City of Winnipeg:
 - .1 Automation Design Guide.

FIBRE OPTIC NETWORK

- .2 Electrical Design Guide.
- .3 Winnipeg Electrical By-Law.
- .4 Information Bulletins.

1.2 Abbreviations

- .1 dB decibel
- .2 EIA Electronic Industries Association
- .3 m meter
- .4 MHz megahertz
- .5 μ , micro $\times 10^{-6}$
- .6 n, nano $\times 10^{-9}$

1.3 System Description

- .1 This section covers requirements for the Fibre Optic Network.
- .2 Function of Fibre Optic Network is to transmit digital data between network nodes.
- .3 Provide a Fibre Optic Network based on referenced standards for use in the site automation networks.

1.4 Submittals

- .1 Action Submittals: Shop Drawings:
 - .1 Subsystem detail design documents:
 - .1 Bill of Materials for Fibre Optic Network Components: Component number, manufacturer, model number, component description, and quantity.
 - .2 Cable schedule showing:
 - .1 Cable identification.
 - .2 Fibre counts for each cable and identification of used fibre pairs.
 - .3 Cable length and attenuation and planned number of splices. Splices, if any, shall be minimized. Splices require Contract Administrator approval.
 - .3 Component Data:
 - .1 Manufacturer and model number.
 - .2 General data and description.

FIBRE OPTIC NETWORK

- .3 Engineering specifications and data sheet.
 - .4 Scaled drawings and mounting arrangements.
 - .5 Power and grounding requirements.
 - .6 Electrical and optic interfaces.
- .2 Informational Submittals:
- .1 Manufacturer's statement that installer is certified to perform installation Work.
 - .2 Contractor Qualifications:
 - .1 Fibre Optic Network Contractor: Minimum of five (5) years' experience providing, integrating, installing, and commissioning of similar systems.
 - .2 Fibre Optic Network Subcontractor's Site Representative: Minimum of five (5) years' experience installing similar systems.
 - .3 Acceptance of Fibre Optic Network Subcontractor does not exempt Subcontractor or Contractor from meeting Contract requirements, nor does it give prior acceptance of subsystems, equipment, materials, or services.
 - .3 Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Quality Assurance.
 - .4 Manufacturer's suggested installation practice.
 - .5 Testing related submittals.
 - .6 Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data including the following:
 - .1 Updated versions of Hardware Shop Drawings Submittals.
 - .2 Component Manufacturers' O&M Manuals: Instructions for installation, operation, maintenance, and troubleshooting.
 - .3 List of spare parts provided.
 - .4 List of recommended additional spare parts.
- .3 Factory Test Reports:
- .1 Copy of Ethernet cable installer's factory certified installation certificate. Certificate shall have the name of the person who completed the training course and that person shall supervise all cable installation and termination for compliance with manufacturer recommendations.
 - .2 Copy of fibre optic cable installer's factory certified installation certificate. Certificate shall have the name of the person who completed training course and that person shall

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supervise all cable installations and terminations for compliance with manufacturer recommendations.

1.5 Environmental Requirements

- .1 Optical Fibre Cable and Cable Splice Centers:
 - .1 Outside, Underground/Submerged: Minus 20 to 40°C.
 - .2 Outside, Overhead: Minus 40 to 80°C.
 - .3 Outside, Aboveground in Conduit: Minus 40 to 75°C.
 - .4 Inside: 0 to 40°C.
- .2 Equipment:
 - .1 Outside, Aboveground: Minus 40 to 75°C.
 - .2 Control Rooms, Equipment Rooms and Telecommunications Closets: 30 to 55 percent relative humidity, 18 to 24°C.
 - .3 Other Interior Areas: 0 to 100 percent relative humidity, 5 to 35°C.

2. PRODUCTS

2.1 Fibre Optic Cable

- .1 Fibre Requirements:
 - .1 Multimode.
 - .2 Comply with the standards on References section.
 - .3 Fibre Core Diameter: 50 µm.
 - .4 Fibre Category: OM3.
 - .5 Wavelengths: 850 nm / 1300 nm.
 - .6 Maximum Attenuation: 3.0 dB/km / 1.0 dB/km.
- .2 Cable Requirements:
 - .1 Type: Loose Tube, double jacket, chemical resistant, non-conductive.
 - .2 Application: Aerial, Direct Buried, Duct, Tray Rated.
 - .3 Flame Rating: LSZH (OFN-LS).
 - .4 Product Type: Dielectric.

FIBRE OPTIC NETWORK

- .5 Temperature Range(operation): Minus 50 to plus 75°C.
- .6 Fibre Count: 24.
- .7 Fibres per Tube: 12.
- .8 Tape: Water-swellable.
- .9 Inner Jacket: FRNC/LSZH Material.
- .10 Tensile Strength Elements: Dielectric strength members.
- .11 Outer Jacket: FRNC/LSZH Material.
- .12 Max. Tensile Strength, Short-Term: 4500 N.
- .13 Max. Tensile Strength, Long-Term: 1500 N.
- .14 Compressive Loading: 2400 N/cm.
- .15 Impact Resistance: 11.8 N*m.
- .16 Min. Bend Radius Installation: 264 mm.
- .17 Min. Bend Radius Operation: 176 mm.
- .18 Nominal Outer Diameter: 17.6 mm.
- .19 Chemical Resistance: RoHS.
- .20 Approvals: CSA FT-4-ST1.
- .3 Manufacturer and Model:
 - .1 Corning 036TUL-T3680D2M.
 - .2 Or approved equal in accordance with B8.

2.2 Fibre Optic Panel

- .1 Enclosure:
 - .1 Corrosive Location:
 - .1 Single Door, Single Access Panel:
 - .1 Free Standing, NEMA 4X.
 - .2 Additional Security Doors:
 - .1 TS 35 DIN Rail Mountable, 445 mm x 483 mm (17.5" x 19").

FIBRE OPTIC NETWORK

- .2 TS 35 DIN Rail Mountable, 711 mm x 483 mm (30" x 19").
- .3 Frame:
 - .1 Tapped Hole, 44RU Main Frame.
 - .2 100 mm (4") Frame Reducing Brackets.
 - .3 Additional 2000 mm (79"), Taped Hole, 44RU Rack Rail Pair.
 - .4 Door Mounted Folding Laptop Shelf.
 - .5 Dimension: 2000 mm x 800 mm x 800 mm (79" x 31" x 31").
- .2 Ordinary Location:
 - .1 Partial Door, Single Access Panel:
 - .1 Free Standing, NEMA 12.
 - .2 Partial Doors on Front Only:
 - .1 Lockable, 1500 mm x 600 mm (59" x 24").
 - .2 Lockable, 500 mm x 600 mm (20" x 24").
 - .3 Tapped Hole, 44RU Frame.
 - .4 Door Mounted Folding Laptop Shelf.
 - .5 Dimension: 2000 mm x 600 mm x 800 mm (79" x 24" x 31").
 - .2 Partial Door, Dual Access Panel:
 - .1 Free Standing, NEMA 12.
 - .2 Partial Doors on Front and Rear:
 - .1 Lockable, 1500 mm x 600 mm (59" x 24").
 - .2 Lockable, 500 mm x 600 mm (20" x 24")
 - .3 Tapped Hole, 44RU Frame.
 - .4 Door Mounted Folding Laptop Shelf.
 - .5 Dimension: 2000 mm x 600 mm x 800 mm (79" x 24" x 31").
 - .3 Single Door, Swingout Panel:
 - .1 Wall Mount, NEMA 12.

FIBRE OPTIC NETWORK

- .2 Single door, lockable, double hinged.
- .3 Tapped Hole, 12RU Frame.
- .4 Dimension: 635 mm x 600 mm x 550 mm (25" x 24" x 22").
- .4 Existing Network Panel Modifications:
 - .1 2000 mm (79"), Tapped Hole, 44RU Rack Rail Pair.
 - .2 Security Doors:
 - .1 TS 35 DIN Rail Mountable, 445 mm x 483 mm (17.5" x 19").
 - .2 TS 35 DIN Rail Mountable, 711 mm x 483 mm (30" x 19").
- .2 DIN Rail Mount Kit:
 - .1 TS 35 mm (1.4"), slotted.
 - .2 Depth adjustable, 2RU, 483 mm (19") Rack Mount.
 - .3 When used to mount terminals, rails shall be mounted on straight raisers (rail support / mounting feet) so as to raise them so that the top of the terminals are at the same height as the top of the adjacent wiring duct.
 - .4 Raisers (rail support / mounting feet) shall not be used when rail hosts heavy components.
- .3 Terminals:
 - .1 Quantity:
 - .1 Accommodate present and spare indicated needs.
 - .2 One wire per terminal for field wires entering/exiting enclosures.
 - .3 Maximum of 2 wires on each side of a terminal for internal enclosure wiring.
 - .4 Installed Spare Terminals: As shown on the drawings.
 - .2 General:
 - .1 Connection Type: Screw compression clamp.
 - .2 Compression Clamp:
 - .1 Complies with DIN-VDE 0611.
 - .2 Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.

FIBRE OPTIC NETWORK

- .3 Guides strands of wire into terminal.
- .3 Screws: Hardened steel, captive, and self-locking.
- .4 Current Bar: Copper or treated brass.
- .5 Insulation:
 - .1 Thermoplastic rated for -55 to 110°C.
 - .2 Two funneled shaped inputs to facilitate wire entry.
- .6 Mounting:
 - .1 Standard DIN rail.
 - .2 Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - .3 End Stops: Minimum of one at each end of rail.
- .7 Jumpers: Allow jumper installation without loss of space on terminal or rail.
- .8 Marking System:
 - .1 Terminal number shown on both sides of terminal block.
 - .2 Markings must be machine printed. Handwritten markings are not allowed.
 - .3 Terminal strip numbers shown on end stops.
 - .4 Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
- .9 Terminal blocks shall be designed for the size of the wires to be connected to them. Terminal blocks used for analog, digital, and power cables shall be identified and physically separated from each other.
- .10 Drawings and templates supplied may not detail all hardware components such as labels, stoppers, rail lifters, end plates, separators, etc. The supplier must supply and install such components when required.
- .11 Loose Spare Requirements:
 - .1 Provide either thirty (30) or three (3) percent, whichever is less, of each type of terminal used on the Project.
- .3 Terminal Block Types:
 - .1 Control wiring
 - .1 General:

FIBRE OPTIC NETWORK

- .1 Connection type: Screw connection.
- .2 Mounting: TS 35 mm DIN rail.
- .3 Approval: CSA.
- .2 Manufacturer and Series:
 - .1 Weidmuller W-series.
 - .2 Or approved equal.
- .3 Standard of Acceptance:
 - .1 Terminal Block, Feed-through:
 - .1 Rated Voltage: 800V AC.
 - .2 Rated Current: 32 A.
 - .3 Wire Size: 26 to 10 AWG.
 - .4 Colour: Dark Beige Body.
 - .5 Width: 6.1 mm.
 - .6 Standard of acceptance: Weidmuller WDU 4.
 - .2 Terminal Block, Ground:
 - .1 Wire Size: 26 to 10 AWG.
 - .2 Colour: Green and yellow body.
 - .3 Width: 6.1 mm.
 - .4 Grounding: Electrically grounded to mounting rail.
 - .5 Standard of acceptance: Weidmuller WPE 4.
 - .3 Terminal Block, Knife Disconnect:
 - .1 Rated Voltage: 300V AC.
 - .2 Rated Current: 10 A.
 - .3 Wire Size: 22 to 10 AWG.
 - .4 Colour: Dark Beige body, orange switch.
 - .5 Width: 6.1 mm.

FIBRE OPTIC NETWORK

- .6 Standard of acceptance: Weidmuller WTR 4.
- .4 Terminal Block, Fused:
 - .1 Rated Voltage: 300V AC.
 - .2 Rated Current: 10 A.
 - .3 Wire Size: 22 to 10 AWG.
 - .4 Colour: Black body.
 - .5 Width: 6.1 mm.
 - .6 Fuse: 5 mm x 20 mm.
 - .7 Standard of acceptance: Weidmuller WFS 4.
- .5 Terminal Block, Double Level, Fused:
 - .1 Rated Voltage: 300V AC.
 - .2 Rated Current: 10 A.
 - .3 Wire Size: 26 to 12 AWG.
 - .4 Color: Dark Beige Body.
 - .5 Width: 8 mm.
 - .6 Fuse: 5 mm x 20 mm.
 - .7 Standard of acceptance: Weidmuller KDKS 1/35 DB.
- .2 Power wiring over 6.3 A
 - .1 General:
 - .1 Connection type: Screw connection.
 - .2 Mounting: TS 35 mm DIN rail.
 - .3 Approval: CSA.
 - .2 Manufacturer and Series:
 - .1 Weidmuller W-series.
 - .2 Or approved equal.
 - .3 Standard of Acceptance:

FIBRE OPTIC NETWORK

- .1 Terminal Block, Feed-through:
 - .1 Rated Voltage: 600V AC.
 - .2 Rated Current: 85 A.
 - .3 Wire Size: 18 to 6 AWG.
 - .4 Colour: Dark Beige body.
 - .5 Width: 11.9 mm.
 - .6 Standard of acceptance: Weidmuller WDU 16.
- .2 Terminal Block, Fused:
 - .1 Rated Voltage: 150V AC.
 - .2 Rated Current: 16 A.
 - .3 Wire Size: 20 to 6 AWG.
 - .4 Color: Dark Beige body.
 - .5 Width: 11.9 mm.
 - .6 Fuse: 6.3 mm x 32 mm.
 - .7 Standard of acceptance: Weidmuller WSI 6/2 GZ/DEF63.
- .4 Power Supply:
 - .1 Approvals: CSA.
 - .2 Watt Rating: 120W.
 - .3 Input: 100-240 V AC, 45-65 Hz.
 - .4 Output: 24V DC.
 - .5 Mounting: TS 35 DIN rail.
 - .6 Capable of parallel operation.
 - .7 Temperature derating: linear derating to half power from 60°C to 70°C
 - .8 Output ripple: < 50 mV peak-to-peak.
 - .9 Efficiency: 88 percent or greater.
 - .10 Status lights:

FIBRE OPTIC NETWORK

- .1 DC OK LED: active, green.
- .11 Status contacts:
 - .1 Power supply failure, qty 1 normally open (Form A), contact closed during normal operation.
- .12 Environmental:
 - .1 Temperature, operating: -10 to 60°C.
 - .2 Humidity, operating: max 90 percent, non-condensing.
- .13 Manufacturer and series:
 - .1 SolaHD SDN-P Series.
 - .2 Or approved equal.
- .5 Uninterruptible Power Supply:
 - .1 Approvals: CSA.
 - .2 Watt Rating: 500W.
 - .3 Input: 100-240 V AC, 45-65 Hz.
 - .4 Output: 120V AC.
 - .5 Mounting: TS 35 DIN rail, shelf, or panel mount.
 - .6 Environmental:
 - .1 Temperature, operating: 0 to 60°C.
 - .2 Humidity, operating: max 90 percent, non-condensing.
- .6 Overcurrent Protection:
 - .1 Panel-mounted devices and all control circuits shall be protected by appropriately sized fuses or circuit breakers.
- .7 Duplex Receptacle:
 - .1 Approvals: CSA.
 - .2 Heavy duty specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
 - .3 High strength, thermoplastic base colour.
 - .4 Colour:

FIBRE OPTIC NETWORK

- .1 Non-essential powered receptacles: White.
- .2 UPS-powered receptacles: Orange.
- .5 Contact Arrangement: contact to be made on two sides of each inserted blade without detent.
- .6 Rating: 125 V, configuration 5-15R, 15 A.
- .7 One-piece mounting strap with integral ground strap, rivetless construction.
- .8 Mounting: TS 35 DIN Rail.
- .9 Enclosure: Outlet box, 115 mm x 75 mm x 55 mm (4.5" x 3" x 2"), with faceplate.
- .10 Receptacles shall be of one Manufacturer throughout the project.
- .11 Manufacturers and products:
 - .1 Arrow Hart 5262 Series.
 - .2 Bryant 5262 Series.
 - .3 Hubbell 5262 Series.
 - .4 Or approved equal.
- .8 Ethernet Switches and Patch Cables as specified in Section 40 95 53.

2.3 Fibre Optic Closet Connectors (CCH)

- .1 Function: The CCH provides a rack-mount housing for fibre cassettes. The cassettes are complete with pre-terminated patch plates and pigtails. The CCH is installed inside plant Network Panels and Network Patch Panels.
- .2 Splice Cassette:
 - .1 24 fibres.
 - .2 Pre-terminated patch plate with LC duplex connectors. Connectors to have zirconium ferrule inserts.
 - .3 OM3.
 - .4 Single Fibre Splicing.
 - .5 3 m pigtail.
- .3 Rack-mount housing:
 - .1 General requirements:

FIBRE OPTIC NETWORK

- .1 RoHS Compliant.
- .2 Suitable for installation on standard 483mm (19") rack.
- .2 48 Strand Maximum Housing:
 - .1 Capacity: up to 48 strands via 2 cassettes.
 - .2 Dimension: 44 mm x 482.6 mm x 434.34 mm (1.75" x 19" x 17"), 1RU.
- .3 96 Strand Maximum Housing:
 - .1 Capacity: up to 96 strands via 4 cassettes.
 - .2 Dimension: 88.9 mm x 482.6 mm x 434.34 mm (3.5" x 19" x 17"), 2RU.
- .4 144 Strand Maximum Housing:
 - .1 Capacity: up to 144 strands via 6 cassettes.
 - .2 Dimension: 133.35 mm x 482.6 mm x 434.34 mm (5.25" x 19" x 17"), 3RU.
- .5 288 Strand Maximum Housing:
 - .1 Capacity: up to 288 strands via 12 cassettes.
 - .2 Dimension: 177.8 mm x 482.6 mm x 434.34 mm (7" x 19" x 17"), 4RU.
- .4 Manufacturer and Models:
 - .1 Corning CCH-01U, CCH-02U, CCH-03U, CCH-04U, and
 - .2 Corning CCH-CS24-E4-P00TE, Splice Cassette.
 - .3 Or approved equal in accordance with B8.

2.4 Fusion Splice Protector

- .1 Heat shrinkable splice protects the fusion splice on fibres securely.
- .2 Requirements:
 - .1 Multifibre or single fibre Sleeve, 40 or 60 mm length.
 - .2 Fibre Diameter: 50 µm.
 - .3 Heating Time: 64 Sec. for single fibre sleeve and 80 sec. for multi fibre sleeve.
- .3 Manufacturer and Model:
 - .1 Corning, 2806031-01.

FIBRE OPTIC NETWORK

- .2 Or approved equal according to B8.

2.5 Patch Cables

- .1 In accordance with requirements of EIT/EIA 568, section 12.5.
- .2 Features:
 - .1 Low Loss.
 - .2 2 fibres, LC duplex to LC duplex.
 - .3 50 µm Multimode (OM3).
 - .4 Wavelengths: 850 nm / 1300 nm.
 - .5 Zip Cord Tight buffered cable.
 - .6 Riser, 2.0 mm legs.
 - .7 Insertion loss, typical: 0.1 dB.
 - .8 Insertion loss, max.: 0.15 dB.
 - .9 Outer jacket material: LSZH/FRNC.
 - .10 Length: as required to suit installations without strain.
- .3 Manufacturer:
 - .1 Corning E050502T5120001M and E050502T5120003M for 1 and 3 m.
 - .2 Or approved equal in accordance with B8.

3. EXECUTION

3.1 Installation

- .1 Coordinate network cable installation with contractor's and City's activities at site. Provide at least five (5) business days notice before requiring access to facility to work in existing Network Panels or installing new.
- .2 Install all underground network cabling in conduit or duct as indicated. Size conduit for the number of cables contained and observe the cable manufacturers recommended bending radius.
- .3 All network cabling within buildings to be installed in cable tray. Conduit runs are not permitted.
- .4 Rod and swab out existing ducts prior to installing new cables. Inspect existing raceways and boxes for allowable bending radius prior to installing cable and notify the Contract Administrator of any condition which would prevent the proper installation of the cable.

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- .5 Install cable without splices between network components.
- .6 Follow manufacturer's installation practices.

3.2 Conduit System

- .1 Ensure that installed conduit system conforms with fibre optic system requirements, including:
 - .1 Conduit size and number.
 - .2 Access Holes and Pull Boxes: Location and size, to ensure cables can be installed without exceeding manufacturer's limitations.
 - .3 Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.
- .2 Expansion Plugs: Seal conduits to stop ingress of water and grit with fabricated expansion plugs.

3.3 Fibre Optic Cable

- .1 Installation by manufacturer certified installer.
- .2 Install cables in accordance with manufacturer's requirements.
- .3 Install cable directly from shipping reels. Ensure that cable is not:
 - .1 Dented, nicked, or kinked.
 - .2 Subjected to pull stress greater, or bend radius less, than manufacturer's specification.
 - .3 Subjected to treatment that may damage fibre strands during installation.
- .4 Cables Per Conduit: One cable maximum.
- .5 If the link loss calculation indicates that the total cable system attenuation equals or exceeds the total link loss budget, rerouting may be allowed, if approved by Contract Administrator.
- .6 Splices: Install fibre optic cables in unspliced lengths between fibre centers.
- .7 Identification: Identify cable on both ends and in access holes and pull points it goes through. Identify with tags in accordance with Division 26. Use water proof tags.
- .8 Sealing: Seal cables to stop ingress of water and grit with fabricated expansion plugs.
- .9 Connect cables between destinations in cross-over configuration.
- .10 Ground armoured cabling as close as practical to where the cables enter the building at one end only.
- .11 Provide a 2 m coil for fibre cables terminating within cabinets. Coil neatly within the bottom of the cabinet.

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.12 Provide a 3 m coil for fibre cables that are to be left unterminated. Cap off and store neatly within the destination room. Coordinate coil location with City staff to ensure coil is located in a suitable area, does not obstruct operations, and will not be exposed to damage.

.13 Access Holes:

.1 Provide supports for cables in access and hand holes at minimum 600 mm centres along sides.

.2 While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

3.4 Field Quality Control

.1 Test components of installation in accordance with standards and specifications.

.2 Provide equipment, instrumentation, supplies and skilled staff necessary to perform testing.

.3 Advise Contract Administrator at least forty-eight (48) hours in advance of each test. Contract Administrator shall have option to witness and participate actively in tests.

.4 Document test results of each cable to confirm that at least specified number of fibres meet standards. Submit all test reports to the Contract Administrator to document the results of all of the testing requirements as well as the state and conditions of the tests.

.5 Document results of repeater and transceiver tests.

3.5 Tests and Inspection

.1 In accordance with Division 01.

.2 Conduit:

.1 Testing and Sealing of Spare Conduits.

.2 Conduit Testing:

.1 Blow full-diameter mouse through each spare conduit to verify they are unrestricted over full length.

.2 If any conduit is not unrestricted over full length, advise Contract Administrator.

.3 Documentation: Document and submit testing results to the Contract Administrator for review prior to installing cable.

.3 Cable Inspection:

.1 Compare cable, connector, and splice data with drawings and specifications.

.2 Inspect cable and connections for physical and mechanical damage.

FIBRE OPTIC NETWORK

- .3 Clean fibre connectors with specialty formulated cleaning solution if required, Follow cleaning kit manufacturer's instruction.
- .4 Cable Testing:
 - .1 Field test all fibres for end to end attenuation of an installed link as per TIA-568-C.0 Test all spare fibres from patch panel to patch panel.
 - .2 The total link attenuation shall be less than its corresponding networking equipment loss budget.
 - .3 All tests shall be bi-directional.
 - .4 Perform cable length measurement, fibre fracture inspection and construction defect inspection using an Optical Time Domain Reflectometer (OTDR). The OTDR signal shall be analyzed for excessive connection, splice or cable backscatter by viewing the reflected power/distance graph.
 - .1 OTDR images shall be included in the test report.
 - .5 Perform connector and splice integrity test using an OTDR. The OTDR signal shall be analyzed for excessive connection, splice or cable backscatter by viewing the reflected power/distance graph.
 - .6 Perform cable attenuation loss measurement with an optical power loss test set. Attenuation loss, of each fibre, in dB/km shall be within manufacturer's recommendation.
 - .7 Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set. Attenuation loss in shall be within manufacturer's recommendation.
 - .8 Until requirements are met, replace and retest all cables that do not have specified number of fibres that meet attenuation standards. The installation will not be considered complete until all requirements are met in all fibres even if communication is occurring.
 - .9 Submit a test report summary and all associated test data to the Contract Administrator at the completion of the testing.

END OF SECTION