PROJECT TITLE: Hamilton, Ontario
Burlington Canal
Vertical Lift Bridge
Replacement of Controls,
Drives and Overhead Cables

PROJECT NUMBER: R.012641.001

PROJECT DATE: 2013-05-31

END

Structural Engineer
Arash Zolghadri, P.Eng.

Professional Engineers Ontario

Temporary Licensee

Name: Michael Elza
Number: 100181046-02
Limitations: Mechanical system design for the Burlington Canal Bridge in Burlington, Ontario for Public Works and Government Services Canada

Collaborator: Cyril Ng, P. Eng.
Expiry Date : July 31, 2013
Association of Professional Engineers of Ontario

2013-07-15

July 15, 2013

Mechanical Engineer
Michael Elza, P.Eng.
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Number: 100181047-02
Limitations: Electrical system design for the Burlington Canal Bridge in Burlington, Ontario for Public Works and Government Services Canada

Collaborator: Zvonko Trajkovic, P. Eng.
Expiry Date : July 31, 2013
Association of Professional Engineers of Ontario

2013-07-25

Electrical Engineer
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Zvonko Trajkovic, P.Eng

END

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Title and description of Work.

.2 Contract Method.

.3 Work by others.

.4 Work sequence.

.5 Contractor use of premises.

.6 Partial Owner occupancy.

.7 Alterations to existing site.

1.2 PRECEDENCE

.1 For Federal Government projects, Division 01 Sections take precedence over technical specification sections in other Divisions of this Project Manual.

1.3 SITE LOCATION

.1 Work of this Contract comprises BURLINGTON CANAL VERTICAL LIFT, BRIDGE-REPLACEMENT OF CONTROLS, DRIVES AND OVERHEAD CABLES located at 1157 Beach Blvd., Hamilton, ON L8H 6Z9. Burlington Canal Lift Bridge is located on Beach Boulevard, between the City of Burlington and the City of Hamilton, Ontario. It is parallel to the Burlington Skyway and provides an alternative year-round vehicular and pedestrian route to Skyway traffic. When the Skyway is open, the Lift Bridge is used primarily by local pedestrians and vehicles. The Lift Bridge is part of provincial Highway No. 20 (Eastport Drive). In addition to providing a canal crossing link for local pedestrians and vehicles, it also facilitates during the navigation season all types of vessels entering and leaving Hamilton Harbour including vessels moving through the St. Lawrence Seaway System. Each year, 6,500 vessels, including more than 1,000 ships that are carrying cargo, rely on the Burlington Lift Bridge to reach their final destination.

1.4 CONTRACT METHOD

.1 Construct work under combined price contract.

1.5 EXAMINATION OF THE SITE

.1 Bidders visiting the site and accessing the towers shall have:
.1 Proof of Fall Protection training.
.2 Harness with a chest "D" ring.

.2 Pay particular attention to clearance between bridge and water conditions, size of lanes, areas affected by winter snow and ice, and decking.

.3 Be completely familiar with every detail and intent of this Specification and scope of work to be performed, and regulatory requirements governing this Work.

1.6 COST BREAKDOWN

.1 Within 48 hours of notification of acceptance of bid furnish a cost breakdown by Section aggregating contract amount.

.2 Within 48 hours of acceptance of bid submit a list of subcontractors.

1.7 WORK BY OTHERS

.1 The Contractor shall for the purpose of the Ontario Occupational Health and Safety Act and Regulations for Construction Projects, and for the duration of the Work of the Contract:
.1 Assume the role of Constructor in accordance with the Authority Having Jurisdictions.
.2 Agree, in the event of two or more Contractors working at the same time and space at the work site, without limiting the General Conditions GC3.7, to the Departmental Representative's order to:
.1 Assume, as the Constructor, the responsibility for the Departmental Representative's other Contractors.
.3 Other contractors and consultants may be working in adjacent areas of the bridge site shall be separated by time or space and the Contractor shall fully cooperate with other entities and as directed.

1.8 WORK SEQUENCE

.1 Construct Work in two phases to accommodate Owner's continued use of premises during construction.

.2 Coordinate Progress Schedule and coordinate with Owner Occupancy during construction.

.3 Construct Work in stages to provide for continuous public usage. Do not close off public usage of facilities until use of one stage of Work will provide alternate usage. Schedule Work in accordance with Section 01 32 16.

.4 Phase I Completion: Work comprises the replacement of controls, drives and overhead cables including but not limited to the testing and commissioning of the bridge and carrying out all necessary pre-operational works as specified and ensuring that the bridge is made ready for operation to service the public as intended. Refer to paragraph 1.4.1.

.5 Phase II Completion: Provide technical and professional support to PWGSC Operating staff during the sixty (60) day trial period of the navigation season and as required for the adequate bridge operation. The successful conclusion of the trial period will be considered as the Phase II completion.

.6 Substantial Completion: At the successful conclusion of Phase II Completion, the Substantial Performance will be considered as achieved. Contractor shall apply for, and the Departmental Representative will issue the Certificate of Substantial Completion.

.7 Final Completion: Following substantial completion and after completion of any deficiencies in the work, the Contractor will be entitled to apply for the Certificate of Completion.

.8 Maintain fire access/control.

1.9 SUGGESTED CONSTRUCTION SEQUENCE (UNLESS NOTED MANDATORY)

.1 The project construction phase will begin with the Contractor submitting the project Health and Safety Plan, Environmental Protection Plan, detailed critical path construction schedule, shop drawings, equipment and material data sheets, factory testing procedures, field testing procedures, traffic maintenance plans, commissioning plans, and MTO (Ministry of

1.9 SUGGESTED CONSTRUCTION SEQUENCE (UNLESS NOTED MANDATORY) (Cont'd)

.1 (Cont'd) Transportation of Ontario) permit application(s).

.2 The project Contract Documents require the Contractor to begin the MTO permit application(s) as early as possible because it is a long lead item. The project Contract Documents require the Contractor to define their traffic maintenance plan, and obtain permits in Compliance with MTO Book 7 for one or more lane closures, and for complete roadway closures if necessary. The Contract Documents restrict complete roadway closures to March and April 2015 if they are longer than one hour (Mandatory).

.3 Coordinate all lane closures and restrictions with MTO and its Contractors for Skyway Bridge construction projects occurring at the same time as this project (Mandatory).

.4 The project Contract Documents require the Contractor to define their plans and methods to handle existing lead paint while performing structural work and steel work.

.5 The project Contract Documents require the Contractor to conclude all work in a manner that is complete and "made good." This requirement of the specification defines the finished product, does not allow any equipment or material to be abandoned in place except where specified, and will require that all holes be filled and painted to match except where doing so will obscure or mask a structural or mechanical defect (Mandatory).

.6 On-site construction activities can begin in August 2014. On site construction activities prior to August 2014 may occur with prior authorization from the Departmental Representative.

.7 Responsible for storing and protecting all equipment.

.8 Initial on-site activities include mobilization, and staging materials and equipment.

.9 Provide a complete external cleaning of the Bridge structure prior to starting other activities. The purpose is to remove debris and accumulated bird waste.

1.9 SUGGESTED CONSTRUCTION SEQUENCE (UNLESS NOTED MANDATORY) (Cont'd)

.10 Measure the balance condition of the Bridge in accordance with the Contract Documents to establish the baseline condition prior to construction (Mandatory). The project Contract Documents require the Contractor to repeat the span balance testing near the completion of construction to verify the balance is unchanged (Mandatory).

.11 The project design allows for the new cable and conduit systems to be installed in parallel with the existing to the greatest extent possible. The existing operating systems and equipment will not be taken out of service until the winter closure beginning January 1, 2015.

.12 Place the new drive motors, drive control equipment, motor control centres and the automatic transfer switch in the tower machinery rooms at prescribed locations identified in the Contract Documents to be readily available for the winter Closure of 2015. The Contractor's approved traffic maintenance plans will be utilized when the roadway is needed for access to the machinery rooms, and if the Contractor ever needs to close the roadway for an extended period. Canal navigation shall never be impeded except during the 2015 winter closure. The project Contract Documents require the Contractor to obtain all necessary MTO permits for their traffic maintenance plan.

.13 Install motor control centres in their permanent location adjacent to the existing motor control centres. This will allow a substantial amount of field wiring to be installed prior to the winter closure of 2015.

.14 The following activities can be substantially completed by the Contractor prior to the winter closure of 2015:

.1 Conduit, raceway, junction boxes, pull boxes, marshalling cabinets, cables and networks.

.2 East side aerial cable between the north and south towers.

.3 Traffic gates, pedestrian gates, traffic barriers, traffic signals and pedestrian don't walk sign, and associated sidewalk repairs and section replacements and sidewalk detours.

.4 Traffic control system- hardwired relays:

.1 Traffic control systems will operate utilizing hardwired relay controls. The traffic control operator console and navigation control console will be

1.9 SUGGESTED CONSTRUCTION SEQUENCE (UNLESS NOTED MANDATORY) (Cont'd)

.14 (Cont'd)

.4 (Cont'd)

.1 (Cont'd)

refurbished and made operational during this period. It will be necessary for the Contractor to use rolling stock (attenuator trucks or equal) and flaggers during the transition from existing traffic control to new hardwired traffic control.

.5 The winter closure of 2015, beginning January 1, consists of construction crews working around the clock on a seven-day work week until construction is complete. Work shall be performed on both towers simultaneously.

.1 The existing span drive operating systems and controls will be removed and the new operating system including the Bridge control system programmable logic controller and the main control console will be installed and made operational.

.2 Install west side aerial cables.

.3 The existing span lock systems and CCTV systems will be interfaced with the new Bridge control system.

.4 The new motor control centres, remote input/output control cabinets, and span drive cabinets will already be installed in the machinery rooms. Power, control, and network wiring will be connected to the greatest extent possible for control systems.

.5 The existing Programmable Logic Controller (PLC) control system equipment and cabinet will be removed and the new Bridge control system PLC processors input/output modules in their new cabinets will be installed.

.6 The project commissioning phase will begin once all conductors are terminated, continuity tests performed, loop checks are completed, and preoperational tests are completed.

.7 The final span balancing will be verified during the initial start-up, functional testing, commissioning phase of the work. Functional testing and commissioning must be completed by March 20, 2015.

.8 Operator training, as-built documentation, and operations and maintenance manuals shall occur during the commissioning and operational trial period.

.15 Field verify all dimensions prior to the start of any and all Work.

1.9 SUGGESTED CONSTRUCTION SEQUENCE (UNLESS NOTED MANDATORY) (Cont'd)

.16 Shop drawings, work plans, and test procedures to be reviewed and dispositioned by the Departmental Representative prior to ordering materials or the fabrication of any equipment (Mandatory).

.17 All equipment to be fabricated, shop tested, and staged prior to Bridge shutdown.

.18 Construction tools, grout, paint, lubricants, and miscellaneous equipment to be staged at the jobsite prior to the start of on-site demolition or installation.

.19 Access platforms, safety netting, temporary structural supports, and material handling equipment to be installed prior to starting on-site demolition or installation.

.20 Gearbox pedestals, motor pedestals, brakes, brake wheels, and couplings may be staged in the motor room as indicated on the structural plans prior to starting on-site demolition or installation.

.21 Mechanical equipment demolition and installation shall be done with the Bridge shall be fully lowered and the span locks locked. Span locks shall be electrically locked out and tagged out to prevent accidental operation.

.22 Mechanical equipment demolition and installation shall be done after releasing all existing brakes to allow the drive machinery to relax and dissipate any residual torque in the system. Manually rotate motor shafts with strap wrench or similar tool to achieve backlash on both sides of gear teeth in primary gear set to insure no potential energy remains in the drive system (Mandatory).

.23 Remove existing mechanical equipment as indicated on the mechanical demolition plan.

.24 Measure floating shafts to be reused and have keys and gear couplings finish machined to match.

.25 Prepare the motor room and sheave room floors for the new equipment in accordance with the structural plans.

.26 Perform initial installation and alignment of mechanical equipment using undersized mounting

1.9 SUGGESTED CONSTRUCTION SEQUENCE (UNLESS NOTED MANDATORY) (Cont'd)

.26 (Cont'd)
holes and fasteners. Equipment to be installed in the following order:
.1 Gearbox pedestal.
.2 Gearbox.
.3 Floating shaft coupling assemblies.
.4 Machinery brakes.
.5 Motor pedestals.
.6 Motors.
.7 Motor brakes.

.27 Perform final alignment of mechanical equipment working backwards from floating shaft couplings (Mandatory).

.28 Final drill and ream mounting holes.

.29 Pour grout pad under motor pedestals.

.30 Final tension mounting fasteners.

.31 Mount auxiliary drive motor.

.32 Lubricate all equipment.

.33 Perform static field inspection and testing.

.34 Perform dynamic field inspection and testing.

.35 Repair motor room and sheave room floor in accordance with structural plans.

.36 Remove temporary access platforms, safety netting, temporary structural supports, and material handling equipment.

.37 Submit as-built documentation.

.38 Submit operation, inspection, and maintenance manuals.

.39 Perform training.

.40 Prior to on-site commissioning, it will be necessary for all equipment and control systems to be completely tested and verified operational at the factory prior to shipment. Factory testing shall comply with the approved written procedures established for the project.

.41 Mechanical and electromechanical devices will be tested on the factory floor.

.42 Control system functionality and network communications will be verified on the factory

1.9 SUGGESTED CONSTRUCTION SEQUENCE (UNLESS NOTED MANDATORY) (Cont'd)

.42 (Cont'd)
floor as a complete integrated assembly including all control panels and cabinets, the motor control centres, motors, and the Bridge control system programmable logic controllers.

.43 Factory testing of the Bridge control system will include all alarms and alarm messaging.

.44 All cable conduit and conductors will be installed in the field. Prior to their termination, the conductor insulation resistance will be tested (megger tested) by the Contractor. Once terminated, continuity checks will be performed by the Contractor to verify the correct terminations.

.45 Following continuity testing, each control circuit will be tested for functionality one loop at a time utilizing the reviewed shop drawing schematics and loop diagrams for the project.

.46 Pre-dynamic field verification will include the following (Mandatory):
.1 Conductor continuity of field wiring.
.2 PLC input and output connections.
.3 Drive wiring and drive control loops.
.4 Continuity between drives and Bridge control system.
.5 Motor control centre (MCC) field wiring.
.6 Control system redundant network connections and function.
.7 Control system control loop and circuit function.

.47 Traffic control and signal systems will be a hybrid system using hardwired relays and PLC control. The hardwired system will be commissioned and made functional prior to the winter closure on January 1, 2015.

.48 Bridge control system logic will be verified one interlock at a time (Mandatory).

.49 The Bridge control system and motor control centres will be functionally tested in the field as an integrated unit following individual loop tests.

.50 Electromechanical equipment will be static tested in the field and then "bumped" to verify correct rotation prior to coupling motors to machinery prior to dynamic testing. The main

1.9 SUGGESTED CONSTRUCTION SEQUENCE (UNLESS NOTED MANDATORY) (Cont'd)

.50 (Cont'd)
drive motors will be operated under no-load conditions to check phases (Mandatory).

.51 Set and adjust brakes.

.52 Install drive shaft couplings.

.53 Test the operation of the auxiliary drive systems including controls and instrumentation.

.54 Test the operation of the PLC data logging operator interface console and graphics screen.

.55 Test the operation of the new UPS system.

.56 Test the operation of new automatic transfer switch in the north machinery room, including new circuit breakers in existing switchgear.

.57 Test the operation of the reconnected controls for the existing 600kW emergency generator and load bank.

.58 Following the control system functionality tests in the field, the Bridge operating system will begin dynamic testing. Dynamic testing will include establishing the final settings for limit switches, span drive tuning parameters, operating speeds and final alarms and messaging on the operator interface stations.

1.10 CONTRACTOR USE OF PREMISES

.1 Contractor has unrestricted use of site until Substantial Performance, and access to allow;
.1 Partial owner occupancy during entire construction period.
.2 Public usage.

.2 Coordinate use of premises under direction of Departmental Representative.

.3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

.4 Departmental Representative will issue direction indicating the extent of the Contractor's access to the premises for each of the five periods.

1.10 CONTRACTOR USE OF PREMISES (Cont'd)

.5 Access during the Navigation Periods, Period #1 and Period #3:

.1 During these two periods, the Owner will continue to have possession of the Bridge Site except for those pre-approved areas on the site allocated to the Contractor.

.2 The Owner will continue to conduct the normal bridge operation and maintenance as required.

.3 The Contractor shall be afforded site access to pre-determined portions of the Bridge grounds and Bridge facilities subject to the prior approval of the Departmental Representative.

.6 Access During Period #2:

.1 The Owner will continue to maintain the bridge and continue to maintain the site, the traffic, and snow removal.

.2 The Owner will require ten (10) calendar day's full and dedicated access to the North Tower and Control Building for maintenance purposes and subsequently will require an additional ten (10) calendar days for the South Tower for similar requirements.

.3 During the balance of the duration of the Navigation Shut-Down Period, the Contractor will be afforded full and uninterrupted access to the North and South Towers and Control Building and the full bridge facilities.

.7 Access During Period #4:

.1 During this period and unless otherwise directed, the bridge will be fully shutdown and consequently the Owner will not require access to conduct any maintenance. The Contractor shall have full access to the whole Bridge site and facilities and shall be responsible to maintain the site and snow removal.

.8 Access During Period #5 (Trial Period):

.1 During this 60-day Trial Period, the Owner will take over the Bridge facilities as a whole and undertake the operation and maintenance of the bridge as intended.

.2 However, during this period, the Contractor shall provide operational, technical and professional support for the Owners Staff to the extent required as directed to ensure safe and adequate operation of the Bridge facilities as required.

.9 Conduct work so as to ensure safety and convenience of the general public and ensure no delays in shipping without prior approval.

1.10 CONTRACTOR USE OF PREMISES (Cont'd)

.10 Regulate operations at all times to protect the public on Crown lands adjacent to the work site.

1.11 OWNER OCCUPANCY

.1 Owner will occupy premises during construction period for execution of normal seasonal operations.

.2 Cooperate with Owner in scheduling operations to minimize conflict and to facilitate Owner's usage.
.1 Operating season - March 21th to December 31st.
.2 Non-operating season - January 1st to March 20th.

1.12 PARTIAL OWNER OCCUPANCY

.1 Schedule and substantially complete designated portions of Work for Owner's occupancy prior to Certificate of Substantial Performance of entire Work.

.2 Complete training specified in Sections 01 32 16 and 01 79 00 prior to the sixty (60) trial period.

1.13 ALTERATIONS TO EXISTING BUILDING AND STRUCTURE

.1 Remove and recycle, compost, anaerobic digest, sell material for reuse or dispose of Structural, Mechanical and Electrical items indicated on drawings.

.2 Remove in good order, turn over to Department, and store within project site where designated by Departmental Representative Mechanical items indicated on drawings.

.3 Remove, temporarily store, clean, alter to suit and reinstall items indicated on drawings.

.4 Remove, temporarily store and turn over to other sections for building in items indicated on drawings.

.5 Provide new openings required in existing construction.

.6 Block in openings where items removed with material and finish to match existing and joining construction.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not used.

END

PART 1 - GENERAL

1.1 ACCESS AND EGRESS

.1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders, independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.

1.2 USE OF SITE AND FACILITIES

.1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.

.2 Maintain existing services to building and provide for personnel and vehicle access.

.3 Use elevators existing in towers for moving workers and material.
.1 Protect walls of passenger elevators, to the approval of Departmental Representative prior to use.
.2 Accept liability for damage, safety of equipment and overloading of existing equipment.
.3 Existing elevators load capacity shall not exceed 600 pounds (272 kg.)
.4 Elevators maintenance occurs monthly, Contractor shall coordinate with the Departmental Representative the use of the elevator during the maintenance period during the contract period.
.5 Contractor may use existing elevators at their own risk.

.4 Use hoisting equipment existing in towers for moving materials.
.1 Accept liability for damage, safety of equipment and overloading of existing equipment.
.2 Existing hoisting equipment load capacity shall be verify prior to use.
.3 Contractor may use existing hoisting equipment at their own risk.

.5 Closures: protect work temporarily until permanent enclosures are completed.

1.3 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

.1 Execute work with least possible interference or disturbance to and normal use of premises. Arrange with Departmental Representative to facilitate execution of work.

1.4 EXISTING SERVICES

.1 Notify, Departmental Representative of intended interruption of services and obtain required permission.

.2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 7 days of notice for necessary interruption affecting bridge operation throughout course of work. Keep duration of interruptions minimum. Carry out interruptions during non-peak hours.

.3 Provide for pedestrian and vehicular traffic.

.4 Construct barriers in accordance with Section 01 56 00.

1.5 SCHEDULES AND IMPORTANT DATES

.1 Navigation Season Operations: The Burlington Lift Bridge is operated 24 hours per day, 7 days per week throughout the navigation season. The annual navigation season generally commences on or about March 20th and ends on or about December 31st of each year.

.2 Lift Span Winter Shutdown Period: Winter shutdown of the Lift Span occurs during the non-navigation season for commercial vessels. The Lift Span Winter Shutdown Period lasts approximately seventy six (79) days, commencing on or about January 1st and ending on or about March 20th. The Lift Bridge continues to be open to pedestrian and vehicular traffic throughout the Lift Span Winter Shutdown Period. Inspection and Balancing shall be completed during the Lift Span Winter Shutdown Period, immediately prior to the Reopening of Lift Span Operations.

.3 Inspection and Balancing: Immediately prior to March 20th commencement of Navigation Season.

.4 Reopening of Lift Span Operations: The established official date for reopening of the Lift Bridge to start the navigation season is on March 20th of each year.

1.6 SPECIAL REQUIREMENTS

.1 Submit schedule in accordance with Section 01 32 16.

.2 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.

.3 Keep within limits of work and avenues of ingress and egress.

.4 Prior to cutting or drilling horizontal or vertical surfaces including concrete, concrete block or other structural substrate, determine location of reinforcing, service lines, pipes, conduits or other items by x-ray, ground penetrating radar or other appropriate method. Submit findings to Departmental Representative prior to cutting or drilling.

1.7 BUILDING SMOKING ENVIRONMENT

.1 Comply with smoking restrictions. Smoking is not permitted.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 APPOINTMENT AND PAYMENT

.1 Departmental Representative will appoint and pay for services of testing laboratory except follows:

.1 Inspection and testing required by laws, ordinances, rules, regulations or orders of public authorities.

.2 Inspection and testing performed exclusively for Contractor's convenience.

.3 Testing, adjustment and balancing of conveying systems, mechanical and electrical equipment and systems.

.4 Mill tests and certificates of compliance.

.5 Tests specified to be carried out by Contractor under supervision of Departmental Representative.

.2 Where tests or inspections by designated testing laboratory reveal Work not in accordance with contract requirements, pay costs for additional tests or inspections as required by Departmental Representative to verify acceptability of corrected work.

1.2 CONTRACTOR'S RESPONSIBILITIES

.1 Provide labour, equipment and facilities to:

.1 Provide access to Work for inspection and testing.

.2 Facilitate inspections and tests.

.3 Make good Work disturbed by inspection and test.

.4 Provide storage on site for laboratory's exclusive use to store equipment and cure test samples.

.2 Notify Departmental Representative 48 hours minimum sufficiently in advance of operations to allow for assignment of laboratory personnel and scheduling of test.

.3 Where materials are specified to be tested, deliver representative samples in required quantity to testing laboratory.

.4 Pay costs for uncovering and making good Work that is covered before required inspection or testing is completed and approved by Departmental Representative.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

END

PART 1 - GENERAL

1.1 ADMINISTRATIVE

.1 Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative.

.2 Prepare agenda for meetings.

.3 Distribute written notice of each meeting five (5) days in advance of meeting date to Departmental Representative.

.4 Provide physical space and make arrangements for meetings.

.5 Preside at meetings.

.6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.

.7 Reproduce and distribute copies of minutes within three days after meetings and transmit to Departmental Representative, meeting participants and affected parties not in attendance.

.8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.2 PRECONSTRUCTION MEETING

.1 Within 15 days after award of Contract, request meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.

.2 Departmental Representative, Contractor, major Subcontractors, field inspectors and Contract (Project) Manager, Production Manager (Superintendent) and Quality Assurance Manager in the contract will be in attendance.

.3 Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.

.4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.

1.2 PRECONSTRUCTION MEETING (Cont'd)

.5 Agenda to include:
.1 Appointment of official representative of participants in the Work.
.2 Schedule of Work: in accordance with Section 01 32 16.
.3 Schedule of submission of shop drawings. Submit in accordance with Section 01 33 00.
.4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00.
.5 Delivery schedule of specified equipment in accordance with Section 01 32 16.
.6 Health and safety in accordance with Section 01 35 29.
.7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
.8 Record drawings and specifications in accordance with Section 01 33 00.
.9 Maintenance and Operation manuals in accordance with Section 01 78 00.
.10 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00.
.11 Monthly progress claims, administrative procedures, photographs, hold backs.
.12 Appointment of inspection and testing agencies or firms.

1.3 PROGRESS MEETINGS

.1 During course of Work and four weeks prior to project completion, schedule progress meetings per construction contract and as when required.

.2 Contractor, major Subcontractors involved in Work, Resident Site Representative and Departmental Representative are to be in attendance.

.3 Notify parties minimum 5 days prior to meetings.

.4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 5 days after meeting.

.5 Agenda to include the following:
.1 Review, approval of minutes of previous meeting.
.2 Review of Work progress since previous meeting.
.3 Field observations, problems, conflicts.
.4 Problems which impede construction schedule.

1.3 PROGRESS MEETINGS (Cont'd)

.5 Agenda to include the following:(Cont'd)
.5 Review of off-site fabrication delivery schedules.
.6 Corrective measures and procedures to regain projected schedule.
.7 Revision to construction schedule.
.8 Progress schedule, during succeeding work period.
.9 Review submittal schedules: expedite as required.
.10 Maintenance of quality standards.
.11 Review proposed changes for affect on construction schedule and on completion date.
.12 Other business.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 DEFINITIONS

.1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.

.2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.

.3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.

.4 Construction Work Week: Monday to Sunday, inclusive, will provide seven day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.

.5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.

.6 Master Plan: summary-level schedule that identifies major activities and key milestones.

.7 Milestone: significant event in project, usually completion of major deliverable.

.8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.

.9 Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones.

1.1 DEFINITIONS (Cont'd)

.10 Navigation Shut-Down Period: Winter shut-down period during which the bridge is not required to make lifts to allow for marine traffic into and out of the Hamilton Harbour. This period starts annually approximately January 1 and ends on March 20 each year during the Work.

.11 Navigation Season: Marine traffic is resumed in the St. Lawrence Seaway System on March 20 each year and the bridge will be required to be lifted to allow the passage of ships and boats under the bridge, then lowered to allow vehicular and pedestrian traffic across the bridge.

.12 Pre-Operational Work: All work that is required to make the bridge fully operational and suitable for public use including marine, vehicular and pedestrian traffic.

.13 Phase I Completion: Completion of the pre-operational work as specified in 1.1.12 above and in Section 01 11 00, 1.8.4.

.14 Phase II Completion: Completion of Phase II work as specified in Section 01 11 00, 1.8.5, and delivery and verification of all contractual obligations and requirements. Contractor shall apply for Certificate of Substantial Completion.

1.2 REQUIREMENTS

.1 Mandatory requirement: In scheduling the work and the sequence of implementation and the associated priorities of the Contract, the Contractor shall take into consideration of the critical dependence of the general public for vehicular, marine and pedestrian traffic at the bridge location and the overriding requirement for the timely and safe operation of the bridge. Unless otherwise directed by the Departmental Representative and to achieve this vital requirement, the Contractor shall carry out the necessary work to achieve the Phases I and II Completion specified above and within the specified periods. Ensure that the bridge is always kept operational during the navigation seasons and only schedule the removal and replacement of the existing equipment during the Navigation Shut Down Periods and as applicable.

.2 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.

1.2 REQUIREMENTS (Cont'd)

.3 Plan to complete Work in accordance with prescribed milestones and time frame.

.4 Limit activity durations to maximum of approximately 14 working days, to allow for progress reporting.

.5 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Certificate of Substantial Performance and Certificate of Completion as defined times of completion are of essence of this contract.

.6 General Overall Schedule, Period Durations:
.1 Period #1 Navigation Season, year 2013: start date Contract Award in 2013, end date December 31, 2013.
.2 Period #2 First Navigation Shut-Down: start date January 1, 2014, end date March 20, 2014.
.3 Period #3 Navigation Season, year 2014: start date March 21, 2014, end date December 31, 2014.
.4 Period #4 Second Navigation Shut-Down: start date January 1, 2015, end date March 20, 2015.
.5 Period #5 Navigation Season, year 2015: start date March 21, 2015, end date December 31, 2015.

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Submit to Departmental Representative within 5 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.

.3 Submit Project Schedule to Departmental Representative within 3 working days of receipt of acceptance of Master Plan.

1.4 PROJECT MILESTONES

.1 Project milestones form interim targets for Project Schedule.
.1 Mobilization and staging.
.2 Start demolition.
.3 Installation of the Aerial Cables at both East and West sides of the bridge completed.
.4 Installation of the Gearboxes at the North and South Motor Rooms completed.

1.4 PROJECT MILESTONES (Cont'd)

.1 (Cont'd)

.5 Installation of the Motor Control Centres at the North and South Motor Rooms completed.

.6 Installation of the Drive Systems at the North and South Motor Rooms completed.

.7 Installation of the Main Drive Motors completed.

.8 Installation of the Bridge Control System. completed.

.9 Installation of the Bridge Electrical System completed.

.10 Control building closed-in and weatherproofed work completed.

.11 Interior finishing and fitting, mechanical and electrical work completed.

.12 Testing and commissioning.

.13 Certificate of Substantial Performance.

.14 Opening of bridge at start of navigation period March 20, 2015.

.15 Demonstration and training of Departmental Representative personnel.

.16 End of sixty (60) day trial period.

.17 Certificate of Completion.

1.5 MASTER PLAN

.1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).

.2 Departmental Representative will review and return revised schedules within 5 working days.

.3 Revise impractical schedule and resubmit within 5 working days.

.4 Accepted revised schedule will become Master Plan and be used as baseline for updates.

1.6 PROJECT SCHEDULE REPORTING

.1 Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress.

.2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

1.7 PROJECT MEETINGS

.1 Discuss Project Schedule at regular site meetings specified in Section 01 31 19, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.

.2 Weather related delays with their remedial measures will be discussed and negotiated.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

END

PART 1 - GENERAL

1.1 ADMINISTRATIVE

.1 Submit to Departmental Representative 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.

.2 Do not proceed with Work affected by submittal until review is complete.

.3 Present shop drawings, product data, samples and mock-ups in Imperial and Metric units.

.4 Where items or information is not produced in Imperial units converted values are acceptable.

.5 Review submittals prior to submission to Departmental Representative. 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 Departmental Representative, in writing at time of submission, 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 Departmental Representative's review of submittals.

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.

.10 Keep one reviewed copy of each submission on site.

.11 Submit five hard copies for each type and format of submittal and also submit in

1.1 ADMINISTRATIVE (Cont'd)

.11 (Cont'd) electronic format as pdf files. Forward pdf files on CD or through email.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, catalog cuts, certifications, brochures, procedures, and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario of Canada.

.3 Indicate materials, methods of fabrication and construction, attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.4 Allow 30 working days for Departmental Representative's review of each submission.

.5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Amount. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested. Work shall not proceed until comments are resolved.

.7 Accompany submissions with transmittal letter, in duplicate, 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 Other pertinent data.

1.2 SHOP DRAWINGS AND PRODUCT DATA (Cont'd)

.8 Submissions shall include:

.1 Date and revision dates.

.2 Project title and number.

.3 Name and address of:

.1 Subcontractor.

.2 Supplier.

.3 Manufacturer.

.4 Specification section, page or drawing number of the Contract documents to which the submission applies.

.5 Part number, item number or catalog number of the items being supplied clearly identified.

.6 Contractor Movable Bridge Construction Specialist's stamp, signed certifying approval of submission, verification of coordination among the Structural, Control, Electrical, and Mechanical components to be supplied.

.7 Contractor Control Systems Engineer's stamp, signed certifying approval of submission, verification of Electrical and Control systems.

.8 Contractor Systems Integrator's stamp, signed certifying approval of submission, verification of coordination among the Control, Electrical, and Mechanical components to be supplied.

.9 Heavy Machinery Specialist's stamp, signed certifying approval of submission, coordination verification of shop and working drawings for the proper assembly of the various machinery components prior to submission for review. When corrections or revisions are required, the Heavy Machinery Specialist shall resubmit shop drawings for review.

.10 Coordinate the Work of machinery component manufacturers where components interface.

.11 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.

.12 Individual shop drawings must be submitted for components requiring left-hand or right-hand orientation. Drawing one component and labeling others as opposite hand will not be acceptable.

.13 Partial or incomplete shop drawing submittals will not be accepted for review.

.14 Submit shop drawings for complete systems, shop testing procedures, field testing procedures and related or interconnected equipment together.

.15 Submit shop drawings for all equipment, complete systems, and materials proposed for purchase or being fabricated.

1.2 SHOP DRAWINGS AND PRODUCT DATA (Cont'd)

.8 Submissions shall include:(Cont'd)

.16 Details of appropriate portions of Work as applicable:

.1 Fabrication.

.2 Layout, showing dimensions, including identified field dimensions, and clearances.

.3 Setting or erection details.

.4 Capacities.

.5 Performance characteristics.

.6 Standards.

.7 Operating weight.

.8 Wiring diagrams.

.9 Single line and schematic diagrams.

.10 Relationship to adjacent work.

.11 Complete systems and related or interconnected equipment together.

.12 Mechanical

.1 State grade and extent of finish machining, with all tolerances and allowances, for each part for which a specific fit is required. Finished surfaces shall be as defined by the ANSI/ASME B46.1-2009; and fits shall be as defined by the ANSI/ASME B4.1-1967 (R1999), unless otherwise stated herein, ANSI/ASME B4.1-1967 (R1999) shall also apply to fits for non-cylindrical parts.

.2 Indicate required tension, method of tensioning, and all other pertinent information for all machinery connection bolts.

.3 Show manufactured components in outline on drawings, with sufficient dimensions and data to determine the clearances required for installation and operation.

.4 Manufacturer's certified dimension prints shall state Project title and number; pertinent ratings of the equipment; and shall indicate, where applicable, the provisions for adding, draining, and checking the level of lubricant; the method of lubrication and type of fittings; and the location of inspection openings.

.5 Fabrication and shop testing procedures shall be submitted. Specific steps shall be outlined in sequence.

.6 Clearly indicate heat treatment, stress relieving, normalizing, tempering, and all other processes.

1.2 SHOP DRAWINGS AND PRODUCT DATA (Cont'd)

.8 Submissions shall include:(Cont'd)

.16 (Cont'd)

.12 (Cont'd)

.7 Weld types and joint sizes shall be shown on the shop drawings. Welding procedures shall be submitted in accordance with AASHTO/AWS D1.5M/D1.5-2002 and shall include:

.1 Temporary welds, tack welds, jigs and other temporary measures required for construction of the elements shall be shown.

.2 All weld processes, including pre-qualified and contractor proposed welding procedures.

.3 Detailed welding drawings, weld sequencing plan, including proposed inspection plans, repair procedures, and welder qualifications.

.4 Procedures for controlling distortion of elements.

.5 Disposition rates, preheat and inter pass temperatures, sequencing, inspection controls by the contractor and other related items for the control of welding.

.8 Complete data regarding the design and construction of all manufactured items to be furnished as part of the machinery under this Contract, including material specifications, cross-sectional assembly drawings, detail drawings of component parts, characteristic curves, the dimensions of principal elements and calculations demonstrating compliance with the contract documents.

.9 Shop bill of materials for all machinery parts. If the bill of materials are not indicated on working drawings, submit prints of the bill of materials for review in the same manner as specified for the drawings. State the weight of each piece of machinery on the shop drawing upon which it is detailed or billed.

.10 Complete assembly and erection drawings. Provide identifying marks and essential dimensions for locating

1.2 SHOP DRAWINGS AND PRODUCT DATA (Cont'd)

.8 Submissions shall include:(Cont'd)

.16 (Cont'd)

.12 (Cont'd)

each part or assembled unit with respect to the bridge or foundation.

.11 The manufacturer shall submit for approval a certified print of each gearbox showing at a minimum the following:

.1 All external mounting dimensions including shaft sizes, bores, and keyways.

.2 Internal plans showing each gearbox component with part numbers.

.3 The ratings that will appear on the nameplate.

.4 Lifting points.

.5 Location of all lubricant connections.

.6 Lubricant recommendations.

.12 Submit detailed field and shop testing procedures for approval prior to testing. The testing procedures shall be supplemented with drawings, photographs, calculations, and catalog cuts as appropriate. The procedures shall include drawings of the testing configuration, detailed step-by-step procedures, details on the testing instrumentation and methods of recording measured data, and applicable pass/fail criteria.

.17 After Departmental Representative's review, distribute copies.

.9 Submit one transparency on plastic film three hard copies and one electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.

.10 Submit three hard copies and one electronic copy of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.

.11 Submit three hard copies and one electronic copy of test reports for requirements requested

1.2 SHOP DRAWINGS AND PRODUCT DATA (Cont'd)

.11 (Cont'd)
in specification Sections and as requested by Departmental Representative.
.1 Reports signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accordance with specified requirements.
.2 Testing must have been within 3 years of date of contract award for project.

.12 Submit three hard copies and one electronic copy of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
.2 Certificates must be dated after award of project contract complete with project name.

.13 Submit three hard copies and one electronic copy of manufacturers instructions for requirements requested in specification Sections and as requested by Departmental Representative.
.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

.14 Submit three hard copies and one electronic copy of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.

.15 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.16 Submit three hard copies and one electronic copy of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.

.17 Delete information not applicable to project.

.18 Supplement standard information to provide details applicable to project.

.19 If upon review by Departmental Representative, no errors or omissions are discovered or if only

1.2 SHOP DRAWINGS AND PRODUCT DATA (Cont'd)

.19 (Cont'd) minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.20 The review of shop drawings by Public Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.

.1 This review shall not mean that PWGSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.

.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

.1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.

.2 Deliver samples prepaid to Departmental Representative's business address.

.3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.

.4 Where colour, pattern or texture is criterion, submit full range of samples.

.5 Adjustments made on samples by Departmental Representative are not intended to change Contract Amount. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.

1.3 SAMPLES (Cont'd)

.7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 PHOTOGRAPHIC DOCUMENTATION

.1 Submit electronic and hard copy of colour digital photography in jpg format, fine resolution monthly with progress statement and as directed by Departmental Representative.

.2 Project identification: name and number of project and date of exposure indicated.

.3 Number of viewpoints: 4 locations.
.1 Viewpoints and their location as determined by Departmental Representative.

.4 Frequency of photographic documentation: weekly and as directed by Departmental Representative.
.1 Existing conditions.
.2 Upon completion of: mechanical, electrical, control and structural Work identified in the Contract documents as project milestones, and as directed by Departmental Representative.

1.5 FEES, PERMITS AND CERTIFICATES

.1 Provide authorities having jurisdiction with information requested.

.2 Pay fees and obtain certificates and permits required.

.3 Furnish certificates and permits.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 Canada Labour Code, Part II.

.2 Canadian Standards Association (CSA): Canada
.1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.

.3 ESA - Electrical Safety Authority.

.4 National Building Code 2010 (NBC):
.1 NBC 2010, Division B, Part 8 Safety Measures at Construction and Demolition Sites.

.5 National Fire Code 2010 (NFC):
.1 NFC 2010, Division B, Part 5 Hazardous Processes and Operations, subsection 5.6.1.3 Fire Safety Plan.

.6 Province of Ontario:
.1 Occupational Health and Safety Act Revised Statutes of Ontario 1990, Chapter O.1 as amended, and Regulations for Construction Projects, O. Reg. 213/91 as amended.
.2 O. Reg. 490/09, Designated Substances.
.3 Workplace Safety and Insurance Act, 1997.
.4 Municipal statutes and authorities.

.7 Fire Commissioner of Canada (FCC):
.1 FC-301 Standard for Construction Operations, June 1982.
.2 FC-302 Standard for Welding and Cutting, June 1982.

Human Resources and Social Development Canada
Labour Program
Fire Protection Engineering Services
4900 Yonge Street 8th Floor
North York, Ontario M2N 6A8

and copies may be obtained from:

Human Resources and Social Development Canada
Labour Program
Fire Protection Engineering Services
Ottawa, Ontario K1A 0J2

1.2 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00.

1.2 SUBMITTALS (Cont'd)

.2 Submit site-specific Health and Safety Plan: Within 14 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:

.1 Results of site specific safety hazard assessment.

.2 Results of safety and health risk or hazard analysis for site tasks and operations found in work plan.

.3 Measures and controls to be implemented to address identified safety hazards and risks.

.4 Provide a Fire Safety Plan, specific to the work location, prior to commencement of work. The plan shall be coordinated with, and integrated into, the existing PWGSC site Emergency Procedures and Evacuation Plan in place at the site. Departmental Representative will provide PWGSC Emergency Procedures and Evacuation Plan.

.5 Contractor's and Sub-contractors' Safety Communication Plan.

.6 Contingency and Emergency Response Plan addressing standard operating procedures specific to the project site to be implemented during emergency situations. Coordinate plan with existing PWGSC Emergency Response requirements and procedures provided by Departmental Representative.

.7 Conduct work so as to ensure safety and convenience of the general public and ensure no delays in shipping without prior approval.

.8 Regulate operations at all times to protect visitors and campers on Crown lands adjacent to the work site.

.3 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 14 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 5 days after receipt of comments from Departmental Representative.

.4 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.

.5 Submit names of personnel and alternates responsible for site safety and health.

.6 Submit records of Contractor's Health and Safety meetings when requested.

1.2 SUBMITTALS (Cont'd)

.7 Submit 2 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative, daily.

.8 Submit copies of orders, directions or reports issued by health and safety inspectors of the authorities having jurisdiction.

.9 Submit copies of incident and accident reports.

.10 Submit Material Safety Data Sheets (MSDS).

.11 Submit Workplace Safety and Insurance Board (WSIB)- Experience Rating Report.

1.3 FILING OF NOTICE

.1 File Notice of Project with Provincial authorities prior to commencement of Work.

1.4 SAFETY ASSESSMENT

.1 Perform site specific safety hazard assessment related to project.

1.5 MEETINGS

.1 Schedule and administer Health and Safety meeting with Departmental Representative prior to commencement of Work.

1.6 REGULATORY REQUIREMENTS

.1 Comply with the Acts and regulations of the Province of Ontario.

.2 Comply with specified standards and regulations to ensure safe operations at site.

1.7 PROJECT/SITE CONDITIONS

.1 Work at site will involve contact with:
.1 Contaminated soil.
.2 Silica in concrete.
.3 Mercury in fluorescent light tubes, and thermostats observed in the control building, workshop, and motor rooms.
.4 Asbestos in vinyl composition tiles, electrical cable insulation, linoleum and ceiling stucco.
.5 Lead in paint applications, lead solder, pipes, and electrical cables sheaths ceramic tile glaze, solder in electronic equipment, solder caulking in ball fittings of cast iron

1.7 PROJECT/SITE CONDITIONS (Cont'd)

.1 (Cont'd)

.5 (Cont'd)
pipes, lead acid batteries, vent and pipe flashings, and solder used on domestic water lines.

.6 Benzene in fuel oil, paints and adhesives.

.7 Guano in crawl spaces, on roof, and on bridge structure beneath the motor and sheave room on both the North and South towers.

.8 PCBs in fluorescent light ballasts and Cubicle No. 4 Capacitors.

.2 Confined spaces in maintenance holes, and counterweight pockets.

1.8 GENERAL REQUIREMENTS

.1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.

.2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns either accepting or requesting improvements.

.3 Relief from or substitution for any portion or provision of minimum Health and Safety standards specified herein or reviewed site-specific Health and Safety Plan shall be submitted to Departmental Representative in writing.

1.9 COMPLIANCE REQUIREMENTS

.1 Comply with Ontario Occupational Health and Safety Act, R.S.O. 1990 Chapter 0.1, as amended and Canada Labour Code, Part II.

1.10 RESPONSIBILITY

.1 Be responsible for health and safety of persons on site including PWGSC employees, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.

.2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.10 RESPONSIBILITY (Cont'd)

.3 Where applicable the Contractor shall be designated "Constructor", as defined by Occupational Health and Safety Act for the Province of Ontario.

.4 Be responsible for health and safety of persons on site during the construction period including the 60 days trial period.

1.11 UNFORSEEN HAZARDS

.1 Should any unforeseen or peculiar safety-related factor, hazard, or condition become evident during performance of Work, immediately stop work and advise Departmental Representative verbally and in writing.

.2 Follow procedures in place for Employees Right to Refuse Work as specified in the Occupational Health and Safety Act for the Province of Ontario.

1.12 HEALTH AND SAFETY CO-ORDINATOR

.1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:

.1 Have minimum 2 years' site-related working experience specific to activities associated with asbestos abatement, lead coating removal, guano remediation, and electrical/mechanical work within the scope of this project.

.2 Have working knowledge of occupational safety and health regulations.

.3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.

.4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

.5 Be on site during execution of Work dealing with removal of designated substances and report directly to and be under direction of site supervisor.

1.13 POSTING OF DOCUMENTS

.1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province of Ontario, and in consultation with Departmental Representative.

1.13 POSTING OF DOCUMENTS (Cont'd)

.1 (Cont'd)
.1 Contractor's Safety Policy.
.2 Constructor's Name.
.3 Notice of Project.
.4 Name, trade, and employer of Health and Safety Representative or Joint Health and Safety Committee members (if applicable).
.5 Ministry of Labour Orders and reports.
.6 Occupational Health and Safety Act and Regulations for Construction Projects for Province of Ontario.
.7 Address and phone number of nearest Ministry of Labour office.
.8 Material Safety Data Sheets.
.9 Written Emergency Response Plan.
.10 Site Specific Safety Plan.
.11 Valid certificate of first aider on duty.
.12 WSIB "In Case of Injury At Work" poster.
.13 Location of toilet and cleanup facilities.

1.14 CORRECTION OF NON-COMPLIANCE

.1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative.

.2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.

.3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.15 BLASTING

.1 Blasting or other use of explosives is not permitted.

1.16 POWDER ACTUATED DEVICES

.1 Use powder actuated devices only after receipt of written permission from Departmental Representative.

1.17 WORK STOPPAGE

.1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

.2 Assign responsibility and obligation to Health and Safety Coordinator and competent Supervisor

1.17 WORK STOPPAGE (Cont'd)

.2 (Cont'd) to stop or start Work when, at Health and Safety Coordinator's discretion, it is necessary or advisable for reasons of health or safety. Departmental Representative may also stop Work for health and safety considerations.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 Definitions:

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

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

.2 Environmental Protection Act, Ontario Regulations O.Reg. 102/94 and O. Reg. 103/94. Regulations made under Ontario Environmental Protection Act, R.S.O. 1990, c. E.19.

.1 O. Reg. 347 Amended to O. Reg. 395/07 "General - Waste Management.

.2 O. Reg. 102/94 "Waste Audits and Waste Reduction Plans.

.3 O. Reg. 103/94 "Industrial, Commercial, and Institutional Source Separation Programs."

.4 O. Reg. 224/07 "Spill Prevention and Contingency Plans."

.5 R.R.O. 1990, Reg. 360 "Spills."

.3 Canadian Species-at-Risk Act (SARA).

.4 Workplace Hazardous Materials Information System (WHMIS).

.5 Fisheries Act, (R.S., 1985, c. F-14).

.6 Migratory Birds Convention Act.

1.2 DEFINITIONS

.1 Deleterious Material: Any substance that, if added to a waterbody, could degrade water quality or impact fish, fish habitat and aquatic wildlife. This includes, but is not limited to hydrocarbons (grease, oil, diesel, gasoline, etc.), paint and solvents, bridge wash water, lead, blast cleaning abrasives, etc.

.2 Dripline: Location on ground surface directly beneath a theoretical line described by tips of outermost branches of trees.

1.2 DEFINITIONS (Cont'd)

.3 Barrier: Fence consisting of approved material, supported by steel posts and being a minimum of 4 feet (1219 mm) high, without breaks or unsupported sections.

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

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for each item specified in Division 02, 09, 26 and 34, and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Submit 2 copies of WHMIS MSDS.

.3 Before commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative.

.4 Environmental Protection Plan must include comprehensive overview of known or potential environmental issues to be addressed during construction.

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

.6 Include in Environmental Protection Plan:
.1 Name of person responsible for ensuring adherence to Environmental Protection Plan.
.2 Name and qualifications of person responsible for manifesting hazardous waste to be removed from site.
.3 Names and qualifications of persons responsible for training site personnel.
.4 Descriptions of environmental protection personnel training program.

1.3 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.6 (Cont'd)

.5 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use.

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

.6 Spill Control Plan to include procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.

.7 Fuel transfer risk assessment and management plan.

.8 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.

.9 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, are contained on project site.

.10 Contaminant Prevention Plan identifying potentially hazardous substances to be used on job site; intended actions to prevent introduction of such materials into air, water, or ground; and detailing provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.

.11 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands.

1.4 FIRES

.1 Fires and burning of rubbish on site is not permitted.

1.5 SITE CLEARING AND PLANT PROTECTION

.1 Protect trees and plants on site and adjacent properties as indicated.

.2 Provide Barrier around trees which may be affected by Work. Locate Barrier 39 inches (1000 mm) beyond Dripline. Barrier to consist of a protective wood framework covered with plastic construction fence material, extending from grade level to a height of 6.5 feet (1981 mm). Maintain Barriers in good repair throughout the duration Work. Remove these upon completion of Work.

1.5 SITE CLEARING AND PLANT PROTECTION (Cont'd)

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

.4 Minimize stripping of topsoil and vegetation.

.5 Damage to trees as a result of Contractor's operations:
.1 Broken branches 1 inch (25.4 mm) or greater in diameter: cut back cleanly at break, or to within 0.4 inch (10 mm) of their base, if a substantial portion of branch is damaged. Departmental Representative will direct.
.2 Exposed roots 1 inch (25.4 mm) or larger: cut back cleanly to soil surface within five calendar days of exposure.
.3 Damaged bark: neatly trim back to un-injured bark, without causing further injury, within five calendar days of damage.

1.6 WORK ADJACENT TO WATERWAYS

.1 Construction equipment to be operated on land only.

.2 Use waterway beds for borrow material only after written receipt of approval from Departmental Representative.

.3 Waterways to be kept free of excavated fill, waste material and debris.

.4 Design and construct temporary crossings to minimize erosion to waterways.

.5 Do not skid logs or construction materials across waterways.

.6 Avoid indicated spawning beds when constructing temporary crossings of waterways.

.7 Blasting is allowed only above water and 100 m minimum from indicated spawning beds.

.8 Do not release any Deleterious Material into waterway.

.9 Ensure all equipment and temporary access structures such as scaffolding placed in waterbodies is free of earth material, and excess, loose or leaking fuel, lubricants, coolant and other Deleterious Material that could enter waterbody.

1.6 WORK ADJACENT TO WATERWAYS (Cont'd)

.10 Storage of fuels, paints, thinners, or other products on the bridge deck is not permitted. Store these in the main lay-down area.

1.7 PROTECTION OF PEREGRINE FALCONS

.1 Comply with Peregrine Falcon Management Plan (included in Appendix C).

1.8 NOISE CONTROL

.1 Comply with City of Burlington and City of Hamilton Noise By-laws.

1.9 POLLUTION CONTROL

.1 Maintain temporary erosion and pollution control features installed under this Contract.

.2 Control emissions from equipment and plant in accordance with local authorities' emission requirements.

.3 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area.
.1 Provide temporary enclosures where directed by Departmental Representative.

.4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

1.10 HAZARDOUS MATERIALS

.1 Place materials defined as hazardous or toxic waste in designated containers away from the watercourse.

.2 Maintain materials and equipment required for cleanup of spills or releases readily accessible on site. Materials may include but are not limited to containers, absorbent floating boom/skimmer, shovels, and personal protective equipment. Make spill response materials available at all times in which hazardous materials or wastes are being handled or transported.

.3 Follow procedures described in reviewed Site-Specific Environmental Protection Plan.

.4 Take immediate action using available resources to contain and mitigate effects on environment and persons from spill or release.

1.10 HAZARDOUS MATERIALS (Cont'd)

.5 Using appropriate safety precautions, collect liquid or solidify liquid with an inert, noncombustible material and remove for disposal.

.6 Be responsible for all costs of cleaning up any spills to satisfaction of the Departmental Representative.

.7 Spill kit as described in Site-Specific Environmental Protection Plan must be on-site at all times.

.8 Reporting: Promptly report spills and releases potentially causing damage to environment to:
.1 Departmental Representative.
.2 Ministry of the Environment SPILL Coordinator (Telephone No. 1-800-268-6060).
.3 Authority having jurisdiction or interest in spill or release including conservation authority, water supply authorities, drainage authority, road authority, and fire department.
.4 Owner of pollutant, if known.
.5 Person having control over pollutant, if known.

1.11 NOTIFICATION

.1 Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.

.2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.
.1 Take action only after receipt of written approval by Departmental Representative.

.3 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.

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

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.
.1 Leave Work area clean at end of each day.

.2 Bury rubbish and waste materials on site where directed after receipt of written approval from Departmental Representative.

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

.4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.5 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END

PART 1 - GENERAL

1.1 REFERENCES AND CODES

.1 Perform Work in accordance with National Building Code of Canada (NBC) 2010, National Fire Code of Canada (NFC) 2010 and Ontario Building Code (OBC) 2012, CSA C22.1-09 Canadian Electric Code , including all amendments up to bid closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.

.2 Meet or exceed requirements of:
.1 Contract documents.
.2 Specified standards, codes and referenced documents.

1.2 HAZARDOUS MATERIAL DISCOVERY

.1 Stop work immediately and notify Departmental Representative if materials which may contain designated substances or PCB's, other than those identified in Section 01 35 29 are discovered in course of work.

1.3 BUILDING SMOKING ENVIRONMENT

.1 Comply with smoking restrictions.

1.4 RELICS AND ANTIQUITIES

.1 Relics and antiquities, and items of historical or scientific interest such as cornerstones and contents, commemorative plaques, inscribed tables, and similar objects found on site shall remain the property of Parks Canada. Protect such articles and request directives from Departmental Representative.

1.5 IAQ - INDOOR AIR QUALITY

.1 Comply with CSA-Z204-94(R1999), Guideline for Managing Indoor Air Quality in Office Buildings.

1.6 TAXES

.1 Pay applicable Federal, Provincial and Municipal taxes.

1.7 EXAMINATION

.1 Examine existing conditions and determine conditions affecting work.

.2 Conduct concrete floor moisture testing using Calcium Chloride moisture tests.
.1 Submit test results to Departmental Representative for approval prior to installing any flooring. Conduct one test per 1076 ft^2 (100 m^2) of area being covered.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 ABBREVIATIONS AND ACRONYMS

.1 The abbreviations and acronyms are commonly found in the Project Manual and represent the associated organizations or terms.

1.2 MATERIALS, EQUIPMENT AND METHODS

.1 A: .1 A: amperes.
.1 AB: anchor bolt. .3 ABBR: Abbreviations.
.2 AC: Alternating current.
.3 A/C: air conditioner.
.4 AEC: architecturally exposed concrete.
.5 AESS: architecturally exposed structural steel.
.6 Af: factored axial load in KIPS (kN)(+ indicates tension, - indicates compression).
.7 AFF: above finished floor.
.8 AL: aluminum.
.9 ALT: alternate.
.10 APPROX: approximate.
.11 ANOD: anodized.
.12 ARCH: architecture.
.13 AROD: anchor rod.
.14 ATS: automatic transfer switch.
.15 AUTO: automatic.
.16 AUX: auxiliary.
.17 AVG: average.
.18 AWG: American wire guage.

.2 B:
.1 B: base.
.2 BCP: bored concrete pile.
.3 BET: between.
.4 BEW: bottom each way.
.5 BG: barrier gate.
.6 BKR: breaker.
.7 BL: blower.
.8 BLL: bottom lower layer.
.9 BLDG: building.
.10 BLK: block.
.11 BLKD: bulkhead.
.12 BLR: blower.
.13 BM: beam.
.14 BOC: elevated bottom of caisson (bored concrete pile).
.15 BOF: elevated bottom of footing.
.16 BOP: elevated bottom of pile.
.17 BOT: bottom.
.18 BP: bearing/base plate.
.19 BRG: bearing.
.20 BSMT: basement.

1.2 MATERIALS, EQUIPMENT AND METHODS (Cont'd)

.2 B:(Cont'd)
- .21 BUL: bottom upper layer.
- .22 BUP: bottom of underpinning.

.3 C:
- .1 C: conduit.
- .2 CA: column above only (no column below).
- .3 CAB: cabinet.
- .4 CAM: camber.
- .5 CANTIL: cantilever.
- .6 CB: circuit breaker.
- .7 CB: column below.
- .8 CC: centre to centre.
- .9 CEL: cut off elevation for piles.
- .10 CF: concrete fireproofed.
- .11 CIP: cast-in-place.
- .12 CHAN: channel.
- .13 CJ: construction joint.
- .14 CK: cork.
- .15 CKT: circuit.
- .16 CL: centreline.
- .17 CLR: clear.
- .18 CNT: steel deck core nominal thickness.
- .19 COL: column.
- .20 CONC: concrete.
- .21 CONT: continuous.
- .22 CONT J: control joint.
- .23 COMP: composite.
- .24 COMPL: complete.
- .25 CM: centimetre (Nursery stock).
- .26 CP: control panel.
- .27 CP: connection plate.
- .28 CR: contact relay.
- .29 CT: ceramic tile.
- .30 CU: copper.
- .31 CUR: current.
- .32 CVT: conductive vinyl tile.
- .33 C/W: complete with.

.4 D:
- .1 D: deep.
- .2 DC: direct current.
- .3 DCA: drilled concrete anchor.
- .4 DEG: degree.
- .5 DET: detail.
- .6 DEV: device.
- .7 D.F-L: Douglas Fir-Larch.
- .8 DIA: diameter.
- .9 DIFL: differential lock
- .10 DIM: dimension.
- .11 DISC: disconnect.
- .12 DISTR: distribution.
- .13 DL: dead load.
- .14 DMA: drilled masonry anchor.
- .15 DN: down.

1.2 MATERIALS, EQUIPMENT AND METHODS (Cont'd)

.4 D:(Cont'd)
.16 DO: ditto.
.17 DP: deep.
.18 DS: disconnect switch.
.19 DWG: drawing.
.20 DWL: dowel.

.5 E:
.1 E: encoder.
.2 EA: each.
.3 EC: empty conduit.
.4 ECR: Epoxy coated reinforcement.
.5 EE: each end.
.6 EF: each face.
.7 EL/ELEV: elevation.
.8 ELEC: electric.
.9 ELEV: elevator.
.10 EM: emergency.
.11 EMBED: embedment.
.12 EMT: electric metallic tubing.
.13 ENCL: enclosure.
.14 EQ: equal.
.15 EQPT: equipment.
.16 EXH: exhaust.
.17 EXIST: existing.
.18 EXPJ/EJ: expansion joint.
.19 EXP STRUCT: exposed structure.
.20 E-STOP: emergency stop.

.6 F:
.1 FBO: furnish by others.
.2 fc: compressive strength of concrete in MPa.
.3 FD: floor drain.
.4 FDN: foundation.
.5 FDR: feeder.
.6 FF: far face.
.7 FIN: finish.
.8 FL: floor.
.9 FLD: field.
.10 FLEX: flexible.
.11 FLUOR: fluorescent.
.12 FMC: full moment connection.
.13 FR: frame.
.14 FRR: fire resistance rating.
.15 FS: foot switch.
.16 FTG: footing.
.17 FU: fuse.
.18 FUT: future.
.19 FVNR: full voltage non-reversing.
.20 FVR: full voltage reversing.
.21 fy: yield strength in MPa.

1.2 MATERIALS, EQUIPMENT AND METHODS (Cont'd)

.7 G:
- .1 G: gate.
- .2 GA: gauge.
- .3 GALV: galvanized steel.
- .4 GB: grade beam.
- .5 GEN: generator.
- .6 GFCI: ground fault circuit interrupter.
- .7 GL: gridline.
- .8 GND: ground.
- .9 GT: glass tile.
- .10 GSC: galvanized steel conduit.

.8 H:
- .1 H: hot
- .2 HA: hand auto.
- .3 HDG: hot dipped galvanized.
- .4 HDW: hardware.
- .5 HDWD: hardwood.
- .6 HEF: horizontal each face.
- .7 HH: hook-hook (hook each end).
- .8 HIC: horizontal in centre.
- .9 HK: hook.
- .10 HOA: hand-off-auto
- .11 HOR: horizontal.
- .12 HPA: Hamilton Port Authority.
- .13 HR: hour.
- .14 HS: hand switch.
- .15 HSB: high strength bolt.
- .16 HT: height.
- .17 HTR: heater.
- .18 HV: high voltage.
- .19 HYD: hydrant.
- .20 HZ: hertz.

.9 I:
- .1 IBA: integrity bars added.
- .2 IBE: integrity bars exterior.
- .3 IBI: integrity bars interior.
- .4 ID: inside diameter.
- .5 IL: indicating light.
- .6 INCL: inclinometer.
- .7 INS: insulation.
- .8 INTLK: interlock.
- .9 I/O: input/output.

.10 J:
- .1 JB: junction box.
- .2 JG: joist girder.
- .3 JT: joint.

.11 K:
- .1 K: key pad/key operated.

1.2 MATERIALS, EQUIPMENT AND METHODS (Cont'd)

.12 L:
- .1 L: single angle.
- .2 L: latching.
- .3 LC: load centre.
- .4 ld: tension development length of rebar.
- .5 ldc: compression development length of rebar.
- .6 LE: left end.
- .7 LED: light emitting diode.
- .8 LFMC: liquidtight flexible metal conduit.
- .9 LG: long/length.
- .10 LINO: linoleum.
- .11 LL: lower level bm/joist; live load in PSF.
- .12 LLH: long leg horizontal.
- .13 LLV: long leg vertical.
- .14 LP: lighting panel.
- .15 LP: low point.
- .16 LR: latching relay.
- .17 LS: limit switch.
- .18 LSC: liquid-tight flexible metal conduit.
- .19 LSH: long side horizontal.
- .20 LSV: long side vertical.
- .21 LT: light.
- .22 LTG: lighting.
- .23 LUM: luminaire.

.13 M:
- .1 MA: master.
- .2 MAB: machinery brake.
- .3 MAX: maximum.
- .4 MCC: motor control centre.
- .5 MCP: motor control panel.
- .6 MCR: motor control relay.
- .7 MACH: machinery.
- .8 MECH: mechanical.
- .9 MET: metal.
- .10 MF: motor forward contact.
- .11 Mf: factored moment in KIP FT.
- .12 MFR: manufacturer.
- .13 MH: maintenance hole.
- .14 MIN: minimum.
- .15 MISC: miscellaneous.
- .16 MLP: metal lath and plaster.
- .17 MOB: motor brake.
- .18 MR: motor reverse contactor.
- .19 MS: motor starter.
- .20 MTD: mounted.
- .21 MTf: factored torsion in KIP FT.
- .22 MTG: mounting.
- .23 MTR: motor.
- .24 MVA: megavolt-ampere.
- .25 MW: megawatt.

1.2 MATERIALS, EQUIPMENT AND METHODS (Cont'd)

.14 N:
- .1 N: neutral.
- .2 NA: not applicable.
- .3 NBC: national building code.
- .4 NC: normally closed.
- .5 NE: northeast.
- .6 NEUT: neutral.
- .7 NF: near face.
- .8 NFC: national fire code.
- .9 NIC: not in contract.
- .10 NMC: non-metallic conduit.
- .11 No.: number.
- .12 NO: normally open.
- .13 NTS: not to scale.
- .14 NW: northwest.

.15 O:
- .1 OBC: Ontario building code.
- .2 OC: on centre.
- .3 OD: outside diameter.
- .4 OL: overload.
- .5 OO: out to out.
- .6 OPNG: opening.
- .7 OPR: operator.
- .8 OVHD: overhead.

.16 P:
- .1 P: prefinished.
- .2 P: point load in KIPS.
- .3 P.A.: public address.
- .4 PB: pull box.
- .5 PCC: precast concrete.
- .6 PE: photoelectric.
- .7 PG: pedestrian gate.
- .8 PH: phase.
- .9 PL: plate.
- .10 PLC: programmable logic controller.
- .11 PLYWD: plywood.
- .12 PNL: panel.
- .13 PR: pair.
- .14 PREFAB: prefabricated.
- .15 PREFIN: prefinished.
- .16 PRFL: profile.
- .17 PS: power supply.
- .18 PSF: pounds per square foot.
- .19 PT: paint.
- .20 PVC: polyvinyl chloride.
- .21 PWR: power.

.17 Q:

.18 R:
- .1 R: radius.
- .2 RA: rock anchor.
- .3 RC: reinforced concrete.

1.2 MATERIALS, EQUIPMENT AND METHODS (Cont'd)

.18 R:(Cont'd)
.4 RCPT: receptacle.
.5 RD: roof drain.
.6 REINF: reinforced/reinforcing.
.7 REL: release.
.8 REQD: required.
.9 REQT: requirement.
.10 REV: revision.
.11 RF: right frame.
.12 Rf: factored vertical reaction in KIPS.
.13 RGS: rigid hot dipped galvanized steel.
.14 RHf: factored horizontal reaction in KIPS.
.15 RM: room.

.19 S:
.1 S: smoke detector.
.2 SAN SEW: sanitary sewer.
.3 SC: short circuit.
.4 SCA: steel column above (no steel column below).
.5 SCHED: schedule.
.6 SCRN: screen.
.7 SDF: step down footing in direction of arrow.
.8 SDT: static dissipative tile.
.9 SE: southeast.
.10 SECT: section.
.11 SHLD: shield.
.12 SIM: similar.
.13 SJ: steel joist.
.14 SL: slave.
.15 SL: slab.
.16 SLR: sealer.
.17 SLS: serviceability limit state.
.18 SM: surface mount.
.19 SOG: slab on grade.
.20 SP: spare.
.21 SPA: spaces.
.22 SPF: spruce pine fir.
.23 SPL: span lock.
.24 SPEC: specification.
.25 SPSW: speed switch.
.26 SS: stainless steel.
.27 STD: standard.
.28 STIR: stirrup.
.29 STIFF: stiffener.
.30 STL: steel.
.31 STL BM: steel beam.
.32 STL FL DK: steel floor deck.
.33 STL PL: steel plate.
.34 STR: structure or structural.
.35 SW: southwest.
.36 SWT: switch
.37 SWGR: switchgear.

1.2 MATERIALS, EQUIPMENT AND METHODS (Cont'd)

.20 T:
- .1 T: top.
- .2 t: thickness.
- .3 TBR: to be removed.
- .4 T&B: top and bottom.
- .5 TC: termination cabinet.
- .6 TEL: telephone.
- .7 TEW: top each way.
- .8 TG: traffic gate.
- .9 THK: thick.
- .10 THKNS: thickness.
- .11 THR: threshold.
- .12 TJ: tie joist.
- .13 TL: traffic light.
- .14 TLE: top left end.
- .15 TLL: top lower layer.
- .16 TMPD: tempered.
- .17 TOC: top of caisson (bored concrete pile).
- .18 TOF: top of footing.
- .19 TOP: top of pile.
- .20 TOPG: topping.
- .21 TPC: top of pile cap.
- .22 TR: time relay.
- .23 TRE: top right end.
- .24 TRANSF: transformer.
- .25 TRANSV: transverse.
- .26 TS: temperature switch/thermostat.
- .27 TSP: twisted shielded pair.
- .28 TUL: top upper level.
- .29 TWR: tower.
- .30 TYP: typical.

.21 U:
- .1 U: unlatching.
- .2 UGRD: underground.
- .3 ULS: ultimate limit state.
- .4 U/N: unless noted.
- .5 UNO: unless noted otherwise.
- .6 UOS: unless otherwise specified.
- .7 UPS: uninterruptible power supply.
- .8 UPT: upturned.
- .9 U/S: underside.

.22 V:
- .1 V: vertical.
- .2 U/S: underside.
- .3 VA: voltage ampere.
- .4 VAC: voltage alternating current.
- .5 VB: vertical bracing.
- .6 VERT: vertical.
- .7 VERT EF: vertical each face.
- .8 Vf: factored shear in KIPS.
- .9 VFD: variable frequency drive.
- .10 VIC: vertical in centre.

1.2 MATERIALS, EQUIPMENT AND METHODS (Cont'd)

.22 V:(Cont'd)
.11 VSC: vertically slotted connection to allow for deflection.
.12 VSF: vinyl sheet flooring.
.13 VT: vinyl tile.
.14 VXB: vertical "X" bracing.

.23 W:
.1 W: watt.
.2 W: Wide flange.
.3 W/: with.
.4 W/O: without.
.5 WC: wind column.
.6 WD: wood.
.7 WDV: wood veneer.
.8 WH: wall hydrant.
.9 WHMIS: workplace hazardous materials information system.
.10 WP: waterproofing.
.11 WR: washroom.
.12 WSIB: workplace safety and insurance board.
.13 WT: weight.
.14 WTP: water treatment plant.
.15 WWA: window washing anchors.
.16 WWF: welded wire fabric.

.24 X:
.1 XFMR: transformer.

.25 Z:
.1 ZI: position current switch.
.2 ZRP: zinc rich paint.
.3 ZS: position limit switch.
.4 ZT: position transmitter.
.5 ZX: position element.

1.3 STANDARDS ORGANIZATIONS

.1 Standards writing organizations:
.1 AA - Aluminum Association.
.2 ACPA - American Concrete Pipe Association.
.3 ANSI - American National Standards Institute.
.4 ASHRAE - American Society of Heating and Refrigerating and Air-Conditioning Engineers.
.5 ASTM - American Society for Testing and Materials.
.6 AWI/AWMAC - Architectural Woodwork Institute/Architectural Woodwork Manufacturers Association of Canada.
.7 AWPA - American Wood Preservers' Association.
.8 AWWA - American Water Works Association.

1.3 STANDARDS ORGANIZATIONS (Cont'd)

.1 (Cont'd)

.9 BHMA - Builders Hardware Manufacturers Association.

.10 CCA - Canadian Construction Association.

.11 CCMPA - Canadian Concrete Masonry Producers Association.

.12 CGSB - Canadian General Standards Board.

.13 CNTA - Canadian Nursery Trades Association.

.14 CPCA - Canadian Painting Contractors Association.

.15 CRCA - Canadian Roofing Contractors Association.

.16 CSA - Canadian Standards Association.

.17 CSC - Construction Specifications Canada.

.18 CSDMA - Canadian Steel Door Manufacturers Association.

.19 CSI - Construction Specifications Institute.

.20 CSSBI - Canadian Sheet Steel Building Institute.

.21 CRCA - Canadian Roofing Contractors Association.

.22 DHI - Door and Hardware Institute.

.23 EEMAC - Electrical and Electronic Manufacturer's Association of Canada.

.24 ESA - Electrical Safety Authority.

.25 FCC - Fire Commissioner of Canada.

.26 FSC - Forest Stewardship Council.

.27 GANA - Glass Association of North America.

.28 HMMA - Hollow Metal Manufacturers Association.

.29 IEEE - Institute of Electrical and Electronics Engineers Inc.

.30 ISO - International Organization for Standardization.

.31 IWFA - International Window Film Association.

.32 LEED - LEED Canada, Leadership in Energy and Environmental Design.

.33 MPI - Master Painters Institute.

.34 MUTCD - Manual on Uniform Traffic Control Devices.

.35 NAAMM - National Association of Architectural Metal Manufacturers.

.36 NCPI - National Clay Pipe Institute.

.37 NRC - National Research Council Canada.

.38 NECA - National Electrical Contractors Association.

.39 NEMA - National Electrical Manufacturers Association.

.40 NFPA - National Fire Protection Association.

.41 ODVA - Open DeviceNet Vendor Association.

1.3 STANDARDS ORGANIZATIONS (Cont'd)

.1 (Cont'd)

.42 OPSD - Ontario Provincial Standard Drawings.

.43 OPSS - Ontario Provincial Standard Specifications.

.44 PPI - Plastics Pipe Institute.

.45 SACC - Standard Acquisition Clauses and Conditions.

.46 SDI - Steel Door Institute.

.47 SCAQMD - South Coast Air Quality Management District.

.48 TIA - Telecommunications Industry Association.

.49 TIAC - Thermal Insulation Association of Canada.

.50 TTMAC - Terrazzo Tile and Marble Association of Canada.

.51 UL - Underwriters Laboratories.

.52 ULC - Underwriters Laboratories of Canada.

.53 US EPA - United States Environmental Protection Agency.

.54 WH - Warnock Hersey.

1.4 FEDERAL GOVERNMENT DEPARTMENTS AND AGENGIES

.1 Departments, agencies and crown corporations.

.1 CEAA - Canadian Environmental Assessment Agency.

.2 CSC - Correctional Service Canada.

.3 CRA - Canada Revenue Agency.

.4 DND - Department of National Defence.

.5 EC - Environment Canada.

.6 FHBRO - Federal Heritage Buildings Review Office.

.7 HC - Health Canada.

.8 HCD - Heritage Conservation Directorate.

.9 LC - Labour Canada.

.10 PC - Parks Canada.

.11 PWGSC - Public Works and Government Services Canada.

.12 RCMP - Royal Canadian Mounted Police.

.13 TBS - Treasury Board Secretariat.

.14 TC - Transport Canada.

1.5 PROVINCIAL GOVERNMENT DEPARTMENTS AND AGENGIES

.1 MOEE - Ontario Ministry of Environment and Energy.

.2 MOL - Ontario Ministry of Labour.

.3 MTO and MOT - Ontario Ministry of Transportation.

1.5 PROVINCIAL GOVERNMENT DEPARTMENTS AND AGENGIES (Cont'd)

.4 TSSA - Technical Standards and Safety Authority.

1.6 INTERNATIONAL GOVERNMENT DEPARTMENTS AND AGENCIES

.1 DOHMH - New York City Department of Health and Mental Hygiene, USA.

.2 GSA - Government Services Administration, USA.

1.7 UNITS OF MEASURE

.1 The following abbreviations of units of measure are commonly found in the Project Manual:

.1 A: Amperes.
.2 Amp: Amperes.
.3 C: Celsius.
.4 cm: centimetre.
.5 in: inch, inches.
.6 ft: feet/foot.
.7 hr: hour.
.8 Hz: hertz.
.9 kg: kilogram.
.10 kg/m^3: kilogram per cubic metre.
.11 kN: kilonewton.
.12 kPa: kilopascals.
.13 KSI: kilo pounds per square inch.
.14 KV: kilovolt.
.15 KVA: kilovolt-ampere.
.16 KW: kilowatts.
.17 lb: pounds.
.18 l/s: litre per second.
.19 m: metre.
.20 m^3: cubic metre.
.21 mm: milimetre.
.22 mg/kg: milligrams per kilogram.
.23 mg/L: milligrams per litre.
.24 mm: millimetres.
.25 MPa: megapascal.
.26 MVA: megavolt-ampere.
.27 MW: megawatt.
.28 N: Newtons.
.29 NTU: nephelometric turbidity unit.
.30 ppm: parts per million.
.31 PSF: pound per square foot.
.32 PSI: pounds per square inch.
.33 s: seconds.
.34 ug/L: micrograms per litre.
.35 ug/m^3: micrograms per cubic metre.
.36 V: volts.

1.8 UNITS OF MEASURE IMPERIAL

.1 The following abbreviations of units of measure are commonly found in the Project Manual:

.1 CY: cubic yard.
.2 F: Fahrenheit.
.3 ft: foot/feet.
.4 ga: gauge.
.5 gpm: gallons per minute.
.6 in: inches.
.7 lbs: pounds.
.8 lf: linear feet.
.9 NTU: nephelometric turbidity unit.
.10 psi: pounds-force per square inch.
.11 ppm: parts per million.
.12 sq ft: square feet.
.13 sq yd: square yard.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Inspection and testing, administrative and enforcement requirements.

.2 Tests and mix designs.

.3 Mill tests.

.4 Equipment and system adjust and balance.

1.2 RELATED SECTIONS

.1 Division 26 - Electrical.

.2 Section 34 81 223 - Lift Bridge Machinery.

1.3 QUALITY CONTROL

.1 Develop a quality control program for the project to include but not limited to the following:
- .1 Workers Welding Certificates.
- .2 Master Electrician Certificates.
- .3 QA/QC programs for individual fabricators.
- .4 Work Plan.
- .5 Shop and Factory Testing Procedures.
- .6 Functional Testing Procedures.
- .7 Material Test Reports.
- .8 Test Results for the mechanical, electrical and control elements.

1.4 TOTAL QUALITY ASSURANCE PROGRAM (TQA)

.1 Prepare a total quality assurance (TQA) program for the project for all bridge work. All TQA program documentation must be submitted for review. TQA documentation to be submitted includes but is not limited to the following:
- .1 Workers Welding Certificates.
- .2 Master Electrician Certificates.
- .3 QA/QC programs for individual fabricators.
- .4 Work Plan.
- .5 Shop and Factory Testing Procedures.
- .6 Functional Testing Procedures.
- .7 Material Test Reports.
- .8 Test Results for the mechanical, electrical and control elements.

1.5 INSPECTION

.1 Allow Departmental Representative 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 Departmental Representative 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 Departmental Representative may order any part of Work to be examined. 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, Departmental Representative shall pay cost of examination and replacement.

1.6 INDEPENDENT INSPECTION AGENCIES

.1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work, above and beyond those required of the Contractor. Cost of such services will be borne by Departmental Representative.

.2 Provide equipment required for executing inspection and testing by appointed agencies.

.3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.

.4 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 Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and reinspection.

1.7 ACCESS TO WORK

.1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.

.2 Cooperate to provide reasonable facilities for such access.

1.8 PROCEDURES

.1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.

.2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in Work.

.3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.9 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 Departmental Representative 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 Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Departmental Representative may deduct from Contract Amount difference in value between Work performed and that called for by Contract Documents, amount of which shall be determined by Departmental Representative.

1.10 REPORTS

.1 Submit four (4) copies of inspection and test reports to Departmental Representative.

.2 Provide copies to Subcontractor of work being inspected or tested, manufacturer or fabricator of material being inspected or tested to the Departmental Representative.

1.11 TESTS AND MIX DESIGNS

.1 Furnish test results and mix designs as may be requested.

.2 The cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work shall be appraised by Departmental Representative and may be authorized as recoverable.

1.12 MILL TESTS

.1 Submit mill test certificates as requested and required of specification Sections.

1.13 EQUIPMENT AND SYSTEMS

.1 Submit testing, adjusting and balancing reports for mechanical, control and electrical systems.

.2 Submit Commissioning Documentation in accordance with Section 01 91 00.

.3 Refer to Section 34 81 23 and Division 26 for definitive requirements.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 U.S. Environmental Protection Agency (EPA) / Office of Water.
.1 EPA 833-R-06-004, May 2007, Developing Your Stormwater Pollution Prevention Plan - A Guide for Construction Sites.

1.2 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

1.3 INSTALLATION AND REMOVAL

.1 Provide temporary utilities controls in order to execute work expeditiously.

.2 Remove from site all such work after use.

1.4 DEWATERING

.1 Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.

1.5 WATER SUPPLY

.1 Arrange for connection with appropriate utility company and pay all costs for installation, maintenance and removal.

1.6 TEMPORARY HEATING AND VENTILATION

.1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.

.2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders are not permitted.

.3 Provide temporary heat and ventilation in enclosed areas as required to:
.1 Facilitate progress of Work.
.2 Protect Work and products against dampness and cold.
.3 Prevent moisture condensation on surfaces.
.4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
.5 Provide adequate ventilation to meet health regulations for safe working environment.

1.6 TEMPORARY HEATING AND VENTILATION (Cont'd)

.4 Maintain temperatures of minimum 10°C in areas where construction is in progress.

.5 Ventilating:

.1 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.

.2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.

.3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.

.4 Ventilate storage spaces containing hazardous or volatile materials.

.5 Ventilate temporary sanitary facilities.

.6 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.

.6 Maintain strict supervision of operation of temporary heating and ventilating equipment to:

.1 Conform with applicable codes and standards.

.2 Enforce safe practices.

.3 Prevent abuse of services.

.4 Prevent damage to finishes.

.5 Vent direct-fired combustion units to outside.

.7 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

1.7 TEMPORARY POWER AND LIGHT

.1 Arrange for connection with appropriate utility company. Pay all costs for installation, maintenance and removal.

.2 Temporary power for electric cranes and other equipment is responsibility of Contractor.

.3 Provide and maintain temporary lighting throughout project. Ensure level of illumination on all floors and stairs is not less than 162 lx. Ensure level of illumination for work at roadway level is 108 lx.

1.8 TEMPORARY COMMUNICATION FACILITIES

.1 Provide and pay for temporary telephone, fax, data hook up, lines, and equipment necessary for own use and use of Departmental Representative.

1.9 FIRE PROTECTION

.1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.

.2 Burning rubbish and construction waste materials is not permitted on site.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Construction aids.

.2 Office and sheds.

.3 Parking.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
.1 CSA A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
.2 CAN/CSA-Z321-96(R2006), Signs and Symbols for the Occupational Environment, withdrawn but still available from CSA, CCOHS and Techstreet.

.2 U.S. Environmental Protection Agency (EPA)/ Office of Water.
.1 EPA 833-R-06-004, May 2007, Developing Your Stormwater Pollution Prevention Plan - A Guide for Construction Sites.

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

1.4 INSTALLATION AND REMOVAL

.1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.

.2 Identify areas which have to be gravelled to prevent tracking of mud.

.3 Indicate use of supplemental or other staging area.

.4 Provide construction facilities in order to execute work expeditiously.

.5 Remove from site all such work after use.

1.5 SCAFFOLDING

.1 Scaffolding in accordance with CSA Z797.

.2 Provide and maintain scaffolding, ramps, ladders, swing stagging, platforms, and temporary stairs.

1.6 HOISTING

.1 Provide, operate and maintain hoists/cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for use thereof.

.2 Hoists/cranes shall be operated by qualified operator.

1.7 ELEVATORS

.1 Designated existing and permanent elevators may be used by construction personnel and transporting of materials. Co-ordinate use with Departmental Representative.

.2 Provide protective coverings for finish surfaces of cars and entrances.

1.8 SITE STORAGE/LOADING

.1 The Contractor must store materials in a secure offsite facility.

.2 Confine work and operations of employees to areas defined by Contract Documents. Do not unreasonably encumber premises with products.

.3 Do not load or permit to load any part of Work with a weight or force that will endanger the Work.

1.9 CONSTRUCTION PARKING

.1 Parking will be permitted on site provided it does not disrupt performance of Work, coordinate with Departmental Representative.

.2 Provide and maintain adequate access to project site.

.3 Build and maintain temporary roads where indicated or directed by Departmental Representative and provide snow removal during period of Work.

.4 If authorized to use existing roads for access to project site, maintain such roads for

1.9 CONSTRUCTION PARKING (Cont'd)

.4 (Cont'd) duration of Contract and make good damage resulting from Contractors' use of roads.

.5 Clean construction runways and taxi areas where used by Contractor's equipment.

1.10 OFFICES

.1 Provide office heated to 22°C, lighted 750 lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing laydown table.

.2 Provide a clearly marked and fully stocked first-aid case in a readily available location.

.3 Subcontractors may provide their own offices as necessary. Direct location of these offices.

.4 Departmental Representative's Site office.

.1 Provide temporary office for Departmental Representative.

.2 Inside dimensions minimum 3.6 m long x 3 m wide x 2.4 m high, with floor 0.3 m above grade, complete with 4 - 50% opening windows and one lockable door.

.3 Insulate building and provide heating system to maintain 22° C inside temperature at -20° C outside temperature.

.4 Finish inside walls and ceiling with plywood, hardboard or wallboard and paint in selected colours. Finish floor with 19 mm thick plywood.

.5 Install electrical lighting system to provide min 750 lx using surface mounted, shielded commercial fixtures with 10% upward light component.

.6 Provide private washroom facilities adjacent to office complete with flush or chemical type toilet, lavatory and mirror and maintain supply of paper towels and toilet tissue.

.7 Equip office with 1 x 2 m table, 4 chairs, 6 m of shelving 300 mm wide, one 3 drawer filing cabinet, one plan rack and one coat rack and shelf.

.8 Maintain in clean condition.

1.11 EQUIPMENT, TOOL AND MATERIALS STORAGE

.1 Provide and maintain, in a clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.

.2 Locate materials not required to be stored in weatherproof sheds on site in a manner to cause least interference with work activities.

.3 Submit their plans for review for material staging areas including obtaining warehousing facilities near the bridge site to facilitate staging.

1.12 SANITARY FACILITIES

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.

.2 Post notices and take such precautions as required by local health authorities. Keep area and premises in sanitary condition.

1.13 CONSTRUCTION SIGNAGE

.1 No other signs or advertisements, other than warning signs, are permitted on site.

.2 Signs and notices for safety and instruction shall be in both official languages. Graphic symbols shall conform to CAN/CSA-Z321.

.3 Maintain approved signs and notices in good condition for duration of project, and dispose of off site on completion of project or earlier if directed by Departmental Representative.

1.14 PROTECTION AND MAINTENANCE OF TRAFFIC

.1 Provide access and temporary relocated roads as necessary to maintain traffic.

.2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by Departmental Representative.

.3 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs

1.14 PROTECTION AND MAINTENANCE OF TRAFFIC (Cont'd)

.4 Protect travelling public from damage to person and property.

.5 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.

.6 Verify adequacy of existing roads and allowable load limit on these roads.

.7 Responsible for repair of damage to roads caused by construction operations.

.8 Construct access and haul roads necessary.

.9 Haul roads: constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided.

.10 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.

.11 Dust control: adequate to ensure safe operation at all times.

.12 Location, grade, width, and alignment of construction and hauling roads: subject to approval by Departmental Representative .

.13 Lighting: to assure full and clear visibility for full width of haul road and work areas during night work operations.

.14 Provide snow removal during period of Work.

.15 Remove, upon completion of work, haul roads designated by Departmental Representative .

1.15 CLEAN-UP

.1 Remove construction debris, waste materials, packaging material from work site daily.
.1 Obtain permission from land owners as required.

.2 Clean dirt or mud tracked onto paved or surfaced roadways.

.3 Store materials resulting from demolition activities that are salvageable.

.4 Stack stored new or salvaged material.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

END

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for designing, supplying, installing, inspecting, modifying for compliance, maintaining, and removing:
- .1 All temporary structures used to access Work.
- .2 Housing and containment systems.
- .3 Heating and ventilating Workspaces.
- .4 Lighting of Workspaces.

.2 Work not included in this section:
- .1 Provision of separate air supply for workers.

.3 Intent: housing, heating and ventilating must be sufficient to:
- .1 Ensure safe working environment.
- .2 Facilitate progress of Work in an efficient manner.
- .3 Protect areas adjacent to Work during procedures which may damage surrounding areas.
- .4 Protect Work and products against dampness and cold.
- .5 Prevent moisture condensation on surfaces.
- .6 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.

1.2 SECTION INCLUDES

.1 Barriers.

.2 Environmental Controls.

.3 Traffic Controls.

.4 Fire Routes.

1.3 REFERENCES

.1 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB-1.59-97, Alkyd Exterior Gloss Enamel.

.2 Canadian Standards Association (CSA):
- .1 CAN/CSA-S269.2-M1987(R2003), Access Scaffolding for Construction Purposes.

.3 Province of Ontario.

1.3 REFERENCES (Cont'd)

.3 (Cont'd)

.1 Occupational Health and Safety Act and Regulations for Construction Projects, R.S.O. 1990 as amended 213/91.

.2 General Air Pollution Regulation (O. Reg. 346/90).

.3 Regulations made under Environmental Protection Act:

.1 O. Reg. 419/05 Amended to O. Reg. 516/07. "Air Pollution - Local Air Quality."

.2 O. Reg. 127/01 "Airborne Contaminant Discharge Monitoring and Reporting."

1.4 DESIGN

.1 Engage sufficient Professional Engineers, licensed to practice in Ontario and who are experienced in this type of work, to both design and perform periodic inspections of:

.1 Scaffolding and access structures.

.2 Enclosure (housing) and containment.

.3 Heating and ventilating.

.4 Lighting.

.2 Professional Engineer(s) must determine where to transfer loads to bridge, and evaluate ability of the bridge to accommodate loads.

1.5 SCAFFOLDING

.1 Design scaffolding to CAN/CSA-S269.2.

.2 Connection of temporary access structures to existing steelwork will be permitted only under these conditions:

.1 Connection does not involve drilling into or welding onto the existing structural member.

.2 Loads applied will not cause plastic deformation of existing steelwork.

.3 Copies of original shop drawings for lift bridge form part of this specification. Professional Engineer to use these when developing scaffolding system.

.4 Temporary structures installed and used before close of Navigation season must not block movement of ships or otherwise interfere with operation of Lift Bridge.

.3 Provide means of clearing snow and ice from exterior of scaffolding as this accumulates with spray from waves, precipitation, etc.

1.6 HOISTING

.1 Hoisting via existing elevators: permitted. Abide by weight restrictions. Provide protective coverings for finish surfaces of cars and entrances.

.2 Hoisting, other:
.1 Provide, operate and maintain hoists attached to scaffolding required for moving of workers, materials and equipment.
.2 Hoists to be operated by qualified operator.

1.7 HOUSING AND CONTAINMENT

.1 Intent: to prevent escape of dust, to muffle sounds to threshold required by Peregrine falcons and noise bylaws.

.2 Provide strong and durable housing and containment for portions of Work to be protected, heated, and/or ventilated during Work.
.1 Housing to be strong enough to withstand rain, wind and snow loads, including accumulating ice from spray off open water.

1.8 HEATING

.1 Provide temporary heating required during construction period, including Watchkeeping attendance, maintenance, and fuel.

.2 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

.3 Ensure no water, including condensation water, can drip onto surfaces during construction period.

.4 Fire protection requirements: to Section 01 35 29 - Health And Safety Requirements.

.5 Monitoring of temperature inside enclosure is part of Contractor's Quality Control requirements.

1.9 VENTILATION

.1 Intent of ventilation:
.1 To ensure required air temperature and relative humidity in all parts of enclosure.
.2 To prevent escape of dust from blast cleaning into the environment.
.3 To enhance health and safety of workers.

1.9 VENTILATION (Cont'd)

.2 Minimum air exchange rate during painting: to Occupational Health and Safety regulations described in Section 01 35 29.

.3 Depending upon configuration of enclosure, it may be necessary to install both a mechanical supply and exhaust ventilation system to effect adequate air changes within confined space. Locate air-moving devices in a manner that assures that airflow is not restricted or short circuited and is supplied in proper direction and does not interfere with Work.

.4 Filters: to SSPC-Guide-16 Guide for Selection of Dust Collectors.

.5 Continue operation of exhaust ventilation system after painting process to assure removal of harmful contaminants during paint drying and curing.

.6 Ventilate storage spaces containing hazardous or volatile materials.

1.10 INSTALLATION AND REMOVAL

.1 Provide temporary controls in order to execute Work expeditiously.

.2 Remove from site all such work after use.

1.11 GUARD RAILS AND BARRICADES

.1 Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs, toeboards as necessary.

.2 Provide as required by governing authorities.

1.12 WEATHER ENCLOSURES

.1 Provide weather tight closures to unfinished door, window and control building openings, tops of shafts and other openings in floors and roofs.

.2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.

.3 Design enclosures to withstand wind pressure and snow loading.

1.13 DUST TIGHT SCREENS

.1 Provide dust tight screens or insulated partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public.

.2 Maintain and relocate protection until such work is complete.

1.14 ACCESS TO SITE

.1 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.

1.15 PUBLIC TRAFFIC FLOW

.1 Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect the public.

1.16 FIRE ROUTES

.1 Maintain access to property including overhead clearances for use by emergency response vehicles.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 SCAFFOLDING

.1 Make all changes to scaffolding required by Ministry of Labour officials.

.2 Ensure transition area from ladder(s) to scaffolding is clear of obstructions and cross bracing.

.3 Make periodic inspections of scaffolding as Work progresses. Provide copies of inspection reports to Departmental Representative.

.4 Make periodic inspections of scaffolding as Work progresses. Provide copies of inspection reports to Departmental Representative.

3.2 HEATING EQUIPMENT

.1 Use only heating equipment types acceptable to Departmental Representative.

.2 Heating fuels:
.1 Use either electricity or propane.
.2 Fuel Storage: to requirements of Fire Commissioner of Canada and Section 01 35 43.
.3 Provide and maintain temporary fire protection equipment during performance of Work commensurate with fuel source selected.

.3 Ensure that heating requirements are met by providing, at optimum efficiency of equipment, a capacity of 125% of heat requirement and a sufficient number of standby heaters ready for use at Site.

.4 Vent exhausts of heating equipment outside of housing, well clear of combustible materials and fresh air intake.

3.3 VENTILATION EQUIPMENT

.1 To that shown in reviewed shop drawings.

.2 Filter type and change interval equal to manufacturer's requirements or more often if necessary due to volume of dust generated.

.3 Used filters are lead-contaminated waste until all lead has been removed from the structure and the filters are handling paint solvents only.

3.4 REMOVAL OF HEATING AND VENTILATING EQUIPMENT

.1 Upon receipt of Departmental Representative's directive at the end of each Phase of Work:
.1 Discontinue heating operations; .2 Remove housing and heating equipment from Site.

3.5 QUALITY CONTROL

.1 Is the responsibility of Contractor.

.2 Provide and post at approved locations within housing, one maximum/minimum thermometer per approximately 107 square feet (10 square metres) of plan area of housing.

.3 Ensure continuity of protection by providing a Watchkeeper to make periodic checks at all times when work is not in progress.

3.5 QUALITY CONTROL (Cont'd)

.4 Watchkeeper's qualifications, under this section of specification, are to be sufficient to perform such duties as:

.1 Maintain strict supervision of operation of temporary heating and ventilating equipment.

.2 Enforce safe practices.

.3 Prevent abuse of services.

.4 Prevent damage to finishes due to missuse of heating and ventilating equipment.

.5 Undertake preventive maintenance and refueling normally performed on any shift.

.6 Complete emergency repairs of minor complexity.

.7 Place standby items in service.

.8 Record maximum and minimum temperature at each thermometer on a daily basis, and re-setting thermometers as necessary.

.1 Make temperature records available to Departmental Representative on a daily basis.

.2 Provide certified written records to Departmental Representative on a weekly basis.

3.6 QUALITY ASSURANCE

.1 Departmental Representative perform random inspections of compliance with approved Plans for auditing purposes. If non-compliance is found, Departmental Representative will issue written instructions to comply.

.2 After receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.

.3 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.

.4 No time extensions will be granted for such suspensions.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Product quality, availability, storage, handling, protection, and transportation.

.2 Manufacturer's instructions.

.3 Quality of Work, coordination and fastenings.

.4 Existing facilities.

1.2 REFERENCES

.1 Within text of specifications, reference may be made to reference standards.

.2 Conform to these standards, in whole or in part as specifically requested in specifications.

.3 If there is question as to whether any product or system is in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.

.4 The cost for such testing will be born by in event Departmental Representative of conformance with Contract Documents or by Contractor in event of non-conformance.

.5 Conform to latest date of issue of referenced standards in effect on date of submission of Bids, except where specific date or issue is specifically noted.

.6 OPSS Ontario Provincial Standard Specifications and OPSD Ontario Provincial Standard Drawings quoted in these specifications are available online at http://www.raqsa.mto.gov.on.ca/techpubs/ops.nsf/OPSHomepage.

.7 The standards, codes and specifications to be used for the upgrade of the bridge shall be the latest edition (including all amendments, supplements and revisions).

.8 The CAN/CSA-S6-06, Canadian Highway Bridge Design Code is the primary code to be used in this project.

1.3 QUALITY

.1 Products, materials, equipment and articles (referred to as products throughout specifications) incorporated in Work shall be new, not damaged or defective, and of best quality (compatible with specifications) for purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.

.2 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.

.3 Should any dispute arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.

.4 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.

.5 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.4 AVAILABILITY

.1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for any items. If delays in supply of products are foreseeable, notify Departmental Representative of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.

.2 In event of failure to notify Departmental Representative at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Departmental Representative reserves right to substitute more readily available products of similar character, at no increase in Contract Amount or Contract Time.

1.5 METRIC SIZED MATERIALS

.1 Imperial units of measurement are used exclusively on the drawings and in the specifications for this project.

.2 The Contractor is required to provide imperial products in the sizes called for in the Contract Documents except where a valid claim can be made that a particular product is not available on the Canadian market.

.3 Claims for exemptions from use of imperial sized products shall be in writing and fully substantiated with supportive documentation. Promptly submit application to Departmental Representative for consideration and ruling. Non-imperial sized products may not be used unless Contractor's application has been approved in writing by the Departmental Representative.

.4 Difficulties caused by the Contractor's lack of planning and effort to obtain modular imperial sized products which are available on the Canadian market will not be considered sufficient reasons for claiming that they cannot be provided.

.5 Claims for additional costs due to provision of specified modular imperial sized products will not be considered.

1.6 STORAGE, HANDLING AND PROTECTION

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

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

.3 Store products subject to damage from weather in weatherproof enclosures.

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

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

1.6 STORAGE, HANDLING AND PROTECTION (Cont'd)

.6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

.7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

.9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.7 TRANSPORTATION

.1 Pay costs of transportation of products required in performance of Work.

1.8 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.

.2 Notify Departmental Representative in writing, of conflicts between specifications and manufacturer's instructions, so that Departmental Representative may establish course of action.

.3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Departmental Representative to require removal and re-installation at no increase in Contract Amount or Contract Time.

1.9 QUALITY OF WORK

.1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Departmental Representative if required Work is such as to make it impractical to produce required results.

1.9 QUALITY OF WORK (Cont'd)

.2 Do not employ anyone unskilled in their required duties. Departmental Representative reserves right to require dismissal from site, workers deemed incompetent or careless.

.3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Departmental Representative, whose decision is final.

1.10 CO-ORDINATION

.1 Ensure cooperation of workers in laying out Work. Maintain efficient and continuous supervision.

.2 Be responsible for coordination and placement of openings, sleeves and accessories.

1.11 CONCEALMENT

.1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.

.2 Before installation, inform Departmental Representative if there is interference. Install as directed by Departmental Representative.

1.12 LOCATION OF FIXTURES

.1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.

.2 Inform Departmental Representative of conflicting installation. Install as directed.

1.13 FASTENINGS

.1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.

.2 Prevent electrolytic action between dissimilar metals and materials.

.3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.

.4 Space anchors within individual load limit or shear capacity and ensure they provide positive

1.13 FASTENINGS (Cont'd)

.4 (Cont'd) permanent anchorage. Wood, or any other organic material plugs are not acceptable.

.5 Keep exposed fastenings to a minimum, space evenly and install neatly.

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

1.14 FASTENINGS - EQUIPMENT

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

.2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No.304 stainless steel for exterior areas.

.3 Bolts may not project more than one diameter beyond nuts.

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

1.15 PROTECTION OF WORK IN PROGRESS

.1 Prevent overloading of any part of building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated without written approval of Departmental Representative.

1.16 EXISTING UTILITIES

.1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, pedestrian and vehicular traffic.

1.17 WARRANTY

.1 Warranty all new equipment, components and software to be free of defects in materials and workmanship for a period of two (2) years from date of substantial performance of work.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Verification of equipment and structural elements.

1.2 REFERENCES

.1 Owner's identification of existing survey control points and property limits.

1.3 EXISTING SERVICES

.1 Before commencing work, establish location and extent of service lines in area of Work and notify Departmental Representative of findings.

.2 Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by Departmental Representative.

1.4 LOCATION OF EQUIPMENT AND STRUCTURAL ELEMENTS

.1 Location of equipment and structural elements indicated or specified are to be considered as approximate.

.2 Locate equipment, structural elements and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.

.3 Inform Departmental Representative of impending installation and obtain approval for actual location.

.4 Submit field drawings to indicate relative position of various services and equipment when required by Departmental Representative.

1.5 RECORDS

.1 On completion of equipment and foundations, prepare as-built drawings showing dimensions, locations, angles and elevations of Work.

.2 Record locations of maintained, re-routed and abandoned service lines.

1.6 SUBMITTALS .1 On request of Departmental Representative, submit documentation to verify accuracy of field engineering work.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

END

PART 1 - GENERAL

1.1 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00.

.2 Submit written request in advance of cutting or alteration which affects:
.1 Structural integrity of elements of project.
.2 Integrity of weather-exposed or moisture-resistant elements.
.3 Efficiency, maintenance, or safety of operational elements.
.4 Visual qualities of sight-exposed elements.
.5 Work of Owner or separate contractor.

.3 Include in request:
.1 Identification of project.
.2 Location and description of affected Work.
.3 Statement on necessity for cutting or alteration.
.4 Description of proposed Work, and products to be used.
.5 Alternatives to cutting and patching.
.6 Effect on Work of Owner or separate contractor.
.7 Written permission of affected separate contractor.
.8 Date and time work will be executed.

1.2 MATERIALS

.1 Required for original installation.

.2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00.

1.3 PREPARATION

.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

.2 After uncovering, inspect conditions affecting performance of Work.

.3 Beginning of cutting or patching means acceptance of existing conditions.

1.3 PREPARATION (Cont'd)

.4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.

.5 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

.6 Maintain pedestrian traffic on sidewalk throughout construction.

1.4 EXECUTION

.1 Execute cutting, fitting, and patching including excavation and fill to complete Work.

.2 Fit several parts together, to integrate with other Work.

.3 Uncover Work to install ill-timed Work.

.4 Remove and replace defective and non-conforming Work.

.5 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.

.6 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.

.7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.

.8 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.

.9 Restore work with new products in accordance with requirements of Contract Documents.

.10 Submit proposed materials, finishes and installation method for patching to Departmental Representative for approval, prior to patching.

.11 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.

1.4 EXECUTION (Cont'd)

.12 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

.13 At penetrations of fire rated wall, ceiling, or floor construction, completely seal voids with fierstopping material full thickness of the construction element.

.14 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse, recycling composting and anaerobic digestion in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Progressive cleaning.

.2 Final cleaning.

1.2 PROJECT CLEANLINESS

.1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Owner or other Contractors.

.2 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.

.3 Clear snow and ice from access to building, sidewalks and stairs to limits of property. Bank/pile snow in designated areas only.

.4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.5 Provide on-site containers for collection of waste materials and debris.

.6 Provide and use clearly marked separate bins for recycling. Refer to Section 01 74 20.

.7 Remove waste material and debris from site and deposit in waste container at end of each working day.

.8 Dispose of waste materials and debris off site.

.9 Clean interior areas prior to start of finish work, and maintain areas free of dust and other contaminants during finishing operations.

.10 Store volatile waste in covered metal containers, and remove from premises at end of each working day.

.11 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

.12 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

1.2 PROJECT CLEANLINESS (Cont'd)

.13 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.3 FINAL CLEANING

.1 When Work is Substantially Performed, remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.

.2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.

.3 Prior to final review, remove surplus products, tools, construction machinery and equipment.

.4 Remove waste products and debris other than that caused by Owner or other Contractors.

.5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.

.6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.

.8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.

.9 Clean lighting reflectors, lenses, and other lighting surfaces.

.10 HEPA vacuum clean and dust building interiors, behind grilles, louvers and screens.

.11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.

.12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

.13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.

1.3 FINAL CLEANING (Cont'd)

.14 Remove dirt and other disfiguration from exterior surfaces.

.15 Clean and sweep roofs, gutters, areaways, and sunken wells.

.16 Sweep and wash clean paved areas.

.17 Clean equipment and fixtures to a sanitary condition; clean or replace filters of mechanical equipment.

.18 Clean roofs, downspouts, and drainage systems.

.19 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

.20 Remove snow and ice from access to building.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 CONSTRUCTION & DEMOLITION WASTE

.1 Carefully deconstruct and source separate materials/equipment and divert, from D&C waste destined for landfill to maximum extent possible. Target for this project is 60% diversion from landfill. Reuse, recycle, compost, anaerobic digest or sell material for reuse except where indicated otherwise. On site sales are not permitted.

.2 Source separate waste and maintain waste audits in accordance with the Environmental Protection Act, Ontario Regulation 102/94 and Ontario Regulation 103/94.
- .1 Provide facilities for collection, handling and storage of source separated wastes.
- .2 Source separate the following waste:
  - .1 Brick and portland cement concrete.
  - .2 Corrugated cardboard.
  - .3 Wood, not including painted or treated wood or laminated wood.
  - .4 Gypsum board, unpainted.
  - .5 Steel.
  - .6 Items indicated in Section 02 42 92, Deconstruction of Structures and Minor Site Work.

.3 Submit a waste reduction workplan indicating the materials and quantities of material that will be recycled and diverted from landfill.
- .1 Indicate how material being removed from the site will be reused, recycled, composted or anaerobically digested using Section 02 42 92,. Deconstruction of Structures and Minor Site Work.

.4 Submit proof that all waste is being disposed of at a licensed land fill site or waste transfer site. A copy of the disposal/waste transfer site's license and a letter verifying that said landfill site will accept the waste must be supplied to Departmental Representative prior to removal of waste from the demolition site.

1.2 WASTE PROCESSING SITES

.1 Province of: Ontario.
- .1 Ministry of Environment and Energy, 135 St. Clair Avenue West, Toronto, ON, M4V 1P5.
- .2 Telephone: 800-565-4923 or 416-323-4321.
- .3 Fax: 416-323-4682.

1.2 WASTE PROCESSING SITES (Cont'd)

.2 Recycling Council of Ontario: 215 Spadina Avenue, #225, Toronto, ON, M5T 2C7.
.1 Telephone: 416-657-2797
.2 Fax: 416-960-8053
.3 Email: rco@rco.on.ca.
.4 Internet: http://www.rco.on.ca/.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 CANADIAN GOVERNMENTAL DEPARTMENTS CHIEF RESPONSIBILITY FOR THE ENVIRONMENT

.1 Government Chief Responsibility for the Environment.

Province	Address	General Inquiries	Fax
Ontario	Ministry of Environment and Energy 135 St Clair Avenue West Toronto, ON M4V 1P5	(416) 323-4321 (800) 565-4923	(416) 323-4682
	Environment Canada Toronto, ON	(416) 734-4494	

END

PART 1 - GENERAL

1.1 INSPECTION AND DECLARATION

.1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.

.2 The Consultant Resident Site representative shall inspect of the work in progress, for the purpose of bringing to the attention of Contractor, after checking with the Consultant, and Departmental Representative any discrepancies between the work, in the contract documents and accepted construction procedures. He shall keep a daily log of such inspections and shall issue a a weekly written report to the Consultant, both for distribution, in the form directed. The Resident Site Representative shall make any other reports or survey as may be requested by the Project Manager through the Consultant.

.3 The Resident Site Representative shall make on site observations and spot check to determine whether the work, materials and equipment conform with the Contract Documents and supplementary conditions. The resident Site Representative shall advise the Contractor of any deficiencies or unapproved deviations report immediately to the Consultant and Departmental Representative. The Resident Site Representative shall arrange for the Consultant's Structural, Electrical, Mechanical consultants make periodic inspections to be made timely with respect to the progress of the work.

.4 Completion: submit written certificate that following have been performed:
.1 Work has been completed and inspected for compliance with Contract Documents.
.2 Defects have been corrected and deficiencies have been completed.
.3 Equipment and systems have been tested, adjusted and balanced and are fully operational.
.4 Certificates required by Fire Commissioner have been submitted.
.5 Operation of systems have been demonstrated to PWGSC personnel.
.6 Work is complete and ready for final inspection.

1.1 INSPECTION AND DECLARATION (Cont'd)

.5 Final Inspection: when items noted above are completed, request final inspection of Work by Resident Site Representative, Departmental Representative and Contractor. If Work is deemed incomplete by Departmental Representative, complete outstanding items and request reinspection.

1.2 CLEANING

.1 In accordance with Section 01 74 11.

.2 Remove waste and surplus materials, rubbish and construction facilities from the site in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 As-built, samples, and specifications.

.2 Equipment and systems.

.3 Product data, materials and finishes, and related information.

.4 Operation, inspection and maintenance manual.

.5 Spare parts, special tools and maintenance materials.

.6 Warranties.

1.2 RELATED SECTIONS

.1 Section 01 91 00 - Commissioning - General Requirements.

.2 Section 01 91 13 - General Commissioning (CX) Requirements.

.3 Section 01 91 20 - Project Commissioning.

.4 Section 01 79 00 - Demonstration and Training.

.5 Division 26 - Electrical

.6 Section 34 81 23 - Lift Bridge Machinery.

1.3 SUBMISSION

.1 Prepare and submit operation, inspection and maintenance manual using personnel experienced in maintenance, inspection and operation of described products. Give complete instructions relative to inspection, assembly, installation, replacement, operation, adjustment, alignment, lubrication, maintenance, disassembly and carrying complete parts lists for equipment and materials installed.

.2 Submit reproducible drawings of all materials as fabricated following fabrication. Any deviations from the Contract Documents or Reviewed shop drawings shall be clearly indicated. These drawings shall be stamped "As Built", immediately above the title block.

.3 Submit one copy of a lubrication chart on mylar showing the location of all lubricating fittings

1.3 SUBMISSION (Cont'd)

.3 (Cont'd) and other points of the mechanical and electrical equipment, which require lubrication of any kind, and shall show the kind of lubricant to be used at each point and the frequency of lubrication. The chart shall be framed under glass in a neat wooden frame and shall be placed as directed by the Departmental Representative within the motor room.

.4 Copy will be returned after final inspection, with Departmental Representative's comments.

.5 Revise content of documents as required prior to final submittal.

.6 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, four final copies of operation, inspection and maintenance manuals and commissioning documentation in English.

.7 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.

.8 If requested, furnish evidence as to type, source and quality of products provided.

.9 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

.10 Pay costs of transportation.

1.4 FORMAT

.1 Organize data in the form of an instructional manual.

.2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

.3 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.

.4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by systems, under Section numbers and sequence of Table of Contents.

1.4 FORMAT (Cont'd)

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: Manufacturer's printed data, or typewritten data.

.8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

.9 Provide 1:1 scaled CAD files in dwg format. Forward pdf and Autocad dwg files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp website, as directed by Departmental Representative.

1.5 CONTENTS - EACH VOLUME

.1 Table of Contents in numerical page order,
.1 provide title of project,
.2 date of submission; names,
.3 addresses, and telephone numbers of Contractor with name of responsible parties;
.4 schedule of products and systems, indexed to content of volume.
.5 Index, in alphabetical order.
.6 Manufacturer's literature describing each piece of equipment and giving complete identification including manufacturer's model numbers and drawing numbers.
.7 A set of descriptive leaflets, bulletins and drawings covering all items of equipment.
.8 The catalog number of each piece shall be given, to be used in case it becomes necessary to order replacement parts from the original manufacturer.
.9 Operation instructions, including step-by-step description for starting, operating, and shutdown, including manual operation where applicable. Operation instructions shall note all precautions required for correct and safe operation.
.10 Sequence of operation and how each component and interlock effects the operation of other components.
.11 Maintenance and lubrication instructions for the machinery components as well as reduced size copy of lubrication charts specified herein elsewhere. Steps for draining and cleaning all machinery will be clearly detailed.
.12 Schematic indicating what items should be cleaned and painted on a regular basis.

1.5 CONTENTS - EACH VOLUME (Cont'd)

.1 (Cont'd)

.13 Complete details and procedures for adjusting and replacing all items that may wear.

.14 Anticipation of possible breakdowns and repairs for trouble-shooting.

.15 Steps for cursory inspection that should be carried out annually.

.16 Steps for semi-in-depth inspection that should be carried out every two years.

.17 Steps for in-depth inspection that should be carried out every four years.

.18 Spare parts data.

.19 Reduced size drawings of working drawings which show all as-built corrections.

.2 For each product or system: list names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement part lists.

.3 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00.

.6 Training: Refer to Section 01 79 00.

1.6 AS-BUILTS AND SAMPLES

.1 In addition to requirements in General Conditions, maintain at the site for Departmental Representative one record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Amendments and addenda.

.4 Change Orders and other modifications to the Contract.

.5 Reviewed shop drawings, product data, and samples.

.6 Field test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store record documents and samples in field office apart from documents used for

1.6 AS-BUILTS AND SAMPLES (Cont'd)

.2 (Cont'd) construction. Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.

.4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.

.5 Keep record documents and samples available for inspection by Departmental Representative.

.6 Turn one set, paper copy and electronic copy, of AS-BUILT drawings and specifications over to Departmental Representative on completion of work.

.7 If project is completed without significant deviations from Contract drawings and specifications submit to Departmental Representative one set of drawings and specifications marked "AS-BUILT".

1.7 RECORDING ACTUAL SITE CONDITIONS

.1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Departmental Representative.

.2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: legibly mark each item to record actual construction, including:
.1 Measured depths of elements of foundation in relation to finish first floor datum.
.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
.4 Field changes of dimension and detail.
.5 Changes made by change orders.

1.7 RECORDING ACTUAL SITE CONDITIONS (Cont'd)

.4 Contract Drawings and shop drawings:(Cont'd)
.6 Details not on original Contract Drawings.
.7 References to related shop drawings and modifications.

.5 Specifications: legibly mark each item to record actual construction, including:
.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
.2 Changes made by Amendments and change orders.

.6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.8 EQUIPMENT AND SYSTEMS

.1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

1.8 EQUIPMENT AND SYSTEMS (Cont'd)

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.12 Include test and balancing reports as specified in Section 01 45 00, 01 91 00 and 34 81 23.

.13 Additional requirements: As specified in individual specification sections.

1.9 MATERIALS AND FINISHES

.1 Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Additional Requirements: as specified in individual specifications sections.

1.10 SPARE PARTS

.1 Provide spare parts, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to site; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.11 MAINTENANCE MATERIALS

.1 Provide maintenance and extra materials, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to site; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.12 SPECIAL TOOLS

.1 Provide special tools, in quantities specified in individual specification section.

.2 Provide items with tags identifying their associated function and equipment.

.3 Deliver to site; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.13 STORAGE, HANDLING AND PROTECTION

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

.3 Store components subject to damage from weather in weatherproof enclosures.

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

1.14 WARRANTIES

.1 Separate each warranty with index tab sheets keyed to Table of Contents listing.

1.14 WARRANTIES (Cont'd)

.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of the applicable item of work.

.4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Certificate of Substantial Performance is determined.

.5 Verify that documents are in proper form, contain full information, and are notarized.

.6 Co-execute submittals when required.

.7 Retain warranties until time specified for submittal.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Procedures for demonstration and instruction of equipment and systems to Owner's O&M personnel.

.2 Owner's O&M personnel includes property facility manager, Bridge Master, Bridge Operators, maintenance staff, security staff and technical specialists, as applicable.

1.2 DESCRIPTION

.1 Demonstrate scheduled operation and maintenance of equipment and systems to Owner's O&M personnel two (2) weeks prior to date of final inspection.

.2 Departmental Representative will provide list of Owner's O&M personnel to receive instructions, and will coordinate their attendance at agreed-upon times.

1.3 QUALITY CONTROL

.1 When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's O&M personnel, and provide written report that demonstration and instructions have been completed.

.2 Submit training schedule of time and date for demonstration and training of each item of equipment and each system in accordance with the training plan four weeks prior to designated dates, for Departmental Representative's approval.

.3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.

.4 Report shall give time and date of each demonstration and training, with list of persons present.

1.4 CONDITIONS FOR DEMONSTRATIONS

.1 Equipment has been inspected and put into operation in accordance with the requirements in Divisions 26 and 34.

.2 Testing, adjusting, and balancing has been performed and equipment and systems are fully operational.

.3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.5 PREPARATION

.1 Verify that conditions for demonstration and instructions comply with requirements.

.2 Verify that designated Owner's O&M personnel are present.

1.6 DEMONSTRATION AND INSTRUCTIONS

.1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, control system alarms, servicing, and maintenance of each item of equipment at scheduled times, at the equipment location.

.2 Instruct Owner's O&M personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.

.3 Review contents of manual in detail to explain all aspects of operation and maintenance.

.4 Prepare and insert additional data in operations and maintenance manuals when the need for additional data becomes apparent during instructions.

1.7 TIME ALLOCATED FOR INSTRUCTIONS

.1 Ensure amount of time required for instruction of each item of equipment or system as follows:
.1 Section 26 09 17 - Bridge Control System: 16 hours of classroom instruction and 40 hours of on-site instructions.
.2 Section 26 24 19 - Motor Control Centres: 16 hours of instruction.
.3 Section 26 29 23 -Vector Variable Frequency Drives: 16 hours of instruction.
.4 Section 34 81 23 - Lift Bridge Machinery: 40 hours of instruction.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Includes general requirements for commissioning facilities and facility systems.

1.2 QUALITY ASSURANCE

.1 Provide System Commissioning Administrator under provisions specified in Section 01 91 20.

.2 Comply with applicable procedures and standards of the certification sponsoring association.

.3 Perform services under direction of supervisor qualified under certification requirements of sponsoring association.

1.3 REFERENCES

.1 NETA Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems 2009.

1.4 SUBMITTALS

.1 Within 15 working days of Award of Contract, submit name of System Commissioning Administrator proposed to perform services who has managerial responsibilities for coordination of all commissioning activities.

.2 Submit documentation to confirm System Commissioning Administrator compliance with quality assurance provision.

.3 Submit 3 preliminary specimen copies of each type of startup checklist, product information and performance verification report forms proposed for use.

.4 Submit completed report forms immediately after completion of each testing to Department Representative for review and verification.

.5 Fifteen days prior to Substantial Performance, submit four (4) copies of final reports on applicable forms for functional performance verification.

.6 Submit post-commissioning reports of testing, adjusting, and balancing postponed due to seasonal, climatic, occupancy, or other reasons

1.4 SUBMITTALS (Cont'd)

.6 (Cont'd) beyond Contractor's control, promptly after execution of those services.

.7 Submit all other commissioning documentation in accordance with Section 01 91 20.

1.5 REPORT FORMS

.1 System Commissioning Administrator shall make reports.

.2 Report forms shall include:
.1 Startup Checklists.
.2 Product Information (PI) Report forms.
.3 Performance Verification (PV) Report forms.

.3 Ensure each form bears signature of recorder, and that of supervisor of reporting organization.

.4 Submit signed form to Consultant for review and approval. After approval, immediately submit form bearing Consultant's signature to Departmental Representative.

.5 Submit signed form to Departmental Representative for review, approval and signature.

.6 Identify each instrument used for testing, adjusting and balancing and its latest date of calibration.

1.6 CONTRACTOR'S RESPONSIBILITIES

.1 Prepare each system for testing and balancing.

.2 Cooperate with testing organization and provide access to equipment and systems.

.3 Provide personnel and operate systems at designated times, and under conditions required for proper testing, adjusting, and balancing.

.4 Notify testing organization and Departmental Representative 7 days prior to time project will be ready for testing, adjusting, and balancing.

.5 Accurately record data for each step.

.6 Report to Departmental Representative any deficiencies or defects noted during performance of services.

1.6 CONTRACTOR'S RESPONSIBILITIES (Cont'd)

.7 Correct deficiencies identified in accordance with Departmental Representative's written instructions.

1.7 PREPARATION

.1 Provide instruments required for testing, adjusting, and balancing operations.

.2 Make instruments available to Departmental Representative to facilitate spot checks during testing and functional performance verification.

.3 Retain possession of instruments and remove at completion of services.

.4 Verify systems installation is complete and in continuous operation.

1.8 EXECUTION

.1 Test equipment, balance distribution systems, and adjust devices for bridge operating mechanical and electrical systems.

.2 Test equipment and adjust devices for bridge control system.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.

.2 Acronyms:

.1 AFD - Alternate Forms of Delivery, service provider.
.2 BMM - Building Management Manual.
.3 Cx - Commissioning.
.4 EMCS - Energy Monitoring and Control Systems.
.5 O&M - Operation and Maintenance.
.6 PI - Product Information.
.7 PV - Performance Verification.
.8 TAB - Testing, Adjusting and Balancing.

1.2 GENERAL

.1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:

.1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
.2 Ensure appropriate documentation is compiled into the BMM.
.3 Effectively train O&M staff.

.2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.

.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
.2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.

1.2 GENERAL (Cont'd)

.3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 COMMISSIONING OVERVIEW

.1 For Cx responsibilities refer to Section 01 91 33.

.2 Cx to be a line item of Contractor's cost breakdown.

.3 Cx activities supplement field quality and testing procedures described in relevant technical sections.

.4 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built work is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.

.5 Departmental Representative will issue Certificate of Substantial Performance when:
.1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
.2 Equipment, components and systems have been commissioned.
.3 O&M training has been completed.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

.1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the nonfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.

.2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor.

1.5 PRE-CX REVIEW

.1 Before Construction:

.1 Review contract documents, confirm by writing to Departmental Representative.

.1 Adequacy of provisions for Cx.

.2 Aspects of design and installation pertinent to success of Cx.

.2 During Construction:

.1 Co-ordinate provision, location and installation of provisions for Cx.

.3 Before start of Cx:

.1 Have completed Cx Plan up-to-date.

.2 Ensure installation of related components, equipment, sub-systems, systems is complete.

.3 Fully understand Cx requirements and procedures.

.4 Have Cx documentation shelf-ready.

.5 Understand completely design criteria and intent and special features.

.6 Submit complete start-up documentation to Departmental Representative.

.7 Have Cx schedules up-to-date.

.8 Ensure systems have been cleaned thoroughly.

.9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.

.10 Ensure "As-Built" system schematics are available.

.4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

.1 Report conflicts between requirements of this section and other sections to Departmental Representative before start-up and obtain clarification.

.2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.7 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00, 01 78 00 and 01 91 00.

.1 Submit no later than fifteen (15) working days after award of Contract:

.1 Names of Contractor's Cx agencies and system.

.2 Draft Cx documentation.

1.7 SUBMITTALS (Cont'd)

.1 Submittals:(Cont'd)
.1 (Cont'd)
.3 Preliminary Cx schedule.
.2 Request in writing to Departmental Representative for changes to submittals and obtain written approval at least two (2) weeks prior to start of Cx.
.3 Submit proposed Cx procedures to Departmental Representative where not specified and obtain written approval at least two (2) weeks prior to start of Cx.
.4 Provide additional documentation relating to Cx process required by Departmental Representative.

1.8 COMMISSIONING DOCUMENTATION

.1 Refer to Sections 01 91 20 and 01 91 33.

.2 Departmental Representative to review and approve Cx documentation.

.3 Provide completed and approved Cx documentation to Departmental Representative.

1.9 COMMISSIONING SCHEDULE

.1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.

.2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
.1 Approval of Cx reports.
.2 Verification of reported results.
.3 Repairs, retesting, re-commissioning, re-verification.
.4 Training.

1.10 COMMISSIONING MEETINGS

.1 Convene Cx meetings following project meetings: Section 01 32 16 and as specified herein.

.2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.

.3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.

.4 At 50%, 75% and 90% construction completion stages. Section 01 32 16. Departmental Representative to call a separate Cx scope meeting to review progress, discuss schedule of

1.10 COMMISSIONING MEETINGS (Cont'd)

.4 (Cont'd)
equipment start-up activities and prepare for Cx. Issues at meeting to include:
.1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
.2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.

.5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.

.6 Meeting will be chaired by System Commissioning Administrator, who will record and distribute minutes.

.7 Ensure subcontractors and relevant manufacturer representatives are present at 50%, 75% and 90% and subsequent Cx meetings and as required.

1.11 STARTING AND TESTING

.1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

1.12 WITNESSING OF STARTING AND TESTING

.1 Provide ten (10) days notice prior to commencement.

.2 Departmental Representative to witness of start-up and testing.

.3 Contractor's System Commissioning Administrator to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.13 MANUFACTURER'S INVOLVEMENT

.1 Factory testing: manufacturer to:
.1 Coordinate time and location of testing.
.2 Provide testing documentation for approval by Departmental Representative.
.3 Arrange for Departmental Representative to witness tests.
.4 Obtain written approval of test results and documentation from Departmental Representative before delivery to site.

1.13 MANUFACTURER'S INVOLVEMENT (Cont'd)

.2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative.
.1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
.2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.

.3 Integrity of warranties:
.1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
.2 Verify with manufacturer that testing as specified will not void warranties.

1.14 PROCEDURES

.1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.

.2 Conduct start-up and testing in following distinct phases:
.1 Included in delivery and installation:
.1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
.2 Visual inspection of quality of installation.
.2 Start-up: follow accepted start-up procedures.
.3 Operational testing: document equipment performance.
.4 System PV: include repetition of tests after correcting deficiencies.
.5 Post-substantial performance verification: to include fine-tuning.

.3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.

.4 Document require tests on approved PV forms.

.5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance

1.14 PROCEDURES (Cont'd)

.5 (Cont'd)
with requirements, and resulted in damage to equipment, implement following:
.1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
.2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
.3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
.1 Rejected equipment to be remove from site and replace with new.
.2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

.1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.

.2 Start-up documentation to include:
.1 Factory and on-site test certificates for specified equipment.
.2 Pre-start-up inspection reports.
.3 Signed installation/start-up check lists.
.4 Start-up reports,
.5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

.1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.

.2 With assistance of manufacturer develop written maintenance program and submit to the Departmental Representative for approval before implementation.

.3 Operate and maintain systems for length of time required for commissioning to be completed.

.4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

.1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.

.2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF COMMISSIONING

.1 Notify Departmental Representative at least 21 days prior to start of Cx.

.2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS / EQUIPMENT

.1 Submit to Departmental Representative for review and approval:
.1 Complete list of instruments proposed to be used.
.2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.

.2 Provide the following equipment as required:
.1 2-way radios.
.2 Ladders.
.3 Equipment as required to complete work.

1.20 COMMISSIONING PERFORMANCE VERIFICATION

.1 Carry out Cx: .1 Under actual operating conditions, over entire operating range, in all modes.
.2 On independent systems and interacting systems.

.2 Cx procedures to be repeatable and reported results are to be verifiable.

.3 Follow equipment manufacturer's operating instructions.

.4 EMCS trending to be available as supporting documentation for performance verification.

1.21 WITNESSING COMMISSIONING

.1 Departmental Representative to witness activities and verify results.

1.22 AUTHORITIES HAVING JURISDICTION

.1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.

.2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.

.3 Provide copies to Departmental Representative within 5 days of test and with Cx report.

1.23 EXTRAPOLATION OF RESULTS

.1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when approved by Departmental Representative in accordance with equipment manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formulae.

1.24 EXTENT OF VERIFICATION

.1 Provide manpower and instrumentation to verify up to 80% of reported results, unless specified otherwise in other sections.

.2 Number and location to be at discretion of Departmental Representative.

.3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.

.4 Review and repeat commissioning of systems if inconsistencies found in more than 10% of reported results.

.5 Perform additional commissioning until results are acceptable to Departmental Representative.

1.25 REPEAT VERIFICATIONS

.1 Assume costs incurred by Departmental Representative for third and subsequent verifications where:
.1 Verification of reported results fail to receive Departmental Representative's approval.
.2 Repetition of second verification again fails to receive approval.
.3 Departmental Representative deems Contractor's request for second verification was premature.

1.26 SUNDRY CHECKS AND ADJUSTMENTS

.1 Make adjustments and changes which become apparent as Cx proceeds.

.2 Perform static and operational checks as applicable and as required.

1.27 DEFICIENCIES, FAULTS, DEFECTS

.1 Correct deficiencies found during start-up and Cx to satisfaction of Departmental Representative.

.2 Report problems, faults or defects affecting Cx to Departmental Representative in writing. Stop Cx until problems are rectified. Proceed with written approval from Departmental Representative.

1.28 COMPLETION OF COMMISSIONING

.1 Upon completion of Cx leave systems in normal operating mode.

.2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.

.3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative.

1.29 ACTIVITIES UPON COMPLETION OF COMMISSIONING

.1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

1.30 TRAINING

.1 In accordance with Section 01 91 41.

1.31 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

.1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract.

1.32 OCCUPANCY

.1 Cooperate fully with Departmental Representative during stages of acceptance and occupancy of facility.

1.33 INSTALLED INSTRUMENTATION

.1 Use instruments installed under Contract for TAB and PV if:
.1 Accuracy complies with these specifications.
.2 Calibration certificates have been deposited with Departmental Representative.

1.34 PERFORMANCE VERIFICATION TOLERANCES

.1 Application tolerances: .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/-10% of specified values.

.2 Instrument accuracy tolerances:
.1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:
.1 Unless otherwise specified actual values to be within +/-2% of recorded values.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

END

PART 1 - GENERAL

1.1 SPECIAL WARNING

.1 This project requires a special enhanced commissioning.

.2 One of the commissioning requirements is that the General Contractor must engage a qualified independent System Commissioning Administrator (SCA) to coordinate and organize all Pre-Commissioning Testing, Commissioning Testing, and O&M Training. The SCA must complete the Contractor's Commissioning Documentation as specified in this Section.

.3 A total of 4% of the construction price will be held back by PWGSC for unfinished commissioning work.

1.2 GENERAL

.1 The "Commissioning" for this project is defined as a planned program of activities which enhance quality management and information transfer that extends throughout all stages of project delivery.

.2 The commissioning activities shall include the standard activities and the enhanced activities which are traditionally not provided by the design and construction industry and which are defined in this document.

1.3 REFERENCE STANDARDS

.1 The most stringent requirements of the following commissioning standards and guidelines shall apply:
.1 NETA Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems 2009.

1.4 ROLES AND RESPONSIBILITIES

.1 The key members of the commissioning team include the Contractor, Departmental Representative, the Consultant, and the PWGSC Commissioning Manager (or its representative).
.1 It is the Contractor's responsibility to engage a qualified independent System Commissioning Administrator (SCA) to represent the Contractor including the Sub-Contractors. The SCA shall be responsible for carrying out

1.4 ROLES AND RESPONSIBILITIES (Cont'd)

.1 (Cont'd)

.1 (Cont'd)

the Contractor's commissioning activities under the direction of the Consultant.

.2 The PWGSC Commissioning Manager (or its representative) will be assisted by the Consultant and other project team members for overview of the commissioning activities on behalf of the Departmental Representative. The PWGSC Commissioning Manager is the Commissioning Authority for this project.

.2 The Contractor is responsible for the following standard commissioning activities and enhanced commissioning activities during project construction, commissioning and operation phases.

.1 Construction Phase:

.1 Engage a qualified independent System Commissioning Administrator as single point of contact for all matters relating to commissioning (enhanced activity).

.2 Conduct separate commissioning meetings and prepare minutes of meeting.

.3 Submit shop drawings (standard activity).

.4 Conduct equipment installation and startup tests, and submit test reports (standard activity).

.5 Perform TAB and submit TAB report (standard activity).

.6 Conduct System Startup Verification Testing and complete Startup Checklists and PI Report forms (enhanced activity).

.2 Commissioning Phase:

.1 Conduct separate commissioning meetings and prepare minutes of meeting.

.2 Conduct Functional Performance Testing and complete PV Report forms (enhanced activity).

.3 Demonstrate system operation (standard activity).

.4 Submit Maintenance Manuals (formerly called O&M Manuals) (standard activity).

.5 Submit "As-Built" drawings and specifications (standard activity).

.6 Conduct O&M training (standard activity).

.3 Operation Phase:

.1 Conduct separate commissioning meetings and prepare minutes of meeting.

.2 Conduct deferred Functional Performance Testing and complete PV Report forms (enhanced activity).

1.4 ROLES AND RESPONSIBILITIES (Cont'd)

.2 (Cont'd)

.3 Operation Phase:(Cont'd)

.3 Provide fine-tuning (standard activity).

.4 Provide specified inspection and maintenance services during warranty period (standard activity).

.3 The Departmental Representative will carry out the following commissioning activities related to the Contractor:

.1 Review and approve Contractor's Startup Checklists, PI and PV Report Forms and Functional Performance Test Forms (enhanced activity).

.2 Review and approve Contractor's Standard Operation Procedures (SOP) Manual (formerly called Systems Manual) (enhanced activity).

.3 Review shop drawings (standard activity).

.4 Review and inspect installation, and prepare construction deficiencies report (standard activity).

.5 Review and approve TAB report (standard activity).

.6 Direct and approve System Startup Verification Testing (enhanced activity).

.7 Direct and approve Functional Performance Testing (enhanced activity).

.8 Review and approve Maintenance Manuals (standard activity).

.9 Review and approve "As-Built" drawings and specifications (standard activity).

.10 Review O&M training (standard activity).

.11 Review and approve commissioning report (enhanced activity).

.12 Witness post-acceptance commissioning testing (enhanced activity).

.13 Direct and approve post-acceptance fine-tuning and review warranty services (standard activity).

.14 Review and approve updated commissioning report (enhanced activity).

.4 The PWGSC Commissioning Manager (or its representative) will carry out the following commissioning activities related to the Contractor and the Consultant:

.1 Review and approve the qualifications of the System Commissioning Administrator (SCA) submitted by the Contractor.

.2 Review and approve Startup Checklists, PI and PV Report Forms prepared by the System Commissioning Administrator (SCA) .

1.4 ROLES AND RESPONSIBILITIES (Cont'd)

.4 (Cont'd)

.3 Witness System Startup Verification Testing conducted by the Contractor and review test reports.

.4 Witness Functional Performance Testing conducted by the Contractor and review test reports.

.5 Review and approve O&M training conducted by the Contractor.

.6 Review commissioning documentation submitted by the Contractor.

.7 Review and approved commissioning report prepared by the System Commissioning Administrator (SCA).

.8 Witness the post-acceptance commissioning testing conducted by the Contractor and review test reports.

.9 Review and approve updated commissioning report prepared by the System Commissioning Administrator (SCA).

1.5 QUALIFICATIONS OF SYSTEM COMMISSIONING ADMINISTRATOR (SCA)

.1 The System Commissioning Administrator: a qualified independent System Commissioning Administrator (SCA) for scheduling, coordination and supervision of Contractor's commissioning activities during construction, acceptance, and post-acceptance stages. The System Commissioning Administrator shall provide Contractor's Commissioning Documentation.

.2 Unless reviewed by the PWGSC Commissioning Manager, the System Commissioning Administrator shall be a qualified SCA in vertical lift tower driven movable bridge commissioning. The Contractor shall hire and submit the name of SCA with documentation confirming qualifications within fifteen (15) working days of award of contract.

.3 The System Commissioning Administrator shall have a minimum of ten (10) years of recent experience in the commissioning of movable vertical lift tower driven bridge construction including the bridge electrical system, bridge control system and bridge machinery system.

1.6 SCHEDULING

.1 Within fifteen (15) working days of contract award, the Contractor shall submit bar chart commissioning schedules indicating anticipated date of start, duration, and date of completion for the following key activities:

1.6 SCHEDULING (Cont'd)

.1 (Cont'd)
.1 Commissioning meetings.
.2 Shop drawings.
.3 Pre-startup installation inspections and tests.
.4 System and Equipment Startup and Verification.
.5 TAB.
.6 Functional Performance Test.
.7 Maintenance Manuals.
.8 "As-Built" drawings and specifications.
.9 O&M Training.
.10 O&M Training report.

.2 Bar chart commissioning schedule shall be prepared for each component, equipment, sub-system, system and integrated system to be commissioned as listed under paragraph 1.11.

.3 The Commissioning shall be carried out to meet the approved project schedule.

1.7 CONTRACTOR'S COMMISSIONING DOCUMENTATION

.1 The Contractor's Commissioning Documentation shall include the following:
.1 Commissioning Schedule.
.2 Minutes of Commissioning meetings.
.3 Shop drawings and product data.
.4 Installation inspection and test reports.
.5 TAB reports.
.6 Startup Checklists.
.7 Product Information (PI) Report forms.
.8 Performance Verification (PV) Report forms.
.9 "As-Built" drawings and specifications.
.10 Operation and Maintenance Manuals.
.11 Operation and Maintenance Training Schedule.
.12 Operation and Maintenance Training Report.

1.8 PRE-COMMISSIONING TESTING - STARTUPS

.1 Requirements of Pre-commissioning Verification: a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems (eg., emergency, fire, and life safety) operate in accordance with contact documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions. Verification of the proper operation of the control system also includes verifying the interface of the control system with the mechanical and power components.

1.8 PRE-COMMISSIONING TESTING - STARTUPS (Cont'd)

.2 The Startup Checklists and PI Report forms shall be completed by the Contractor and verified by the Consultant.

1.9 COMMISSIONING TESTING

.1 Commissioning Testing shall include System Operation Demonstration and Functional Performance Testing of all systems to be commissioned. Test each system independently and then in unison with integrated systems.

.2 Requirements of Functional Performance Testing (FPT): FPT shall determine if the systems are providing the required services in accordance with the finalized design intent. If FPT cannot be completed due to seasonal reasons, lack of occupancy, deficiencies beyond the scope of the electrical and mechanical work, or any other reason, this shall be noted along with an indication of when tests will be rescheduled. If any identified performance deficiencies need to be corrected, the tests shall be repeated after corrective work is carried out, and this process shall continue until acceptable performance is achieved.

.3 The PV Report forms shall be completed by the Contractor and verified by the Departmental Representative.

1.10 EXTENT OF COMMISSIONING

.1 Systems to be commissioned with the comprehensive commissioning to include:
.1 Interface portion of the associated electrical and other bridge systems.
.2 Power Distribution Systems.
.3 Drive Systems.
.4 Mechanical Systems.
.5 Generator System.
.6 Bridge Control System.
.7 Aerial Cable Automatic Transfer Switch.

1.11 O&M TRAINING

.1 The Contractor shall provide qualified training instructors to conduct O&M training.

.2 Four weeks prior to commencement of O&M training, the Contractor shall submit training schedule with course outline, agenda and a copy of training manual in accordance with the

1.11 O&M TRAINING (Cont'd)

.2 (Cont'd) training plan for review by the Departmental Representative and the PWGSC Commissioning Manager.

.3 Training shall include familiarization sessions, hands-on instruction, and classroom sessions.

.4 Classroom training shall include: review of Operation and Maintenance Manuals, Standard Operating Procedures (SOP) Manual, System Operational Procedures for all modes of operation, acceptable tolerances for system adjustments and procedures for dealing with abnormal and emergency situations.

1.12 COMMISSIONING REPORT AND POST-ACCEPTANCE COMMISSIONING

.1 When the acceptable Functional Performance Testing, O&M Training, and commissioning documentation have been completed, the Consultant shall prepare a commissioning report. The report will identify the completed functional performance tests, the deferred functional performance tests, construction deficiencies, design deficiencies, user's changes of requirement, and outstanding commissioning issues. The report will provide review comments on test results, O&M training and commissioning documentation, and will recommend follow-up actions to be taken during post-acceptance commissioning.

.2 The Project Manager will not issue the "Interim Certificate of Completion" until the commissioning report with a recommendation of acceptance is submitted by the PWGSC Commissioning Manager.

1.13 ADDITIONAL COMMISSIONING REQUIREMENTS

.1 Refer to other specifications sections for additional commissioning requirements.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not used.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes: Commissioning forms to be completed for equipment, system and integrated system.

1.2 INSTALLATION/START-UP CHECK LISTS

.1 Include the following data: .1 Product manufacturer's installation instructions and recommended checks.
.2 Special procedures as specified in relevant technical sections.
.3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.

.2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Departmental Representative supplemental additional data lists will be required for specific project conditions.

.3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.

.4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Departmental Representative. Check lists will be required during Commissioning and will be included in Bridge O&M Manual at completion of project.

.5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

.1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the BMM at completion of work.

1.3 PRODUCT INFORMATION (PI) REPORT FORMS (Cont'd)

.2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Departmental Representative's approval.

1.4 PERFORMANCE VERIFICATION (PV) FORMS

.1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.

.2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.

.3 Prior to PV of integrated system, complete PV forms of related systems and obtain Departmental Representative's approval.

1.5 SAMPLES OF COMMISSIONING FORMS

.1 System Commissioning Administrator (SCA) will develop and provide to Contractor required project-specific Commissioning forms in electronic format complete with specification data.
.1 PI Forms.
.2 PV Forms.
.3 Installation/Startup Checklist.
.4 Functional Performance Test.

.2 Revise items on Commissioning forms to suit project requirements.

1.6 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

.1 When additional forms are required, develop appropriate verification forms and submit to Departmental Representative for approval prior to use.
.1 Additional commissioning forms to be in same format as other forms in use.

1.7 COMMISSIONING FORMS

.1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.

1.7 COMMISSIONING FORMS (Cont'd)

.2 Strategy for Use:

.1 System Commissioning Administrator (SCA) provides Contractor project-specific Commissioning forms with Specification data included.

.2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.

.3 Confirm operation as per design criteria and intent.

.4 Identify variances between design and operation and reasons for variances.

.5 Verify operation in specified normal and emergency modes and under specified load conditions.

.6 Record analytical and substantiating data.

.7 Verify reported results.

.8 Form to bear signatures of recording technician.

.9 Submit immediately after tests are performed to Departmental Representative for review.

.10 Reported results in true measured Imperial unit values.

.11 Provide Departmental Representative with originals of completed forms.

.12 Maintain copy on site during start-up, testing and commissioning period.

.13 Forms to be both hard copy and electronic format with typed written results in O&M Manual.

1.8 LANGUAGE

.1 To suit the language profile of the awarded contract.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 This Section specifies roles and responsibilities of Commissioning Training.

1.2 TRAINEES

.1 Trainees: personnel selected for operating and maintaining this facility. Includes Facility Bridge Master, bridge operators, maintenance staff, security staff, and technical specialists as required.

.2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

.1 Departmental Representative will provide:
.1 Descriptions of systems.
.2 Instruction on design philosophy, design criteria, and design intent.

.2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
.1 Start-Up, operation, shut-down of equipment, components and systems.
.2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
.3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.

.3 Contractor and equipment manufacturer to provide instruction on:
.1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

1.4 TRAINING OBJECTIVES

.1 Training to be detailed and duration to ensure:
.1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
.2 Effective on-going inspection, measurements of system performance.
.3 Proper preventive maintenance, diagnosis and trouble-shooting.

1.4 TRAINING OBJECTIVES (Cont'd)

.1 (Cont'd)
.4 Ability to update documentation.
.5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.5 TRAINING MATERIALS

.1 Instructors to be responsible for content and quality.

.2 Include hands-on training for each PWGSC staff member up to twelve (12) persons.

.3 Training materials to include:
.1 "As-Built" Contract Documents.
.2 Standard Operating Procedures (SOP).
.3 Operation and Maintenance Manual with lockout points.
.4 Management Manual.
.5 TAB and PV Reports.
.6 Maintenance Log.

.4 Departmental Representative, PWGSC Commissioning Manager and Bridge Master will review training manuals.

.5 Training materials to be in a format that permits future training procedures to same degree of detail.

.6 Supplement training materials:
.1 Overhead projectors.
.2 Multimedia presentations.
.3 Manufacturer's training videos.
.4 Equipment models.

1.6 SCHEDULING

.1 Include in Commissioning Schedule time for training.

.2 Deliver training during regular working hours, training sessions to be eight (8) hours in length.

.3 Training to be completed prior to acceptance of facility.

1.7 RESPONSIBILITIES

.1 Be responsible for:
.1 Implementation of training activities,
.2 Coordination among instructors,
.3 Quality of training, training materials,

.2 Departmental Representative will evaluate training and materials.

.3 Upon completion of training, provide written report, signed by Instructors, witnessed by Departmental Representative.

1.8 TRAINING CONTENT

.1 Training to include demonstrations by Instructors using the installed equipment and systems.

.2 Content includes:
.1 Review of facility and occupancy profile.
.2 Functional requirements.
.3 System philosophy, limitations of systems and emergency procedures.
.4 Review of system layout, equipment, components and controls.
.5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
.6 System operating sequences, including step-by-step directions for starting up, shut-down, switches, and emergency procedures.
.7 Maintenance and servicing.
.8 Trouble-shooting diagnosis.
.9 Inter-action among systems during integrated operation.
.10 Review of O&M documentation.

.3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

1.9 VIDEO-BASED TRAINING

.1 Manufacturer's videotapes/DVDs/Blu-ray to be used as training tool with Departmental Representative's review and written approval two (2) months prior to commencement of scheduled training.

.2 On-Site training videos:
.1 Videotape or record training sessions for use during future training.
.2 To be performed after systems are fully commissioned.

1.9 VIDEO-BASED TRAINING (Cont'd)

.2 On-Site training videos:(Cont'd)
.3 Organize into several short modules to permit incorporation of changes.

.3 Production methods to be professional and high quality.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Demolition of Control Building Wall, Concrete Floor Slab in Motor Room, Wall between the Motor/Sheave Rooms, Reinforced Concrete Supports for Gates, Sidewalks, Curbs, Light Poles, Pipe Railing, Guide Rails, Misc Structural Steel components and hardware.

1.2 MEASUREMENT PROCEDURES

.1 Structural Demolition includes removals on the bridge and on the approach roadways, and will be measured as follows:
- .1 Concrete and masonry - kilograms.
- .2 Steel - kilograms.
- .3 Other metals - kilograms.
- .4 Misc. components -kilograms.

1.3 REFERENCES

.1 Canadian Council of Ministers of the Environment (CCME)
- .1 PN 1326-July 2005, Environmental Code of Practice for aboveground and underground tank systems containing petroleum products and allied petroleum products.

.2 Canadian Standards Association (CSA International)
- .1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.

1.4 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Shop Drawings:
- .1 Provide shop drawings and product data in accordance with Section 01 33 00 .
- .2 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.3 Before proceeding with demolition of load bearing elements and where required by authority having jurisdiction submit for review by Departmental Representative shoring and underpinning drawings prepared by qualified professional engineer registered or licensed in the Province of Ontario in Canada showing proposed method.

1.4 SUBMITTALS (Cont'd)

.4 Submit a demolition plan detailing the methods and equipment to be used by the departmental representative for approval 30 days before demolition operations.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal: .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

1.6 SITE CONDITIONS

.1 Review designated substance report and take precautions to protect environment.

.2 Should material resembling spray or trowel-applied asbestos or other designated substance be encountered, stop work, take preventative measures, and notify Departmental Representative immediately.
.1 Do not proceed until written instructions have been received from Departmental Representative.

.3 Notify Departmental Representative before disrupting access or services.

.4 Prevent damage to existing structures to remain. If portions of existing structures scheduled to remain are damaged by removal activities, submit a repair plan to the Departmental Representative for review. Repair damaged portions of existing structures according to the approved repair plan.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Leave equipment and machinery running only while in use, except where extreme temperatures prohibit shutting down.

.2 Demonstrate that tools and machinery are being used in manner which allows for salvage of materials in best condition possible.

.3 Only the following equipment is permitted for the work:
.1 Pneumatic or Electric Equivalent Hand Operated Hammers.
.1 When demolishing concrete not closer than 150mm (6 inches) to structural

2.1 EQUIPMENT (Cont'd)

.3 (Cont'd)

.1 (Cont'd)

members: hammers weighing no more than 40Kg (90 lbs)(exclusive of bit).

.2 When demolishing concrete within 150mm (6 inches) of structural members: hammers weighing no more than 14Kg (30lbs) (exclusive of bit).

.2 Saw Cutters

.1 When cutting concrete within 150mm (6 inches) of structural members: concrete cutters and concrete saws. While using water in the cutting operation, provide shielding beneath the cutting operation to prevent water leakage. Continuously collect slurry and dispose of. Ensure the slurry does not enter the structure or highway drainage system.

.3 Hydraulic Breakers. Ram-hoe type breakers, hydraulic breakers, and demolition shears may be used with the following restrictions:

.1 Submit required data to the Departmental Representative for analysis of stresses induced to the girders.

.2 Delineate the centreline and limits of the top flange of girders before the equipment operation.

.3 Do not use equipment within 150mm (6 inches) of the delineated flanges.

.4 Do not pull or twist the reinforcement steel.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Do Work in accordance with Section 01 35 29.

.2 Protection:

.1 Prevent movement, settlement, or damage to adjacent structures, utilities, to remain in place. Provide bracing and shoring required.

.2 Keep noise, dust, and inconvenience to occupants to minimum.

.3 Protect building systems, services and equipment.

.4 Provide temporary dust screens, covers, railings, supports and other protection as required.

.3 Disconnect electrical, telephone and communication service lines. Post warning signs on electrical lines and equipment which must

3.1 PREPARATION (Cont'd)

.3 (Cont'd) remain energized to serve other products during period of demolition.

.4 Locate and protect utility lines. Do not disrupt active or energized utilities designated to remain undisturbed.

3.2 DEMOLITION SALVAGE AND DISPOSAL

.1 Remove parts of existing structure to permit new construction. Sort materials into appropriate piles for reuse and recycling.

.2 Refer to demolition drawings and specifications for items to be salvaged for reuse.

.3 Remove items to be reused, store as directed by Departmental Representative.

.4 Trim edges of partially demolished building elements to tolerances as defined by Departmental Representative to suit future use.

.5 Dispose of removed materials, to appropriate recycling facilities except where specified otherwise, in accordance with authority having jurisdiction.

3.3 REMOVAL FROM SITE

.1 Dispose of materials not designated for alternate disposal in accordance with applicable regulations. Disposal facilities must be approved of and listed in waste reduction workplan. Do not deviate from disposal facilities listed in waste reduction workplan without prior written authorization from Departmental Representative.

3.4 CLEANING AND RESTORATION

.1 Keep site clean and organized throughout demolition procedure.

.2 Upon completion of project, reinstate areas affected by Work to condition which existed prior to beginning of Work.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 Comply with requirements of this Section when performing following work:
.1 Removing non-friable asbestos-containing vinyl composition tiles, if the material is installed or removed without being broken, cut, drilled, abraded, ground, sanded or vibrated at locations indicated on drawings.
.2 Break, cut, grind, sand, drill, scrape, vibrate or abrade non-friable asbestos containing materials using non-powered hand-held tools, and the material is wetted to control the spread of dust or fibres.
.3 Removing and handling of cables with asbestos-containing insulating sheathing.

1.2 SECTION INCLUDES

.1 Requirements and procedures for asbestos abatement of non-friable asbestos-containing materials, including vinyl composition tiles and electrical cable insulating sheathing.

1.3 MEASUREMENT PROCEDURES

.1 Measure asbestos abatement of vinyl floor tiles in square metres of asbestos-containing material removed.

.2 Measure asbestos abatement of cable in kilograms removed.

1.4 REFERENCES

.1 Department of Justice Canada (JUS)
.1 Canadian Environmental Protection Act, 1999 (CEPA).

.2 Transport Canada (TC)
.1 Transportation of Dangerous Goods Act, 1992 (TDGA).

.3 O. Reg. 278/05, Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations.

.4 O. Reg. 490/09, Designated Substances.

.5 A Guide to the Regulations respecting Asbestos on Construction Projects and in Buildings and Repair Operations released in November 2007,

1.4 REFERENCES (Cont'd)

.5 (Cont'd) http://www.labour.gov.on.ca/english/hs/asbestos/index.html.

1.5 DEFINITIONS

.1 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.

.2 Amended Water: water with nonionic surfactant wetting agent added to reduce water tension to allow thorough wetting of fibres.

.3 Asbestos-Containing Materials (ACMs): materials that contain 0.5 per cent or more asbestos by dry weight and are identified under Existing Conditions including fallen materials and settled dust.

.4 Asbestos Work Area: area where work takes place which will, or may, disturb ACMs.

.5 Authorized Visitors: Engineers, Consultants or designated representatives, and representatives of regulatory agencies.

.6 Competent worker person: in relation to specific work, means a worker who:
.1 Is qualified because of knowledge, training and experience to perform the work.
.2 Is familiar with the provincial and federal laws and with the provisions of the regulations that apply to the work.
.3 Has knowledge of all potential or actual danger to health or safety in the work.

.7 Friable material: means material that:
.1 When dry, can be crumbled, pulverized or powdered by hand pressure, or
.2 is crumbled, pulverized or powdered.

.8 Non-Friable Material: material that when dry cannot be crumbled, pulverized or powdered by hand pressure.

.9 Occupied Area: any area of the building or work site that is outside Asbestos Work Area.

.10 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and

1.5 DEFINITIONS (Cont'd)

.10 Polyethylene:(Cont'd) tears, and elsewhere as required to provide protection and isolation.

.11 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for work.

1.6 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00.

.2 Submit proof satisfactory to Departmental Representative that suitable arrangements have been made to dispose of asbestos-containing waste in accordance with requirements of authority having jurisdiction.

.3 Submit Provincial/Territorial and/or local requirements for Notice of Project Form.

.4 Submit proof of Contractor's Asbestos Liability Insurance.

.5 Submit to Departmental Representative necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed.

.6 Submit proof that all asbestos workers and/or supervisor have received appropriate training and education by a competent person in the hazards of asbestos exposure, good personal hygiene and work practices while working in Asbestos Work Areas, and the use, cleaning and disposal of respirators and protective clothing.

.7 Submit proof satisfactory to Departmental Representative that employees have respirator fitting and testing. Workers must be fit tested (irritant smoke test) with respirator that is personally issued.

1.7 QUALITY ASSURANCE

.1 Regulatory Requirements: comply with Federal, Provincial/Territorial, and local requirements pertaining to asbestos, provided that in case of conflict among these requirements or with these specifications, more stringent requirement applies. Comply with regulations in effect at time Work is performed.

1.7 QUALITY ASSURANCE (Cont'd)

.2 Health and Safety:

.1 Perform construction occupational health and safety in accordance with Section 01 35 29.

.2 Safety Requirements: worker protection.

.1 Protective equipment and clothing to be worn by workers while in Asbestos Work Area include:

.1 Air purifying half-mask respirator with N-100, R-100 or P-100 particulate filter, personally issued to worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority having jurisdiction. The respirator to be fitted so that there is an effective seal between the respirator and the worker's face, unless the respirator is equipped with a hood or helmet. The respirator to be cleaned, disinfected and inspected after use on each shift, or more often if necessary, when issued for the exclusive use of one worker, or after each use when used by more than one worker. The respirator to have damaged or deteriorated parts replaced prior to being used by a worker; and, when not in use, to be stored in a convenient, clean and sanitary location. The employer to establish written procedures regarding the selection, use and care of respirators, and a copy of the procedures to be provided to and reviewed with each worker who is required to wear a respirator. A worker not to be assigned to an operation requiring the use of a respirator unless he or she is physically able to perform the operation while using the respirator.

.2 Disposable-type protective clothing that does not readily retain or permit penetration of asbestos fibres.Protective clothing to be provided by the employer and worn by every worker who enters the work area, and the protective clothing shall consist of a head covering and full body covering that fits snugly at the ankles, wrists and neck, in order to prevent asbestos fibres from reaching the garments and skin under the protective clothing to include

1.7 QUALITY ASSURANCE (Cont'd)

.2 Health and Safety:(Cont'd)

.2 Safety Requirements:(Cont'd)

.1 (Cont'd)

suitable footwear, and to be repaired or replaced if torn.

.2 Eating, drinking, chewing, and smoking are not permitted in Asbestos Work Area.

.3 Before leaving Asbestos Work Area, the worker can decontaminate his or her protective clothing by using a vacuum equipped with a HEPA filter, or by damp wiping, before removing the protective clothing, or, if the protective clothing will not be reused, place it in a container for dust and waste. The container to be dust tight, suitable for asbestos waste, impervious to asbestos, identified as asbestos waste, cleaned with a damp cloth or a vacuum equipped with a HEPA filter immediately before removal from the work area, and removed from the work area frequently and at regular intervals.

.4 Facilities for washing hands and face shall be provided within or close to the Asbestos Work Area.

.5 Ensure that no person required to enter an Asbestos Work Area has facial hair that affects seal between respirator and face.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Separate for reuse and recycling and place in designated containers waste in accordance with Waste Management Plan.

.5 Place materials defined as hazardous or toxic in designated containers.

1.8 WASTE MANAGEMENT AND DISPOSAL (Cont'd)

.6 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional and Municipal regulations.

.7 Fold up metal banding, flatten and place in designated area for recycling.

.8 Disposal of asbestos waste generated by removal activities must comply with Federal, Provincial, Territorial and Municipal regulations. Dispose of asbestos waste in sealed double thickness 0.15 mm thick (6 mil) bags or leak proof drums. Label containers with appropriate warning labels.

.9 Provide manifests describing and listing waste created. Transport containers by approved means to licensed landfill for burial.

1.9 EXISTING CONDITIONS

.1 Reports and information pertaining to ACMs to be handled, removed, or otherwise disturbed and disposed of during this project bound to this specification. Refer to Appendix A.

.2 Notify Departmental Representative of friable material discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material pending instructions from Departmental Representative.

1.10 OWNER'S INSTRUCTIONS

.1 Before beginning Work, provide Departmental Representative satisfactory proof that every worker has had instruction and training in hazards of asbestos exposure, in personal hygiene and work practices, and in use, cleaning, and disposal of respirators and protective clothing.

.2 Instruction and training related to respirators includes, following minimum requirements:
.1 Fitting of equipment.
.2 Inspection and maintenance of equipment.
.3 Disinfecting of equipment.
.4 Limitations of equipment.

.3 Instruction and training must be provided by a competent, qualified person.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Drop Sheets:
.1 Polyethylene: 6 mil (0.15 mm) thick.
.2 FR polyethylene: 6 mil (0.15 mm) thick woven fibre reinforced fabric bonded both sides with polyethylene.

.2 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in a concentration to provide thorough wetting of asbestos-containing material.

.3 Waste Containers: contain waste in two separate containers.
.1 Inner container: 6 mil (0.15 mm) thick sealable polyethylene waste bag.
.2 Outer container: sealable metal or fibre type where there are sharp objects included in waste material; otherwise outer container may be sealable metal or fibre type or second 6 mil (0.15 mm) thick sealable polyethylene bag.
.3 Labelling requirements: affix pre-printed cautionary asbestos warning in both official languages that is visible when ready for removal to disposal site.

.4 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.

.5 Tape: fibreglass - reinforced duct tape suitable for sealing polyethylene under both dry conditions and wet conditions using amended water.

PART 3 - EXECUTION

3.1 PROCEDURES

.1 Do construction occupational health and safety in accordance with Section 01 35 29.

.2 Before beginning Work, isolate Asbestos Work Area using, minimum, preprinted cautionary asbestos warning signs in both official languages that are visible at access routes to Asbestos Work Area.
.1 Remove visible dust from surfaces in the work area where dust is likely to be disturbed during course of work.

3.1 PROCEDURES (Cont'd)

.2 (Cont'd)

.2 Use HEPA vacuum or damp cloths where damp cleaning does not create a hazard and is otherwise appropriate.

.3 Do not use compressed air to clean up or remove dust from any surface.

.3 Prevent spread of dust from Asbestos Work Area using measures appropriate to work to be done.

.1 Use FR polyethylene drop sheets over flooring such as carpeting that absorbs dust and over flooring in Asbestos Work Area where dust and contamination cannot otherwise be safely contained. Drop sheets are not to be reused.

.4 Wet materials containing asbestos to be cut, ground, abraded, scraped, drilled, or otherwise disturbed unless wetting creates hazard or causes damage.

.1 Use garden reservoir type low - velocity fine - mist sprayer.

.2 Perform Work to reduce dust creation to lowest levels practicable.

.3 Work will be subject to visual inspection and air monitoring.

.4 Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas.

.5 Frequently and at regular intervals during Work and immediately on completion of work:

.1 Dust and waste to be cleaned up and removed using a vacuum equipped with a HEPA filter, or by damp mopping or wet sweeping, and placed in a waste container, and

.2 Drop sheets to be wetted and placed in a waste container as soon as practicable.

.6 Cleanup:

.1 Place dust and asbestos containing waste in sealed dust-tight waste bags. Treat drop sheets and disposable protective clothing as asbestos waste; wet and fold these items to contain dust, and then place in plastic bags.

.2 Clean exterior of each waste-filled bag using damp cloths or HEPA vacuum and place in second clean waste bag immediately prior to removal from Asbestos Work Area.

.3 Seal waste bags and remove from site. Dispose of in accordance with requirements of Provincial/Territorial and Federal Authority having jurisdiction. Supervise dumping and ensure that dump operator is fully aware of hazardous nature of material to be dumped and

3.1 PROCEDURES (Cont'd)

.6 Cleanup:(Cont'd)

.3 (Cont'd)
that the appropriate guidelines and regulations for asbestos disposal are followed.

.4 Perform final thorough clean-up of Work areas and adjacent areas affected by Work using HEPA vacuum.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 Comply with requirements of this Section when performing following Work: Type 1 Operation.
.1 Removal of lead-containing coatings with a chemical gel or paste and fibrous laminated cloth wrap on steel as indicated on drawings.
.2 Removal of lead-containing coatings or materials using a power tool with an effective dust collection system equipped with a HEPA filter on steel as indicated on drawings.
.3 Removal of lead-containing coatings or materials with non-powered hand tool, other than manual scraping and sanding on steel as indicated on drawings.

1.2 MEASUREMENT PROCEDURES

.1 Measure lead abatement in square metres of lead-containing material removed.

1.3 REFERENCES

.1 Ontario Ministry of Labour
.1 Occupational Health and Safety Branch, Guideline Lead On Construction Projects, September 2004, and O. Reg. 490/09 respecting Designated Substances - Lead made under the Occupational Health and Safety Act as amended by O. Reg. 148/12 and O. Reg. 149/12.

.2 Department of Justice Canada
.1 Canadian Environmental Protection Act, 1999 (CEPA).

.3 Health Canada
.1 Workplace Hazardous Materials Information System (WHMIS), Material Safety Data Sheets (MSDS).

.4 Transport Canada (TC)
.1 Transportation of Dangerous Goods Act, 1992 (TDGA).

.5 U.S. Environmental Protection Agency (EPA)
.1 EPA 747-R-95-007-1995, Sampling House Dust for Lead.

.6 U.S. Department of Health and Human Services/Centers for Disease Control and

1.3 REFERENCES (Cont'd)

.6 (Cont'd)
Prevention/National Institute for Occupational Safety and Health (NIOSH)
.1 NIOSH 94-113 - NIOSH Manual of Analytical Methods (NMAM), 4th Edition (1994).

.7 U.S. Department of Labour - Occupational Safety and Health Administration (OSHA) - Toxic and Hazardous Substances
.1 Lead in Construction Regulation - 29 CFR 1926.62-1993.

.8 Underwriters' Laboratories of Canada (ULC)

.9 Report of the Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario, 1984.

1.4 DEFINITIONS

.1 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with a filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.

.2 Authorized Visitors: Departmental Representative or designated representatives.

.3 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects over cuts and tears, and elsewhere as required to provide protection and isolation. For protection of underlying surfaces from damage and to prevent lead dust entering in clean area.

.4 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must be appropriate capacity for scope of work.

.5 Action level: employee exposure, without regard to use of respirators, to airborne concentration of lead of 50 micrograms per cubic meter of air (50 ug/m^3) calculated as 8-hour time-weighted average (TWA). Minimum precautions for lead abatement are based on airborne lead concentrations less than 0.05 milligrams per cubic meter of air for removal of lead based paint by methods noted in paragraph 1.1.

.6 Competent person: individuals, Departmental Representative capable of identifying existing

1.4 DEFINITIONS (Cont'd)

.6 Competent person:(Cont'd)
lead hazards in workplace taking corrective measures to eliminate them.

.7 Lead dust: wipe sampling on vertical surfaces and/or horizontal surfaces, dust and debris is considered to be lead contaminated if it contains more than 40 micrograms of lead in dust per square foot.

1.5 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Provide proof satisfactory to Departmental Representative that suitable arrangements have been made to dispose of lead based paint waste in accordance with requirements of authority having jurisdiction.

.3 Quality Control:
.1 Provide Departmental Representative necessary permits for transportation and disposal of lead based paint waste and proof that lead based paint waste has been received and properly disposed.
.2 Provide proof satisfactory to Departmental Representative that employees have had instruction on hazards of lead exposure, respirator use, dress, and aspects of work procedures and protective measures.

1.6 QUALITY ASSURANCE

.1 Regulatory Requirements: comply with Federal, Provincial/Territorial and local requirements pertaining to lead paint, provided that in case of conflict among those requirements or with these specifications more stringent requirement applies. Comply with regulations in effect at time work is performed.

.2 Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29.
.2 Safety Requirements: worker and visitor protection.
.1 Protective equipment and clothing to be worn by workers and visitors in work Area include:
.1 Respirator NIOSH approved and equipped with replaceable HEPA filter cartridges with an assigned protection factor of 10, acceptable to Authority

1.6 QUALITY ASSURANCE (Cont'd)

.2 Health and Safety:(Cont'd)

.2 Safety Requirements:(Cont'd)

.1 (Cont'd)

having jurisdiction. Suitable for type of lead and level of lead dust exposure. Provide sufficient amount of filters. It should be noted that respirators should not be necessary if general work procedures are followed and if level of lead in the air is less than 0.05 mg/m^3.

.2 Eating, drinking, chewing, and smoking are not permitted in work area.

.3 Ensure workers wash hands and face when leaving work area. Facilities for washing are located as indicated on drawings.

.4 Visitor Protection:

.1 Provide approved respirators to Authorized Visitors to work areas.

.2 Instruct Authorized Visitors procedures to be followed in entering and exiting work area.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

.2 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.

.3 Disposal of lead waste generated by removal activities must comply with Federal, Provincial, Territorial and Municipal regulations. Dispose of lead waste in sealed double thickness 0.152 mm thick bags or leak proof drums. Label containers with appropriate warning labels.

.4 Provide manifests describing and listing waste created. Transport containers by approved means to licensed landfill for burial.

1.8 EXISTING CONDITIONS

.1 Reports and information pertaining to lead based paint to be handled, removed, or otherwise disturbed and disposed of during this Project bound to this specification. Refer to Appendix. A.

.2 Notify Departmental Representative of lead based paint discovered during Work and not

1.8 EXISTING CONDITIONS (Cont'd)

.2 (Cont'd) apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material until instructed by Departmental Representative.

1.9 SCHEDULING

.1 Not later than two days before beginning Work on this Project notify following in writing:
.1 Appropriate Regional or Zone Director of Medical Services Branch, Health Canada.
.2 Provincial Ministry of Labour.
.3 Disposal Authority.

.2 Inform sub trades of presence of lead-containing materials identified in Existing Conditions.

.3 Provide Departmental Representative copy of notifications prior to start of Work.

1.10 OWNER'S INSTRUCTIONS

.1 Provide Departmental Representative satisfactory proof that every worker has had instruction and training in hazards of lead exposure, in personal hygiene, in aspects of work procedures, and in use, cleaning, and disposal of respirators when respirators are used.

.2 Instruction and training related to respirators includes, at minimum:
.1 Proper fitting of equipment.
.2 Inspection and maintenance of equipment.
.3 Disinfecting of equipment.
.4 Limitations of equipment.

.3 Instruction and training must be provided by competent, qualified person.

.4 Supervisory personnel to complete required training.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Polyethylene 6 mil(0.15 mm) thick unless otherwise specified; in sheet size to minimize joints.

.2 Tape: fibreglass - reinforced duct tape suitable for sealing polyethylene under dry conditions and wet conditions using amended water.

.3 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual lead paint residue.

.4 Lead waste containers: metal or fibre type acceptable to dump operator with tightly fitting covers and 6 mil (0.15 mm) thickness sealable polyethylene liners.
.1 Label containers with pre-printed bilingual cautionary Warning Lead clearly visible when ready for removal to disposal site.

PART 3 - EXECUTION

3.1 SUPERVISION

.1 One Supervisor for every ten workers is required.

.2 Supervisor must remain within work area during disturbance, removal, or handling of lead based paints.

3.2 PREPARATION

.1 Remove and store items to be salvaged or reused.
.1 Protect and wrap items and transport and store in area specified by Departmental Representative.

.2 Work Area:
.1 Shut off and isolate HVAC system to prevent dust dispersal into other building areas. Conduct smoke tests to ensure duct work is airtight.
.2 Pre-clean fixed casework and equipment within work area, using HEPA vacuum and cover and seal with polyethylene sheeting and tape.

3.2 PREPARATION (Cont'd)

.2 Work Area:(Cont'd)

.3 Clean work area using HEPA vacuum. If not practicable, use wet cleaning method. Do not raise dust.

.4 Seal off openings with polyethylene sheeting and seal with tape.

.5 Protect floor surfaces covered from wall to wall with polyethylene sheets.

.6 Maintain emergency fire exits or establish alternatives satisfactory to Authority having jurisdiction.

.7 Where water application is required for wetting lead containing materials, provide temporary water supply appropriately sized for application of water as required.

.8 Provide electrical power and shut off for operation of powered tools and equipment. Provide 24 volt safety lighting and ground fault interrupter circuits on power source for electrical tools, in accordance with applicable CSA Standard. Ensure safe installation of electrical cables and equipment.

.3 Do not start work until:

.1 Arrangements have been made for disposal of waste.

.2 Tools, equipment, and materials waste containers are on site.

.3 Notifications have been completed and preparatory steps have been taken.

3.3 LEAD ABATEMENT

.1 Removal of lead-containing coatings with a chemical gel or paste and fibrous laminated cloth wrap; or removal equipped with HEPA filters; or removal with using power tools, non-powered hand tool, other than manual scraping and sanding.

.2 Remove lead based paint in small sections and pack as it is being removed in sealable 6 mil (0.15 mm) plastic bags and place in labelled containers for transport.

.3 Seal filled containers. Clean external surfaces thoroughly by wet sponging. Remove from immediate working area to staging area. Clean external surfaces thoroughly again by wet sponging. Wash containers thoroughly pending removal to outside. Ensure containers are removed by workers who have entered from uncontaminated areas dressed in clean coveralls.

3.3 LEAD ABATEMENT (Cont'd)

.4 After completion of stripping work, wire brush and wet sponge surface from which lead based paint has been removed to remove visible material. During this work keep surfaces wet.

.5 After wire brushing and wet sponging to remove visible lead based paint, and after encapsulating lead containing material impossible to remove, wet clean entire work area, and equipment used in process. After inspection by Departmental Representative apply continuous coat of slow drying sealer to surfaces of work area. Do not disturb work area for 8 hours no entry, activity, ventilation, or disturbance during this period.

3.4 INSPECTION

.1 Perform inspection to confirm compliance with specification and governing authority requirements. Deviations from these requirements not approved in writing by Departmental Representative will result in work stoppage, at no cost to Departmental Representative.

.2 Departmental Representative will inspect work for:
.1 Adherence to specific procedures and materials.
.2 Final cleanliness and completion.
.3 No additional costs will be allowed by Contractor for additional labour or materials required to provide specified performance level.

3.5 LEAD SURFACE SAMPLING - WORK AREAS

.1 Final lead surface sampling to be conducted as follows:
.1 After work area has passed a visual inspection for cleanliness approved and accepted by Departmental Representative. Apply coat of lock-down agent to surfaces within enclosure, and appropriate setting period of 8 hours has passed, Departmental Representative will perform lead wipe sampling.
.1 Final lead wipe sampling results from horizontal and vertical surfaces must show lead levels of less than 40 micrograms of lead in dust per square foot. Samples collected and analyzed in accordance with EPA 747-R-95-007.
.2 If wipe sampling results show levels of lead in excess of 40 micrograms per square foot, re-clean work area at contractor's expense and apply another

3.5 LEAD SURFACE SAMPLING - WORK AREAS (Cont'd)

.1 (Cont'd)

.1 (Cont'd)

.2 (Cont'd)

acceptable coat of lock-down agent to surfaces.

.3 Repeat as necessary until fibre levels are less than 40 micrograms per square foot.

3.6 FINAL CLEANUP

.1 Following cleaning and when lead wipe surfaces sampling are below acceptable concentrations, proceed with final cleanup.

.2 Remove polyethylene sheet by rolling it away from walls to centre of work area. Vacuum visible lead containing particles observed during cleanup, immediately, using HEPA vacuum.

.3 Place polyethylene sheets, tape, cleaning material, clothing, and contaminated waste in plastic bags and sealed labelled waste containers for transport.

.4 Conduct final check to ensure no dust or debris remains on surfaces as result of dismantling operations.

3.7 RE-ESTABLISHMENT OF OBJECTS AND SYSTEMS

.1 Repair or replace objects damaged in course of work to their original state or better, as directed by Departmental Representative.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Title and description of Work.

.2 Contract Method.

.3 Contractor use of premises.

.4 Owner occupancy.

1.2 REFERENCES

.1 American Conference of Governmental Industrial Hygienists (ACGIH), Bioaerosols Assessment and Control 1999.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
.1 Material Safety Data Sheets (MSDS).

.3 Canadian Standards Association (CSA International).
.1 CAN/CSA-Z94.4-02 Selection, Use and Care of Respirators.

.4 Occupational Health and Safety Act and Regulations for Construction Projects, Revised Statutes of Ontario RSO 1990, Chapter O.1 as amended, O. Reg. 278/05.

.5 Canada Labour Code 1985 Canada Occupational Safety and Health Regulations.

.6 Environmental Protection Act RRO 1990, O. Reg. 347 as amended.

.7 Environmental Abatement Contractors of Ontario (EACO) Mould Abatement Guidelines, 2004, Appendix B - Procedures for Clean Up of Bird and Bat Droppings.

1.3 OUTLINE OF WORK

.1 Work of this Contract comprises of removal of bird and animal guano on the two towers of the Burlington Lift Bridge in Burlington, Ontario.

.2 The work will be conducted in the open space, below the machine rooms on both towers, extended to below the high voltage wire raceway and the catwalk but will also include the vertical surfaces of the side walls protecting this area and any surfaces within this described area.

1.3 OUTLINE OF WORK (Cont'd)

.3 There are nesting Falcons on the North Tower Bridge and considerations for the protection of these birds and for the protection of the workers from these birds will be included.

.4 Cleanup surfaces and decontaminate.

.5 Remove and dispose of existing insulation materials.

.6 Removal of guano shall follow the Type 3 asbestos removal process in accordance with Ontario Regulation 278/05 under the Occupational Health and Safety Act as modified in this Section.

.7 Cable inspections by a qualified electrician must be conducted after dry removal of guano and prior to wet cleaning of cables to ensure integrity of cables.

.8 Removal, disposal and cleanup must proceed slowly and carefully in a systematic manner.

1.4 EXISTING CONDITIONS

.1 Reports and information pertaining to Guano to be handled, removed, or otherwise disturbed and disposed of during this project are bound into this specification. Refer to Appendix A.

1.5 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

1.6 DEFINITIONS

.1 Airlock: a system for permitting ingress or egress without permitting air movement between a contaminated area and an uncontaminated area, typically consisting of two curtained doorways at least 6-1/2 feet (2 m) apart.

.2 Amended water: water with a non-ionic surfactant wetting agent added to reduce water tension to allow thorough wetting of guano.

.3 Authorized visitor: the Departmental Representative or designated representative, Clerk-of-Works, and persons representing regulatory agencies.

.4 Competent person: individuals who can demonstrate that remediation training has been

1.6 DEFINITIONS (Cont'd)

.4 Competent person:(Cont'd) obtained, is capable of identifying existing microbial hazards in workplace and selecting appropriate control strategy for microbial exposure.

.5 Contaminated Work Area (CWA): specific area or location where actual work is being performed or such other area of facility which it has been determined may be hazardous to public health as result of remediation.

.6 Contractor: remediation contractor providing demolition and removal services as defined in specifications.

.7 Critical barrier or enclosure: minimum of two separate layers of 6 mil (0.15 mm) fibre reinforced polyethylene sheeting (FRPS) taped securely and separately over openings between work area and uncontaminated areas outside of work area.

.8 Curtained doorway: arrangement of closures to allow ingress and egress from one room to another. Typically constructed as follows: Place two overlapping sheets (minimum overlap of 1 metre or width of doorway) of FRPS over existing or temporarily framed doorway, securing each along top of doorway, securing vertical edge of one sheet along one vertical side of doorway and securing vertical edge of other sheet along opposite vertical side of doorway. Reinforce free edges of FRPS with fibre reinforced adhesive tape and weight bottom edge to ensure proper closing. Space curtained doorways minimum of 6-1/2 feet (2 metres) apart.

.9 Decontamination Room: enclosure located between Contaminated Work Area and uncontaminated area for decontamination of equipment and workers, typically consisting of two curtained doorways at least 6-1/2 feet (2 metres apart).

.10 DOP Test: a testing method used to determine the integrity of the Negative Pressure unit using dioctyl phthalate (DOP) HEPA-filter leak test.

.11 Disinfectant solution: Wide spectrum disinfectant solution.

.12 Fibre Reinforced Polyethylene Sheet (FRPS): rip proof polyethylene sheeting with fibre reinforced adhesive tape added along edges.

1.6 DEFINITIONS (Cont'd)

.13 HEPA vacuum: a high efficiency particulate air filtered vacuum equipment with filter system capable of collecting and retaining particles greater than 0.3 microns at 99.97 percent efficiency.

.14 Negative pressure: maintain decontamination area at negative pressure relative to surrounding space to prevent contaminants from leaving contaminated area. Use exhaust fan with HEPA filter to maintain at lower pressure than surrounding areas.

.15 Polyethylene sheeting: polyethylene sheeting with tape seals along all edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide a continuous polyethylene membrane to protect underlying surfaces from water damage or damage by sealants, and to prevent escape of spores through sheeting into clean areas.

.16 Occupied Area: areas of building or work site that are outside Contaminated Work Area.

.17 PPE: Personnel Protective Equipment.

.18 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray; with minimum of six litres capacity for work.

1.7 REGULATORY AGENCIES

.1 Comply with Federal, Provincial, and local requirements, provided that in any case of conflict among those requirements or with these specifications the more stringent requirement shall apply.

1.8 SUBMITTALS

.1 Before commencing work:

.1 Obtain from the appropriate agency and submit to Departmental Representative all necessary permits for transporting and disposal of waste. Ensure that dump operator is fully aware of hazardous nature of material being dumped, and proper methods of disposal. Submit proof satisfactory to Departmental Representative that suitable arrangements have been made to receive and properly dispose of waste. In Ontario, this means that the wastes shall be handled and disposed of under the requirements of Ontario Regulation 347.

1.8 SUBMITTALS (Cont'd)

.1 (Cont'd)

.2 Submit proof satisfactory to Departmental Representative that all employees have had instruction on the hazards of the work, respirator use, dress, use of showers, entry and exit from work areas, and all aspects of work procedures and protective measures. The Contractor's Superintendent shall have attended an asbestos abatement course, of not less than two days duration, approved by the Departmental Representative Submit proof of attendance in the form of a certificate.

.3 Submit layout of proposed enclosures and decontamination facilities to Departmental Representative for review.

.2 Work must be carried out by an experienced removal company that is familiar with the hazard controls required for such an operation. Submit an outline of experience.

1.9 WORKER PROTECTION

.1 Instructions: Before commencing work instruct workers in use of respirators, dress, showers, entry and exit from work areas, and all aspects of work procedures and protective measures.

.2 Respirators: Provide workers with personally issued and marked respiratory equipment. Equipment must be powered air purifying positive pressure dust respirators with HEPA filters. This equipment must be worn at all times. Filters must be replaced daily. All respiratory protective devices shall be acceptable to the Occupational Health Branch of Ministry of Labour. No supervisor, worker or authorized visitor shall wear facial hair which affects seal between respirator and face.

.3 Protective Clothing: Provide workers with full body coveralls including head covers. Once coveralls are worn in the work area, they must be treated as contaminated waste and disposed of. Provide safety shoes and other protective apparel required by Ministry of Labour construction regulations.

.4 Each worker shall:

.1 Remove street clothes in clean change room and put on respirator with new filters or reusable filters that have been tested as satisfactory, and clean coveralls before entering Equipment and Access Rooms or work area. If reusable protective clothing is used

1.9 WORKER PROTECTION (Cont'd)

.4 Each worker shall:(Cont'd)

.1 (Cont'd)

each worker shall don respirator only before entering Equipment and Access Rooms where clothing is stored. All street clothes, uncontaminated footwear, towels, and similar uncontaminated articles shall be stored in clean change room.

.2 Remove gross contamination from clothing before leaving work area then proceed to Sheave Room and remove all clothing except respirators. Place contaminated worksuits in receptacles for disposal with other contaminated materials. Leave reusable items except respirator in Equipment and Access trailer. Still wearing the respirator, don clean coveralls and footwear, proceed to shower located in Bldg C-4 as indicated on the drawings. Clean outside of respirator with soap and water while showering; remove respirator; remove filters and wet them and dispose of filters in the container provided for the purpose; and wash and rinse the inside of the respirator. When not in use in the work area, store work footwear in Equipment and Access Room. Upon completion of work, dispose of footwear as contaminated waste or clean thoroughly inside and out using soap and water before removing from work area or from Equipment and Access Room.

.3 Following showering and drying off, proceed to clean change room and dress in street clothes at the end of each day's work, or in clean coveralls before eating, smoking, or drinking. If re-entering work area, follow procedures outlined in 5.4.1 above.

.4 Enter the unloading room from outside dressed in clean coveralls to remove waste containers and equipment from the Holding Room of the Container and Equipment Decontamination Enclosure system. No worker shall use this system as a means to leave or enter the work area.

.5 Workers shall not eat, drink, smoke or chew gum or tobacco at the work site except in established clean room.

.5 Provide and post in Clean Change Room and in Equipment and Access Room the procedures described in 1.9 of this section.

1.10 VISITOR PROTECTION

.1 Provide protective clothing and approved respirators to authorized visitors to Contaminated Work Area.

.2 Instruct authorized visitors in proper use of protective clothing, respirators and procedures.

.3 Instruct authorized visitors proper procedures to be followed in entering into and exiting from Contaminated Work Area.

1.11 NOTIFICATION

.1 Not later than ten (10) days before commencing work on this project notify the following in writing:
.1 The appropriate Regional or Zone Director of Medical Services Branch, Health and Welfare Canada.
.2 Regional Office of Labour Canada.
.3 Provincial Department of Labour.
.4 Disposal Authority.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Drop Sheets: fibre reinforced polyethylene 6 mil (0.15 mm), thick woven fibre reinforced fabric bonded both sides with polyethylene.

.2 Fibre reinforced adhesive tape: used in sealing joints of fibre reinforced polyethylene sheets and for attachment of fibre reinforced polyethylene sheet to finished and unfinished surfaces. Fibre reinforced adhesive tape must be capable of adhering under both dry and wet conditions.

.3 Provide materials such as polyethylene sheeting, lumber, nails and other hardware necessary to construct and dismantle decontamination enclosures and barriers that isolate Work Area as appropriate for work.

.4 Disposal bags: dust-tight 6 mil (0.15 mm) clear polyethylene waste bags.

.5 Disinfectant Solution: for misting guano material.

.6 Receptors: Receptors for the disposal of waste materials contaminated with guano shall comply with Section 14 of Ministry of Environment

2.1 MATERIALS (Cont'd)

.6 Receptors:(Cont'd) Regulation 309. Use a "double bagging" system with the first container consisting of minimum 6 mil (0.15 mm) thick sealable polyethylene bag; second container to be rigid sealable metal or fibre drum with tightly fitting cover and 6 mil (0.15 mm) thickness sealable, polyethylene liner or a rigid, sealable, impermeable cardboard box. Containers must be acceptable to disposal site selected and Ministry of the Environment. Labelling shall refer to "Pigeon Guano" rather than "Asbestos".

.7 Sprayer: garden reservoir type, low velocity, capable of producing mist or fine spray.

2.2 TOOLS AND EQUIPMENT

.1 Tools and equipment: suitable for use with microbial contamination and must be able to withstand de-contamination.

.2 Personnel protective equipment (protective clothing, personal respiratory filter cartridges, HEPA air filters, etc.) provide in sufficient quantities for duration of project.

.3 Vacuum cleaners: HEPA filters.

.4 Ladders and/or scaffolds: adequate length, strength and sufficient quantity to support work schedule.

.5 Safety Harnesses and associated equipment for working at heights.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Contaminated Working Area (CWA) and areas adjacent and around: unoccupied. Vacating is required for persons having undergone recent surgery, immune suppressed people or people with chronic inflammatory lung diseases.

.2 One supervisor for every ten trained remediation workers is required.

.3 Approved supervisor must remain within CWA during disturbance, removal, or other handling of contaminated materials.

3.1 PREPARATION (Cont'd)

.4 Prior to work in the vicinity of the high voltage wires, electricity to these wires may have to be locked out or isolated by the Contractor. The Contractor shall not proceed with any work in such areas until the completion of the isolation has been verified by a qualified electrician.

.5 If power to the cables is locked out cables will be inspected by a qualified electrician for any damage caused by the remediation prior to being reenergized.

.6 Power lockouts will affect bridge operation, traffic lights, navigation lights, bridge span lights, elevators and power to the Towers. Locking out of power, if required, should be limited to agreed upon conditions with the Bridge Operator. Any power outages must not impede shipping and the Contractor must be prepared to re-energize all electrical systems in short order (15 minutes notice) as to not delay shipping traffic.

.7 If during the remediation activities, the bridge is required to be operational, any equipment (including drop cloths) that would interfere with the operation of the bridge, shall be removed. No remediation personnel will be present below the Machine House in the remediation area during the operation of the bridge.

.8 Suspend and secure a safety canopy below and/or around the work area, as necessary, in order to prevent tools, guano, contaminated water and/or any other material disturbed during the remediation work from falling to the ground or otherwise escaping from the CWA into the surrounding environment. Canopy must be lined with FRP sheeting that can be disposed of as contaminated waste at the end of the job.

.9 All tools will be double secured to prevent the tools from falling.

.10 Do not use compressed air to clean up or remove residue from surfaces.

.11 Build worker Decontamination Room at exits from work areas, within the Machine House.

.12 Put negative pressure system in operation in the decontamination area and operate continuously from time first fibre reinforced

3.1 PREPARATION (Cont'd)

.12 (Cont'd) polyethylene is installed to seal openings until final completion of work including final clean-up.

.13 Before beginning remediation work, at each access to Contaminated Work Area, install warning signs in both official languages in upper case 'Helvetica Medium' letters reading as follows, where number in parentheses indicates font size to be used: 'CAUTION BIOHAZARD AREA (1 inch)(25 mm) / NO UNAUTHORIZED ENTRY (1 inch)(25 mm) / WEAR ASSIGNED PROTECTIVE EQUIPMENT (3/4 inch)(19 mm) / BREATHING GUANO OR MOULD DUST MAY CAUSE SERIOUS BODILY HARM (1/4 inch)(6 mm).

3.2 PREPARATION OF WORKER DECONTAMINATION ENCLOSURE SYSTEM

.1 Establish worker decontamination enclosure system between Contaminated Work Area and uncontaminated area in Machine House. Access to Contaminated work area through this enclosure.

.2 Access to Decontamination Room through double flap curtained openings.

.3 Decontamination Room: build Decontamination Room between Contaminated Work Area, with two curtained doorways, one to Contaminated Work Area and one to uncontaminated area. Install waste receptor and storage facilities for workers' shoes and protective clothing to be reworn in Decontamination Room. Decontamination Room: large enough to accommodate specified facilities, equipment needed, and at least one worker allowing sufficient space to change clothes comfortably. Provide storage for clean protective clothing and respiratory equipment. Install mirror to permit workers to fit respiratory equipment properly.

.4 No personnel permitted to leave Decontamination Room unless first decontaminated by changing, wet cleaning or HEPA vacuuming to remove dust or other residue. No contaminated materials or persons to enter uncontaminated area.

3.3 MAINTENANCE OF ENCLOSURE

.1 Maintain enclosures in tidy condition.

.2 Ensure that barriers and fibre reinforced polyethylene linings are effectively sealed with duct tape at beginning of each working period.

3.3 MAINTENANCE OF ENCLOSURE (Cont'd)

.2 (Cont'd)
Repair damaged barriers and remedy defects immediately upon discovery.

3.4 MICROBIAL REMEDIATION WORK AREAS

.1 Commence guano remediation work when:
.1 Contaminated Work Area and decontamination enclosure are effectively segregated from parts of building required to remain in use. Enclosures are to be inspected by Departmental Representative.
.2 Tools, equipment and materials waste containers are on site.
.3 Warning signs as specified are displayed where access to contaminated areas is possible.
.4 Notifications have been completed and preparatory steps have been taken.
.5 Authorized supervisor employed by contractor and qualified in microbial contamination remediation to be on job site to ensure establishment and maintenance of negative pressure enclosure and proper work practices throughout project.
.6 Do not begin remediation work until authorized by Departmental Representative.
.7 Perform an initial shoveling to remove as much of the guano residue as possible.
.8 Dry HEPA vacuum all surfaces (vertical, horizontal and angled) to remove as much of the residue as possible.
.9 Prior to disinfectant application, a full cable inspection by a qualified electrician will be undertaken to ensure there is no damage to the cable jackets prior to spraying the disinfectant solution.
.10 After HEPA vacuuming, apply disinfectant solution to all surfaces (vertical, horizontal, angled). Apply with garden sprayer set for droplet (versus mist) spraying. Lightly brush to ensure uniform wetting and contact through to the underlying surface. Apply additional disinfectant as necessary to maintain the area wet for the contact time specified by the manufacturer.
.11 Clean the areas of residue with suitable tools and HEPA vacuum. Lightly mist with water to reduce dust formation.
.12 After surfaces have been cleaned of all residue, apply a second application of disinfectant, maintaining contact for the period recommended by the manufacturer.

3.5 REPAIR AND CLEAN-UP

.1 During remediation and immediately after completion of remediation, clean work area starting at the top and working down. Clean both work area and Decontamination Room using HEPA vacuum and/or by damp mopping with cleaning solution.

.2 HEPA vacuum inside layer of polyethylene sheeting within work area and on safety canopy and damp wipe prior to removal and disposal. Removal of this layer to occur after removal and decontamination activities are completed and work area inspected by Departmental Representative.

.3 Remove inside layer of fibre reinforced polyethylene sheeting by rolling it away from walls to centre of work area. Vacuum visible debris during cleanup, immediately, using HEPA vacuum.

.4 Include Decontamination Room in similar clean-up.

.5 Remove non-essential fibre reinforced polyethylene sheetings and visible accumulations of material and debris.

.6 Dispose of used fibre reinforced polyethylene sheets, used fibre reinforced adhesive tape, cleaning material, clothing, and contaminated waste.

.7 Include sealed waste containers and equipment used in Contaminated Work Area in cleanup and removed from work area via Decontamination Room.

.8 Carry out final visual inspection check to ensure that no guano residue remains on surfaces as result of dismantling operations.

.9 Remove remaining critical barriers including final safety canopy at the end of the work.

3.6 WASTE DISPOSAL

.1 Place debris and microbial infected waste in doubled-bagged dust-tight 6 mil (0.15 mm) clear polyethylene waste bags. Treat drop sheets and disposable protective clothing as waste; fold these items to contain dust, and place in plastic bags. Securely seal bags and place in waste containers for transport.

3.6 WASTE DISPOSAL (Cont'd)

.2 Clean outside of bags and/or waste containers with damp cloth and cleaning solution or HEPA vacuumed prior to their transport to uncontaminated areas of building.

.3 Remove waste bags and/or containers from site and dispose. There are no special requirements for disposal of guano material; as such they can be disposed of in MOE certified landfill in accordance with O.Reg. 347 and Section 01 74 20.

3.7 RE-ESTABLISHMENT OF SYSTEMS

.1 Advise Bridge Operator to re-establish electrical systems to proper working condition.

END

PART 1 - GENERAL

1.1 MEASUREMENT PROCEDURES

.1 No measurement will be made under this Section. Include costs in items of work for which concrete formwork and falsework is required.

1.2 REFERENCES

.1 Canadian Standards Association (CSA)
.1 CSA A23.1-09/A23.2-09, Concrete materials and methods of concrete construction/Test methods and standard practices for concrete.
.2 CSA-O86-09, Consolidation-Engineering Design in Wood (Limit States Design).
.3 CAN/CSA-S269.3-M92(R2008), Concrete Formwork.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Formwork materials:
.1 For concrete without special architectural features, use wood and wood product formwork materials to CSA-O86.

.2 Tubular column forms: round, spirally wound laminated fibre forms, internally treated with release material. Spiral pattern to show not to show in hardened concrete.
.1 Spiral pattern to show in hardened concrete.

.3 Form release agent: non-toxic, biodegradable, low VOC.

PART 3 - EXECUTION

3.1 FABRICATION AND ERECTION

.1 Verify lines, levels and centres before proceeding with formwork and ensure dimensions agree with drawings.

.2 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.

3.1 FABRICATION AND ERECTION (Cont'd)

.3 Align form joints and make watertight. Keep form joints to minimum.

.4 Use 25 mm chamfer strips on external corners and/or 25 mm fillets at interior corners , joints, unless specified otherwise.

.5 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.

.7 Clean formwork in accordance with CSA A23.1/ A23.2, before placing concrete.

3.2 REMOVAL AND RESHORING

.1 Leave formwork in place for following minimum periods of time after placing concrete.
.1 3 days for columns and piers.
.2 3 days for footings and abutments.
.3 7 days for slabs.

.2 Re-use formwork and falsework subject to requirements of CSA A23.1/A23.2.

.3 Provide reshoring for slabs and until 28 day strength is achieved.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 ASTM International:
.1 ASTM A82/A82M-07, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
.2 ASTM A123/A123M-12, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
.3 ASTM A143/A143M-07, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement.
.4 ASTM 185/185M-07, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

.2 CSA International
.1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
.2 CAN/CSA-A23.3-04(R2010), Design of Concrete Structures.
.3 CSA-G30.18-09, Carbon Steel Bars for Concrete Reinforcement.
.4 CSA-G40.20-04(R2009)/G40.21-04(R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
.5 CSA W186-M1990(R2007), Welding of Reinforcing Bars in Reinforced Concrete Construction.

.3 Reinforcing Steel Institute of Canada (RSIC)
.1 RSIC-2004, Reinforcing Steel Manual of Standard Practice.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Prepare reinforcement bar schedules in accordance with RSIC Manual of Standard Practice and SP-66.

.3 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
.1 Indicate placing of reinforcement and:
.1 Bar bending details.
.2 Lists.

1.2 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.3 Shop Drawings:(Cont'd)
.1 (Cont'd)
.1 (Cont'd)
.3 Quantities of reinforcement.
.4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by Departmental Representative, with identifying code marks to permit correct placement without reference to structural drawings.
.5 Indicate sizes, spacings and locations of chairs, spacers and hangers.
.2 Detail lap lengths and bar development lengths to CAN/CSA-A23.3, unless otherwise indicated.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Storage and Handling Requirements: .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.1 Replaced defective or damaged materials with new.

1.4 MEASUREMENT PROCEDURES

.1 Measure reinforcement steel in kilograms.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Substitute different size bars only if permitted in writing by Departmental Representative.

.2 Reinforcing steel: billet steel, grade, deformed bars to CSA-G30.18, unless indicated otherwise, minimum 30% recycled content, all reinforcing steel galvanized.

.3 Reinforcing steel: weldable low alloy steel deformed bars to CSA-G30.18, minimum 30% recycled content.

.4 Cold-drawn annealed steel wire ties: to ASTM A82/A82M, minimum 30% recycled content.

2.1 MATERIALS (Cont'd)

.5 Welded deformed steel wire fabric: to ASTM A82/A82M, minimum 30% recycled content.
.1 Provide in flat sheets only.

.6 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.

.7 Mechanical couplers galvanized steel, locknut pipe coupler, capable of developing 125% yield of 400MPa rebar.

2.2 FABRICATION

.1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2 SP-66 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.

.2 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

PART 3 - EXECUTION

3.1 FIELD BENDING

.1 Do not field bend or field weld reinforcement except where indicated or authorized by Departmental Representative.

.2 When field bending is authorized, bend without heat, applying slow and steady pressure.

.3 Replace bars, which develop cracks or splits.

3.2 PLACING REINFORCEMENT

.1 Place reinforcing steel as indicated on placing drawings and in accordance with CSA-A23.1/A23.2.

.2 Prior to placing concrete, obtain Departmental Representative's approval of reinforcing material and placement.

.3 Ensure cover to reinforcement is maintained during concrete pour.

.4 Protect galvanized coated portions of bars with covering during transportation and handling.

3.3 FIELD TOUCH-UP .1 Touch up damaged and cut ends of galvanized reinforcing steel with compatible finish to provide continuous coating.

END

PART 1 - GENERAL

1.1 ACTION AND INFORMATION SUBMITTALS

.1 Provide testing and inspection results and reports for review by Departmental Representative and do not proceed without written approval when deviations from mix design or parameters are found.

1.2 MEASUREMENT PROCEDURES

.1 Payment for concrete includes payment for formwork, falsework, and all accessories. Method of measurement shall be as follows:
.1 Measure concrete for gate supports and platforms in cubic metres.
.2 Measure concrete for curbing in linear metres.
.3 Measure concrete for sidewalk in square metres.
.4 Measure concrete for deck slab in cubic metres.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Concrete: mix proportion method Alternative 1 to CSA A23.1-09/A23.2-09, Concrete materials and methods of concrete construction.
.1 Cement: to CAN/CSA-A3000-08, type GU.
.2 Compressive strength: 35MPa at 28 days.
.3 Exposure class: C-1 to CSA A23.1-09/A23.2-09.
.4 Aggregate size: 20 mm maximum size to CSA A23.1-09/A23.2-09.
.5 Slump: 70 mm+/-20 mm at time of deposit.
.6 Air content: Table 4, Category 2, 6%.
.7 Admixtures: air entraining to ASTM C233/C233M-11 Standard Test Method for Air-Entraining Admixtures for Concrete. Calcium chloride or compounds containing calcium chloride not permitted.
.8 Water: potable, to Table 9.

.2 Anchor bolts: to CSA G40.20-04(R2009)/ G40.21-04(R2009), Grade 300W, minimum 30% recycled content.

.3 Grout: non-shrink, premixed, 35MPa compressive strength at 24 hours, 40MPa at 28 days.

2.1 MATERIALS (Cont'd)

.4 Epoxy bonding agent 2 component epoxy resin bonding system conform to ASTM C881, Type 2, Grade 1 or 2, Class B or C.

PART 3 - EXECUTION

3.1 PLACING AND INSTALLATION

.1 Do concrete work in accordance with CSA A23.1-09/A23.2-09.

.2 Provide 25 mm chamfer on exposed corners.

.3 Build-in items supplied by other Sections.

.4 Anchor bolts:
.1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.
.2 With approval of Departmental Representative, grout anchor bolts in preformed holes or holes drilled after concrete has set. Formed holes to be minimum 100 mm diameter. Drilled holes to manufacturer's recommendations.
.3 Set bolts and fill holes with shrinkage compensating grout.

.5 Grout structural steel base plates in place.

.6 Fill bollards with concrete.

.7 Install concrete foundations for signage posts. Set galvanized steel post in concrete.

3.2 FINISHING

.1 Finish concrete in accordance with CSA A23.1-09/A23.2-09.

.2 Formed surfaces exposed to view: sack rubbed finish in accordance with CSA A23.1-09/ A23.2-09.

.3 Equipment pads: smooth trowelled surface; in accordance with CSA-A23.1-09/A23.2-09 Table 22, finish classification Class D.

.4 Pavements, walks, curbs and exposed site concrete: screed to plane surfaces and float using aluminum, magnesium, or wood floats in accordance with CSA-A23.1-09/A23.2-09, Table 22, finish classification Class A. Round edges and provide joint spacings using standard tools. Trowel smooth followed by lightly brushed non-slip finish to CSA B651-12.

3.3 CURING

.1 Cure concrete in accordance with CSA A23.1-09/A23.2-09, Clause 7.4 Table 20, type 1-Basic.

3.4 EXISTING STRUCTURE

.1 Take precautions to protect the existing structure from damage.

.2 Remove portions of existing concrete structure as required. Provide temporary shoring and bracing required for these operations. Retain a professional engineer to design the temporary shoring and bracing to review this work on site.

.3 Locate existing reinforcement and conduits. Obtain approval of Departmental Representative before coring or cutting existing slabs, beams, or walls. Retain an independent testing company to locate existing reinforcement and conduit in the areas of proposed openings and to mark locations on surfaces of slabs and walls on which the cores and cuts are to be started. X-ray concrete unless other methods can be shown by Contractor to accurately locate reinforcement and conduit. Remove toppings prior to locating reinforcement and conduit. Mark locations and sizes of cores and openings and locations of reinforcement and conduit using indelible markers with red for top bars, green for bottom bars and black for cores, openings, and conduit. Departmental Representative will review marked-up locations once a week. If locations are not acceptable relocate proposed openings and repeat process at no extra cost to the Contract.

.4 Coring: Do not cut existing reinforcement and conduit when coring existing concrete unless approved in advance by the Representative. Save the complete length of all cores. Label each core with location taken. Make all cores available for review by Representative. Dispose of cores only with approval of Representative.

.5 Cutting: Do not cut existing reinforcement and conduit when cutting existing concrete unless approved in advance by the Representative. Core four corners and ends of intermediate sawcuts of all openings prior to cutting sides and intermediate lines. Sawcut sides and intermediate lines. Do not over cut openings. Chip corners square if necessary. See detail on drawings. If new reinforcement is required at an opening, install reinforcement before cutting

3.4 EXISTING STRUCTURE (Cont'd)

.5 Cutting:(Cont'd) opening or shore up structure until new reinforcement is installed.

.6 Roughening existing surfaces: Where drawings call for a roughened surface, bush hammer entire surface to a full amplitude of at least 5 mm.

.7 Infilling: Infill all existing concrete openings including those due to existing mechanical and electrical services. This does not apply to existing openings that are being reused. See infill details on drawings.

.8 Reinforcing: Reinforce openings in existing concrete according to details on drawings. Install reinforcement before cutting openings or shore up structure until new reinforcement is installed.

.9 Patching: Patch existing concrete where necessary to provide required smooth, flat surfaces for reinforcement and for other trades.

.10 Add cold and hot weather concreting as required.

3.5 BONDING

.1 Bond new to existing concrete with epoxy bonding. Preparation and installation to CSA A23.1 and manufacturer's requirements.

3.6 HOT AND COLD WEATHER

.1 Comply with requirements of CSA A23.1, A23.2.

END

PART 1 - GENERAL

1.1 SHOP DRAWINGS

.1 Submit shop drawings of each item specified, in accordance with Sections 01 33 00 and 01 78 00.

1.2 MEASUREMENT PROCEDURES

.1 No measurement will be made under this Section. Include costs in items of work which fasteners are required.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Concrete anchors:

.1 Sizes indicated on drawings threaded steel anchor rod to ASTM F568M-07, Class 5.8, two part epoxy adhesive.

.1 Minimum yield: 420 MPa.

.2 Acceptable material: 'Hilti HIT HY-20 Adhesive Anchoring System' manufactured by HILTI (Canada) Ltd., 1-800-363-4458, www.ca.hilti.com.

.2 Sizes indicated on drawings, two part epoxy adhesive.

.1 Acceptable material: 'Power-Fast + System: Installation of Threaded Rod and Screens in Hollow Base Material' manufactured by Powers Industries Ltd., 514-631-4216 or 905-673-7295, division of Powers Fasteners Inc., www.powers.com. 'Chem-Stud Anchor System' manufactured by Powers Fasteners Inc., 514-631-4216 or 905-673-7295, www.powers.com.

.2 Epoxy adhesive anchor/repair mortar: pre-packaged, two component adhesive consisting of base resin and slow fast set hardener, mixed when dispensed from dual chamber cartridge, type recommended by anchor manufacturer.

.3 Bolts, nuts and washers: stainless steel to ASTM F593-02(2008).

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Drill holes to accept anchors in accordance with manufacturer's instructions.

.2 Clean drilled holes with a nylon 'bottle brush'. Blow out.

END

PART 1 - GENERAL

1.1 SHOP DRAWINGS

.1 Submit shop drawings of each item specified, in accordance with Sections 01 33 00 and 01 78 00.

1.2 MEASUREMENT PROCEDURES

.1 No measurement will be made under this Section. Include costs in items of work for which expansion anchors are required.

PART 2 - PRODUCTS

2.1 MATERIALS

1. Stud type expansion anchor:
   .1 Carbon steel type: studs to ASTM A510M-08
   .1 Carbon steel type: studs to ASTM A510M-08 with chemical composition of AISI 1038 and zinc plated in accordance with ASTM B63-07. Wedges to AISI 1010 carbon steel. Nuts to ASTM A653/A653M-11, Grade A and to dimensional requirements of ANSI/ASME B18.2.2-2010. Washers to SAE 1005-1020 and to dimensional requirements of ASME B18.21.1-2009. Sizes indicated on drawings.
   .2 Stainless steel type: studs to ASTM A276-10 with chemical composition of AISI 304 316. Wedges with AISI 304 316. Washers with AISI 304 316. Sizes indicated on drawings.

.2 Expansion anchor: single end, heavy duty, expansion shield anchor.
   .1 Carbon steel type: to ASTM A449-10 and zinc plated to minimum 5 micrometres.
      .1 UTS: 800 MPa minimum.
      .2 YTS: 640 MPa minimum.
      .3 Acceptable material: 'HSL/HSLG Heavy Duty Anchor' manufactured by Hilti, 1-800-363-4458, www.ca.hilti.com.
   .2 Stainless steel type: to ASTM F738M-02(2008), type 316.
      .1 UTS: 700 MPa minimum.
      .2 YTS: 450 MPa minimum.
      .3 Acceptable material: 'HSLG-R Heavy Duty Anchor' manufactured by Hilti, 1-800-363-4458, www.ca.hilti.com.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Drill holes to accept anchors in accordance with manufacturer's instructions.

.2 Install work straight, plumb and level to a tolerance of 1:600.

.3 Clean drilled holes with a nylon 'bottle brush'. Blow out.

.4 Install expansion anchors in accordance with manufacturer's written instructions.

END

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 05 41 00: Load bearing metal stud system.

.2 Section 09 91 00: Painting.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Sections 01 33 00 and 01 78 00.

.2 Shop drawings shall bear the stamp of a Registered Professional Engineer, registered in the Province of Ontario.

.3 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details and accessories.

1.3 MEASUREMENT PROCEDURES

.1 Payment for steel included payment for expansion anchors and adhesive anchors as required for steel connections. Measure steel in kilograms.

PART 2 - PRODUCTS

2.1 MATERIAL

.1 Structural steel including base, cap plates and anchor bolts: to CSA G40.20-04(R2009)/G40.21-04(R2009), Grade 300W, minimum 30% total recycled content.

.2 Hollow structural sections: to CSA-G40.20-04 (R2009)/G40.21-04(R2009), Grade 350W, Class H, BOF minimum 30% total recycled content.

.3 Shop paint primer: CAN/CGSB-1.181-99 zinc rich primer.

.4 Zinc rich primer for galvanized surfaces: zinc rich, readymix to CAN/CGSB-1.181-99, Ecologo certified.

2.2 FABRICATION

.1 Fabricate to CSA S16-09.

.2 Weld to CSA W59-03(R2008).

.3 Provide and reinforce holes required.

.4 Provide required connectors.

.5 Surface preparation: clean surfaces to receive primer using SSPC-SP 7, Brush-Off Blast Cleaning to provide an appearance after cleaning of SSPC-SP 6, Commercial Blast Cleaning to provide an appearance after cleaning of "BSA2" as determined from SSPC-VIS 1-89, Visual Standard for Abrasive Blast Cleaned Steel.

.6 Apply primer to steel surfaces providing a minimum dry film thickness of 70 um as determined in accordance with CGSB 85-GP-14M.

PART 3 - EXECUTION

3.1 ERECTION

.1 Erect in accordance with CSA S16-09.

.2 Tolerance: 1:500.

.3 Supply other sections with base plates and anchors for building in.

.4 Connect with high tensile bolts.

.5 Restore damaged surfaces to appearance Grade BSA2 using mechanical cleaning methods as required.

.6 Touch up connections, scratches and burns with primer.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 American National Standards Institute (ANSI):
.1 ANSI/NAAMM MBG 531-09, Metal Bar Grating Manual.
.2 ASTM A53/A53M-10, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
.3 ASTM A307-10, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.2 American Society for Testing and Materials International, (ASTM):
.1 ASTM A123/A123M-12, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
.2 ASTM A786-05(2009)/A786M-05(2009), Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
.3 ASTM A1011/A1011M-12, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
.4 ASTM B36/B36M-08a, Standard Specification for Brass Plate, Sheet, Strip, And Rolled Bar.

.3 Canadian General Standards Board (CGSB):
.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating

.4 Canadian Standards Association (CSA):
.1 CSA G40.20-04(2009)/G40.21-04(R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
.2 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
.3 CAN/CSA-S16.1-09, Limit States Design of Steel Structures.
.4 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding (Developed in co-operation with the Canadian Welding Bureau).
.5 CSA W59-03(R2008), Welded Steel Construction (Metal Arc Welding) (Imperial Version).

.5 The Environmental Choice Program
.1 CCD-047a-98, Paints, Surface Coatings.
.2 CCD-048-98, Surface Coatings - Recycled Water-borne.

1.1 REFERENCES (Cont'd)

.6 Ontario Provincial Standards
.1 OPSS 1504 Steel Beam Guide Rails

1.2 MEASUREMENT PROCEDURES

.1 Payment for Metal Fabrications includes Expansion Anchors and Adhesive Anchors as required.
.1 Pipe Rail in linear metres.
.2 Guard Rails in linear metres.

1.3 SUBMITTALS

.1 Product Data:
.1 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 01 33 00 - Submittal Procedures.
.2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets - Safety Requirements. Indicate VOC's:
.1 For finishes, coatings, primers and paints.

.2 Shop Drawings
.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
.2 Indicate materials, core thicknesses, finishes, connections, joints, methods of anchorage, number of anchors, supports, reinforcement, details, and accessories.
.3 Shop Drawings to bear stamp of a Professional Engineer registered in Ontario.
.4 Guards shall be designed to meet all requirements of NBCC and OBC.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, Shipping, Handling and Unloading: Deliver, store, handle and protect materials in accordance with Section 01 61 00- Equipment and Materials.

.2 Storage and Protection.

1.5 WASTE MANAGMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction / Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Steel sections and plates: to CAN/CSA-G40.20/G40.21, Grade 300W.

.2 Steel shapes to CAN/CSA-G40.20/G40.21, Grade 350W.

.3 Steel pipe: to ASTM A53/A53M Schedule 40.

.4 Welding materials: to CSA W59

.5 Welding electrodes: to CSA W48 Series.

.6 High Strength Bolts: to ASTM A325M-00.

.7 Bolts and anchor bolts: to ASTM A307-00.

.8 Grout: non-shrink, non-metallic, flowable, 35MPa at 24 hours.

2.2 FABRICATION

.1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.

.2 Where possible, fit and shop assemble work, ready for erection.

.3 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

2.3 FINISHES

.1 Galvanizing: hot dipped galvanizing with zinc coating 600g/m2 to CAN/CSA-G164.

.2 Zinc primer: zinc rich, ready mix to CAN/CGSB-1.181.

2.4 PIPE RAILINGS

.1 Steel pipe: sized as indicated on shop drawings outside diameter, formed to shapes and sizes as indicated.

.2 Finish: Hot Dipped galvanized, after fabrication.

2.5 TRAFFIC GUIDE RAILS

.1 Provide traffic Guide Rails to OPSS Standards including rails, posts, hardware, and terminations.

PART 3 - EXECUTION

3.1 ERECTION

.1 Do welding work in accordance with CSA W59-03 (R2008) unless specified otherwise.

.2 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.

.3 Provide suitable means of anchorage acceptable to Departmental Representative such as dowels, anchor clips, bar anchors, expansion bolts and shields and toggles.

.4 Exposed fastening devices to match finish and be compatible with material through which they pass.

.5 Provide components for building by other sections in accordance with shop drawings and schedule.

.6 Make field connections with bolts to CAN/CSA-S16.1-09, or weld.

.7 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.

.8 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

3.2 PIPE RAILINGS

.1 Install pipe railings as indicated on drawings and shop drawings.

3.3 CLEANING

.1 Perform cleaning after installation to remove construction and accumulated environmental dirt.

.2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END

PART 1 - GENERAL

1.1 GENERAL

.1 This section refers to the Preformed Steel Siding assembly and insulated metal wall panels including all accessories and steel doors and frames including all accessories and hardware.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
.1 ASTM A 167-99(2004), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
.2 ASTM A 240/A 240M-05a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
.3 ASTM A 480/A 480M-05, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
.4 ASTM D 523-89(R1999), Standard Test Method for Specular Gloss.
.5 ASTM D 822-01, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.

.2 Canadian Standards Association(CSA International)
.1 CSA-S136-01 (R2007) North American Specification for the Design of Cold Formed Steel Structural Members.

.3 National Building Code of Canada 2010.

1.3 MEASUREMENT PROCEDURES

.1 Payment for Siding includes complete siding assembly for wall and payment for Expansion Anchors or Adhesive Anchors as required.
.1 Measure per square metre of siding.

.2 Work for steel doors and frames including all accessories and hardware will not be measured separately for payment.

1.4 QUALITY ASSURANCE

.1 Supplier shall design, supply and fabricate work of this Section.

.2 Supplier/installer shall have a minimum of 10 years proven experience and must have completed at least 5 major wall panel projects.

1.5 DESIGN REQUIREMENTS

.1 Design, fabricate and erect wall system to meet the following requirements:

.1 Rain penetration: prevent rain penetration through wall system.

.2 Design system based on Rainscreen System based on guidelines published by the National Research Council. Incorporate means of draining moisture to the exterior. Testing on reasonably comparable systems will be considered acceptable.

.3 Design system based on "Rain Screen Principle" by the National Research Council. Incorporate means of draining moisture to the exterior.

.4 Wind Load: Design wall system to resist wind loads, positive and negative expected in this geographical region, without causing rattling, vibration or excessive deflection of panels, overstressing of fastener clips or other detrimental effects on wall systems.

.5 Structural and thermal movement: Accommodate movement of supporting structural framing and movement caused by thermal expansion and contraction of system component parts without causing bowing buckling, delamination, oil canning failure of joint seals, excessive stress on fasteners, or any other detrimental effects.

1.6 PRODUCT DATA

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

.2 Submit product data sheets for cladding, metal wall panels, and steel doors system materials. Include product characteristics, performance criteria, limitations and colours.

.3 Provide maintenance data for cleaning and maintenance of panel finishes. This information is to be in format for O+M Manuals.

1.7 SHOP DRAWINGS

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

.2 Indicate dimensions and thickness of panels, siding assembly, and steel doors, fastening and anchoring methods, detail and location of joints and gaskets, thermal movement provision, wall openings, head, jamb and sill details, materials and finish, compliance with design criteria and requirements of related work.

.3 Indicate elevations, profiles, dimensions and thickness of panels.

.4 Indicate location and detail of joints including joints necessary to accommodate thermal movement.

.5 Indicate attachment clips, joint extrusion system and installation details.

.6 Show fastening and anchoring details.

.7 Drawings shall be signed and sealed by a Professional Engineer, attesting to the ability of the metal panels assembly to withstand the specified loads.

.8 Panels shall be identified on the shop drawings as to building location to facilitate panel removal and replacement.

1.8 SAMPLES

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

.2 Submit duplicate 600 x 600mm samples of wall system, representative of materials.

.3 Submit duplicate 76 x 127mm samples to illustrate colour and finish.

.4 Submit 1 litre sealed can of touch-up paint, properly identified for panel colour provided. Submit instructions for touch-up, repair and removal of panels.

1.9 EXISTING CONDITIONS

.1 Visit site to verify existing materials steel siding assembly, insulated metal wall panels, and steel doors and frames are all to be matched to existing conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Steel siding: 22GA (0.71mm) A653/A653M-07, Z275 zinc coating designation or ASTM A792/A792M -08, Commercial Steel CS Type A, Forming Steel FS type, Grade 230, AZ180 aluminum-zinc coating designation, prefinished to CSSBI Technical Bulletin No. 7, October 1979, 10000 Series paint system, Green colour selected by Departmental Representative to match existing and profile 38mm deep x 935mm (or to match existing) wide panel coverage x 3658mm high. New profile shall not exceed depth of existing profile. Steel minimum 30% recycled content.

.1 Profile to match: 'CL7040' manufactured by Vicwest 905-825-2252 www.vicwest.com.

.2 Steel liner: 1.2mm thick to match existing galvanized steel with ZF075 zinc coating designation, prefinished, colour to match existing and as selected by Departmental Representative.

.3 Steel eave panels: 1.22mm thick steel to ASTM A653/A653M-07, Z275 zinc coating designation or ASTM A792/A792M-08, Commercial Steel CS type A, Forming Steel FS Type, Grade 230, AZ180 aluminum-zinc coating designation, prefinished to CSSBI Technical Bulletin No. 7, October 1979, 10000 Series paint system, White colour selected by Departmental Representative to match existing profile and dimensions. Steel minimum 30% recycled content.

.4 Z-bars or sub-girts, drip closures and notched steel closures: 1.26mm thick galvanized steel to ASTM A653/A653M-07, Z275 zinc coating designation.

.5 Thermal clip: triangular, galvanized steel.

.6 Soffit, flashing and accessories: exposed trim, metal closures, cap pieces, etc. of same material and colour as siding.

.7 Fasteners: self tapping and self drilling screws, zinc coated steel, prepainted head colour to match siding, neoprene washers.

.8 Composite metal wall panels including accessories to match existing insulated wallpanels.

2.1 MATERIALS (Cont'd)

.8 (Cont'd)

9. Steel doors, frames, and hardware to match existing daybar insulated doors. Verify on site.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Attach sub-girts to structural supports as indicated.

.2 Install starter strips, inside corners, continuous outside corners, edgings, soffits and drip, cap and sill flashings.

.3 Install siding and attachments sequentially from starter strips up, to manufacturer's instructions.

.4 Install eaves panel facing on soffit where indicated.

.5 Install exterior corners, fillers and closure strips with individually formed and profiled work using concealed fasteners.

.6 Maintain joints in exterior sheets, true to line, tight fitting.

.7 Apply sealant where detailed, at junction with other materials, around door and window perimeters, at metal flashings and perimeter of mechanical and electrical work.

.8 Wash down surfaces with mild detergent.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions and data sheets.

.2 Follow manufacturer's instructions for steel siding assembly, insulated composite wall assembly, and insulated steel doors and frames including all accessories and hardware.

3.3 CLEANING

.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:
.1 Material and installation of site applied paint finishes including site painting of shop primed surfaces.
.2 Sustainable requirements for construction and verification.

1.2 MEASUREMENT PROCEDURES

.1 Measure per square metre of surface painted.

1.3 REFERENCES

.1 Department of Justice Canada (Jus)
.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33

.2 Environmental Protection Agency (EPA)
.1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 - 1995, (for Surface Coatings).

.3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).

.4 Master Painters Institute (MPI)
.1 MPI Architectural Painting Specifications Manual, 2004.

.5 National Fire Code of Canada - 1995

.6 Society for Protective Coatings (SSPC)
.1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

.7 Transport Canada (TC)
.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.4 QUALITY ASSURANCE

.1 Qualifications:
.1 Contractor: minimum of five years proven satisfactory experience. Provide list of last three comparable jobs including, job name and

1.4 QUALITY ASSURANCE (Cont'd)

.1 Qualifications:(Cont'd)
.1 (Cont'd)
location, specifying authority, and project manager.

.2 Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 SCHEDULING

.1 Submit work schedule for various stages of painting to Departmental Representative for review. Submit schedule minimum of 48 hours in advance of proposed operations.

.2 Obtain written authorization from Departmental Representative for changes in work schedule.

.3 Schedule painting operations to prevent disruption.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
.1 Submit product data and instructions for each paint and coating product to be used.
.2 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures. Indicate VOCs during application and curing.

.3 Samples:
.1 Submit full range colour sample chips to indicate where colour availability is restricted.
.2 Submit duplicate 8 x 12 inch (200 x 300 mm) sample panels of each paint with specified paint or coating in colours, gloss/sheen and textures required to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:
.1 1/8 inch (3 mm) plate steel for finishes over metal surfaces.
.2 2 inch (50 mm) concrete block for finishes over concrete or concrete masonry surfaces.
.3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.

1.6 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.3 Samples:(Cont'd)

.4 Test reports: submit certified test reports for paint from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.1 Lead, cadmium and chromium: presence of and amounts.

.2 Mercury: presence of and amounts.

.3 Organochlorines and PCBs: presence of and amounts.

.5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.6 Manufacturer's Instructions:

.1 Submit manufacturer's installation and application instructions.

.7 Closeout Submittals: submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include following:

.1 Product name, type and use.

.2 Manufacturer's product number.

.3 Colour numbers.

.4 MPI Environmentally Friendly classification system rating.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Packing, Shipping, Handling and Unloading:

.1 Pack, ship, handle and unload materials in accordance with Section 01 61 00 - Common Product Requirements and manufacturer's written instructions.

.2 Acceptance at Site:

.1 Identify products and materials with labels indicating:

.1 Manufacturer's name and address.

.2 Type of paint or coating.

.3 Compliance with applicable standard.

.4 Colour number in accordance with established colour schedule.

.3 Remove damaged, opened and rejected materials from site.

.4 Storage and Protection:

.1 Provide and maintain dry, temperature controlled, secure storage.

.2 Store materials and supplies away from heat generating devices.

1.7 DELIVERY, STORAGE AND HANDLING (Cont'd)

.4 Storage and Protection:(Cont'd)
.3 Store materials and equipment in well ventilated area with temperature range 7 degrees C to 30 degrees C.

.5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

.6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.

.7 Remove paint materials from storage only in quantities required for same day use.

.8 Fire Safety Requirements:
.1 Provide one 19.85 lbs (9 kg) Type ABC dry chemical fire extinguisher adjacent to storage area.
.2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
.3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

.9 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
.3 Place materials defined as hazardous or toxic in designated containers.
.4 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal, regulations.
.5 Ensure emptied containers are sealed and stored safely.
.6 Unused paint materials must be disposed of at official hazardous material collections site as approved by Departmental Representative.
.7 Paint finishes and related materials (thinners, and solvents) are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.

1.7 DELIVERY, STORAGE AND HANDLING (Cont'd)

.9 Waste Management and Disposal:(Cont'd)

.8 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.

.9 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground follow these procedures:

.1 Retain cleaning water for water-based materials to allow sediments to be filtered out.

.2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.

.3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.

.4 Dispose of contaminants in approved legal manner in accordance with hazardous waste regulations.

.5 Empty paint cans are to be dry prior to disposal or recycling (where available).

.10 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

1.8 SITE CONDITIONS

.1 Heating, Ventilation and Lighting:

.1 Ventilate enclosed spaces.

.2 Provide heating facilities to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.

.3 Provide continuous ventilation for seven days after completion of application of paint.

.4 Coordinate use of existing ventilation system with Departmental Representative and ensure its operation during and after application of paint as required.

.5 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.

.6 Provide minimum lighting level of 323 Lux on surfaces to be painted.

.2 Temperature, Humidity and Substrate Moisture Content Levels:

.1 Perform no painting when:

.1 Ambient air and substrate temperatures are below 10 degrees C.

1.8 SITE CONDITIONS (Cont'd)

.2 (Cont'd)

.1 Perform no painting when:(Cont'd)

.2 Substrate temperature is above 32 degrees C unless paint is specifically formulated for application at high temperatures.

.3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.

.4 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.

.5 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.

.2 Perform painting work when maximum moisture content of the substrate is below:

.1 Allow new concrete and masonry to cure minimum of 28 days.

.3 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".

.4 Test concrete surfaces for alkalinity as required.

.3 Surface and Environmental Conditions:

.1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.

.2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.

.3 Apply paint when previous coat of paint is dry or adequately cured.

.4 Additional interior application requirements:

.1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.

.2 Provide paint materials for paint systems from single manufacturer.

.3 Only qualified products with E2 E3 "Environmentally Friendly" rating are acceptable for use on this project.

.4 Conform to latest MPI requirements for painting work including preparation and priming.

.5 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing.

.6 Linseed oil, shellac, and turpentine: highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.

2.2 COLOURS

.1 Departmental Representative will provide Colour Schedule after Contract award.

.2 Where specific products are available in restricted range of colours, selection based on limited range.

.3 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 PAINTING SYSTEMS

.1 Concrete horizontal surfaces: floors:
.1 INT 3.2C - Epoxy finish to match existing.

.2 Structural steel and metal fabrications:
.1 EXT 5.1D - Alkyd semi-gloss finish. Colour to match existing.

.3 Galvanized Metal: not chromate passivated.
.1 EXT 5.3B - Alkyd semi-gloss finish.

PART 3 - EXECUTION

3.1 GENERAL

.1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.

.2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.2 EXAMINATION

.1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Departmental Representative damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.

.2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

.3 Maximum moisture content as follows:
.1 Concrete: 12%.

3.3 PREPARATION

.1 Protection:
.1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Departmental Representative.
.2 Protect items that are permanently attached such as Fire Labels on doors and frames.
.3 Protect factory finished products and equipment.
.4 Protect passing pedestrians, building occupants and general public in and about the building.

.2 Surface Preparation:
.1 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

3.3 PREPARATION (Cont'd)

.2 Surface Preparation:(Cont'd)

.2 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Departmental Representative.

.3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:

.1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.

.2 Wash surfaces with a biodegradable detergent and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.

.3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.

.4 Allow surfaces to drain completely and allow to dry thoroughly.

.5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.

.6 Use trigger operated spray nozzles for water hoses.

.7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.

.4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.

.5 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 39.4 inches (1000 mm).

.6 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes blowing with clean dry compressed air or vacuum cleaning.

.7 Touch up of shop primers with primer as specified.

3.3 PREPARATION (Cont'd)

.8 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.

3.4 APPLICATION

.1 Method of application to be as approved by Departmental Representative. Apply paint by brush roller air sprayer airless sprayer. Conform to manufacturer's application instructions unless specified otherwise.

.2 Brush and Roller Application:
.1 Apply paint in uniform layer using brush and/or roller type suitable for application.
.2 Work paint into cracks, crevices and corners.
.3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
.4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
.5 Remove runs, sags and brush marks from finished work and repaint.

.3 Spray application:
.1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
.2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
.3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.
.4 Brush out immediately all runs and sags.
.5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.

.4 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.5 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.6 Sand and dust between coats to remove visible defects.

3.5 FIELD QUALITY CONTROL

.1 Field inspection of painting operations to be carried out be independent inspection firm as designated by Departmental Representative.

.2 Advise Departmental Representative when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

.3 Cooperate with inspection firm and provide access to areas of work.

.4 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Departmental Representative.

3.6 RESTORATION

.1 Clean and re-install hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.

.4 Protect freshly completed surfaces from paint droppings and dust to approval of Departmental Representative. Avoid scuffing newly applied paint.

.5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Departmental Representative.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes supplying and installing four new traffic gates assembly, two new pedestrian gates assembly, two new barrier gates assembly and spare parts in compliance with the Contract Documents. Including all supporting hardware in conjunction with new electrical system as shown on the Contract Documents.

.2 Demolition of existing traffic gates, barrier gates, and barrier/pedestrian gates.

1.2 REFERENCES

.1 American Iron and Steel Institute (AISI)- 4150 Oil Hardening Chromium Molybdenum Steel

1.3 PERFORMANCE REQUIREMENTS

.1 Complete gate operators in every detail permitting field adjustment to obtain the required rotation between "raise" and "lower" position of the gates.

.2 The operation shall be smooth with gradual acceleration to approximately 50 percent of arm travel and then gradual deceleration until the "stop" position is reached.

.3 The operating time for a complete 90-degree rotation of the arm, either opening or closing shall be 9 seconds maximum for the traffic and pedestrian gates, and 14 seconds maximum for the barrier gates.

.4 Supply and install limit switches to interrupt the control circuit when either door is open.

1.4 SUBMITTAL

.1 Submit manufacturers shop drawings.

.2 Submit Product Data.

.3 Submit manufacturer's installation instructions.

.4 Submit operation and maintenance data.

1.5 MEASUREMENT PROCEDURES

.1 Work for the new traffic gates, barrier gates and pedestrian gates will not be measured separately for payment.

.2 Measure demolition of traffic gates including all supporting hardware in each unit incorporated into Work.

.3 Measure demolition of barrier gates including all supporting hardware in each unit incorporated into Work.

.4 Measure demolition of barrier/pedestrian gates including all supporting hardware in each unit incorporated into Work.

.5 Measure spare parts for gates - composite set in each unit incorporated into Work.

PART 2 - PRODUCTS

2.1 MATERIAL REQUIREMENT

.1 Provide new materials as needed to maintain, interface and wire the gates to the control system, and provide any other wiring for input to the control schematic diagrams as shown on the Contract Documents.

2.2 TRAFFIC GATE

.1 Counterweights:
.1 At the rear end of the side arm channels, hot dip galvanized counterweights shall be mounted to balance the arm.
.2 Counterweights shall be sectional and shall permit at least 10% adjustment.
.3 Reverse counterweight type.
.4 The gate operator shall be sized to handle the weight of the arm used and be able to operate against a wind speed of 80 mph and ice loading.

.2 Arm:
.1 The gate arm shall be 3 inch (76 mm) square, end section of high strength ultra violet resistant fibreglass.
.2 Stainless steel truss cables and a damping type bumper rod shall be furnished at the discretion of the manufacturer.
.3 Front and rear arm surfaces shall be covered with alternating red and white high intensity reflective sheeting. Stripes shall be 16 inch (406 mm) wide, and shall slope at 45

2.2 TRAFFIC GATE (Cont'd)

.2 Arm:(Cont'd)

.3 (Cont'd)

degrees down toward the arm tip. Remaining exposed surfaces shall be painted white.

.4 Arm assembly mounting shall be fully gasketed, and shaft openings shall incorporate O-ring seals. Traffic gate arms, when down shall meet at an approximately the center of the bridge with no more than a 18 inches (457 mm) gap.

.5 Arm lengths shall be measured from the centerline of the gate housing to the tip of the arm.

.6 Arm mounting channels shall be carbon steel, hot dip galvanized.

.7 The roadway arm shaft centerline shall be 5 feet (1524 mm) above the base line of the gate housing.

.8 Channels shall be offset to place the gate arm centerline at the 3 feet-8 inches (1118 mm) height above the roadway.

.9 The gate arms shall be equipped with flashing red lights and one steady burn, powered from within the gate power enclosures. The gate lights shall be wired to be turned on before the gate arm begins to descend with a limit switch also in the circuit that turns on the lights anytime the arm is not fully up.

.3 Arm Base:

.1 Designed with a shear pin mechanism to minimize damage to the gate and vehicle in the event of a collision. In the event of an impact, the shear pin shall break, allowing the arm to swing approximately 75 to 80 degrees.

.2 Design shear pin base and lightweight arm assembly for easy, rapid reinstallation or replacement by one person.

.3 At the full raise position, a spring-loaded latch shall engage, preventing the arm from swinging back into traffic.

.4 Arm shall be easily reset by manually releasing the latch, rotating the arm back into position and replacing the shear pin.

.4 Shafts:

.1 The main arm shaft shall be of 2 inch (51 mm) diameter AISI 4150 fatigue resistant steel with a minimum tensile strength of 140,000 psi.

.2 The shaft shall be mounted in heavy duty relubricable ball bearings.

.3 All bearings shall be designed for a minimum of one million cycles of operation.

2.2 TRAFFIC GATE (Cont'd)

.5 Arm Mounting Channels:

.1 A pair of carbon steel channels, hot dip galvanized, shall be rigidly affixed to the ends of the main arm shaft. The channels and a steel crossmember shall provide a sturdy mount for the arm, arm base assembly and counterweights.

.6 Transmission:

.1 Fully enclosed, all gear, direct drive unit running in oil bath.

.2 Connecting Rod: Steel; AISI 4150, minimum 1 inch (25 mm) diameter high strength, adjustable with self-aligning ball ends. Belts or chains are not acceptable in drive train.

.3 The mechanism linkage shall be driven by a full enclosed, heavy duty worm gear, double reduction speed reducer.

.4 Gear ratio used shall produce an operation time of approximately 9 seconds.

.7 Motors:

.1 Motors shall be C-face design and shall be mounted directly to the transmission. Enclosed gear trains shall be used for gate arm drive and limit switches. Motors shall be drip-proof or totally enclosed. Motors shall be constructed for 600-V a.c., 3-phase operation. They may be short time rated but shall have ample torque to start and accelerate the driven load under 80 mph wind load.

.2 The power supply to the motor shall include a 3-pole disconnect lockable switch with an auxiliary contact to disconnect the heater. Two strip or cartridge type 200-watt, 120 V a.c., heaters with thermostat and a NEMA Type 4-20R GFCI duplex receptacle shall be mounted in the operator enclosure.

.3 All wiring for external connections shall be brought to terminal blocks and marked with engraved marking strips of a permanent type. Wherever possible, internal wiring shall be brought to terminal strips for connecting purposes. Splicing shall not be allowed in any wiring within the gate control cabinet except on terminal strips.

.4 Fuse holders shall be for panel mounting, rated 250 V a.c. and shall be sized for the appropriate load.

.8 Operating Mechanism:

.1 The warning arm shall pivot in the vertical plane via a mechanical 4-bar linkage. The linkage shall utilize cranks keyed to the main arm shaft and transmission shaft and an adjustable connecting rod between a pair of

2.2 TRAFFIC GATE (Cont'd)

.8 Operating Mechanism:(Cont'd)
.1 (Cont'd)
self-aligning spherical rod ends. The connecting rod shall be of 1 inch (25 mm) diameter AISI 4150. The linkage shall be driven by a fully enclosed, double reduction, worm gear speed reducer. Gear ratio used shall produce an operation time of 9 seconds.

.9 Hand Crank:
.1 One hand crank shall be furnished per gate for manual operation. It shall be necessary to open the operator door in order to operate the hand crank.

.10 Braking Mechanism:
.1 The motor shall be equipped with a solenoid-release, automatic brake which automatically releases when hand crank is inserted.
.2 The brake shall have a manual release lever to permit manual operation of the gate during emergencies or setup.

.11 Housing:
.1 The operating mechanism and main control components shall be contained in a weatherproof housing.
.2 The housing shall be constructed of 0.188 inch (4.8 mm)aluminum alloy 5005 H16 with a natural anodized finish and shall be dust-tight and weatherproof.
.3 Each housing shall be rigidly constructed, free of warps and buckles and shall form an integral part of the unit. The integral framing shall be designed by the manufacturer and shall effectively transfer all directed loads to the concrete base.
.4 The housing and frame shall be designed to prevent distortion of the housing in the event of collision with the gate arm.
.5 Permanent lifting lugs shall be secured to the base angle such that the entire motor unit may be removed as a single piece.
.6 Furnish and install a waterproof gasket between the gate housing and the base.
.7 Maintenance doors shall be located to allow maintenance to be performed without requiring workers to be exposed to traffic on the roadway. Front and rear access doors hung on bronze, slip-off type full cross hinges with stainless steel hinge pins. Door latches, two per door, shall use a vice action to compress a neoprene bulb-type gasket to seal the door openings. A stainless steel strap shall extend

2.2 TRAFFIC GATE (Cont'd)

.11 Housing:(Cont'd)

.7 (Cont'd)

across each door and fit over a heavy hasp to permit use of a padlock. Strap and hasp shall be designed to fit both standard style heavy-duty padlocks and high security shackleless padlocks. Padlocks shall be provided, the Departmental Representative will supply the key number for the padlocks.

.8 The traffic gates shall be fixed to foundations as required by the structural Contract Documents, but shall comply with the following minimum anchorage requirements:

.1 Four anchor bolts, gate housing base shall provide maximum 1.0 inch (25 mm) diameter bolt holes in a square pattern.

.12 Warning Lights, Gongs and Bells:

.1 The gates shall be equipped with an audible distinctive gongs powered from within the gate power enclosure, as required by the AASHTO Standard Specification for Movable Highway Bridges. The audible gongs shall be controlled by the bridge control system.

.2 The warning lights housing shall be of high impact molded plastic; moisture and corrosion proof with 2-way visibility, 7 inch (178 mm) diameter red lenses. The lamp shall be 12 V.

.3 The lamp shall be 12 V d.c., LED 100,000 hour design for the application.

.4 The flasher shall be heavy duty, solid state, fully factory wired, with two alternately flashing circuits and one steady burn circuit. The flasher shall include mounting hardware, solid state flashing circuitry, clearly labelled terminal block, heat sink, and transformer when required. The flashing rate shall be 0.50 seconds ON, 0.50 seconds OFF. Terminals shall be clearly labelled and shall be compression type screw terminals. input voltage shall be 120 V a.c. The flasher shall operate properly for input voltages within 10% of nominal.

.5 Gong shall be heavy-duty, motor driven, industrial quality. The housing shall be cast aluminum; machined for proper fit with gasketed rear door hinged with stainless steel hinge pins and equipped with a swing bolt with provisions for a pad lock. The gear trained shall be journaled in oil-impregnated, bronze bearings and driving a cam and hammer to strike gong shell approximately 100 times per minute. The motor shall operate at 120 V a.c. The gong shell shall be 12 inches (305 mm)spun silicon bronze shell held in place with tamper resistant,

2.2 TRAFFIC GATE (Cont'd)

.12 Warning Lights, Gongs and Bells:(Cont'd)
.5 (Cont'd)
stainless steel stud and protected by a cast aluminum weather guard. The warning bells shall be weatherproof, adjustable sound level, 10 inch (254 mm) diameter (90 decibels) 120 V a.c.

.13 Limit Switches:
.1 The gate limit switch assembly shall be a self-contained unit.
.2 The assembly shall provide 8 independent DPDT (double pole double throw) control switches. Switches shall be controlled by individually adjustable cams. Each individual limit switch shall have one set of normally open and one set of normally closed contacts each. The contacts shall be totally enclosed with ULC rating of not less than 15 Amps at 600 V a.c.
.3 The limit switch assembly design shall permit adjustment of all cams with the gate in any position.
.4 The limit switch assembly shall have a removable cover to help prevent accidental contact with switch terminals.
.5 Shaft, cams, bushings and housing pieces shall be of non-ferrous corrosion resistant materials.
.6 The limit switch shall be motor driven, heavy duty, positive contact opening type with adjustable cam operators.
.7 Use corrosion resistant non-ferrous materials for limit switch body, shafts and cams.

.14 Safety Switches, Terminal Blocks, and Wiring.
.1 Wiring interconnections for all gate components shall conform to the following:
.1 Interior wiring shall be installed in non-metallic raceways.
.2 All wiring other than portable cord shall be rated for 600 volts.
.3 Wire to heater shall be a minimum of No. 12 AWG stranded, with high temperature insulation.
.4 Grounding of the system shall conform to CSA C22.1-2012, Canadian Electrical Code.
.5 All wiring shall be color code or number conductors to match wiring diagram.
.6 Protect all wiring and conductors from physical damage caused by sharp metal edges.
.2 Safety Switches:
.1 Equip gate with a manual disconnect switch and an automatic disconnect switch

2.2 TRAFFIC GATE (Cont'd)

.14 (Cont'd)

.2 Safety Switches:(Cont'd)

to break control circuit when door is opened.

.2 A handcrank safety switch shall be provided to prevent powered actuation of the gate during manual operation.

.3 Lockable disconnect shall be provided for disconnecting main gate motor.

.4 Lockable disconnect switches shall be horsepower rated.

.3 Terminal Blocks:

.1 Pressure type, modular terminal blocks shall be fully labelled and clearly coded to wiring diagrams, installed inside housing on roadway side. Terminate all control wires on terminal blocks.

.2 Connections to screw-type terminals shall have lugs.

.3 Conductors shall be RW90 insulation and No. 14 AWG stranded, minimum.

2.3 BARRIER GATES

.1 Counterweights:

.1 At the rear end of the side arm channels, hot dip galvanized counterweights shall be mounted to balance the arm.

.2 Counterweights shall be sectional and be shall balanced at the factory.

.3 Reverse counterweight type.

.4 The gate operator shall be sized to handle the weight of the arm used and be able to operate against a wind speed of 80 mph and ice loading.

.2 Arm:

.1 The barrier arm design shall be double rail aluminum tube.

.2 Arm length shall be measured from the centerline of the housing.

.3 Stainless steel truss cables and a roadway type bumper rod shall be supplied.

.4 Front and rear arm surfaces shall be covered with alternating red and white high intensity reflective sheeting. Stripes shall be 16 inch (406mm) wide and shall slope at 45 degrees down toward the arm tip. Remaining exposed surfaces shall be painted white.

.5 Arm assembly mounting shall be fully gasketed, and shaft openings shall incorporate O-ring seals. Barrier gate arm, when down shall meet at an approximately the center of the

2.3 BARRIER GATES (Cont'd)

.2 Arm:(Cont'd)

.5 (Cont'd)
bridge with no more than a 18 inches (457 mm) gap.

.6 Arm length shall be measured from the centerline of the gate housing to the tip of the arm.

.7 Arm mounting tubes:

.1 A pair of carbon steel rectangular tubes, hot dip galvanized after fabrication, shall be rigidly affixed to the ends of the main arm shaft.

.2 The tubes shall be offset to locate the arm centerline at the height specified above the housing base.

.3 The tubes and a steel cross-member shall provide a sturdy mount for the arm and counterweights.

.4 The tubes shall have provision for easily adjusting the counterweight offset so the arm can be properly balanced in all positions.

.8 The roadway arm shaft centerline shall be 5 feet (1524 mm) above the base line of the gate housing.

.9 Channels shall be offset to place the gate arm centerline at the 3 feet-8 inches (1118 mm) height above the roadway.

.10 The gate arm shall be equipped with flashing red lights, powered from within the gate power enclosures. The gate lights shall be wired to be turned on before the gate arm begins to descend with a limit switch also in the circuit that turns on the lights anytime the arm is not fully up.

.11 Side Arm Locks:

.1 The energy absorption cables shall be anchored at both ends of the span in the closed to traffic position.

.2 At the housing, heavy duty side arm locks shall be mechanically linked to the operating mechanism to automatically engage and lock the side arm tubes into a rigid configuration when the arm is lowered, to assist in transferring the load into the housing in the event of an impact. This will minimize the chance of damage to the internal operating mechanism.

.12 Arm End Latch:

.1 The energy absorption cables shall be anchored at the tip end of the arm in the closed to traffic position.

.2 A passive end latch mounted on the arm tip shall engage a rigidly mounted and

2.3 BARRIER GATES (Cont'd)

.2 Arm:(Cont'd)

.12 Arm End Latch:(Cont'd)

anchored socket on or in a wall or post for independent barriers.

.13 Shafts:

.1 The main arm shaft shall be of 2.5 inches (63mm) diameter AISI 4150 with a minimum tensile strength of 140,000 psi.

.2 The shaft shall be mounted in heavy duty sealed ball bearings with lubrication fittings.

.3 All bearings shall be designed for a minimum of one million cycles of operation.

.3 Transmission:

.1 The mechanism linkage shall be driven by a fully enclosed, heavy duty worm gear, double reduction speed reducer.

.2 The transmission shall have an occasional momentary peak load rating of not less than 30,000 inch-pounds (3390 Nm).

.3 The output shaft shall be 2 inch (50 mm)in diameter.

.4 Gear ratio used shall produce an operation time of approximately 14 seconds.

.5 A heavy duty torque limiter shall be provided to limit the torque transmitted to the operating mechanism due to excessive wind loads and ice loads, or a physical obstructions to the arm or instant reversing of arm assemblies. The torque limiter shall be capable of being set anywhere within a range of 10,000 to 75,000 in-lbs torque. Each torque limiter shall be factory set for the load recommended by the manufacturer, based on installation requirements. Each torque limiter shall be adjusted and tested at the factory, under over-load conditions, for a minimum of 5 minutes to verify the settings. The gate limit switch assembly shall be driven from the output side of the torque limiter so that slippage of the torque limiter will have no effect on the limit switch settings.

.4 Motors:

.1 The motor shall be a C-face design and shall be mounted directly to the transmission. Enclosed gear trains shall be used for gate arm drive and limit switches. Motors shall be drip -proof or totally enclosed. Motors shall be constructed for 600-V a.c., 3-phase operation. They may be short time rated but shall have ample torque to start and accelerate the driven

2.3 BARRIER GATES (Cont'd)

.4 Motors:(Cont'd)

.1 (Cont'd)
load under 80 mph (128.75 kmh) wind and ice load.

.2 The motor shall be instantly reversing and overload protected.

.3 The power supply to the motor shall include a 3-pole disconnect switch with an auxiliary contact to disconnect the heater. Two strip or cartridge type 200-watt, 120 V a.c., heaters with thermostat and a NEMA Type 4-20R GFCI duplex receptacle shall be mounted in the operator enclosure. Lockable disconnect switches shall be horsepower rated.

.4 All wiring for external connections shall be brought to terminal blocks and marked with engraved marking strips of a permanent type. Wherever possible, internal wiring shall be brought to terminal strips for connecting purposes. Splicing shall not be allowed in any wiring within the gate control cabinet except on terminal strips.

.5 Fuse holders shall be for panel mounting, rated 250 V a.c. and shall be sized for the appropriate load.

.5 Operating Mechanism:

.1 The barrier arm shall pivot in the vertical plane via a mechanical 4-bar linkage. The linkage shall utilize cranks keyed to the main arm shaft and transmission shaft and an adjustable connecting rod between a pair of self-aligning spherical rod ends. The connecting rod shall be of AISI 4150.

.2 An auxiliary crank shall be used, paired with the transmission crank, to reduce the load on the transmission and to better balance and stabilize the load on the housing and mounting structure. The auxiliary crank shall be mounted in a permanently lubricated bronze bearing.

.3 The velocity of the arm shall follow a sinusoidal pattern to provide smooth operation. The arm shall begin and end its full motion path with zero velocity and accelerate smoothly to maximum velocity at mid-travel.

.6 Energy Absorption Cables:

.1 The barrier shall utilize 6x25 construction, 300-series stainless steel, annealed energy absorption cables to assist in diffusing the kinetic energy of an impacting vehicle. Cables shall be annealed in a coil not less than 42 inches (1067 mm) diameter.

.2 The barrier shall typically be capable of absorbing the energy of a 5,000 pound (2,270 kg)

2.3 BARRIER GATES (Cont'd)

.6 Energy Absorption Cables:(Cont'd)
.2 (Cont'd)
vehicle traveling up to 50 mph (80 kmh). Actual capacity shall necessarily depend on individual barrier configuration.
.3 Double rail aluminum tube arms shall have three ½ inch (12mm) cables, one inside each tube, and one along the center of the arm.

.7 Hand Crank:
.1 Both a handcrank and a drill crank shall be provided with each barrier to facilitate manual operation. It shall be necessary to open the operator door in order to operate the hand crank.

.8 Braking Mechanism:
.1 The motor shall be equipped with a solenoid-release, automatic brake which automatically releases when hand crank is inserted.
.2 The brake shall have a manual release lever to permit manual operation of the barrier during setup or emergencies.

.9 Housing:
.1 The operating mechanism and main control components shall be contained in a weatherproof housing.
.2 The housing shall be constructed of 0.375 inches (9.5 mm) carbon steel, hot dip galvanized after fabrication.
.3 Exterior surfaces shall be painted aluminum.
.4 All external fasteners ½ inch (12 mm) and under shall be stainless steel.
.5 Fasteners over ½ inch (12 mm)shall be stainless steel.
.6 Fasteners to be provided with isolation bushings and washers to eliminate dissimilar metals contact.
.7 Arm shaft openings shall incorporate O-ring seals.
.8 Front and rear access doors shall be mounted on strap hinges. Hinges shall be of the slip-off type and shall have stainless steel pins. A stop shall be mounted inside the door to secure the door from being raised off the hinges in the closed position. Door latches, two per door, shall use a vise action to compress a neoprene bulb-type gasket to seal the door openings. Door latches shall be of stainless steel and tamper resistant. A stainless steel strap shall extend across each door and fit over a heavy hasp to permit use of a padlock. Strap

2.3 BARRIER GATES (Cont'd)

.9 Housing:(Cont'd)

.8 (Cont'd)

and hasp shall be designed to fit both standard style heavy-duty padlocks and high security shackleless padlocks. Padlocks shall be provided, the Departmental Representative will supply the key number for the padlocks.

.9 Each housing shall be rigidly constructed, free of warps and buckles and shall form an integral part of the unit. The integral framing shall be designed by the manufacturer and shall effectively transfer all directed loads to the concrete base. Permanent lifting lugs shall be secured to the base angle such that the entire motor unit may be removed as a single piece. The Contractor shall furnish and install a waterproof gasket between the gate housing and the base.

.10 The barrier gates shall be fixed to foundations as required by the structural Contract Documents, but shall comply with the following minimum anchorage requirements:

.1 Twelve anchor bolts, gate housing base shall provide 1.25 inches(32 mm) diameter bolt holes.

.10 Warning Lights, Gongs and Bells:

.1 The gates shall be equipped with an audible distinctive gongs powered from within the gate power enclosure, as required by the AASHTO Standard Specification for Movable Highway Bridges. The audible gongs shall be controlled by the bridge control system.

.1 The warning lights housing shall be of high impact molded plastic; moisture and corrosion proof with 2-way visibility, 7 inch (178 mm) diameter red lenses. The lamp shall be 12 V.

.2 The lamp shall be 12 V d.c., LED 100,000 hour design for the application.

.3 The flasher shall be heavy duty, solid state, fully factory wired, with two alternately flashing circuits and one steady burn circuit. The flasher shall include mounting hardware, solid state flashing circuitry, clearly labelled terminal block, heat sink, and transformer when required. The flashing rate shall be 0.50 seconds ON, 0.50 seconds OFF. Terminals shall be clearly labelled and shall be compression type screw terminals. input voltage shall be 120 V a.c. The flasher shall operate properly for input voltages within 10% of nominal.

2.3 BARRIER GATES (Cont'd)

.10 Warning Lights, Gongs and Bells:(Cont'd)

.1 (Cont'd)

.4 Gong shall be heavy-duty, motor driven, industrial quality. The housing shall be cast aluminum; machined for proper fit with gasketed rear door hinged with stainless steel hinge pins and equipped with a swing bolt with provisions for a pad lock. The gear trained shall be journaled in oil-impregnated, bronze bearings and driving a cam and hammer to strike gong shell approximately 100 times per minute. The motor shall operate at 120 V a.c. The gong shell shall be 12 inches (305 mm) spun silicon bronze shell held in place with tamper resistant, stainless steel stud and protected by a cast aluminum weather guard. The warning bells shall be weatherproof, adjustable sound level, 10 inch (254 mm) diameter (90 decibels) 120 V a.c.

.11 Limit Switches:

.1 The gate limit switch assembly shall be a self-contained unit.

.2 The assembly shall provide 8 independent DPDT (double pole double throw) control switches. Switches shall be controlled by individually adjustable cams. Each individual limit switch shall have one set of normally open and one set of normally closed contacts each. The contacts shall be totally enclosed with ULC rating of not less than 15 Amps at 600 V a.c.

.3 The limit switch assembly design shall permit adjustment of all cams with the gate in any position.

.4 The limit switch assembly shall have a removable cover to help prevent accidental contact with switch terminals.

.5 Shaft, cams, bushings and housing pieces shall be of non-ferrous corrosion resistant materials.

.6 The limit switch shall be motor driven, heavy duty, positive contact opening type with adjustable cam operators.

.7 Use corrosion resistant non-ferrous materials for limit switch body, shafts and cams.

.12 Safety Switches, Terminal Blocks, and Wiring.

.1 Wiring interconnections for all gate components shall conform to the following:

.1 Interior wiring shall be installed in non-metallic raceways.

.2 All wiring other than portable cord shall be rated for 600 volts.

2.3 BARRIER GATES (Cont'd)

.12 (Cont'd)

.1 (Cont'd)

.3 Wire to heater shall be a minimum of No. 12 AWG stranded, with high temperature insulation.

.4 Grounding of the system shall conform to CSA C22.1-2012, Canadian Electrical Code.

.5 All wiring shall be color code or number conductors to match wiring diagram.

.6 Protect all wiring and conductors from physical damage caused by sharp metal edges.

.13 Safety Switches:

.1 Equip gate with a manual disconnect switch and an automatic disconnect switch to break control circuit when door is opened.

.2 A handcrank safety switch shall be provided to prevent powered actuation of the gate during manual operation.

.3 Lockable disconnect shall be provided for disconnecting main gate motor.

.14 Terminal Blocks:

.1 Pressure type, modular terminal blocks shall be fully labelled and clearly coded to wiring diagrams, installed inside housing on roadway side. Terminate all control wires on terminal blocks.

.2 Connections to screw-type terminals shall have lugs.

.3 Conductors shall be RW90 insulation and No. 14 AWG stranded, minimum.

2.4 PEDESTRIAN GATES

.1 Arm:

.1 The gate arm shall be 2 inch by 5 inch (50mm x 127mm), 6005-T5 aluminum extruded tubing.

.2 Maximum arm length shall be measured from the centerline of the housing.

.3 Front and rear arm surfaces shall be covered with alternating red and white high intensity reflective sheeting. High intensity reflectorized sheeting shall be 16 inches (406 mm) wide, and shall slope at 45 degrees down toward the arm tip. Remaining exposed surfaces shall be painted white.

.4 Arm Base:

.1 The arm base shall be designed with a shear pin mechanism to minimize damage to the gate and vehicle in the event of a collision. In the event of an impact, the

2.4 PEDESTRIAN GATES (Cont'd)

.1 Arm:(Cont'd)

.4 Arm Base:(Cont'd)

.1 (Cont'd)
shear pin shall break, allowing the arm to swing approximately 60 to 80 degrees.

.2 At the full open position, a spring-loaded latch shall engage, preventing the arm from swinging back into traffic.

.3 Arm shall be easily reset by manually releasing the latch, rotating the arm back into position and replacing the shear pin.

.5 Shafts:

.1 The main arm shaft shall be of 1.5 inch (38mm) diameter AISI 4150 with a minimum tensile strength of 140,000 psi. The shaft shall be mounted in heavy duty relubricable ball bearings.

.2 Motors

.1 Motors shall be C-face design and shall be mounted directly to the transmission. Enclosed gear trains shall be used for gate arm drive and limit switches. Motors shall be drip-proof or totally enclosed. The motor shall be constructed for 600-V a.c., 3-phase operation. They may be short time rated but shall have ample torque to start and accelerate the driven load under 80 mph (130 kmh) wind load.

.2 The motor horsepower shall be ½ hp.

.3 The motor shall be a C-face design and shall be mounted directly to the transmission.

.4 The power supply to the motor shall include a 3-pole disconnect switch with an auxiliary contact to disconnect the heater. Two strip or cartridge type 200-watt, 120 V a.c., heaters with thermostat and a NEMA Type 4-20R GFCI duplex receptacle shall be mounted in the operator enclosure.

.5 All wiring for external connections shall be brought to terminal blocks and marked with engraved marking strips of a permanent type. Wherever possible, internal wiring shall be brought to terminal strips for connecting purposes. Splicing shall not be allowed in any wiring within the gate control cabinet except on terminal strips.

.6 Fuse holders shall be for panel mounting, rated 250 V a.c. and shall be sized for the appropriate load.

.3 Braking Mechanism

.1 The motor shall be equipped with a solenoid-release, automatic brake.

2.4 PEDESTRIAN GATES (Cont'd)

.3 (Cont'd)

.2 The brake shall have a manual release lever to permit manual operation of the gate during emergencies or setup.

.4 Hand Crank

.1 One hand crank shall be furnished per gate for manual operation. It shall be necessary to open the operator door in order to operate the hand crank.

.5 Housing

.1 The operating mechanism and main control components shall be contained in a weatherproof housing.

.2 The housing shall be constructed of 0.188 inch (4.8 mm)aluminum alloy 5005 H16 with a natural anodized finish and shall be dust-tight and weatherproof.

.3 Each housing shall be rigidly constructed, free of warps and buckles and shall form an integral part of the unit. The integral framing shall be designed by the manufacturer and shall effectively transfer all directed loads to the concrete base.

.4 The housing and frame shall be designed to prevent distortion of the housing in the event of collision with the gate arm.

.5 Permanent lifting lugs shall be secured to the base angle such that the entire motor unit may be removed as a single piece.

.6 The Contractor shall furnish and install a waterproof gasket between the gate housing and the base.

.7 Maintenance doors shall be located to allow maintenance to be performed without requiring workers to be exposed to traffic on the roadway. Front and rear access doors hung on bronze, slip-off type full cross hinges with stainless steel hinge pins. Door latches, two per door, shall use a vice action to compress a neoprene bulb-type gasket to seal the door openings. A stainless steel strap shall extend across each door and fit over a heavy hasp to permit use of a padlock. Strap and hasp shall be designed to fit both standard style heavy-duty padlocks and high security shackleless padlocks. Padlocks shall be provided, the Departmental Representative will supply the key number for the padlocks.

.8 The traffic gates shall be fixed to foundations as required by the structural

2.4 PEDESTRIAN GATES (Cont'd)

.5 (Cont'd)

.8 (Cont'd)

Contract Documents, but shall comply with the following minimum anchorage requirements:

.1 Four 1/2 inch (13 mm) diameter anchor bolts, gate housing base shall provide four 3/4 inch (19 mm) diameter bolt holes, spaced 9-3/4 inches (248 mm) by 17-3/4 inches (451 mm) in a square pattern.

.6 Warning Lights:

.1 The gates shall be equipped with warning lights. The warning lights housing shall be of high impact molded plastic; moisture and corrosion proof with 2-way visibility, 7 inch (178 mm) diameter red lenses. The lamp shall be 12 V.

.2 The lamp shall be 12 V d.c., LED 100,000 hour design for the application.

.3 The flasher shall be heavy duty, solid state, fully factory wired, with two alternately flashing circuits and one steady burn circuit. The flasher shall include mounting hardware, solid state flashing circuitry, clearly labelled terminal block, heat sink, and transformer when required. The flashing rate shall be 0.50 seconds ON, 0.50 seconds OFF. Terminals shall be clearly labelled and shall be compression type screw terminals. Input voltage shall be 120 V a.c. The flasher shall operate properly for input voltages within 10% of nominal.

.7 Limit Switches:

.1 The gate limit switch assembly shall be a self-contained unit.

.2 The assembly shall provide four independent SPDT control switches. Each individual limit switch shall have one set of normally open and one set of normally closed contacts each. The contacts shall be totally enclosed with ULC rating of not less than 15 Amps at 480 V a.c.

.3 The limit switch assembly design shall permit adjustment of all cams with the gate in any position.

.4 The limit switch assembly shall have a removable cover to help prevent accidental contact with switch terminals.

.5 Shaft, cams, bushings and housing pieces shall be of non-ferrous corrosion resistant materials.

.6 The limit switch shall be motor driven, heavy duty, positive contact opening type with adjustable cam operators.

2.4 PEDESTRIAN GATES (Cont'd)

.7 Limit Switches:(Cont'd)
.7 Use corrosion resistant non-ferrous materials for limit switch body, shafts and cams.

.8 Safety Switches, Terminal Blocks, and Wiring:
.1 Wiring interconnections for all gate components shall conform to the following:
.1 Interior wiring shall be installed in non-metallic raceways.
.2 All wiring other than portable cord shall be rated for 600 volts.
.3 Wire to heater shall be a minimum of No. 12 AWG stranded, with high temperature insulation.
.4 Grounding of the system shall conform to CSA C22.1-2012, Canadian Electrical Code.
.5 All wiring shall be color code or number conductors to match wiring diagram.
.6 Protect all wiring and conductors from physical damage caused by sharp metal edges.
.2 Safety Switches:
.1 Equip gate with a manual disconnect switch and an automatic disconnect switch to break control circuit when door is opened.
.2 A handcrank safety switch shall be provided to prevent powered actuation of the gate during manual operation.
.3 Lockable disconnect shall be provided for disconnecting main gate motor.

2.5 SPARE PARTS

.1 Provide in their original boxes or containers, the following spare parts:
.1 One (1) barrier gate arm.
.2 One (1) traffic gate arm.
.3 One (1) pedestrian gate arm.

PART 3 - EXECUTION

3.1 CONSTRUCTION REQUIREMENTS

.1 Installation

.1 Verify system voltage matches gate requirements.

.2 Install in accordance with manufacturer's instructions.

.3 Make connections to control console. Manually test hand crank.

.4 Power test traffic, barrier and pedestrian gates to ensure proper operation of warning bells, gate operator, gate arm lights and gate interlock.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 It is the intent of this Specification that only individuals of high competence and experience be utilized to perform the Work of this Section.

.2 It is not the intent of the Contract Documents to identify all necessary methods, means, equipment, or appurtenances that will be required in order to accomplish the work of the Contract Documents.

.3 Expertise and competence in vertical lift bridge tower driven electrical system installation is required to understand the necessary methods, means and equipment to ensure a successful operating system.

.4 This section describes the requirements for the Work to be done which includes furnishing all labour, materials, equipment and tools required to complete and leave ready for operation the installation of all items of electrical Work in accordance with the Contract Documents.

.5 Items of electrical Work include but are not limited to the following:

.1 Prepare detailed electrical and control system shop drawings as required to fabricate and supply the control equipment, define the installation and interconnection of the electrical equipment including all required interconnections with equipment supplied under other sections, and test and verify that the completed electrical system's installation and performance is satisfactory with respect to the requirements of the Contract Documents.

.2 Demolition of existing electrical installation/equipment including removal of all wiring and conduit no longer in use.

.3 Demolition of existing traffic gates, barrier/pedestrian gates including removal of all wiring and conduit no longer in use.

.4 Demolition of existing Programmable Logic Controller (PLC) cabinet, existing control cubicles, existing motors, existing Automatic Transfer Switch (ATS), existing resistors, existing main motors, existing Motor Control Centres (MCCs), existing aerial cables, existing uninterruptible power supply, and existing height indicators.

1.1 SUMMARY (Cont'd)

.5 (Cont'd)

.5 Supply and install Programmable Logic Controller(PLC). Program the PLC to provide the control functions as specified.

.6 Underground duct work for all the barrier gates, pedestrian gates and traffic gates.

.7 All sidewalk repair and replacement following underground and embedded duct work.

.8 Supply and install all wire, cables, aerial cables, conduits, wiring, wiring devices, motors, control panels, control consoles, motor control centres, panelboards,circuit breakers, relays, control equipment, transfer switch, barrier gates, pedestrian gates, traffic gates, safety switches, limit switches, height indicating systems, skew control systems, uninterruptible power supply, grounding system, panelboards, automatic transfer switch and all other apparatus and accessories indicated, specified, or required for a complete power and control systems for the Bridge, and Control Building.

.9 Supply and install the connections to the new motors and to other equipment, which motors and equipment are furnished and installed under. the Contract Documents.

.10 Supply and install the electrical and control connections to existing span lock motors, existing auxiliary drive panel, existing heating panels, existing lighting panels, existing diesel generator, existing diesel generator alarms, existing public announcement (P.A.) system, existing fire protection system, existing CCTV system, and existing elevators.

.11 Locate operating and control equipment to provide easy access, and arrange entire electrical work with adequate access for operation and maintenance as per the CSA C22.1-2012 requirements.

.12 Comply with all applicable federal provincial and municipal laws and regulations applicable to electrical installations in effect and with the regulations of the CSA C22.1-2012, where such regulations do not conflict with the laws in effect and with the requirements of the utility company.

.13 Prepare detailed shop drawings of electrical and control system conduit and wiring to provide the functionality specified in the Contract Documents. Provide signed and sealed drawings if proposed system differs from the Contract Documents.

.14 It is the intention of these Contract Documents to call for finished Work, tested and ready for operation.

1.1 SUMMARY (Cont'd)

.5 (Cont'd)

.15 Supply, deliver, and install any apparatus, appliances, materials, or Work not indicated on the Drawings but mentioned in the Specifications or vice versa, or any incidental accessories necessary to make the Work complete in all respects and ready for operation.

.16 Wiring and conduit Work includes runs to all traffic gates, pedestrian gates, barriers gates, limit switches, span lock motors, main span drive motors, motor brakes, machinery brakes, motor blowers, auxiliary drive motors, stand-by generators and automatic transfer switches, motor control centres, control consoles, control panels, air horns, sirens, navigation lights, limit switches, system grounding scheme, panelboards, uninterruptible power supply, control building lighting panels, and any other component necessary for a complete electrical operating system.

1.2 CLASSIFICATIONS

.1 Unless otherwise specified, all manufactured items, fabrications, components, pieces, assemblies and appurtenances that are to be removed, salvaged, repaired, rehabilitated, supplied new, installed or reinstalled under the provisions of these Contract Documents are classified as electrical construction.

1.3 MEASUREMENT PROCEDURES

.1 Electrical work will not be measured separately for payment.

1.4 WORK INCLUDED

.1 Electrical:

.1 Remove and dispose all existing electrical and control equipment, including but not limited to electrical and control equipment identified for demolition or decommissioning, including:

- .1 Control panels and motor starters.
- .2 Resistors.
- .3 Traffic gates, pedestrian gates, and traffic barriers.
- .4 Conduit, junction boxes, wire and cable associated with removed equipment.
- .5 Span main drive motors and all its electrical components.
- .6 Transfer switches at North Motor Room.
- .7 Limit switches.
- .8 Aerial cables.

1.4 WORK INCLUDED (Cont'd)

.1 Electrical:(Cont'd)

.2 Main control console and master controller switch are to be kept and refurbished.

.3 Remove and turn over to Departmental Representative:

.1 Existing gate arms.

.2 North cable reel.

.3 Operational desktop computer located in main control console.

.4 Existing Programmable Logic Controller (PLC).

.4 Supply and install 600-volt, 3 Phase, 3 wire motor control centres (MCCs).

.5 Supply and install:

.1 An integrated Programmable Logic Control (PLC) system including control consoles, control panels, skew control systems and field limit switches.

.2 Vector-controlled pulse width modulated motor drives for main span drive motors.

.3 Main span drive motors.

.4 Local disconnect switches for motors and brakes as indicated in the Contract Documents.

.5 Aerial cables with new NEMA 4X Stainless Steel Type 316 terminal boxes.

.6 Traffic gates, pedestrian gates, and barrier gates.

.7 All conduit, wire and supporting hardware required for a complete installation of the equipment listed above, and equipment to remain as indicated in the Contract Documents.

.6 Relocate equipment and its associated wiring as shown in the Contract Documents.

.7 Provide training to PWGSC Bridge Operators, O&M Manuals, as-built drawings and specifications.

.8 Equipment grounding.

1.5 HIERARCHY OF DOCUMENTS

.1 Unless otherwise noted, all items shall conform to the CAN/CSA-S6-06. All discrepancies between the CAN/CSA-S6-06, the Contract Documents shall be brought to the Departmental Representative's immediate attention for review and clarification.

1.6 REFERENCES

.1 Canadian Standards Association (CSA)
.1 CSA C22.1-2012, Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations.
.2 CSA C22.2 No.0-10 (R2010) General Requirements - Canadian Electrical Code, Part II.
.3 CAN/CSA-C22.3 No. 1-06, Overhead Systems.
.4 CAN3-C235-83(R2006), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
.5 Do underground systems in accordance with CSA C22.3 No.7-06, Underground Systems, except where specified otherwise.
.6 CAN/CSA-S6-06, Canadian Highway Bridge Design Code.
.1 CSA S6S1-10, Supplement #1 to CAN/CSA-S6-06, Canadian Highway Bridge Design Code.
.2 CSA S6.1S1-10, Supplement #1 to S6.1-06, Commentary on CAN/CSA-S6-06, Canadian Highway Bridge Design Code.
.3 CSA S6.1S2-11, Supplement #2 to S6.1-06, Commentary on CAN/CSA-S6-06, Canadian Highway Bridge Design Code.
.4 CSA S6S2-11, Supplement #2 to CAN/CSA-S6-06, Canadian Highway Bridge Design Code.
.7 CAN/CSA-Z462-11, Workplace Electrical Safety.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC).
.1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

.3 Health Canada / Workplace Hazardous Materials Information System (WHMIS).
.1 Material Safety Data Sheets (MSDS).

.4 Institute of Electrical and Electronics Engineers (IEEE) Standard 519-1992 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

.5 National Electrical Contractor Association - NECA 1-2010 - Standard Practice of Good Workmanship in Electrical Contracting.

.6 National Fire Protection Agency - NFPA 79-2012 -Electrical Standard for Industrial Machinery.

.7 The Ontario Electrical Safety Code 2012, and all bulletins (Ontario).

1.6 REFERENCES (Cont'd)

.8 Hydro requirements and local applicable codes and regulations.

1.7 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: provide identification nameplates and labels for control items in English.

1.8 COORDINATION

.1 Employ the services of a Movable Bridge Construction Specialist to coordinate the mechanical, electrical, and structural tasks.

.2 Movable Bridge Construction Specialist shall manage the on-site integration of the electrical control system with the electrically operated equipment and shall work with the Bridge Control System Integrator.

.3 Movable Bridge Construction Specialist shall be responsible for the fitting of motors to the drive machinery, alignment of the machinery, and shall serve as the director of functional testing of the bridge operating systems.

.4 Movable Bridge Construction Specialist shall be on-site full time, starting 2 weeks prior to delivery of any mechanical or electrical equipment to the site, except while witnessing factory fabrication, fittings, and testing.

.5 Contract documents are diagrammatic in showing certain physical relationships which must be arranged within the electrical Work, and which must interface with other Work including utilities, structural, and machinery Work.

.6 Locate operating and control equipment to provide easy access, and arrange entire electrical Work with adequate access for operation and maintenance in accordance with CSA C22.1.

1.8 COORDINATION (Cont'd)

.7 Coordinate electrical Work with the Work of other trades to eliminate conflicts. Advise other trades of Bridge operations required in their Work for the subsequent move-in of large units of electrical equipment. Contractor shall be solely responsible for the coordination of electrical Work with the Work of other trades.

.8 Protect all electrical equipment from damage caused during installation or by subsequent activities.

.9 Replace any and all damaged equipment at no extra cost to Departmental Representative and with no additional time allowance.

1.9 BRIDGE CONTROL SYSTEMS INTEGRATOR

.1 Designate and provide the services, of an individual to act as the Bridge Control System Integrator and to serve as the Contractor's sole representative for the integration of the electrical power and control systems with the mechanical components into a single bridge operating system. Bridge Control System Integrator's responsibilities shall include the detailed design, development, and coordination of Contractor completed assemblies including, the motor control centres (MCCs), vector-controlled pulse width modulated motor drives, motor controllers, the control panels, the control consoles, and programming of the control panels, with the mechanical operating equipment.

.2 Ensure the Bridge Control Systems Integrator is qualified in developing and coordinating these types of Specialty Items, and is approved by the Departmental Representative.

.3 Bridge Control Systems Integrator will serve as a single point of contact prior to, during, and after construction, and must be available for consultation during all phases of the project, including shop drawing submittal and review.

1.10 SUBMITTALS

.1 Submittals: in accordance with Sections 01 33 00 and 01 78 00.

.2 Product Data: submit WHMIS MSDS.

.3 Submit after construction has been completed (4) four single line electrical diagrams

1.10 SUBMITTALS (Cont'd)

.3 (Cont'd)
(showing as-built conditions) in glazed frames to be locate as indicated below:
.1 Electrical distribution system in main electrical room.
.2 Electrical distribution system in motor rooms.
.3 Electrical power generation and distribution systems in generator room.

.4 Shop drawings and product data:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario within 12 weeks of Award of Contract.
.2 Submit, prior to purchase of any materials or equipment required to be supplied and installed under this section, a complete list of all such materials and equipment including manufacturer's catalogue numbers, catalogue data sheets, illustrations, and shop drawings, to the Departmental Representative for review.
.3 If changes are required, notify the Departmental Representative of these changes before they are made.
.4 Complete wiring interconnection diagrams, giving complete termination identification of wires and cables, and sizes and numbers of all wires and cables, and the make and capacity of all apparatus, including the rating of all impedance. Schematic diagrams shall include 3-line power diagrams showing the scheme of connections including detailed apparatus, and complete control schematic diagrams which shall include the control panels and the control console. The number of each wire and an individual device designation for each electrical device or piece of apparatus shall be shown on the control schematic diagram. This device designation shall be unique and used to identify each piece of apparatus on all assembly and installation drawings. Assembly drawings shall include locations to scale of all external and internal identified components, including terminal blocks contained on or in the control panels, terminal boxes, and control consoles.
.5 Complete conduit drawings, which show the physical routing and size of each conduit and the wire number and size of each wire therein. These drawings shall show the exact location and method of support of all conduits, ducts, boxes, and expansion fittings, and each conduit shall be given an individual conduit designation.
.1 Welding, drilling, tapping, or cutting structural steel is not permitted

1.10 SUBMITTALS (Cont'd)

.4 Shop drawings and product data:(Cont'd)

.5 (Cont'd)

without the permission of the Departmental Representative. Vibration proof compression clamps and fasteners may be used followed by steel coating restoration. Clamping and cribbing to provide mounting surfaces may be used providing they are type 316 stainless steel strut, all-thread, and bolts with lock washers.

.6 Installation drawings giving locations of all cables, conduits, motor drives, motor control centres, terminal boxes, automatic transfer switch, disconnect switches, control panels, control consoles, resistance values, switches, lamps, and all other apparatus.

.7 Drawings showing the general construction and dimensions of all control panels and the arrangement of all apparatus thereon.

.8 Submit working drawings, shop drawings, and descriptive material of each separately mounted piece of equipment.

.1 Supply the following drawings: Control consoles, control panels, motor drives, motor control centres, transfer switch, motors, traffic gates, barrier gates, pedestrian gates, aerial cables, limit switches, and braking resistors.

.1 Assembly drawings, with plan, elevations, front and end views, which gives the necessary dimensions and notations to permit proper equipment installation.

.2 Proposed location of all apparatus on the front and at the rear of the panel.

.3 The size of the individual panels, showing segregation for shipment.

.4 Proposed engraved metal nameplates with designation as to function of the apparatus mounted on the front of the board.

.5 Bill of material of all apparatus proposed, on both the front and rear of the panels with the necessary terminals and terminal blocks.

.6 Elementary wiring diagrams, which show the control scheme and general connection of all apparatus supplied under this Section, arranged to permit ready analysis of the sequence of operation.

1.10 SUBMITTALS (Cont'd)

.4 Shop drawings and product data:(Cont'd)

.8 (Cont'd)

.7 A wiring diagram showing the detailed wiring of the panels and controllers, listing all apparatus furnished under this Section, with terminals, etc., properly identified and coordinated.

.8 Control console and control panel wiring diagrams, showing proposed wiring and position of all apparatus and terminal boards on the control consoles and control panels.

.9 Detailed construction drawings of pedestrian gates, traffic gates and barrier gates including structural supports.

.10 Drawings of all boxes, troughs, ducts, and raceways.

.11 Certified dimensioned prints of all electrical apparatus.

.12 Complete curves for the span-drive motor.

.5 Conduct field surveys to verify existing dimensions shown on the plans, prior to development of submittals. Identify field verified dimensions on submittals. Conduct field measurements and surveys as required to supplement the information provided in the plans and to provide a complete and satisfactory fitting and operational installation.

.6 The shop drawings, as called for in this Section, shall include detailed and assembly drawings for all electrical components.

.7 Submittals for each manufactured items shall be manufacturer's descriptive literature, drawings, diagrams, performance and characteristic curves, and catalogue cuts, and shall include the manufacturer's name, trade name, catalogue model or number, nameplate data, size, certified layout dimensions, capacity, specification reference, including ASTM, ANSI and any other applicable references, and all other information necessary to establish Contract compliance.

.8 As used herein, certified test reports refer to reports of test conducted on previously manufactured materials, or equipment identical to that proposed for use.

1.10 SUBMITTALS (Cont'd)

.9 As used herein, factory tests refer to tests required to be performed on the actual materials or equipment proposed for use. Results of the test shall be submitted in accordance with provisions of this Contract for laboratory test results. Manufacturer's Certifications:
.1 When specified in individual Sections, submit manufacturers' certificate for review.
.2 Indicate material or product conforms to or exceeds specified requirements.
.3 Submit supporting reference data, affidavits, and certifications as appropriate.
.4 Certificates may be recent or previous test results on material or product, but must be acceptable to the Departmental Representative.

.10 Manufacturers' Instructions: Identify conflicts between manufacturers' instructions and Contract Documents and submit resolution for review and approval.

.11 Before preparation of shop drawings for new components that must mate with the new and or existing structure, obtain all necessary field dimensions to provide proper fit of the new components.

.12 All dimensions shown on the shop drawings that were obtained by field measurements shall be clearly identified. Verify these dimensions.

.13 Submit shop drawings when installation and mounting details of manufactured components or devices are different from or not specifically detailed on the Contract Documents.

.14 Product Data:
.1 Submit the number of copies that the contract requires.
.2 Submit product data in binders. Organize with tab dividers.
.3 Clearly mark each copy to identify applicable products, models, options and other data.
.4 Supplement manufacturers' standard data to provide information unique to this project.

.15 Quality Control: in accordance with Section 01 45 00.
.1 Provide CSA, ULC or UL certified equipment and material.
.2 Where CSA or ULC certified equipment and material is not available, submit such equipment and material to inspection authority having

1.10 SUBMITTALS (Cont'd)

.15 Quality Control:(Cont'd)
.2 (Cont'd)
jurisdiction for special approval before delivery to site.
.3 Submit test results of installed electrical systems and instrumentation.
.4 Submit, upon completion of Work, electrical load balance report.
.5 Submit certificate of acceptance from Electrical Inspection Department authority having jurisdiction upon completion of Work to Departmental Representative.

.16 Manufacturer's Field Reports: submit to Departmental Representative, manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in Section 01 45 00.

.17 As-built drawings and specifications in accordance with Section 01 33 00.

1.11 WORKING DRAWINGS

.1 Make complete working drawings for the electrical equipment. Use a set of reviewed shop drawings (incorporate all review comments if Reviewed with Comments) and mark, in red all circuit changes made in the field.

.2 Maintain a full set of working drawings on the jobsite at all times.

.3 Working drawings must be available at the time of the Functional Checkout.

.4 Furnish complete shop drawings and details, and working plans for the electrical equipment.

.5 Working drawings shall become the property of the Departmental Representative after they have been corrected to show the Work as constructed.

.6 Working drawings, shop drawings, and catalogue sheets for all materials and equipment shall be submitted for the Departmental Representative's review. The Departmental Representative's review is needed prior to purchasing and installing materials or equipment. The drawings shall become the property of the Departmental Representative after they have been corrected to

1.11 WORKING DRAWINGS (Cont'd)

.6 (Cont'd)
show the Work as constructed. These drawings shall include:
.1 Complete wiring interconnection diagrams, giving complete termination identification including device designation of wires and cables, and sizes and numbers of all wires and cables, and the make and capacity of all apparatus, including the rating of all impedance. Schematic diagrams shall include 3-line power diagrams showing the scheme of connections including detailed apparatus, and complete control schematic diagrams which shall include the control panels and the control console. The number of each wire and an individual device designation for each electrical device or piece of apparatus shall be shown on the control schematic diagram. This device designation shall be used to identify each piece of apparatus on all assembly and installation drawings. Assembly drawings shall include locations to scale of all external and internal identified components, including terminal blocks contained on or in the control panels, terminal boxes, and control console.
.2 Complete conduit drawings, which show the physical routing and size of each conduit and the wire number and size of each wire therein. These drawings shall show the exact location and method of support of all conduits, ducts, boxes, and expansion fittings, and each conduit shall be given an individual conduit designation.
.3 Installation drawings giving locations of all cables, conduits, motor drive, motor control center, terminal boxes, automatic transfer switch, disconnect switches, control panels, control console, resistance values, switches, lamps, and all other apparatus.
.4 Drawings showing the general construction and dimensions of all control panels and the arrangement of all apparatus thereon.
.5 Drawings showing the general construction and dimensions of the control console and the arrangement of all apparatus thereon.
.6 Certified dimensioned prints of all electrical apparatus.
.7 Detailed construction drawings of pedestrian gates, traffic gates and barrier gates including internal schematics and wiring diagrams.
.8 Detailed construction drawings of all boxes, troughs, ducts, and raceways other than conduit.
.9 Complete curves for the span-drive motors, showing the variation in motor speeds and motor

1.11 WORKING DRAWINGS (Cont'd)

.6 (Cont'd)

.9 (Cont'd)

currents with output torque for each power point on the controller.

.10 Special apparatus shall be designated by the manufacturer's name and catalog reference.

.11 Complete support rack details for electrical room (control building) conduit and equipment.

.12 Complete cable and conduit schedules with conduit size, fill, and wire numbers. These schedules shall be in addition to those shown in the Contract Documents. All control conduits shall have a sampling of 15-percent-installed spare conductors. Conduit fill and ampacity derating shall be in compliance with CSA C22.1-2012.

1.12 AS BUILT DRAWINGS AND OPERATION MANUAL

.1 At the completion of the project, provide a complete set of as-built drawings as well as operations and maintenance manuals.

.2 Compile operations and maintenance manuals of the manufacturer's catalogue data, installation, operation, and maintenance instructions of all equipment supplied and installed.

.3 Draft as-built drawings and specifications from the marked-up working drawings. Working drawings shall be provided for checking purposes. In addition to the hard copies, AutoCAD format electronic files of the as-built drawings shall be submitted.

.4 Include all source of code of control software.

1.13 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Section 01 45 00.

.2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction.

.1 Employees registered in provincial apprentices 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.

1.13 QUALITY ASSURANCE (Cont'd)

.3 Site Meetings:
.1 In accordance with Section 01 31 19.
.2 Site Meetings: as part of Manufacturer's Field Services described in Part 3 - FIELD QUALITY CONTROL, schedule site visits, to review Work, as a minimum at stages listed:
.1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
.2 Twice during progress of Work at 25% and 60% complete.
.3 Upon completion of Work, after cleaning is carried out.
.4 During the shut down period, weekly meetings.

.4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.

.5 Tools and procedures:
.1 Manufacturer Requirements:
.1 Install, apply, or adjust all electrical equipment and materials in accordance with manufacturer's written recommendations including the usage of the manufacturer specified tooling. When such materials are ULC, or other 3rd party, listed or recognized, the tooling used for field Installation must be the same as, or the manufacturer's approved equivalent to, the tooling utilized in the approval testing.
.2 Quality Assurance Tooling Identification:
.1 When applicable, the approved tooling will provide a suitable identification to the work to allow verification that the appropriate tool was used to perform the work. For example, use crimping dies that contain identification marks that emboss the crimps made with them with an identification embossment.
.2 Quality Isolation: Where possible, the requirement to provide a level of workmanship quality will be transferred to the tooling rather than the skills of the workman. As examples, but not limited to:
.1 Conductor Stripping: Depend upon the use of approved non-nicking strippers rather than the operator's skill with knife edged stripping tools to prevent wire nicking.
.2 Crimp Tightness: Proper crimping will depend upon the exclusive use of controlled cycle crimping tools that

1.13 QUALITY ASSURANCE (Cont'd)

.5 Tools and procedures:(Cont'd)

.2 (Cont'd)

.2 Quality Isolation:(Cont'd)

require the proper degree of compression before releasing the work rather than upon the operator's judgment of how hard the tool handle is being squeezed.

.3 Tie Tightness: Determine proper tensioning of cable and wrap ties by the use of the manufacturer's specified calibrated tensioning tool rather than the operator's judgment of what is "tight enough."

.4 Fastener Torque: Tighten fasteners with a recommended torque, where the proper tightness is important to the performance of the function (which includes all electrical terminals), with a calibrated torque (limiting) screwdriver or other torque-indicating tool.

.6 Tool verification:

.1 Whenever any other Section requires material submittals, when tooling is associated therewith, submit the manufacturer's tooling requirements and procedures, including catalogue and calibration information, on the tooling that is proposed.

.2 Document all tooling that is used as to the method of use and the calibration requirements and procedures. Provide calibrations that can be traced to the National Research Council Canada (NRC) or other recognized standards laboratory. Equipment that requires repetitive calibration (e.g. terminal crimpers often require daily verification by pull testing sample crimps) must be supported, on site, by the required calibration verification instruments. Ensure that operating manuals for all specialized tooling are available on the site for reference by the Departmental Representative at any time.

.7 Tool application:

.1 Journeyman electrician intending to operate a specialized tool must demonstrate his knowledge of, and skill in using, the tool including the knowledge and ability to judge the results produced by the tool and to recognize failure of the tool to perform satisfactorily.

1.14 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

.3 Protect electrical equipment from water damage, especially from rain, condensation, and water dripping or splashing on equipment and wiring, at all times during shipment, storage and construction (prior to final acceptance).

.4 Provide temporary electrical connections to equipment heaters, or provide temporary heaters, as required to prevent damage from moisture and as required in other Sections of these Specifications.

.5 Provide climate controlled environment for the storage of control equipment/assemblies during construction. Thoroughly dry out and put through special dielectric tests as directed by the Departmental Representative or replace if not tested to the satisfaction of the Departmental Representative, any apparatus that has been subjected to possible injury by water or dampness (including the interiors of motor control equipment or any other electrical devices).

.6 Protect equipment from damage from mishandling, dropping or impact. Do not install damaged equipment. Immediately replace damaged equipment at no cost to Departmental Representative.

1.15 SYSTEM STARTUP

.1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.

1.16 VERIFICATION TESTING

.1 General: Whenever verification testing is required in the performance of the Work of other Sections, perform the tests and measurements in accordance with the necessary requirements.

.2 Test equipment:
.1 Provide test and measurement instruments suitable to perform the required tests including ratings and measurement accuracy as specified by

1.16 VERIFICATION TESTING (Cont'd)

.2 Test equipment:(Cont'd)

.1 (Cont'd)

the manufacturer. Clearly indicate the exact make and model of instrument to be used and include manufacturer's specification data indicating the suitability of the instrument's specifications in all procedure submittals. No test instrument may be used unless it has been calibrated and certified by an independent certification laboratory to the required accuracy and in accordance with the instrument manufacturer's requirements, provided that all instruments have been calibrated within a maximum interval of the preceding twelve (12) months. Certify all calibrations as traceable to the NRC or other recognized standardization authority.

.2 Test instrument operating manuals and certification certificates must be available on the project site for reference by the Departmental Representative whenever the instrument is being used or evaluated.

.3 Test result reporting:

.1 Where test or inspection data submittal is required by the provisions of other Sections of this Contract Documents, insure the form(s) to be used for recording and submitting the data are reviewed by the Departmental Representative prior to performing the tests.

.2 Record the test results directly upon the approved forms as the tests are performed, re-copying the data onto the forms from informal field notes is not acceptable.

.3 Record all data with ball-point pen or other non-erasable and non water-soluble writing media; strike-thru and initial errors or corrections in such a manner that the original is still readable.

.4 Identify each measurement item or group of items with the measurement date and approximate measurement time to the nearest quarter hour.

.5 Record where the environment has an effect upon the measurements, such as insulation measurements, the weather including approximate temperature, rain/fair, and approximate relative humidity, on the form at appropriate intervals as determined by the changing meteorological conditions.

.6 Record wind velocity and direction for balancing measurements or other vertical lift span related tests where the wind loading is a factor in the performance or results.

.7 Identify each measurement item or group of items with the signature or initials of the

1.16 VERIFICATION TESTING (Cont'd)

.3 Test result reporting:(Cont'd)

.7 (Cont'd)

approved measurement technician performing the tests.

.8 A separate sheet cross-referencing the signatures or initials to the printed name of the technician will accompany the submittal of the test results to identify the technician. The use of manuscript initials will be treated the same as the full signature and will constitute the technicians certification that the tests were performed in accordance with the submitted and approved procedures, utilizing approved test instruments, and that the results recorded are a true and accurate representation of the test conditions and results.

.9 Record test instrument identification, including traceable serial number, for each measurement group. The data submittal will include a copy of the Certificate of Calibration for the particular instrument.

.4 Test performance: journeyman electrician, or other proposed test equipment operator, must demonstrate knowledge of the test equipment operating and testing procedures to the Departmental Representative's satisfaction before performing tests. Only test results signed by such approved testing technician will be acceptable.

1.17 ELECTRICAL IDENTIFICATION

.1 General requirements:

.1 Nameplates and labels.

.1 Numbering and lettering to be 1/2 the nameplate depth. Tags and plates to be three ply lamicoid black lettering on white background.

.2 Provide legend nameplates for all major pieces of equipment named on the drawings, and for all control devices.

.3 Provide legend nameplates for devices that show the device designation and name used on the schematic wiring diagram.

.4 Provide fuse legend nameplates that show the type, ampere, and voltage rating of the fuses.

.5 Provide identification for each branch circuit in a panelboard.

.6 Provide typewritten directories for all panelboards with covers and directory pockets.

1.17 ELECTRICAL IDENTIFICATION (Cont'd)

.1 (Cont'd)

.1 (Cont'd)

.7 Legend Nameplate Engraving Schedule: Provide nameplates of minimum letter height as scheduled below.

.1 Panelboards, Switchboards, and Motor Control Centers: 1/4 inch (6 mm); identify equipment designation.

.2 Individual Circuit Breakers, Switches, and Motor Starters in Panelboards: 1/8 inch (3 mm); identify voltage rating and source.

.3 Switchboards, and Motor Control Centers: 1/8 inch (3 mm); identify circuit and load served, including location.

.4 Individual Circuit Breakers, Enclosed Switches, and Motor Starters: 1/8 inch (3 mm); identify load served.

.5 Transformers: 1/4 inch (6 mm); identify equipment designation. 1/8 inch (3 mm); identify primary and secondary voltages, primary source, and secondary load and location.

.6 Underground Warning Tape: 4-inch (102 mm) wide plastic tape, coloured yellow with suitable warning legend describing buried electrical lines.

.2 Wire and cable markers (Paper marker not acceptable).

.1 Computer generated, vinyl cloth markers, split sleeve, or tubing type.

.3 Conduit markers.

.1 Provide adequate marking of primary conduits that are exposed or concealed in accessible spaces, to distinguish each run as either a power or signal/communication conduit.

.2 Locate markers at both ends of conduit runs, near switches and other control devices, near items of equipment served by the conductors, at points where conduits pass through walls, floors or into non-accessible construction, and at spacing of not more than 50 feet (15 m) along each run of exposed conduit.

.3 Switch-leg conduit and short branches for power connections need not be marked, except where conduit is larger than 1 inch (25 mm).

.4 Provide both ends of each marked conduit run with a 14 gauge metal tag with 1/4 inch (6.35 mm) numbers or letters, 1/2 depth of tag, having a number stamped thereon in accordance with the conduit

1.17 ELECTRICAL IDENTIFICATION (Cont'd)

.1 (Cont'd)
.3 (Cont'd)
.4 (Cont'd)
diagrams. Securely and permanently fasten these tags to the conduit ends with bare 14 gauge copper wire.

.2 Construction requirements:
.1 Degrease and clean surfaces to receive nameplates and tape labels. Install nameplates and tape labels parallel to equipment lines. Secure nameplates to equipment fronts using screws, rivets, or permanent adhesive. Use embossed tape only for identification of individual wall switches and receptacles, control device stations.
.2 Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Provide material and equipment in accordance with Section 01 61 00.

.2 Material and equipment to be CSA, ULC or UL certified. Where CSA, ULC or UL certified material and equipment are not available, obtain special approval from the Departmental Representative before delivery to site and submit such approval as described in Section 01 33 00.

.3 Factory assemble control panels and component assemblies.

.4 Furnish and install all new conduit, wiring, aerial cables, disconnect switches, panelboards, controls and relays, wiring devices, boxes, terminal blocks, traffic gates, pedestrian gates, barrier gates, limit switches, electrical identification, motor controls, controlled pulse width modulated motor drives, motors, and supporting devices for a complete electrical installation for the vertical lift tower driven bridge.

2.1 MATERIALS AND EQUIPMENT (Cont'd)

.5 Ensure all electrical equipment used outside of the conditioned spaces of the control building and motor rooms is suitable for use in a marine (salt atmosphere) environment.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

.2 Control wiring and conduit: in accordance with Section 26 05 19.

2.3 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of authority having jurisdiction, inspection authorities and Departmental Representative.

.2 Decal signs, minimum size 7 inches (178 mm) x 10 inches (254 mm).

.3 Electrical equipment Arc Flash and Short Circuit Current to CSA C22.1-2012.

.4 Panels with multi-source circuits.

2.4 WIRING TERMINATIONS

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

2.5 WIRING IDENTIFICATION

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

.2 Maintain phase sequence numbering and colour coding throughout.

.3 Colour coding: to CSA C22.1.

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

2.6 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 50 feet (15 m) intervals.

.3 Colours: 1 inch (25 mm) wide prime colour and 0.78 inch (20 mm) wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
Other Communication Systems	Green	Blue

2.7 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
.1 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

.2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.

.3 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, distribution panels, cable trays, traffic gates, barrier gates, pedestrian gates.

3.2 NAMEPLATES AND LABELS

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

3.3 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete.
.1 Sleeves through concrete: schedule 40 PVC pipe, sized for free passage of conduit, and protruding 2 inch (51 mm).

.2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

3.4 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.
.1 Local switches: maximum 48 in (1200 mm) for accessible space.
.2 Panelboards: as required by Code or as indicated.

3.5 CO-ORDINATION OF PROTECTIVE DEVICES

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.6 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.

END

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

.1 Work of this Section includes supplying, installing and testing all electrical conductors and cables to new and existing equipment in compliance with the Contract Documents, but not limited to, building wire and Variable Frequency Drive Cable. Include all hardware necessary for a complete system.

.2 Demolition of existing wiring no longer in use.

1.2 SECTION INCLUDES

.1 Building wire and cable.

.2 Wiring connectors and connections.

1.3 REFERENCES

.1 American Society for Testing and Materials (ASTM).
.1 ASTM-B3-2012 Standard Specification for Soft or Annealed Copper Wire.
.2 ASTM B33-2010 Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.

.2 Canadian Standards Association (CSA International)
.1 CSA C22.1-2012, Canadian Electrical Code.

.3 ANSI/NETA ATS-2009 Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

1.4 MEASUREMENT PROCEDURES

.1 Work for new wiring will not be measured separately for payment.

.2 Measure Demolition of Existing Wiring no longer in use including all installed hardware in linear metres incorporated into Work.

1.5 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Test Reports: Indicate procedures and values obtained.

1.5 SUBMITTALS (Cont'd)

.3 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.6 REGULATORY REQUIREMENTS

.1 Conform to requirements of CSA C22.1-12.

.2 Supply products listed and classified by Underwriters Laboratories of Canada, Inc. as suitable for purpose specified and shown.

1.7 SITE CONDITIONS

.1 Verify that field measurements are as shown on Contract Documents.

.2 Wire and cable routing shown on Contract Documents is approximate unless dimensioned. Route wire and cable as required to meet site conditions.

.3 Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

.1 Coordination:

.1 Determine required separation between cable and other Work.

.2 Determine cable routing to avoid interference with other Work.

PART 2 - PRODUCTS

2.1 BUILDING WIRE AND CABLE

.1 Do not use aluminum conductors.

.2 Single conductor stranded wire minimum 600 volts insulation. Use no wire smaller than No. 12 AWG for power, lighting circuits and control wiring, except that control wiring within a cabinet may be No. 14 AWG. minimum field wire size No. 12 AWG. Use minimum No. 10 AWG for main motor feeder conductors, and 20 A, 120 V a.c., branch circuit home runs longer than 75 feet (22.5 m).

.3 Insulated conductors of seven or nineteen strand copper, minimum 98% conductivity and connector accessories for copper shall be furnished in sufficient quantities for a complete installation.

2.1 BUILDING WIRE AND CABLE (Cont'd)

.4 In cases of low-level audio or digital signals, use twisted shielded pairs when required.

.5 Insulation shall be RW90 unless otherwise noted.

2.2 VARIABLE FREQUENCY DRIVE CABLE

.1 Variable Frequency Drive Cable:
.1 Class B stranded, tinned copper per ASTM B-3, B-33.
.2 Class B stranded, tinned copper per ASTM B-3, B-33.
.3 Insulation: Cross-linked Polyethylene (XLP) per ICEA S-95-685.
.4 Assembly: Three insulated conductors are cabled with three uninsulated grounds and an overall copper tape shield.
.5 Overall Jacket: Black sunlight-resistant Polyvinyl Chloride (PVC) per UL 1277.
.6 Voltage: 2,000 volts.
.7 Temperature: 90°C.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Installation shall include placement, terminating, identification, testing, and verification, of each circuit and conductor.

.2 No splicing will be permitted.

.3 Use solderless, mechanical compression connectors with insulating covers rated for 600V for wire splices and taps, No. 8 AWG and smaller.

.4 Wire nuts or twist on connectors or split bolt connectors shall not be used for any connections.

.5 Make lug connections with high pressure indent connector tools as recommended by the lug manufacturer.

.6 Use heat shrink insulation sleeves over uninsulated conductors and connectors with electrical tape to 150% of the insulation value of conductor.

.7 Terminate spare conductors with electrical tape heat shrink insulation sleeves.

3.1 INSTALLATION (Cont'd)

.8 Neatly train and lace wiring inside boxes, equipment, and panelboards.

.9 Place an equal number of conductors for each phase (three phase system) of a circuit in same raceway or cable.

.10 Make conductor lengths for parallel circuits equal.

.11 Pull all conductors into a raceway at the same time.

.12 Use ULC listed wire pulling lubricant for pulling No. 6 AWG and larger wire.

.13 Tighten all connections to manufacturer's recommendations.

3.2 INTERFACE WITH OTHER PRODUCTS

.1 Identify wire and cable as indicated in Section 26 05 00.

.2 Identify each conductor with its circuit number or other designation indicated on Contract. Documents.

3.3 CONDUCTOR TESTS

.1 Test each circuit for continuity and short-circuits for its complete length before being connected to its load.

.2 Verify identification numbers for the circuit's entire length.

.3 Inspect wire and cable for physical damage and proper connection.

.4 Insulation Resistance Test @ 1000 V d.c. per. ANSI/NETA ATS-2009

3.4 MINIMUM INSULATION RESISTANCE

.1 Minimum insulation resistance to comply with the ANSI/NETA ATS-2009.

3.5 IDENTIFICATION

.1 Equipment Identification: to Section 26 05 00.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes manufactured wiring assemblies comprising of, but not limited to, supplying and installing in compliance with the Contract Documents all aerial cable assemblies. Aerial Cable Assemblies include full compensation for furnishing all labour, materials, tools, equipment, and appurtenances necessary to supply, install and test all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation.

1.2 SUMMARY

.1 This section covers 600 or 2,000 volts multiple conductor power and control cables for self-supporting aerial installations. These cables are suitable for installations in a horizontal position while being supported at both ends. They are designed to accommodate movement due to oscillation and vibration. These cables may be used in wet or dry locations and are sunlight (UV) and weather resistant.

.2 General configuration consists of multiple conductor extra flexible copper conductors, ethylene propylene rubber (EPR) insulation, cabled with fillers as necessary, binder tape, aramid fibre reinforcement, and a weather resistant polyethylene jacket. This jacketed cable is then laid parallel to a stainless steel wire rope messenger and bound with a stainless steel wire rope along its entire length. Stainless Steel straps are applied overall at 10 foot intervals along the entire length as an additional binder.

1.3 REFERENCES

.1 ANSI/NEMA WC70/ICEA S-95-658-2009 (14 AWG & larger)- Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.

.2 ASTM B172-10 Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors.

1.3 REFERENCES (Cont'd)

.3 ASTM B174-10 Standard Specification for Bunch-Stranded Copper Conductors for Electrical Conductors.

.4 ICEA S-73-532/NEMA WC 57-2004(22-16 AWG)- Standard for Control, Thermocouple Extension, and Instrumentation Cables.

.5 ICEA T-27-581/NEMA WC 53-2008 - Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test.

1.4 MEASUREMENT PROCEDURES

.1 Work for new Aerial Cable Assemblies will not be measured separately for payment.

.2 Measure Demolition of Aerial Cable Assemblies linear metres incorporated into Work. The Aerial Cable Assembly Demolition includes all supports and hardware installed.

1.5 DESIGN REQUIREMENTS

.1 Unless otherwise indicated, furnish wiring as shown in the Contract Documents as part of the Aerial cable assembly.

.2 In the event that the installation requires more conductors than those included in one cable, then use multiple conductors of the type as required. Furnish a minimum of 20% spare conductors for each conductor size.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packaging Waste Management: remove for reuse by manufacturer of pallets and packaging materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 CONDUCTORS

.1 Conductors shall be annealed copper in accordance with ASTM B174-10 for #10 AWG and smaller, and ASTM B172-10 for #8 AWG and larger.

.2 Conductors shall be stranded in accordance with ASTM B174-10 or ASTM B172-10, class "K" stranding, and Section 2 of ANSI/NEMA WC70/ICEA S-95-658, as applicable.

2.2 INSULATION

.1 Conductor insulation shall be an ethylene propylene rubber (EPR) compound meeting the requirements for ethylene propylene rubber - Type E-2 insulation,
.1 ICEA S-73-532/NEMA WC 57, Table 3-2 (22-16 AWG), 600V.
.2 ANSI/NEMA WC70/ICEA S-95-658, Table 3-8 (14 AWG & larger), EP Rubber, Class E-2.

.2 Physical and Aging Requirements:
.1 The EPR insulation shall meet the following physical and thermal aging requirements:
.1 Unaged:
.1 Tensile Strength - minimum, psi: 1200.
.2 Elongation - minimum, %: 150.
.3 Tensile Stress @100% elongation, psi minimum: 500.
.2 Aged:
.1 After air oven 168 hrs. @121°C Tensile Strength and Elongation at rupture - min. % of unaged: 75.
.2 Hot Creep at 150°C, Hot Creep elongation, max. %: 50.
.3 Set, maximum %: 5.

.3 Water Absorption Requirements:
.1 The EPR insulation shall meet the following accelerated water absorption requirements when tested in accordance with ICEA T-27-581/NEMA WC 53, Electrical Method EM-60:
.2 Dielectric Constant after 1 day, 6.0 max.
.3 Increase in Capacitance - max. %
.1 1 to 14 days: 5.0.
.2 7 to 14 days: 3.0.
.4 Stability Factor after 14 days, max.: 1.0 or Stability Factor Difference, 1 to 14 days, max.: 0.5.

.4 The insulation thickness shall comply with:
.1 ICEA S-73-532/NEMA WC57, paragraph 3.2 and Table 3-1 for cables as follows:
.2 ANSI/NEMA WC70/ICEA S-95-658, paragraph 3.3 and Table 3-4 for cables as follows:

2.2 INSULATION (Cont'd)

.4 (Cont'd)

.2 (Cont'd)

Conductor Size AWG or kcmil	0 - 600 V Mil Thickness	601 - 2000 V Mil Thickness
14 - 9	45	60
8 - 2	50	70
1 - 4/0	80	90
225 - 500	95	105
525 - 1000	110	120

Table of ICEA S-95-658, NEMA WC70

.5 Strippability: The insulation shall be readily removable from the conductor. To enhance strippability, a separator shall be employed between the conductor and the insulation. The separator shall be coloured so as to be distinguishable from the conductor once the insulation is removed.

.6 Colour Coding of the insulated conductors shall be accomplished by surface printed legends consisting of numbers and words (1-One, 2-Two, 3-Three.19-Nineteen. 37-Thirty Seven, etc.).

.7 Colour coding sequence shall be in accordance with ICEA S-73-532/NEMA WC 57, Appendix E, Method No.4.

.8 Sequence shall begin from the inner conductor layer and progress to the outer conductor layer. For ease of identification during installation, number sequence may be reset to 1-One for each group of different size conductors.

.9 Contrasting colour print shall be employed and be legible after normal handling during installation.

2.3 FLEXIBLE CORRUGATED DUCT

.1 Provide a flexible corrugated polyethylene duct within the cable construction for fiber optic cables, and future requirements.

.2 The inside diameter of the duct shall be a minimum of 2 inches (51 mm).

.3 Provide pull rope in the Duct.

2.4 CABLE ASSEMBLY

.1 Cabling: The cable components shall be cabled into a tight concentric configuration. The direction of lay for adjacent layers of cable conductors shall be reversed. The maximum lay length shall be 12 time the outside diameter (OD) of the cabled layer.

.2 Fillers: Fillers shall be employed as necessary within the cable core to produce a substantially circular cross section. Fillers shall be non-hygroscopic.

.3 Binder: The cabled conductors shall be covered with a rubber/fabric binder tape. The tape shall be applied helically with a minimum overlap of 25 percent.

2.5 CABLE JACKET

.1 Jacket Reinforcement: The jacket reinforcement shall be aramid fibers. The reinforcement shall be applied helically in two layers, reversing direction in each layer. This reinforcement shall be applied directly over the binder tape, prior to application of the jacket.

.2 Jacket Material: The cable jacket reinforcement shall be covered with a homogeneous layer of black low density polyethylene (LDPE) in accordance with ANSI/NEMA WC70/ICEA S-95-658, paragraph 4.1.5 and Table 4-1 for LDPE jackets. The jacket shall be sunlight (ultraviolet) and weather resistant.

.1 The polyethylene jacket shall meet the following physical and thermal aging requirements:

.1 Unaged:

.1 Tensile Strength - minimum, psi 1400.

.2 Elongation - minimum, % 350.

.2 Aged:

.1 After air oven 48 hrs. @100°C.

.2 Tensile Strength and Elongation at rupture - min.% of unaged 75.

.3 Heat Distortion @90°C, max. % 25.

.4 Absorption coefficient, Milli (absorbance/meter), min. 320.

.3 Jacket Thickness: The cable jacket thickness shall be in accordance with ANSI/NEMA WC70 / ICEA S-95-658, paragraph 4.1.18, and Table 4-5, as follows:

2.5 CABLE JACKET (Cont'd)

.3 Jacket Thickness:(Cont'd)

Calculated Dia. of Cable Under Jacket	Jacket Thickness - mils
0-0.425	45
0.426-0.700	60
0.701-1.500	80
1.501-2.500	110
2.501 and larger	140

2.6 FINAL AERIAL ASSEMBLY

.1 The jacketed cable shall be laid parallel to a stainless steel strength member and bound with a stainless steel wire rope binder. The binder shall be spirally applied with a lay length of approximately 12 inches.

.1 Stainless Steel Messenger

.1 The messenger shall be Stainless Steel Type 316.

.2 The selected messenger size shall support the cable with a mid-span sag of not more than 9 feet under the weight of the messenger and cable at a temperature of 15 degrees Celsius.

.3 Under the above loading conditions, the tension in the messenger shall not exceed 20 percent of the ultimate breaking strength of the messenger.

.4 Each messenger shall be no less than 7/16 inches (11.11 mm) in diameter with a minimum of 19 wires.

.5 Standard messenger type employed is a stainless steel IWRC.

.6 The messenger shall not employ any jacket or covering.

.2 Stainless Steel Binder:

.1 The binder shall be Stainless Steel Type 316.

.2 The binder shall be 1/8 inch (3.175 mm) in diameter with a stranding of 7 x 19.

.3 The nominal breaking strength shall be 1,700 lbf.

.4 The binder shall not employ any jacket or covering.

2.7 AERIAL CABLE TERMINATION CABINET

.1 Aerial cable cabinets shall be, Stainless Steel Type 316 NEMA Type 4X, sizes shall be exactly as shown in the Contract documents, and arranged so that terminal strips, supports and other devices are readily accessible for maintenance, repair,

2.7 AERIAL CABLE TERMINATION CABINET (Cont'd)

.1 (Cont'd)
and replacement. Furnish cabinet with hinged doors. The general arrangement and shape of the cabinet shall be such as to fit in with the scheme of installation, which shall be approved by the Departmental Representative. The aerial cable terminal cabinets shall be barriered to separate 600 V a.c. motor power conductors, 120 V a.c. control conductors, and low level shielded conductors.

PART 3 - EXECUTION

3.1 CONSTRUCTION REQUIREMENTS

.1 Installation:
.1 The cable manufacturer shall have a company employee present during the installation procedure to insure that the cable is installed in a manner that will not damage the cable and who can certify that the cable was installed in a manner approved by the manufacturer. A representative of a supplier will not be acceptable.
.2 The cables shall cross the channel suspended between the towers. Install power, and signal and control cables in the same area. Provide adequate equipment for installation of the cables.
.3 All cable bends shall be of large easy curvature well within that recommended by its manufacturer.

3.2 INSPECTION REQUIREMENTS

.1 Tests on Completed Cable:
.1 Voltage Test: The finished cable shall withstand between each conductor and all other conductors, an AC (rms) voltage in accordance with:
.1 ICEA S-73-532/NEMA WC 57, table 3-3, paragraphs 3.4 & 6.17.1 (22-16 AWG).
.2 ANSI/NEMA WC70/ICEA S-95-658, table 3-4, par. 3.6.2 & 6.10.1.1 (14 AWG & larger).
.3 ICEA T-27-581/NEMA WC 53, paragraph 2.2.2.

Conductor Size AWG or kcmil	AC Test Voltage - kV (one minute duration)
18-16	1.0
14-10	2.5
8 - and larger	8.0

3.2 INSPECTION REQUIREMENTS (Cont'd)

.1 (Cont'd)

.2 Insulation Resistance: The insulation resistance shall be measured after the completed cable AC voltage tests. The measurement method shall be in accordance with:

.1 ICEA S-73-532/NEMA WC 57, paragraphs 3.5 & 6.18 (22-16 AWG).

.2 ANSI/NEMA WC70/ICEA S-95-658, paragraphs 3.6.3 & 6.10.2 (14 AWG & larger).

.3 ICEA T-27-581/NEMA WC 53, paragraph 2.3.

.3 The insulation resistance constant (IRK) for EPR insulation shall be 10,000 in accordance with ICEA S-95-658/NEMA WC 70, paragraph 3.6.3, and Table 3-8 for insulation Class E-2.

$$IR = (IRK)\log_{10}(D/d)$$

IR = Insulation resistance in megohms-1000 feet

IRK = Constant for the Insulation

D = Diameter over the Insulation

d = Diameter under t

.4 Conductor Resistance: The dc resistance of each conductor in the completed cable shall be measured and comply with:

.1 ICEA S-73-532/NEMA WC 57, paragraph 2.3.4 (22-16 AWG).

.2 ANSI/NEMA WC70/ICEA S-95-658, paragraph 2.3 (14 AWG & larger).

.3 ICEA T-27-581/NEMA WC 53, paragraph 2.1.

3.3 PACKAGING

.1 Reels: Packaging of the finished cable shall be on suitable non-returnable reels capable of supporting the weight during transportation and normal handling .

.2 Cable Ends: Suitably seal cable ends to prevent moisture from entering the conductor core area during shipment and storage only.

3.4 SPARE PARTS

.1 No spare parts are required for this section.

3.5 IDENTIFICATION

.1 Equipment Identification: to Section 26 05 00.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this section includes pull boxes and junction boxes, comprising of, but not limited to, supplying and installing in compliance with the Contract Documents all pull boxes and junction boxes to new and existing equipment including all hardware necessary for a complete installation.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
.1 CSA C22.1-12, Canadian Electrical Code, Part 1, 22nd Edition.

1.3 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

1.4 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:
.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Provide shop drawings: in accordance with Section 01 33 00.
.1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 JUNCTION AND PULL BOXES

.1 Construction:

.1 NEMA 4X (stainless steel Type 316) boxes in all exposed areas.

.2 NEMA 12 in the enclosed areas of the Control Building.

.3 Provide drain holes in the boxes with protective drain fittings. Drain fittings shall be stainless steel with neoprene tube.

.4 Provide mesh filter at drain holes to prevent ingress of bugs.

.5 Provide anti-condensation felt on inside wall of junction boxes.

.6 Provide all boxes with mounting lugs and securely fasten to the structure with not less than four stainless steel fasteners.

.7 Drill sheet metal enclosures to receive the conduit ends, to be secured with insulated hub connectors.

.8 Equip conduit ends projecting into all boxes and enclosures with insulated bushings.

.9 Do not drill any box or enclosure for more conduits than actually enter it.

.2 Fabricate framework for supporting boxes, switches, and other externally mounted electrical devices from structural stainless steel not less than 1/4 inch (6.3 mm) thick or if material of thickness less than 1/4 inch (6.3 mm) is used, obtain review of the Departmental Representative.

.3 All mounting bolts, nuts, washers, and other hardware used for fastening boxes, disconnect switches, devices, conduit clamps, and similar devices shall be type 316 stainless steel. Bolt heads and nuts shall be hexagonal, and do not use bolts smaller than 3/8 inch (10 mm) in diameter except as may be necessary to fit the mounting holes in small devices, outlet boxes, and similar standard equipment.

.4 Provide isolation pads or washers where stainless steel fixtures make contact with dissimilar metals to prevent corrosion.

.5 All enclosures shall be provided with grounding terminals.

.6 Drilling on bridge structure is strictly prohibited without prior written permission from the Departmental Representative.

2.1 JUNCTION AND PULL BOXES (Cont'd)

.7 For junction boxes in open area, including Bridge structure, latch must be provided for paddle-locking the junction boxes.

PART 3 - EXECUTION

3.1 JUNCTION, AND PULL BOXES INSTALLATION

.1 Install pull boxes accessible locations.

.2 Mount cabinets with top not higher than 6-1/2 feet (1980 mm) above finished floor except where indicated otherwise.

.3 All panels must be able to fit in the dimensioned space shown on the Contract Documents.

.4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1-12.

.5 Junction boxes in open area should not be easily accessible by the general public(passers-by) but they should be accessible for maintenance and clean-up work.

.6 Mount terminal strips in junction boxes to factory installed back panels.

3.2 IDENTIFICATION

.1 Equipment Identification: to Section 26 05 00.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes raceway for electrical system comprising of, all supports and hardware necessary for complete conduit system, supplying all labour, materials, tools, equipment, and appurtenances necessary to supply, prepare and install all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents and as required by CSA C22.1-2012, but which are required to complete the installation. Includes partial demolition of raceway.

1.2 REFERENCES

.1 CSA International.
.1 CSA C22.2 No.40-M1989(R2009), Cutout, Junction and Pull Boxes.
.2 CSA C22.1-2012, Canadian Electrical Code.

1.3 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for raceway and boxes and include product characteristics, performance criteria, physical size, finish and limitations.

1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for raceway and boxes for incorporation into manual.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:
.1 Store materials off ground, indoors, and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Store and protect raceway and boxes from nicks, scratches, and blemishes.
.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 CONDUIT AND RACEWAYS

.1 Conduit inside the Control Buildings shall be rigid hot dipped galvanized steel. The conduit shall be hot dipped galvanized inside and out, and ULC listed. The minimum size shall be 3/4 inch (19 mm) unless noted.
.1 Fittings: Galvanized malleable iron or non-corrosive alloy compatible with galvanized conduit.

.2 Conduit on the vertical lift span and exposed shall be PVC coated rigid hot dipped galvanized steel.
.1 All PVC coated, hot dipped galvanized rigid steel conduit shall be PVC coated inside and out. The outside PVC coating shall be a minimum of 40 mils. The inside PVC coating shall be a minimum of 2 mils.
.2 All rigid steel conduit fittings shall be hot dip galvanized after fabrication in accordance with ASTM requirements and PVC coated inside and out.

.3 Minimum Size: 3/4 inch (19 mm) minimum trade size unless otherwise specified.

.4 No non-metallic flexible conduit is allowed.

2.1 CONDUIT AND RACEWAYS (Cont'd)

.5 Liquidtight Flexible Stainless Steel Metal Conduit: Interlocked Stainless Steel construction with PVC jacket.
.1 All fittings shall be ANSI/NEMA FB 1.

.6 ULC listed schedule 80 PVC conduit meeting the requirements of NEMA TC 2 and fittings and Conduit Bodies meeting the requirements of NEMA TC 3.

.7 Conduit under the sidewalk and embedded in concrete shall be Schedule 80 PVC.

.8 Provide suitable cover and fittings to open raceway to prevent accumulation of bird droppings and nesting.

.9 Provide both ends of each conduit run with a brass tag having a number stamped thereon in accordance with the conduit diagrams.

.10 Provide expansion/deflection fittings.

.11 Provide suitable pull string in each empty conduit except sleeves and nipples.

.12 Use suitable caps to protect installed conduit against entrance of dirt and moisture.

.13 Conduits shall be supported on strut fabricated from type 316 stainless steel.

.14 All conduit mounting hardware shall be type 316 stainless steel. Provide isolation materials, bushings and washers as needed to separate dissimilar metals.

.15 Conduit sections shall be connected to each other with threaded couplings.

.16 Support conduit using stainless steel straps, lay-in adjustable hangers, clevis hangers, and split hangers.

.17 Grounding bushings or hubs shall be used for all conduits entering electrical enclosures, and boxes.

PART 3 - EXECUTION

3.1 EXAMINATION

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

.1 Visually inspect substrate in presence of Departmental Representative.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

.1 Conduits mounted externally on parts of the steel work shall be set not less than 1-1/2 inches (38 mm) clear from the supporting structure to prevent accumulation of dirt. Parallel horizontal conduit shall be spaced 1 inch (25 mm) apart and they shall be securely supported to prevent rattling and wear.

.2 Conduit supports and anchors shall be installed at maximum spacings of 5 feet (1254 mm).

.3 Fasten brass tags securely and permanently to the conduit ends with bare copper wire.

.4 Arrange conduit to maintain headroom and present neat appearance. Route exposed conduit parallel and perpendicular to walls. Route conduit in and under slab from point-to-point.

.5 Install expansion/deflection fittings at any point where a conduit crosses an expansion joint, or where movement between adjacent sections of conduit can be expected.

.6 All conduits shall be carefully cleaned, both before and after installation. Upon completion of the conduit installation, clear each conduit with a tube cleaner equipped with a mandrel of a diameter not less than eighty percent (80%) of the nominal inside diameter of the conduit, and shall then draw in the conductors.

3.2 INSTALLATION (Cont'd)

.7 All conduits shall be installed so that they will drain properly and drainage tees shall be provided at low points where required.

.8 All field bends shall be long sweep, free from kinks, and of such easy curvatures as to facilitate the drawing in of conductors without injury. Conduit runs shall be made with as few couplings as standard lengths will permit. There shall be no more than four bends between pulling points and total angle of all bends between any two boxes shall not exceed 360 degrees. Long running threads will not be permitted.

.9 Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch (51 mm) size.

.10 Where conduits pass through the floors of the tender house the openings shall be sealed with RTV silicon medium density foam.

.11 Pull boxes shall be used wherever necessary to facilitate the installation of the conductors. Condulets shall not be used for pulling more than ten conductors or for making such turns in conduit runs or for branching conductors, except for indoor wiring to lighting fixtures and receptacles.

.12 Exposed raceway runs shall be straight and shall be parallel or at right angles to the general structure lines. Conduits shall change elevation when changing direction to avoid blocking the path of other conduits.

.13 Conduits shall be installed to be continuous and watertight between boxes or equipment.

.14 Conduits shall be protected at all times from the entrance of water and other foreign matter by being capped or well plugged overnight and when the Work is temporarily suspended. Duck tape is not an acceptable method.

.15 The use of liquidtight flexible stainless steel metal conduit is allowed only for the connection of motors, limit switches, and other devices that must be periodically adjusted in position.

.16 Make connections between the rigid galvanized steel PVC coated conduit system and all movable motors, and movable limit switches with flexible conduit with couplings and threaded terminal

3.2 INSTALLATION (Cont'd)

.16 (Cont'd) fittings. The flexible conduit shall be fully interlocked.

.17 Flexible conduit extensions not to exceed 36 inches (914 mm) in length and to be equipped with bonding jumpers.

.18 Provide separate conduits for control (up to 120 V a.c.) conductors and power conductors.

.19 All Work shall be performed by personnel who are trained by the manufacturer, using only tools provided by the PVC coated conduit manufacturer.

.20 Running thread or set screw type fittings are not permitted.

.21 To prevent dissimilar metal corrosion isolation bushings or washers shall be provided where stainless steel comes into contact with other metals.

.22 Group related conduits; support using conduit rack. Construct rack using stainless steel strut; provide space on each for 25 percent additional conduits.

.23 Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

.24 Install conduit in accordance with NECA 1-2010.

.25 Use pull boxes wherever necessary to facilitate the installation of the conductors. Do not use condulets for pulling more than ten conductors or for making such turns in conduit runs or for branching conductors, except for indoor wiring to lighting fixtures and receptacles.

.26 Conduit drawings: Before the initial start of construction, submit a scaled full size drawing showing all conduit runs between all pieces of equipment for review.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

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

3.3 CLEANING (Cont'd)

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

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

3.4 IDENTIFICATION

.1 Equipment Identification: to Section 26 05 00.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes three phase AC electric motors comprising of furnishing all labour, materials, tools, equipment, and appurtenances necessary to supply, install and test all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation. Perform all Work in conformance with the notes, dimensions and sizes shown on the Contract Documents. Includes the demolition of existing motors including all supports and hardware as shown in the Contract Documents.

1.2 REFERENCES

.1 ANSI/IEEE 112-2004 -IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.

.2 ANSI/NEMA MG 1-2011 - Motors and Generators.

1.3 SUBMITTAL

.1 Submit manufacturer's product data, installation instructions, operation and maintenance data. Include assembly drawings, bearing data with replacement sizes, and lubrication instructions.

1.4 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

.2 Measure spare encoder in each unit incorporated into Work.

.3 Measure spare span motor in each unit incorporated into Work.

PART 2 - PRODUCTS

2.1 MAIN SPAN MOTOR .1 Provide four (4) each, base speed of 600 rpm, capable of providing 1,432 lb-ft full load torque, totally enclosed fan cooled (A-TEFC), cast iron construction, footed ribbed body, vector duty rated induction motor, 600 volts, three phase voltage.

.2 Coordinate motor shaft diameter and length with requirements for the existing motor brakes. Verify that the size and length of the motor shaft matches the requirements for the existing brake to be installed before installing the motors.

.3 Shop drawings shall be submitted in accordance with Section 01 33 00 of the Contract Documents. Shop drawing data shall include fully dimensioned outline drawings, motor electrical specifications, motor torque speed performance data and motor brake ratings. Certified shop drawings shall be developed and coordinated with the machinery manufacturer for an integrated motor driven machinery assembly.

.4 Shop drawings shall also provide complete machining details for each motor shaft extension including dimensional tolerances, surface finishes and keyseat details. Note that all keys shall be retained in closed end keyways.

.5 Motor construction shall be suitable for marine or corrosive environment duty with epoxy coated interior, stainless steel shaft and hardware. Windings shall be copper. Insulation shall be Class H temperature rise above 50° C ambient. Insulation shall be tropicalized with anti-fungal treatment. Motor shall be rated for 30 minute duty. The frame shall be 449T in order to fit. Frame sizes cannot be substituted.

.6 Each motor shall be provided with a 120V a.c. frame heater and a high temperature disconnect switch. All terminations shall be in one terminal box.

.7 The motor shall be fitted with a pancake type, thru shaft, bearingless, pulse-generating encoder with dual outputs. The pulse generator shall provide an A,B,Z pulse code, 1024 pulses per revolution (ppr), with bi-directional quadrature, 90-degree phase gap between A and B

2.1 MAIN SPAN MOTOR (Cont'd)

.7 (Cont'd) phases. Encoder cable shall have four No.16 AWG, individually twisted shielded pairs. Shields shall be grounded at the motor, only.

.8 Motor shaft bearing shall be antifriction or roller type with an L10 life of 100,000 hours for coupled service. Grease fittings and relief tubes shall be provided.

.9 The motor shall be capable of having a minimum breakdown torque of 300 percent, and must be capable of having full torque at zero speed. Motor design shall be low inertia and slip.

.10 Motor shall be dynamometer tested with the vector-controlled drives specified in Section 26 29 23. As a minimum requirement, the motor tests shall demonstrate the motor and drive are capable of operating at the manufacturers' nameplate ratings, factory furnished motor curves for torque and speed, and as required by the Contract Documents. Results of the dynamometer testing shall be recorded and submitted as a section of the O&M manuals.

.11 Motor shall be installed to the existing machinery brakes.

.12 Furnish and install conduit and wire as shown in the Contract Documents.

2.2 AUXILIARY DRIVE MOTOR

.1 Provide two (2) each, 20 horsepower, NEMA Design B Brake Motors, cast aluminum construction, round ribbed body, base speed of 1800 rpm, totally enclosed fan cooled (TEFC), cast iron construction, 600 volts, three phase voltage, 60 Hz with a 125 ft-lbs motor mounted brake.

.2 Motor construction shall be suitable for marine or corrosive environment duty with epoxy coated interior, stainless steel shaft and hardware. Windings shall be copper. Insulation shall be super Class H temperature rise above 50° C ambient. Insulation shall be tropicalized with anti-fungal treatment. Motor shall be rated for continuous duty. The frame shall be 284TC in order to fit. Frame sizes cannot be substituted.

.3 Each motor and brake shall be provided with a 120V a.c. space heaters. All terminations shall be in one terminal box.

2.2 AUXILIARY DRIVE MOTOR (Cont'd)

.4 Shop drawings shall be submitted in accordance with Section 01 33 00 of the Contract Documents. Shop drawing data shall include fully dimensioned outline drawings, motor electrical specifications, motor torque speed performance data and motor brake ratings. Certified shop drawings shall be developed and coordinated with the machinery manufacturer for an integrated motor driven machinery assembly.

2.3 STORAGE

.1 The storage period is assumed to continue after the motors are installed. Provide temporary power connection to internal motor heaters, or provide external heater, to maintain constantly elevated internal temperature to assure prevention of condensation or moisture accumulation.

.2 Manually rotate the rotor every 30 (thirty) days to prevent flatting of bearings. If the storage arrangement permits, rotate the entire housing 90 degrees every 60 (sixty) days.

2.4 SPARE PARTS

.1 Provide, in their original boxes or containers, the following spare parts:
.1 One (1) main span motor.
.2 One (1) encoder.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install motors per manufacturers' instructions. Utilize millwright for field installations, base modifications, and shaft alignment with the machinery and the brakes.

.2 Provide new motor mounting bases as required to accommodate new motors. Properly align motor shaft with speed reducer shaft before connecting motor coupling.

.3 Verify alignment of motor shaft with motor brake prior to installation of shaft couplings; correct as required to provide proper alignment within coupling misalignment tolerances.

.4 Provide motor heater connections and record the wiring in the as-built drawings if motor heaters are connected after motors have been installed.

3.1 INSTALLATION (Cont'd)

.5 Verify power connections.

3.2 FIELD TESTING

.1 Perform a no-load spin test prior to make-up of machinery couplings.

.2 Record readings and submit with "As-Built" Drawings and Operations and Maintenance Manuals.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 Additional specific testing of the Integrated Bridge Control System is included in Sections 26 29 23 and 26 09 17. The work in this section includes testing of all bridge electrical equipment, bridge mechanical systems, bridge structural systems, and integrated bridge operations in addition to specific testing requirements listed in other sections.

.2 Work of this Section shall be conducted in three stages.
- .1 Electrical Testing and Installation Check Out.
- .2 Conditional Acceptance Functional Test.
- .3 Final Acceptance Trial Period.

.3 Electrical testing and installation check out.
- .1 Be responsible for testing circuit continuity and megger testing of conductor insulation.
- .2 Engage the services of a corporate financially independent testing firm for the purpose of performing the inspections and tests specified in this section. The purpose of these inspections is to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with the Contract Documents. The testing firm shall supply all materials, instruments, labour and supervision to perform such tests and inspections. The following tests shall be performed:
  - .1 Panelboard testing.
  - .2 Grounding system test.
  - .3 Motor and motor starter tests.

1.2 MEASUREMENT PROCEDURES

.1 Startup and commissioning will not be measured separately for payment.

1.3 REFERENCES

.1 Canadian Standards Association (CSA)
- .1 CSA C22.1-2012, Canadian Electrical Code.

.2 ICEA S-73-532 / NEMA WC 57-2004(22-16 AWG)-Standard for Control, Thermocouple Extension, and Instrumentation Cables.

1.3 REFERENCES (Cont'd)

.3 Standard Test Methods are in accordance with ICEA T-27-581 / NEMA WC 53-2008- Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test.

.4 ANSI/NEMA WC70 / ICEA S-95-658-2009 (14 AWG & larger)- Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.

.5 Institute of Electrical and Electronic Engineers (IEEE) Standard 519-1992 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

.6 National Electrical Contractor Association -NECA 1-2010 - Standard Practice of Good Workmanship in Electrical Contracting.

.7 InterNational Electrical Testing Association - NETA ATS-2007 Acceptance Testing Specifications.

.8 CAN/CSA-S6-06, Canadian Highway Bridge Design Code.
.1 CSA S6S1-10, Supplement #1 to CAN/CSA-S6-06, Canadian Highway Bridge Design Code.
.2 CSA S6.1S1-10, Supplement #1 to S6.1-06, Commentary on CAN/CSA-S6-06, Canadian Highway Bridge Design Code.
.3 CSA S6.1S2-11, Supplement #2 to S6.1-06, Commentary on CAN/CSA-S6-06, Canadian Highway Bridge Design Code.
.4 CSA S6S2-11, Supplement #2 to CAN/CSA-S6-06, Canadian Highway Bridge Design Code.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit a written startup and commissioning plan to the Departmental Representative at least 30 working days prior to commencement of any testing.

.2 Testing of electrical installation: submit test reports, bound and signed. Include the following:
.1 Summary of test.
.2 Description of equipment tested.
.3 Description of test procedure.
.4 List of test equipment and calibration date.
.5 Test results.
.6 Recommendations.
.7 Appendix - including all field test reports to be incorporated in the O&M Manuals.

1.4 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.3 Submit a step-by-step procedure to demonstrate the bridge systems. The procedure shall be numbered and shall have a Pass and Fail check blanks.

1.5 QUALITY ASSURANCE

.1 Furnish and use safety devices such as Personal Protection Equipment (PPE), rubber gloves and blankets, protective screens, barriers and danger signs to adequately protect and warn all personnel in the vicinity of the tests.

.2 Test equipment shall be calibrated and certified traceable to the National Bureau of Standards. Certification data shall be no later than 6 months old.

.3 The testing of the various components and completion of any corrective work shall be performed prior to placing equipment into service. All testing shall be performed after the equipment has been set in its final location.

.4 Testing shall be performed by qualified personnel having a minimum of 2 years experience performing the type of tests required.

.5 Be responsible for any damage to equipment or material due to improper test procedures or test apparatus handling, and shall replace or restore to original condition any damaged equipment or material.

1.6 TEMPORARY TRIAL USAGE

.1 The Departmental Representative reserves the privilege of putting to temporary or trial usage before acceptance of any apparatus, device or equipment for such reasonable length of time that the Departmental Representative deems necessary for making a complete and thorough test of equipment operation.

.2 The temporary trial usage by the Departmental Representative of any equipment or materials supplied under this Contract before their final completion and written acceptance by the Departmental Representative shall not be construed as an evidence of the acceptance of same by the Departmental Representative.

.3 No claim for damage shall be made by the Contractor for the injury to or breaking of any

1.6 TEMPORARY TRIAL USAGE (Cont'd)

.3 (Cont'd)
part of equipment including test and measuring equipment during temporary or trial usage, which may be caused by defective equipment and materials or poor workmanship on the part of the Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Test equipment:
.1 Furnish test equipment, of types approved by the Departmental Representative, properly calibrated to conduct testing.
.2 Prepare reports recording test results.

PART 3 - EXECUTION

3.1 CONSTRUCTION REQUIREMENTS

.1 Conduct tests in the presence of the Departmental Representative, except when advised in writing by the Departmental Representative that his presence will not be necessary.

.2 Include tests and inspections recommended by NETA ATS-2007.

.3 Maintain a written record of all tests showing the date, personnel making the tests, equipment or material tested, tests performed, manufacturer, serial number of testing equipment, and results.

.4 To prevent accidents, testing will be done only during period when the bridge is closed to traffic unless approved in advance by the. Departmental Representative.

3.2 TECHNICAL REQUIREMENTS

.1 Insulation Resistance Tests (Megger)
.1 All conductors shall be tested with a 200 megohm d.c. megger correctly calibrated with 500V, 1000V, and 2500V settings.
.2 Immediately notify the Departmental Representative of any cable insulation defects as detected by the high voltage tests. Test voltage at failure shall be recorded.
.3 Minimum acceptable values of test results shall be as indicated in these Specifications. In the event that these minimum values are not achieved, the Contractor shall advise the

3.2 TECHNICAL REQUIREMENTS (Cont'd)

.1 (Cont'd)
.3 (Cont'd)
Departmental Representative, who will direct what subsequent action will be required.

.2 Testing shall be performed in compliance with the latest edition of NETA ATS-2007 , and as specified in the Contract Documents. The values of the insulation resistance measurements required by the NETA ATS-2007 shall be the minimum acceptable values for his project.

3.3 PANELBOARDS

.1 600/346 V a.c., and 208/120 V a.c. panelboards shall be megger tested.

.2 Check internal components for the following:
.1 Bus and cable connections to assure proper torque and tightness.
.2 Mechanical and electrical check of disconnecting devices.
.3 Electrical operation of all meters and relays.
.4 Polarity of current and potential transformers.
.5 Ratio of current and potential transformers.
.6 Wiring and operation of all control switches.

.3 Perform testing in accordance with NETA ATS-2007, and as specified in the Contract Documents.

3.4 GROUNDING SYSTEMS

.1 Tests shall include measurement of ground resistance at the following equipment and structures:
.1 All transformer frames and neutral grounds.
.2 Other miscellaneous grounds selected at random in a manner to be representative of the entire installation.

.2 Ground tests shall be made on system ground rods using the "3 PROBE - FALL OF POTENTIAL" method. All other ground tests may be measured to system ground by use of ground reference method.

.3 Prior to testing, Contractor shall verify that the equipment has been correctly installed.

3.4 GROUNDING SYSTEMS (Cont'd)

.4 Maximum acceptable resistance value shall be no more than 25 ohms to ground without approval of the Departmental Representative.

.5 Testing shall be performed in compliance with the latest edition of NETA Acceptance Testing Standards, IEEE Standard No. 81, and as specified in the Technical Special Provisions.

3.5 CABLE

.1 600V Insulation Cable:

.1 Feeders for motors: insulation resistance of all 600V a.c. rated motor feeders shall be checked with a 1000V megger. Take readings with all motor wiring connected, with all disconnect switches of combination starters in the open position, and with all starter contactors mechanically held closed. Take readings between phases and between each phase and ground. Mark conductors reading less than 100 megohms for replacement, and replace.

.2 Feeders: insulation resistance of all 600V a.c. feeders shall be checked with a 1000V megger. Readings shall be taken after wires have been pulled but before connections are made to equipment. Readings shall be taken between phases and between each phase and ground. Conductors reading be less than 100 megohms shall be marked for replacement, and replaced.

3.6 CONTROL CABLES

.1 Test all control cables for continuity.

.1 Motor Starter and Motor.

.2 Inspect all motor control centres and starters for missing parts and any damage.

.3 Check all bus and cable connections for tightness. Check all contacts for proper alignment and pressure. Verify that all movable parts are free to operate and that all bolts are tightened.

.4 Megger test all motor control centers and starters in accordance with the manufacturer's written recommendations.

.5 Mechanically and electrically check all disconnecting devices.

3.6 CONTROL CABLES (Cont'd)

.6 Install fuses and overload devices. Prepare motor list showing the following:
.1 Motor nameplate data, including horsepower, full load and locked rotor amperes.
.2 RPM, voltage, service factor, and temperature rise.
.3 Manufacturer's overload heater code number used for motor protection.
.4 Fuse size and type.

.7 Perform a complete operational test of each motor control from each point to assure correctness of sequencing, interlocking, and other control functions of the equipment being tested.

.8 Check motors for proper lubrication.

.9 Check motors for proper rotation after insulation tests and lubrication check but before coupling motor to the load.

.10 Perform 1000V insulation resistance test from load side of motor starter on each complete motor circuit, both phase-to-phase and phase-to-ground. Record results and submit to the Departmental Representative.

3.7 CONDITIONAL ACCEPTANCE FUNCTIONAL TESTING

.1 Perform a step-by-step demonstration of the bridge operating systems. This demonstration shall be witnessed and approved by the Departmental Representative. This demonstration shall not be conducted until all construction is complete and the Electrical Testing (and any remedial work), has been completed.

.2 Prepare a test procedure which lists in numbered steps each device to be demonstrated, the action required by the operator and the expected result. Each step shall be provided with Pass and Fail blanks.

.3 Upon completion of electrical testing, all required mechanical and structural testing, bridge pre-operational testing, and any required remedial work, perform a demonstration of the bridge operating systems to be witnessed and approved by the Departmental Representative.

.4 Include the following operations when demonstrating the bridge operating systems:
.1 Emergency stop operation.

3.7 CONDITIONAL ACCEPTANCE FUNCTIONAL TESTING (Cont'd)

.4 (Cont'd)
.2 Low speed operation (not on auxiliary drive).
.3 Auxiliary drive operation.
.4 Complete power-up and power down operations.
.5 Bridge operation under generator power.
.6 By-pass key switches operation.
.7 Manual and automatic speed control.

.5 At the conclusion of the step-by-step demonstration the bridge shall be operated for 20 consecutive error-free operation cycles. A operation cycle shall be defined as starting from green traffic signals a complete bridge operation (fully raised and fully seated span) ending with green traffic signals. Any failures or adjustments shall reset the count. The functional test shall be preceded by an in-depth inspection by the Departmental Representative. All findings shall be resolved to the satisfaction of the Departmental Representative prior to testing.

.6 Departmental Representative will "conditionally accept the bridge" when the Contractor completes or submits the following:
.1 At the conclusion of the 20 error-free operations of the bridge.
.2 Completion of all training.
.3 Submission of all test reports.
.4 Submission of all as-built drawings and specifications.
.5 Submission of all O&M Manuals, including source code of software.

3.8 FINAL ACCEPTANCE PERIOD

.1 Upon Substantial Acceptance, a 60-day period shall begin. The bridge shall be put into service. The bridge systems shall operate fault-free for a 60-day trial period. This 60-day trial period shall include a minimum of one complete bridge operation, three times a week, in addition to the bridge opening requested by vessels. Any faults shall be corrected to the satisfaction of the Departmental Representative and shall reset the 60-day trial period, unless permitted otherwise in writing by the Departmental Representative. During this period, all testing materials, equipment, personnel, adjustments, calibrations, and fault remedies shall be furnished by the Contractor. The Contractor shall perform any required maintenance and shall repair or

3.8 FINAL ACCEPTANCE PERIOD (Cont'd)

.1 (Cont'd)
replace, as directed by the Departmental Representative, any component that fails.

3.9 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

3.10 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.
.1 Leave Work area clean at the end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes Electrical Controls and Relays comprising of, but not limited to, all labour, materials, tools, equipment, and appurtenances necessary to supply, install and test all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation.

.1 Supply, install and test resolver and programmable limit switch assembly for full raised assembly, near raised and near lowered, and overspeed switch controller with split collar pulser wrap.

.2 Supply, install and test lever operated limit switches for fully raised, near raised and near lowered.

.3 Supply, install and test plunger type limit switches for the span fully seated for connection to the new system and to the auxiliary drive system.

.4 Supply, install and test bridge skew transmitting biaxial force balance inclinometer, wireless modules, and antennas.

.5 Supply, install and test 24 V d.c. power supply for biaxial force balance inclinometer, biaxial force balance inclinometer wireless module, and bridge position meter circuit.

.6 Supply and install a NEMA 4X stainless steel Type 316 enclosure for the 24 V d.c. power supply for biaxial force balance inclinometer, biaxial force balance inclinometer wireless module, and bridge position meter circuit.

.7 Supply, install and test 24 V d.c. power supply for bridge skew transmitter.

.8 Supply, install and test time delay relays.

.9 Supply, install and test rotary switches to transfer between the normal and backup set of aerial cables.

.10 Supply, install and test magnetic latching relays.

.11 Supply, install and test flasher relays.

.12 Supply, install and test travel limit switches at both ends of travel for slow down and total stop.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA C22.2 No. 14-10, Industrial Control Equipments.

.2 National Electrical Manufacturers Association (NEMA)
.1 NEMA ICS 1-2000 (R2008), Industrial Control and Systems: General Requirements.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00.

.2 Submit product data for all specified products. Submit shop drawings showing mounting details that are not clearly shown in manufacturer's data.

1.4 DEFINITIONS

.1 Near Raised: is defined as that position where the vertical lift span is 105 feet (32 m) from fully raised. The span is allowed to travel up at only low speed beyond this point.

.2 Near Lowered: is defined as that position where the vertical lift span is 18 inches (457 mm) from fully seated. The span is allowed to travel down only at low speed beyond this point. These heights are just a starting point, final position is bridge dependent.

.3 Full Seated: is defined as that position where the vertical lift span is properly aligned with the roadway, and the span will allow travel of traffic, only after all the span locks are engaged.

.4 Fully Raised: is defined as that position where the vertical lift span is 110 feet (33.5 m) above seat, and the span is not allowed to travel further up.

.5 Creep Speed: is defined as ten (10) percent of full operating speed.

1.5 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LIMIT SWITCH AND POSITION TRANSMITTER

.1 The span position shall be sensed with a programmable limit switch (PLS)in conjunction with the redundant fully lowered, near lowered, near raised and fully raised limit switches.

.2 Programmable limit switches:
.1 Power requirements: 105-135 V a.c., 60 hertz, 20 watts.
.2 Operating temperature: -10 to +130°F (-23 to +55°C).
.3 Programming: 8 selectable from keyboard or externally via 3 program selected inputs (PS0 015-PS2).
.4 PLS Setpoint: 160 per PLS Program, 1280 total.
.5 Scale Factor: Programmable from 16 to 999, common to all PLS programs (resolution 17 to 1000 counts/turn).
.6 Offset: Programmable from 0 to Scale Factor Value, common to all PLS programs.
.7 Speed Compensation: Programmable in scale factor units per 100 rpm, up to full scale factor value. Each PLS channel has its own speed compensation. Channels 1-4 have 16 speed compensation zones.
.8 Motion Detector: Low and High Motion Limits, common to all PLS programs. Programmable from 0 to 999 RPM.
.9 Resolver interface:
.1 Position transducer: Resolver.
.2 Cable Length between Resolver and PLS: 2500 feet (762 meters) maximum, shielded.
.3 Maximum resolver shaft speed: 3600 RPM.
.4 Resolver Decoder: Ratiometric.
.10 Control Inputs:
.1 Electrical specifications: (All Inputs).
.1 Optical Isolation: 1500 V.
.2 Input impedance:1800 Ohms.
.2 Logic levels: TRUE: 1 to 28V d.c. sourcing; FALSE: 0 to 0.8V d.c.
.3 Program enable 2 (PE2): When TRUE, enables setpoint and setup (scale factor, offset, program #, etc.)
.4 Output Enable (OE): When TRUE, PLS Channel outputs enabled (both Fault and Motion always enabled).
.5 Fault Check Enable (FCE): When TRUE, disables PLS and Motion Detector Outputs

2.1 PROGRAMMABLE LIMIT SWITCH AND POSITION TRANSMITTER (Cont'd)

.2 Programmable limit switches:(Cont'd)

.10 Control Inputs:(Cont'd)

.5 Fault Check Enable (FCE):(Cont'd) whenever Resolver Broken Wire Fault or PLS internal fault occurs.

Program Select Inputs PLS Program

PS0	PS1	PS2	Selected
F	F	F	1
T	F	F	2
F	T	F	3
T	T	F	4
F	F	T	5
T	F	T	6
F	T	T	7
T	T	T	8

T: TRUE F: FALSE

.11 Outputs:

.1 Unregulated Voltage Out (VO): Current limited, unregulated 12V d.c. for use with PLS inputs ONLY. Not for external sensor power.

.2 Fault Output:

.1 Detects resolver broken wire and PLS internal faults) electromechanic relay (Form C) output; 10 Amp resistive max @ 120 V a.c.

.2 Without Fault: Relay remains energized.

.3 With Fault: Relay de-energized.

.3 Motion Output: Electromechanic relay (Form C) output; 10 Amp resistive max @ 120 V a.c.; relay energized whenever resolver RPM is between programmed motion limits.

.4 PLS Outputs: Number of PLS Outputs: 16.

.5 Number of PLS Setpoints: 160 PLS setpoints per program; 1280 total for 8 programs. 80 for channel 1-8 , 80 for channel 9-16.

.6 Types of Ouputs:

.1 Electromechanical Relays , 120 V a.c.:

.1 10 Amp resistive, single pole, single throw (SPST).

.2 10 Amp resistive, single pole, double throw (SPDT).

.2 Solid-State Relays:

.1 AC output: 120 V a.c. @ 3 A; ON time: <3ms after zero cross; OFF time: At zero cross; Leakage: 2.1mA @ 120 V a.c.

2.1 PROGRAMMABLE LIMIT SWITCH AND POSITION TRANSMITTER (Cont'd)

.2 Programmable limit switches:(Cont'd)
.11 Outputs:(Cont'd)
.6 Types of Ouputs:(Cont'd)
.2 Solid-State Relays:(Cont'd)
.2 DC output: Up to 60 V d.c. @ 3 A; ON time: 5 µs; OFF time: 35 µs; Leakage: 0.29 mA @ 15 V d.c.
.3 DC output: Up to 200 V d.c. @ 1 A; ON time: 15 µs OFF time: 100 µs; Leakage: < 0.01mA @ 30 V d.c.

.3 Position Transmitter: Position transmitter shall be resolver type and shall provide a 4-20 mA d.c. signal proportional to the rotation of the input shaft. Transmitter shall be enclosed in an explosion proof-weatherproof enclosure and shall be provided with a thermostatically controlled space heater. Input voltage shall be 15 V d.c. or 24 V d.c.

2.2 OVERSPEED SWITCH CONTROLLER SENOR, AND SPLIT COLLAR PULSER WRAP

.1 The overspeed switch controller shall display rotational speed or time for rotation. Unit shall be panel, flush surface mountable. Unit shall operate on 120 V a.c. and accept three programmable AC switched inputs. Unit shall provide 4-20 mA output and six programmable form C relays with double throw contacts (1-normally open (NO), 1-normally closed (NC)) rated for 250 V a.c, 5 amperes, resistive load. Contacts shall be programmable for six independent speed (trip) setpoints and be direction sensitive. Unit shall have provisions for selecting the relay contacts to be non-latching or latching with external reset. Unit shall have minimum accuracy and response time of 0.1% and 0.02 seconds respectively. Unit shall have a 4-digit, 7.6 mm high LED display and be rated to operate from 0°C to 50°C.

.2 The overspeed switch sensor shall be a hall effect sensor for use with magnetic targets. Unit shall operate on 6-24 V d.c., 10 mA, at frequencies from 0 KHz to 20 KHz. Sensor shall be encased in a cast aluminum housing with 1 inch (27 mm) female threaded pipe connection. Unit shall provide an NPN open collector output and be rated to operate at temperatures from from -40°C to 60°C.

2.2 OVERSPEED SWITCH CONTROLLER SENOR, AND SPLIT COLLAR PULSER WRAP (Cont'd)

.3 The split collar pulser wrap is to be made of stainless steel and contain 16, 0.5 inches (13 mm) diameter magnets of alternating polarity.

2.3 PLUNGER TYPE LIMIT SWITCH

.1 The full seated limit switch shall be a plunger type limit switch.

.1 Construction:

.1 Switch shall be a weather-sealed design, with neoprene gaskets between exterior bolted connections. Cover shall be designed to positively retain a gasket. Drain plugs and a breather shall allow condensation to evaporate or drain from housing. Construction shall be heavy duty, durable and suitable for marine environment. All materials shall be non-corrosive, such as aluminum, bronze, stainless steel or non-metallic. Finish shall be painted aluminum or safety orange, as specified.

.2 Plunger:

.1 Plunger extension shall permit at least 0.75 inches (21 mm) field adjustment and shall have a ball end. Design shall also allow for simple field swapping of service cover hand. Plunger shaft shall be stainless steel. Pre-travel shall be approximately 1.50 inches (41 mm)with a minimum overtravel of 2.00 (53 mm) inches.

.3 Activation Mechanism:

.1 Trip plate shall be spring loaded with an over-center mechanism to provide simultaneous, positive, accurate, and repeatable snap-action activation of all switches. Trip point shall be field adjustable by simple adjustment of plunger extension.

.4 Circuit Switches:

.1 The number of circuits shall be as specified in the Contract Documents. Each circuit shall provide independent normally open and normally closed sets of contacts (1 NO and 1 NC). Heavy-duty snap-action microswitches shall be double-break type to increase contact life. Individual switches shall be rated for 15A make/40A break at 120 V a.c. (see manufacturer for ratings at other voltages). Switches shall have clearly labelled screw-type compression

2.3 PLUNGER TYPE LIMIT SWITCH (Cont'd)

.1 (Cont'd)

.4 Circuit Switches:(Cont'd)

.1 (Cont'd)

wire connections and corrosion-resistant contacts.

.5 Conduit Entry:

.1 A 1 inch (27 mm) conduit hub shall be provided for wire entry. Housing shall be pre-drilled to permit switching the hub to either side of the housing. Second opening shall be sealed with an o-ring and cover plate.

2.4 BRIDGE POSITION TRANSMITTING INCLINOMETER SENSOR

.1 Biaxial Force Balance Inclinometer: The biaxial force balance inclinometer designed with an output circuit configuration made for use in 4-20 mA data transmission systems.

.1 Range: ±5°.

.2 Output current: 4-20mA.

.3 Output Function: Io = 12 + K Sin ϕ(mA) ±0.5% of normal into a maximum load of 600 Ohms.

.4 Excitation: +18 To +28 V d.c. <50 mA.

.5 Output Impedance: 50 Megohm typical.

.6 Non-Linearity: ±0.1% frequency response.

.7 Non-Repeatability: ±0.1% frequency response.

.8 Scale Factor Tolerance: ±1%.

.9 Scale Factor Temp Coefficient: ±0.02%/Deg C.

.10 Zero Bias: 12 ±0.02 mA.

.11 Zero Bias Temp. Coefficient: ±0.002% frequency response/Deg C.

.12 Resolution: 0.001% frequency response.

.13 Bandwidth 0 To 3 Hz ±5%(-18 dB/Octave Rolloff).

.14 Orthogonal Sensitivity: <1%.

.15 Case Alignment: ±0.25 Deg.

.16 Operating Temperature: -40° to +85°C.

.17 Random Vibration (2 to 2,000 Hz.): 15 G RMS, 0.25 inches Disp. D.A.

.18 Shock Survival: 1000 G, 1 mSec.

.19 Case Material: Anodized aluminum.

.2 Biaxial Force Balance Inclinometer Wireless Module: Unidirectional, wireless, 900 MHz transmission system, made up of a transmitter (Tx) and a receiver (Rx) and two omnidirectional antennas with connecting cable.

.1 Direction: Uni-directional.

.2 Frequency Range: 302 MHz to 928 MHz.

.3 Number of channel groups: 4.

.4 Number of channels per group: 63.

.5 Transmission power: 1 watt.

2.4 BRIDGE POSITION TRANSMITTING INCLINOMETER SENSOR (Cont'd)

.2 (Cont'd)

.6 Analog Input(Sender): Current input (analog input).

.1 Current input signal: 4mA to 20mA.

.2 Input resistance current input: <150 ohms.

.7 Digital Input (Sender):

.1 Input voltage range: 5 V a.c./d.c. to 30 V a.c./d.c.

.2 Switching threshold "0" signal, voltage: max. 1.5 V d.c.

.3 Switching threshold "1" signal voltage: min. 5 V d.c.

.8 Analog Output (Receiver):

.1 Current output signal: 4mA to 20mA.

.2 Load/output load current output: 700 ohms.

.9 Digital Output (Receiver):

.1 Contact type: 3 floating PDT contacts.

.2 Contact material: Silver, gold plated.

.3 Maximum switching voltage: 30 V d.c.

.4 Limiting continuous current: 0.5A.

.3 Power supply for biaxial force balance inclinometer: DIN rail power supply unit 24 V d.c./2 A, primary-switched mode, slim design.

2.5 TIME DELAY RELAYS

.1 Time delay relays shall operate on 120 V a.c, have standard 8-pin sockets, start timing when powered on, and have contacts rated for 5 amperes resistive at 250 V a.c.

.2 Relay to have mechanical device to hold relay in socket.

2.6 MAGNETIC LATCHING RELAY

.1 Magnetic latching relays shall operate on 120 V a.c., have a 11-blade socket, and have contact rated for 15 A (make) and 1.5 A (break) at 240V a.c.

.2 Relay to have mechanical device to hold relay in socket.

2.7 HIGH PERFORMANCE TIMING RELAY

.1 The high performance timing relays shall operate on 120 V a.c., and be DIN rail mounted. It shall have adjustable function and timing range of 0.05 seconds to 60 hours. The flasher operating mode (repeat cycle after starting with pulse or pause) shall have a contact output of 0.05 seconds to 60 hours.

.2 Relay to have mechanical device to hold relay in socket.

2.8 DETENT ACTION ROTARY SWITCH

.1 The detent action rotary switch shall be a double sided, double-wiping, knife-type rotary contacts. It shall have a maintained mechanism. It shall have an interrupting rating of 30A at 600 V a.c. The switch shall have a pistol grip handle, with a minimum of two contacts, six poles and twenty sections. Refer to Contract Documents for additional information.

2.9 CONTROL RELAYS AND CURRENT SENSING RELAYS

.1 Control relays shall be track mounted industrial control relays, two to eight poles as required by the Contract Documents. Contacts shall be rated for 10A continuous duty at 120 V a.c. Operating voltage shall be 120 V a.c. Relays shall have provisions for stacking additional poles or timing modules. Socket mounted relays shall not be used.

.2 Current sensing relays shall sense 0.25 Amps to 5.0 Amps. Contacts shall be rated for 5.0 Amps, continuous duty at 120 V. Current sensing relays shall have time delay capabilities of 0 to 5 seconds off delay.

PART 3 - EXECUTION

3.1 CONSTRUCTION REQUIREMENTS

.1 Install limit switches in accordance with manufacturer's instructions. Provide all mounting hardware and supports as required.

.2 Terminate all limit switch wiring connections on terminal blocks.

.3 Install and interconnect all equipment per the Contract Documents.

3.1 CONSTRUCTION REQUIREMENTS (Cont'd)

.4 Program the encoder/transmitter to accurately display span motor speed using the input from the sensor monitoring the bridge machinery's shaft speed. Verify the speed readout by direct measurement of the motor shaft speed using a calibrated tachometer.

.5 Program the overspeed switch controller sensor and split collar pulser wrap to trip the high speed overspeed contacts at 600 RPM - motor speed. This overspeed trip should latch the contacts until a reset signal is sent to the controller.

.6 Program the overspeed switch controller sensor and split collar pulser wrap to trip the creep speed overspeed contacts at 110 RPM - motor speed. Program the controller so this overspeed trip is enabled when the span is lowering and raising. This trip should not latch inside the controller.

.7 Calibrate the span position indicating meters as per the manufacturer's recommendations using fully-lowered and seated as the zero position.

.8 Calibrate the biaxial force balance inclinometer for span skew per the manufacturer's recommendations using fully-lowered and seated as the zero position.

3.2 TESTS

.1 After installation, test switches, in the presence of the Departmental Representative, to determine if operation is as intended. Switches should relay signal to the control system at intended "point of operation". Switches should provide positive indications with no intermittent signals or flickering of lights on control console. Adjust position of switches as required.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes Bridge Control System comprising of, but not limited to,

.1 Furnishing all labour, materials, tools, equipment, and appurtenances necessary to supply, install and test all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation of Control Consoles, PLC Cabinets, Remote I/O Panels, UPS Unit, Limit Switches, Biaxial Force Balance Inclinometer, Biaxial Force Inclinometer Wireless Module, Bridge Position Meter Circuit, Power Supplies, Pushbuttons, Switches, Indicators, Console Meters, PLC system, Human Machine Interface (HMI), PLC Programming Software, Programming Terminal, Control Panels, Relays, Rotary Switches and spare parts.

.2 Demolition of Existing Bridge Control System: Control Cubicles, PLC Cabinets, Fully Seated Limit Switches, UPS Unit, Height Instrumentation, Skew Instrumentation, Navigation and Pedestrian Signaling System Control Panel, and Traffic Control Desk.

.3 Refurbishment of the Master Controller.

.4 Furnishing and installing a fully developed hybrid PLC and relay based control system, PLC program, and Graphical Display using the Required Control and Operation Sequence provided in the Contract Documents. Allowing for specific requirements of the PLC as supplied, the program ladder logic shall follow as closely as possible the Contract Documents. All software licenses and programming source code shall be given to the Departmental Representative at the end of the construction free and clear of all encumbrances.

1.2 SUMMARY

.1 The major components of the bridge control system include a new main control console top, new navigation, pedestrian signal and traffic system control console, control panels, motor control centres, limit switches, programmable limit switches, overspeed switches, uninterruptable power supplies, biaxial force balance inclinometer and wireless module, skew indicators, and position transmitters. The operation of the bridge is performed with control switches mounted on the control console,

1.2 SUMMARY (Cont'd)

.1 (Cont'd)
control relays and Programmable Logic Controller (PLC) providing all of the operation sequences and safety interlock logic. Bypasses shall be provided to operate individual components, for maintenance purposes.

1.3 QUALITY ASSURANCE

.1 Prior to shipment, the complete control system shall be functionally tested to assure completeness and correct operation. Testing shall be witnessed and reviewed by the Departmental Representative. Sufficient notice, 30 days, shall be given to the Departmental Representative so that the arrangements may be made. The Contractor shall prepare and submit for review a test procedure and schedule.

.2 Testing shall include simulation of all control functions. Inputs shall be simulated with toggle switches and outputs shall be simulated with indicator lights or relays. Forcing of contacts will not be accepted during the witnessed test and shall be cause for rejection of the program.

.3 Procedure shall be a step-by-step description of manual actions or simulations and the expected control response, output, or sequence of outputs, including all alarms and messages and graphical operator display functions.

1.4 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

.2 Measure spare PLC CPU in each unit incorporated into Work.

.3 Measure spare fully seated limit switch in each unit incorporated into Work.

.4 Measure spare over-speed switch in each unit incorporated into Work.

.5 Measure spare I/O Cards (composite set) in each unit incorporated into Work.

.6 Measure Bridge Control System spare parts (composite set) in each unit incorporated into Work.

PART 2 - PRODUCTS

2.1 CONTROL PANEL

.1 New navigation, pedestrian signal and traffic system control panel: Panel shall be a 47-5/16 inch (1202 mm) wide x 35.5 inch (901.7 mm) high (front) (46.29 inch (1175.7 mm) high (back)) x 18.46 inch (468.8 mm) deep, 14 gauge steel enclosure with two doors.

.1 Construction shall conform to NEMA 12 standards.

.2 Enclosure seams shall be continuously welded and ground smooth. There shall be a rolled lip around the doors to prevent dirt and water from falling into the enclosure when the doors are opened.

.3 Doors shall be fully gasketed with neoprene gaskets securely glued in place. Doors shall be provided with continuous heavy-duty stainless steel hinges and a lockable, three point latch. Vent (louvers with filters) and interior fan shall be provided to keep temperatures to reasonable operating limits within the cabinets.

.4 After fabrication of enclosure has been completed, all sides and supports, internal and external, shall be cleaned and phosphatized prior to the application of a high quality, rust-inhibiting primer.

.5 Finish coat shall be black baked enamel or polyester powder.

.6 Interior and back panel shall be high gloss white baked enamel.

.7 The console top shall be 12 gauge stainless steel hinged sloping top. The sloping top shall be mounted as indicated in the Contract Documents. After punching for the control devices, the top shall be brush finished.

.8 Surface preparation shall be as described for the control panel.

.9 The main control console top panel shall be hinged and lock in open position for easy access to the wiring side of the panel. Device designation shall be on wiring side of panel.

.10 Control console will contain all push buttons, switches, and indications to operate the bridge. The layout of the controls shall be as shown on the Contract Documents.

.11 Two fluorescent fixtures with 20 watt (min.) lamps with a door activated switch shall be fastened to the inside of the panel. Install a ground lug for bonding of enclosure.

2.1 CONTROL PANEL (Cont'd)

.1 (Cont'd)
.12 The control consoles shall be located and oriented as shown in the Contract Plans.

.2 The main control console top:
.1 The console top shall be 12 gauge stainless steel hinged sloping top. The sloping top shall be mounted as indicated in the Contract Documents.
.2 Construction shall conform to NEMA 12 standards. The enclosure dimensions shall be as shown on the Contract Documents. Surface preparation shall be as described for the control panel. After punching for the control devices, the top shall be brush finished.
.3 Control console will contain all push buttons, switches, and indications to operate the bridge. The layout of the controls shall be as shown on the Contract Documents.
.4 A fluorescent fixture with 20 watt (min.) lamp with a door activated switch shall be fastened to the inside of the panel. Install a ground lug for bonding of enclosure.
.5 The control consoles shall be located and oriented as shown in the Contract Plans.

2.2 UNINTERRUPTIBLE POWER SUPPLY (UPS)

.1 Provide for system distributed power as shown on the Contract Documents.

.2 Input voltage of 208 V a.c. and output voltage shall be 120/208V a.c., +/- 3 percent on utility or battery power. Output voltage shall be a sine wave with less than a 3-percent distortion.

.3 Rated at 10kVA/9kW with a runtime of 27 minutes at full load and 70 minutes at half load.

.4 Have internal batteries and external battery cabinets as required to obtain the required power rating.

.5 This system shall self-test on startup.

.6 Diagnostics and status shall be displayed on an LCD screen.

.7 An audible alarm shall be sounded for "on battery," low battery, overload, and UPS fault.

.8 A dry contact, relay output shall be provided.

.9 Transfer time shall be 0ms.

2.2 UNINTERRUPTIBLE POWER SUPPLY (UPS) (Cont'd)

.10 Automatically transfer to bypass upon UPS failure. Transfer time to bypass shall be less than 4 ms. UPS shall have provisions for hardwire connection input and output sources.

2.3 WIRING

.1 Provide interconnection wiring between all electrical devices mounted in the panels and enclosures. If the devices are to be connected to external equipment, they shall be connected to terminal blocks. Conductors shall be ULC listed type RW90. Minimum field installed control wire size within the control console shall be No. 14 AWG, everywhere else use No. 12 AWG minimum wire size.

.2 Control wiring served by circuit breakers shall be appropriately sized, as follows:
.1 20 AMP - No.12 AWG.
.2 15 AMP - No.14 AWG
.3 10 AMP - No.14 AWG
.4 5 AMP - No.14 AWG

.3 Install all interior wiring neatly and carefully, and terminate on ULC approved terminal blocks.

.4 Individually bundle wiring to each control switch and install with a "drop loop" of sufficient length to allow its removal for maintenance without disconnecting the wiring. Use plastic wireways (open slot type) for routing all internal wiring in the control console.

.5 Internal wiring in factory prewired electronic system cabinets may be installed according to the Manufacturer's standard as to wire size, insulation, and method of termination on internal equipment.

2.4 TERMINAL BLOCKS

.1 Provide terminal blocks for conductors requiring connection to circuits external to the specified equipment, for internal circuits crossing shipping splits, and where equipment parts replacement and maintenance will be facilitated.

.2 Group terminal blocks for easy accessibility unrestricted by interference from structural members and instruments. Provide sufficient space on each side of each terminal block to

2.4 TERMINAL BLOCKS (Cont'd)

.2 (Cont'd)
allow an orderly arrangement of all leads to be terminated on the block.

.3 Permanently label each terminal block, device, fuse block, terminal, and both ends of each conductor to coincide with the identification indicated on the manufacturer's wiring diagrams.

.4 Terminal blocks and devices already numbered on the Contract Documents shall be so numbered on the equipment supplied. Identify mounted electronic components by marking with contrasting colored ink beside the component.

.5 Permanently identify individual conductors. The marking shall be done on a sleeve not less than 1/2 inches (13 mm) long. Mark each sleeve so that the identification is permanent and waterproof. Adhesive type labels are not acceptable.

2.5 PUSHBUTTONS, SWITCHES AND INDICATORS

.1 Unless otherwise noted, all pushbuttons and indicator lights shall be located in the control console. All pushbuttons and switches shall be 30.5 mm, heavy duty, and oiltight. Contacts shall be rated 10A at 120 V a.c. Indicator lights shall be 30.5 mm, high intensity LED type, 120 V a.c., as indicated in the Contract Documents.

.2 Where indicated on the Contract Documents, lights and buttons shall use a Bezel Legend Plate. The plate shall be black with white engraved letters a minimum of 3/16 inches (5 mm) high.

.1 Single button operator momentary contact shall have two normally open contacts. Black Button unless shown differently on Contract Documents:

	Tag Name	Legend
.1	HS-606	TG-NW TRAFFIC GATE LOWER
.2	HS-605	TG-NW TRAFFIC GATE RAISE
.3	HS-609	TG-NE TRAFFIC GATE LOWER
.4	HS-608	TG-NE TRAFFIC GATE RAISE
.5	HS-613	TG-SW TRAFFIC GATE LOWER
.6	HS-612	TG-SW TRAFFIC GATE RAISE
.7	HS-616	TG-SE TRAFFIC GATE LOWER
.8	HS-615	TG-SE TRAFFIC GATE RAISE
.9	HS-810	SIREN
.10	HS-720	NAVIGATION TEST
.11	HS-707	SMALL CRAFT RESET
.12	HS-710	SMALL CRAFT EAST

2.5 PUSHBUTTONS, SWITCHES AND INDICATORS (Cont'd)

.2 (Cont'd)

.1 (Cont'd)

.13	HS-619	BG-NE BARRIER GATE	LOWER
.14	HS-618	BG-NE BARRIER GATE	RAISE
.15	HS-622	BG-SE BARRIER GATE	LOWER
.16	HS-621	BG-SE BARRIER GATE	RAISE
.17	HS-713	PEDESTRIAN LIGHT	HALT
.18	HS-712	PEDESTRIAN LIGHT	WALK
.19	HS-705	PG-SW GATE	LOWER
.20	HS-704	PG-SW GATE	RAISE
.21	HS-702	PG-NW GATE	LOWER
.22	HS-701	PG-NW GATE	RAISE
.23	HS-239	LAMP TEST	
.24	HS-211	SPAN LOCKS	ENGAGE
.25	HS-213	SPAN LOCKS	DISENGAGE
.26	HS-712	GATE GROUP	RAISE
.27	HS-708	SMALL CRAFT WEST	
.28	HS-709	SMALL CRAFT BOTH	
.29	HS-238	ALARM ACKNOWLEDGE	
.30	HS-550	FUEL SENSOR ALARM ACKNOWLEDGE	
.31	HS-535	MAIN BREAKER	CLOSE
.32	HS-537	MAIN BREAKER	OPEN
.33	HS-539	GENERATOR BREAKER	CLOSE
.34	HS-541	GENERATOR BREAKER	OPEN
.35	HS-543	LOAD BANK BREAKER	CLOSE
.36	HS-545	LOAD BANK BREAKER	OPEN
.37	HS-215	NAVIGATION HORN	

.2 Selector Switch: two position, maintained, operator with "gloved hand" lever. The selector switch shall have two normally open contacts.

	Tag	Legend Plate	
.1	HS-718A/B	NAVIGATION	WEST EAST
.2	HS-570	BRIDGE GENERATOR	OFF RUN
.3	HS-315	SKEW-BYPASS	NORMAL BYPASS

.3 Selector Switch: three position, maintained, operator with "gloved hand" lever, heavy duty, four normally open and two normally closed contacts.

	Tag	Legend		
.1	HS-1601	TRAFFIC LIGHTS/	GREEN	RED FLASHER

.4 Selector Switch: two position, spring return to normal position, keyed operator with two normally open contacts.

	Tag Name	Legend	
.1	HS-706	PEDESTRIAN GATES BYP	NORM BYPASS
.2	HS-603	BARRIER GATES BYPASS	NORM BYPASS
.3	HS-611	TRAFFIC GATE BYPASS	NORM BYPASS

2.5 PUSHBUTTONS, SWITCHES AND INDICATORS (Cont'd)

.2 (Cont'd)

.4 Selector Switch:(Cont'd)

.4	HS-311	SPAN LOCK BYPASS	NORM BYPASS
.5	HS-309	SIGNALS BYPASS	NORM BYPASS
.6	HS-310	SPAN SEATED BYPASS	NORM BYPASS
.7	HS-313	SOUTH DIFFERENTIAL LOCK	UNLOCK LOCK
.8	HS-314	NORTH DIFFERENTIAL LOCK	UNLOCK LOCK

.5 Cam action rotary switch: 10 position, 7 stacks of double throw with off position contacts, contact rating 12 amps at 120 Va.c., ball tip handle. Existing switch to be refurbished and reused. Refurbish the existing drum controller type switch to restore it to the original condition including replacing contacts, bushings, bearings, and position indicating back-plate.

	Tag Name	Legend
.1	HS-300	MASTER CONTROLLER

.6 Rotary Switch: 3 position, 17 section, double sided, double wiping knife type rotary contacts, contacts shall be break before make and have silver surfaces. The contacts shall have a continuous rating of 30A at 600V. The switch shall pull to lock safety lockout feature and have an oval handle.

	Tag Name	Legend
.1	NORTH CONTROL CABLE TRANSFER SWITCH	

.7 Single indicating light.

	Tag Name	Colour	Legend
.1	IL-638	RED	TG-NW LOWER
.2	IL-639	GREEN	TG-NW RAISE
.3	IL-640	RED	TG-NE LOWER
.4	IL-641	GREEN	TG-NE RAISE
.5	IL-642	RED	TG-SW LOWER
.6	IL-643	GREEN	TG-SW RAISE
.7	IL-644	RED	TG-SE LOWER
.8	IL-645	GREEN	TG-SE RAISE
.3	IL-647	RED	BG-NE LOWER
.4	IL-648	GREEN	BG-NE RAISE
.7	IL-649	RED	BG-SE LOWER
.8	IL-650	GREEN	BG-SE RAISE
.9	IL-651	RED	TRAFFIC LIGHT
.10	IL-652	AMBER	TRAFFIC LIGHT
.11	IL-653	GREEN	TRAFFIC LIGHT
.12	IL-736	RED	PG-NW LOWER
.13	IL-735	GREEN	PG-NW RAISE
.14	IL-738	RED	PG-SW LOWER
.15	IL-737	GREEN	PG-SW RAISE

2.5 PUSHBUTTONS, SWITCHES AND INDICATORS (Cont'd) .2 (Cont'd) .7 (Cont'd)

.16	IL-741	RED	WEST NAVIGATION
.16	IL-742	GREEN	WEST NAVIGATION
.17	IL-743	RED	EAST NAVIGATION
.18	IL-744	GREEN	EAST NAVIGATION
.19	IL-747	BLUE	SMALL CRAFT WEST
.20	IL-748	BLUE	SMALL CRAFT EAST
.21	IL-411	RED	SPAN LOCK SOUTH HAND CRANK
.22	IL-412	RED	SPAN LOCK NORTH HAND CRANK
.23	IL-124	GREEN	PLC OPERATIONAL
.24	IL-112	AMBER	PLC FAILED
.25	IL-335	WHITE	SPAN LOCK SOUTH ENGAGE
.26	IL-336	GREEN	SPAN LOCK SOUTH DISENGAGE
.27	IL-337	WHITE	SPAN LOCK NORTH ENGAGE
.28	IL-338	GREEN	SPAN LOCK NORTH DISENGAGE
.29	IL-339	WHITE	S.E. CORNER SEATED
.30	IL-340	WHITE	S.W. CORNER SEATED
.31	IL-341	WHITE	N.E. CORNER SEATED
.32	IL-342	WHITE	N.W. CORNER SEATED
.33	IL-343	WHITE	SPAN FULLY SEATED
.34	IL-361	AMBER	TWO BRAKES HAND RELEASE
.35	IL-345	AMBER	SKEW TRIP
.37	IL-352	RED	BRAKE S1 RELEASED
.38	IL-353	RED	BRAKE S2 RELEASED
.39	IL-363	RED	BRAKE S3 RELEASED
.40	IL-354	RED	BRAKE S4 RELEASED
.41	IL-355	RED	BRAKE N1 RELEASED
.42	IL-358	RED	BRAKE N2 RELEASED
.43	IL-359	RED	BRAKE N3 RELEASED
.44	IL-360	RED	BRAKE N4 RELEASED
.45	IL-347	GREEN	MOTOR 4W-SL RUNNING
.46	IL-348	GREEN	MOTOR 2W-MA RUNNING
.47	IL-349	GREEN	MOTOR 3E-MA RUNNING
.48	IL-350	GREEN	MOTOR 1E-SL RUNNING
.49	IL-421	RED	N. DIFFERENTIAL UNLOCKED
.50	IL-422	GREEN	N. DIFFERENTIAL LOCKED
.51	IL-423	RED	S. DIFFERENTIAL UNLOCKED
.52	IL-424	GREEN	S. DIFFERENTIAL LOCKED
.53	IL-426	RED	N. AUXILIARY DRIVE ENGAGED
.54	IL-427	GREEN	N. AUXILIARY DRIVE DISENGAGED

2.5 PUSHBUTTONS, SWITCHES AND INDICATORS (Cont'd)

.2 (Cont'd)

.7 (Cont'd)

.55	IL-428	RED	S. AUXILIARY DRIVE ENGAGED
.56	IL-429	GREEN	S. AUXILIARY DRIVE DISENGAGED
.57	IL-536	RED	MAIN BREAKER CLOSE
.58	IL-538	GREEN	MAIN BREAKER OPEN
.59	IL-540	RED	GENERATOR BREAKER CLOSE
.60	IL-542	GREEN	GENERATOR BREAKER OPEN
.61	IL-544	RED	LOAD BANK BREAKER CLOSE
.62	IL-546	GREEN	LOAD BANK BREAKER OPEN
.63	IL-557	GREEN	GENERATOR PROTECTION DISABLED
.64	IL-560	RED	GENERATOR PROTECTION ENABLED
.65	IL-563	WHITE	HOUSE GENERATOR ATS NORMAL
.66	IL-566	AMBER	HOUSE GENERATOR ATS STANDBY

.8 Mushroom Operator: maintained position shall have three contacts closed when button pulled out, open when pushed in. 67mm red aluminum button.

	Tag	Legend
.1	HS-210	EMERGENCY STOP

.9 Motor Speed Indicators: The speed digital indicators shall have a 5 digit, 7 segment red LED display 0.56 inches high. The indicator shall have a 4-20mA d.c. input and 24 V d.c. power. Coordinate polarity and calibration with the motor drive and PLC. Main Legend for all four indicators: MOTOR SPEED INDICATOR.

	Tag Name	Legend	Approx. Calibration/Scale
.1	SI-500	3E NORTH	4.00-20mA / 000.0'-600.0'
.2	SI-502	4W NORTH	4.00-20mA / 000.0'-600.0'
.3	SI-504	1E SOUTH	4.00-20mA / 000.0'-600.0'
.4	SI-506	2W SOUTH	4.00-20mA / 000.0'-600.0'

Meters shall be zero and span calibrated as required for proper indication.

2.5 PUSHBUTTONS, SWITCHES AND INDICATORS (Cont'd) .2 (Cont'd)

.9 Motor Speed Indicators:(Cont'd)

digit, 7 segment, 0.56 inches (14 mm) LED display. Install on control console top panel as shown on Contract Documents: Operating on 24 V d.c., with a 1-10 V d.c. input signal corresponding to a 0-400A display. Contractor shall match meter and transmitter.

	Tag Name	Legend	Approx. Calibration/Scale
.1	II-510	3E NORTH	4.00-20mA / 000.0 A-400.0 A
.2	II-512	4W NORTH	4.00-20mA / 000.0 A-400.0 A
.3	II-518	1E SOUTH	4.00-20mA / 000.0 A-400.0 A
.4	II-518	2W SOUTH	4.00-20mA / 000.0 A-400.0 A

.11 Main Bus Power Monitor: A remote power monitor display connected to the Main Switchboard power monitor shall be provided. The power monitor shall display 3 phase energy and power measurements and alarm loss of any phase. Power monitor shall include phase rotation indication and alarm a change of rotation.

.12 Span Skew Indicator: The span skew indicator shall be a high resolution 50 segment LED (Light Emitting Diode) bar array, with a five digit display with resolution to 0.01%. Field programmable. Install on control console top panel as shown on Contract Documents: Operating on 120 V a.c., with a 4-20 mA input signal corresponding to a 0-120 feet display.

	Tag Name	Legend
.1	ZI-524	LONGITUDINAL SPAN SKEW INDICATION

.13 Span Height Indicator: The longitudinal span skew indicator shall be a high resolution 50 segment LED (Light Emitting Diode) bar array, with a five digit display with resolution to 0.01%. Field programmable. Install on control console top panel as shown on Contract Documents: Operating on 120 V a.c., with a 4-20mA. input signal corresponding to a 0-120 feet display.

	Tag Name	Legend
.1	ZI-522	SPAN HEIGHT INDICATION

2.5 PUSHBUTTONS, SWITCHES AND INDICATORS (Cont'd)

.2 (Cont'd)

.14 Transverse Span Skew Indicator: The transverse span skew digital indicator shall have a 5 digit, 7 segment red LED display 0.56 inches (14 mm) high. The indicator shall have a 4-20mA d.c. input and 24 V d.c. power. Coordinate polarity and calibration with the motor drive and PLC. Main Legend for all four indicators: Span Skew Indicators.

(Cont'd)

	Tag Name	Legend
.1	ZI-514	TRANSVERSE SPAN SKEW INDICATION

.15 Alarm Panel: Refer to Section .2.5.8 Human Machine Interface (HMI) Alarm Message Display, for alarm panel requirements.

	Tag	Legend Name
.1	UI-526	ALARM PANEL

2.6 PROGRAMMABLE LOGIC CONTROLLER (PLC)

.1 Supply the PLC and all components in the PLC system manufactured by a single source and the product of a company with a minimum of twenty years experience in the manufacture and service of this type of equipment, install, and program a programmable logic controller (PLC) system.

.2 The PLC system includes all central processing units (CPUs), power supplies, communication cards, distributed I/O racks, discrete input and output cards, analog input and output cards , Message Display (MD)(also referred to as the HMI), cables, and associated peripheral equipment, software and documentation required to monitor the bridge control system as required.

.3 Processor shall have a maximum potential capacity of 128,000 discrete inputs and outputs, and 4,000 analog I/O, distributed in up to 4 remote input and output chassis. The processor shall be provided with a minimum of 32 megabytes of non-volatile user memory using secure digital card, requiring no battery I/O memory 0.98 megabytes, and built in USB port.

.4 The following minimum features are required in the PLC system:

.1 The PLC system includes a primary and secondary CPU, bus controller, power supplies, communication cards, distributed Input/Output (I/O) blocks, and plug-in chassis.

2.6 PROGRAMMABLE LOGIC CONTROLLER (PLC) (Cont'd)

.4 (Cont'd)

.2 Furnish a PLC system with industry standard ladder logic at all programming levels. No Assembly Language, "C", micro-code, or embedded function block programming is allowed.

.3 Furnish a PLC system that is internally capable of running auto-diagnostics on CPUs, I/O blocks, bus controllers, and other devices that are part of the PLC systems.

.4 Include I/O blocks, interface module (if required) and power supply for system inputs and outputs (if required). Ensure that all I/O modules are compatible with the main PLC rack and Bus Controllers.

.1 Inputs: As required plus 25% expansion capability at 120/240 V a.c., 4-20 mA and 0-10 V d.c. This 25% shall include 15% installed spare capacity. Furnish input modules that provide status lights indicating active inputs.

.2 Outputs: As required plus 25% expansion capability at 2 A loads (fused with fault status light indicator on output) 4-20mA and 0-10 V d.c. This 25% shall include 15% installed spare capacity. Provide output modules that provide status lights indicating active outputs. Outputs for indicator lamps may be solid state. Use relay contact output modules for motor control functions.

.3 Ensure that all functions have dedicated I/O assignments. Do not use BCD (binary coded decimal), except with permission from the Departmental Representative.

.4 Use industry standard wire terminals.

.5 PLC manufactured to NEMA ICS 3, with component circuit boards manufactured to NEMA ICS 2.

.6 The PLC system shall be of a modular design with a plug-in processing unit, input-output racks, and plug-in peripherals. All necessary cables shall be included.

.7 Communications plug-ins shall be provided for redundant ControlNet communications (2 channels), and a fibre optic synchronizing card.

.8 All major assemblies, sub-assemblies, circuit cards, and devices shall be permanently marked with the manufacturer's part or identification number.

.9 All components of the PLC system, except programming terminals, shall be capable of continuous operation at temperatures of 10° to 60°C, and humidity levels of 25 to 95 percent non-condensing. The programming terminals shall

2.6 PROGRAMMABLE LOGIC CONTROLLER (PLC) (Cont'd)

.4 (Cont'd)
.9 (Cont'd)
be capable of continuous operation at temperatures of 0° to 60°C and humidity levels of 5 to 95 percent.
.10 All programming and monitoring equipment shall be able to be connected or disconnected with the PLC in operation.
.11 Input/output units shall be capable of being removed without disconnecting field wiring.
.12 The PLC, including output devices, shall be shut down and an alarm sound in the event of:
.1 A disruption of program execution or scan.
.2 A loss of logic power.
.3 A loss of communication between PLC and essential devices.
.4 A memory error.

.5 Central Processing Unit:
.1 Processor shall be programmable both off-line and on-line. A key lock switch shall be provided to protect the memory from unauthorized editing. Programming shall be accomplished via a laptop computer. The processor shall mount in and receive its power from an I/O chassis.
.2 Processor shall be provided with LED indicating lights to indicate the following:
.1 Run/Fault Status.
.2 Communication Active/Fault Status.
.3 Forced Contacts Status.

.6 Programming Instruction Set:
.1 Language Characteristics, Ladder Diagram. Structured text, sequential function charts, and embedded sub-routine programming shall not be used.
.2 Logic Operations: AND, OR, XOR, NOT.
.3 Register Operations: Store, Recall.
.4 Math Operations: Addition, subtraction, multiplication, division.
.5 Instruction Set: Relay coil; latch; bit follow; timer; counter; shift register; master control relay; skip; arithmetic; comparison; data move; block transfer; search matrix; AND; OR; XOR matrix; complement matrix; first-in stack; first-out fetch; last-out fetch; bit operate; n-bit serial register; I/O update immediate.

.7 Input and Output: Each Input/output rack shall be complete with power supply and communication adapter. Chassis shall be sized as shown. Module slots shall be keyed to prevent the insertion of

2.6 PROGRAMMABLE LOGIC CONTROLLER (PLC) (Cont'd)

.7 Input and Output:(Cont'd)
improper modules. Slots shall be marked with type of module and address range. For modules that require DIP switch settings, slot marker shall also indicate the proper setting.
.1 Input modules shall be 16 point, 120 V ac.
.2 Output modules for indicating lights shall be 8 point, 120 V ac.
.3 Relay outputs. Individual outputs shall be rated for 5 A. Outputs for inductive loads shall have MOV (metal oxide varistors) surge suppressors.
.4 Analog input modules shall accept a 4-20 mA dc. signal.
.5 Communications modules shall provide redundant (2-channel) ControlNet protocol communications to and from both primary and secondary CPUs.

.8 Human Machine Interface (HMI) Alarm Messages Display:
.1 Use ControlNet communications.
.2 Keypad and touch input type.
.3 Messages shall be programmed for display in response to input received from the PLC. Display programming shall feature historical recording for up to 1500 events. Message programming and historical data shall be stored in 64MB (minimum) of flash memory. Provisions shall be made for connecting a printer and downloading historical data.
.4 512 MB nonvolatile flash/512 MB RAM.
.5 2 USB host ports, 1 USB device port.
.6 Equipped with an integrated AC power supply for 120 V a.c.
.7 Memory firmware shall include a real time clock and programming menu.
.8 Messages shall be programmable via laptop computer. The Contractor shall provide programming software. Display shall be provided with a housing, panel face for flush mounting on the control console, a sunshield, and glare guard.

.9 Programming Terminal: A programming terminal shall be provided to the Departmental Representative. The terminal shall be a semi-rugged, severe-duty laptop, drop and spill resistant, with 15.4-inch (391 mm) flat display color monitor, and an operating system compatible with PLC CPU and peripherals . The programming terminal shall be provided with a minimum of 4GB of RAM memory and a minimum of 200 GB shock-mounted hard disk capacities. The optical disk drive shall be capable of reading

2.6 PROGRAMMABLE LOGIC CONTROLLER (PLC) (Cont'd)

.9 Programming Terminal:(Cont'd)
and writing to Compact Disk (CD) and Digital Video Disk (DVD) format disks. The terminal shall be provided to the Departmental Representative with the following files stored on the hard disk along with original commercial software CDs and DVDs and licenses.
.1 PLC programming software.
.2 Final PLC program.
.3 Input/Output tag name and rung documentation.
.4 Ladder listing with annotations including cross-referencing.
.5 Human Machine Interface (HMI) programming software.
.6 HMI alarm messages.
.7 Installation and programming manuals for the PLC processor, HMI, modules, and all related components.
.8 The final PLC program shall also be provided to the Departmental Representative on DVD format disk.
.9 Seven (7) copies of the PLC and HMI programming manuals shall be provided.

.10 Internal PLC Diagnostics: Log input faults in easy to understand English language message format with a date and time stamp for each fault. Include any corresponding address information (to determine location of the fault) in the fault message that gets logged. List faults in chronological order. In addition to fault logs of input faults, provide a fault bit for each I/O point that reflects the health of the I/O point and that is easily usable in a ladder logic application program in the form of relay contacts to allow the program to act on the diagnostic information. The fault bits shall also be available to be read by a host or operator interface device. Provide diagnostic LED indicators viewable at each physical module (block). Module diagnostics include the following:
.1 Input shorted.
.2 Input under range.
.3 Input over range.
.4 Loss of input module (block).
.5 Stuck on output circuit. Stuck off output circuit.
.6 Output-to-output short circuit.
.7 Open circuit load.
.8 Output circuit overload (greater than 2 A).
.9 Loss of Output module (block).

2.6 PROGRAMMABLE LOGIC CONTROLLER (PLC) (Cont'd)

.11 Main PLC Card Racks: Include processor, power supply, memory, bus controller, spare slots, and terminators as required.

.12 Capability to program instructions from laptop PC. Provide minimum 25% spare un-used memory capacity.

.13 Programming cables (2 each) shall be provided to connect the laptop to either PLC or the HMI via USB, to download program updates or upload data for analysis.

.14 Electrical Interface: Capabilities shall be such as to provide for 25-percent expansion of input/outputs and instructions by the connection of additional units of equipment.

.15 Supply Voltage: 90-130 V ac.

.16 Electrostatic discharge immunity: 6kV contact discharge, 8kV air discharge radiated radio frequency immunity:
.1 10V/m 1kHz sine-wave 80% AM from 80 to 200 MHz.
.2 10V/m with 200Hz 50% pulse 100% AM at 900 MHz.
.3 10V/m with 200Hz 50% pulse 100% AM at 1890 MHz.
.4 3V/m 1kHz sine-wave 80% AM from 200 to 2700 MHz.

.17 Certification: Furnish manufacturer's certification that the PLC, as ordered and as can be normally used with any optional devices from the manufacturer, has been tested to successfully operate in the high electrical background noise environment of a large industrial plant.

2.7 SPARE PARTS

.1 Provide, in their original boxes or containers, the following spare parts:
.1 One (1) complete assembly of each of type of pushbutton used on the control console.
.2 One (1) complete pilot light assembly and 1 lens of each color used on the control desk.
.3 One (1) of each type of control and time delay relay used in the control panels.
.4 One (1) each of every type PLC card or module required.
.5 One (1) of each type contactor.
.6 One (1) of each type of power supply.
.7 One (1) control power transformer.

2.7 SPARE PARTS (Cont'd)

.1 (Cont'd)

.8 Twelve (12) replacement incandescent or LED lamps for each type of pilot light used on the control console.

.9 Six (6) contact blocks for each type of selector switch.

.10 Four (4) of each I/O blocks required.

.11 One (1) of each HMI.

.12 One (1) of each Biaxial Force Balance Inclinometer.

.13 One (1) set of spare parts necessary for start-up.

PART 3 - EXECUTION

3.1 REQUIRE CONTROL AND OPERATION SEQUENCE

.1 The bridge control system shall be configured to raise as described herein.

.1 After a vessel has signalled, the navigation lights are set to "FLASHING RED" (WEST/EAST selector switch) for large vessel or for small vessels the "FLASHING BLUE" lights (SMALL CRAFT EAST/SMALL CRAFT WEST pushbutton) are turned on.

.2 Push the "NAVIGATION HORN" button to signal marine traffic.

.3 Push the "HALT" button to turn the pedestrian lights from "WALK" to "DON'T WALK" and activate the warning bells. Warning bells will stop 15 second after the HALT light turns on. At this point, pedestrian gates can be lowered as described in Section 3.1.1.9.

.4 Turn the traffic light switch from the "GREEN" position to the "RED" position. Traffic signals change to YELLOW. After 2 to 5 seconds (a setting to be finalized during commissioning), traffic signals turn to RED automatically enabling the pedestrian gates, gate arm lights flash and all gate gongs start. The north traffic gate gongs will stop once the northeast traffic gate is fully down, and the south traffic gate gongs will stop once the southwest traffic gate is fully down. If the pedestrian "HALT" button is not pushed, turning the traffic switch to the "RED" position will turn the pedestrian lights from "WALK" to "DON'T WALK" and activate the warning bells. Warning bells will stop 15 second after the HALT light turns on.

.5 The Northwest (NW) and Southeast (SE) traffic gates are enabled.

.6 Observe that traffic has stopped. Push and hold the Southeast (SE) and Northwest (NW) gate

3.1 REQUIRE CONTROL AND OPERATION SEQUENCE (Cont'd)

.1 (Cont'd)

.6 (Cont'd)

"LOWER" buttons. The SE and NW gates are lowered. Observe that when gates start to lower, both the red and green indicator lights are illuminated. The green lights turn off when each gate is fully down and the red light glows steady. This indicates that the Southwest (SW) and Northeast (NE) gates are enabled. Releasing the button at any time will halt gate movement and the gates can be either raised or lowered at this time.

.7 Observe that traffic and pedestrians have cleared the bridge. Push and hold the Southwest (SW) and Northeast (NE) gates "LOWER" buttons. The NE and SW gates are lowered. Observe that when gates start to lower, both the red and green indicator lights are illuminated when the gates begin to move. The green lights turn off when the off going gates are fully down and the red lights glow steady. This indicates that the barrier gates are enabled. Releasing the button at any time will halt gate movement the gates can be either raised or lowered at this time.

.8 Push and hold the Southeast (SE) and Northeast (NE) barrier gates "LOWER" buttons. The barrier gates are lowered. Observe that both the red and green indicator lights are illuminated when the gates begin to move. The green indicator lights turn off when the barrier gates are fully down and the red indicator lights glow steady. Releasing the button at any time before the gates are lowered completely will halt gate movement. The gates can be either raised or lowered at this time.

.9 Push and hold the Southwest (SW) and Northwest (NW) pedestrian gates "LOWER" buttons. The pedestrian gates are lowered. Observe that both the red and green indicator lights are illuminated when the gates begin to move. Releasing the button at any time will halt gate movement the gates can be either raised or lowered at this time. The green indicator lights turn off when the pedestrian gates are fully down and the red indicator lights glow steady.

.10 When all the traffic, barrier, and pedestrian gates are fully lowered the span locks are enabled.

.11 Push the "SIREN" button to sound the siren.

.12 Push and release the "SPAN LOCKS DISENGAGE" button. The circuit seals in using an auxiliary contact of the motor starter until the span locks are disengaged. Observe that both the "SPAN LOCK SOUTH" and "SPAN LOCK NORTH" "WHITE

3.1 REQUIRE CONTROL AND OPERATION SEQUENCE (Cont'd)

.1 (Cont'd)

.12 (Cont'd)

ENGAGED" and "GREEN DISENGAGED" indicator lights are illuminated when the span locks begin to move. The "WHITE ENGAGED" indicator lights turn off and the "GREEN DISENGAGED" indicator lights glow steady when the span locks are disengaged. When the "GREEN DISENGAGED" INDICATOR light glows steady the span motor drives are enabled. Releasing the button at anytime before the locks are totally disengaged will halt span locks movement. The locks can be either engaged or disengaged at this time.

.13 When all the span locks are disengaged the Programmable Logic Controller (PLC) sends a run output signal to the master and slave motor drive selected by the alternating scheme.

.14 The selected master and slave drive respond through the control communication network back to the PLC and the master and slave "MOTOR DRIVE RUNNING" indicating light glows steady. The span may now be raised.

.15 Turn the bridge "MASTER CONTROLLER" from the "OFF" position to RAISE SPEED 1 position. The PLC releases the machinery brakes and sends a raise command to the selected master and slave motor drives. The motor drives will energize the motors, release the motor brakes after motor torque has been proven, and the span begins to rise at speed 1 (approximately 50 rpm). Returning the "MASTER CONTROLLER" to the OFF position the Raise operation stops and sets the machinery brakes.

.16 Observe the brake release indicators, the meters, the position indicators, and the skew indicators.

.17 Advance the "MASTER CONTROLLER" from RAISE SPEED 1 position through SPEED 2, 3, and 4, to RAISE SPEED 5, ALLOWING SUFFICIENT TIME FOR THE MOTOR AMPS TO SETTLE AT EACH SPEED POSITION. This accelerates the span to full speed.

.18 The span may be stopped at any position by returning the "MASTER CONTROLLER" to the off position. Reduced speed operation may be accomplished by moving the "MASTER CONTROLLER" to a lower numbered speed position. Movement may proceed from the stop in either direction by operating the "MASTER CONTROLLER" in the appropriate direction. The span may be stopped by pushing the "EMERGENCY STOP" on the main control console (this is only to be used in an emergency).

.19 Span operation is controlled by the motor drives. As the span reaches its nearly raised position at 105 FOOT SPAN HEIGHT the motor

3.1 REQUIRE CONTROL AND OPERATION SEQUENCE (Cont'd)

.1 (Cont'd)

.19 (Cont'd)

drives will automatically slow the span to SPEED 1. The "MASTER CONTROLLER" may be returned to the SPEED 1 position. At the full raised position the motor drives stops the span and sets the motor brakes automatically. The motor brake indicating lights will go out. Returning the "MASTER CONTROLLER" to the off position sets the machinery brakes. The machinery brake indicating lights will go out.

.20 At the 109 FOOT SPAN HEIGHT, the large vessel NAVIGATION SIGNALS for the required direction of ship travel change from FLASHING RED to GREEN.

.2 The bridge control system shall be configured to lower as described herein.

.1 Begin closing sequence by observing that waterway is clear and that pedestrians have not proceeded past the pedestrian gates.

.2 Push the NAVIGATION HORN button to signal marine traffic. Push the siren button to sound SIREN.

.3 Turn the bridge "MASTER CONTROLLER" from the "OFF" position to LOWER SPEED 1 position. The PLC releases the machinery brakes and sends a lower command to the selected master and slave motor drives. The motor drives will energize the motors, release the motor brakes after motor torque has been proven, and span begins to lower at speed 1 (approximately 50 rpm). Returning the "MASTER CONTROLLER" to the OFF position the lower operation stops the span and sets the brakes.

.4 Observe the brake release indicators, the meters are on and the position indicator is moving.

.5 When the span is no longer fully raised, the large vessel NAVIGATION SIGNALS for the required direction of ship travel change from GREEN to STEADY RED.

.6 Advance the "MASTER CONTROLLER" from LOWER SPEED 1 position through SPEED 2, 3, and 4, to LOWER SPEED 5. This accelerates the span to full speed.

.7 The span may be stopped at any position by returning the "MASTER CONTROLLER" to the off position. Reduced speed operation may be accomplished by moving the "MASTER CONTROLLER" to a lower numbered speed position. Movement may proceed from the stop in either direction by operating the "MASTER CONTROLLER" in the appropriate direction. The span may be stopped by pushing the "EMERGENCY STOP" on the main

3.1 REQUIRE CONTROL AND OPERATION SEQUENCE (Cont'd)

.2 (Cont'd)

.7 (Cont'd)

control console (this is only to be used in an emergency as it causes increased mechanical stresses).

.8 At the 30 foot level turn the "MASTER CONTROLLER" to the LOWER SPEED 4 position, then at the 15 foot level turn the "MASTER CONTROLLER" to the LOWER SPEED 3 position. At the 10 FOOT SPAN HEIGHT the motor drives will automatically slow the span to LOWER SPEED 2, then at the 3 FOOT SPAN HEIGHT automatically reduce the span speed to LOWER SPEED 1. The "MASTER CONTROLLER" is returned to the LOWER SPEED 1 position.

.9 Span operation is controlled by the motor controllers. As the span passes the 3 foot (914 mm) SPAN HEIGHT the "SEATING FOOT SWITCH" must be depressed and held depressed to continue automatic lowering operation of the span.

.10 If the span reaches the height of 18 inches (457 mm) ABOVE SPAN SEAT and the "SEATING FOOT SWITCH" is not depressed, the span motor drives will deenergize the span drive motors and set the motor brakes.

.11 In order to restart the automatic lowering process the "MASTER CONTROLLER" must be returned to the OFF position, the foot switch depressed and the "MASTER CONTROLLER" turned to the LOWER SPEED 1 position.

.12 The motor drives will energize the motors, release the motor brakes, and lower the span to the fully seated position.

.13 Actuation of the northeast or northwest fully seated limit switch will stop the north motors and set the north motor brakes, and actuation of the southeast or southwest fully seated limit switch will stop the south motors and set the south motor brakes. The PLC will set the machinery brakes and enable the span locks. Actuating any one of either north or south fully seated limit switches will stop that specific sides motors and set that specific sides motor brakes. The PLC will set the machinery brakes and enable the span locks.

.14 Push and release the "SPAN LOCKS ENGAGE" button. The circuit seals-in using an auxiliary contact from the motor starter until fully engaged. The machinery and motor brakes are released and the span locks engaged. Observe that both the "SPAN LOCK SOUTH" and "SPAN LOCK NORTH" "WHITE ENGAGED" and "GREEN DISENGAGED" indicator lights are illuminated when the span locks begin to move. Releasing the button will not halt span lock movement. The "GREEN

3.1 REQUIRE CONTROL AND OPERATION SEQUENCE (Cont'd)

.2 (Cont'd)

.14 (Cont'd)

DISENGAGED" indicator lights turn off, the "WHITE ENGAGED" indicator lights glow steady and the brakes set when the span locks are engaged. When the "WHITE ENGAGED" INDICATOR light glows steady the PEDESTRIAN and BARRIER GATES are enabled.

.15 Push and release the Southwest (SW) and Northwest (NW) pedestrian gates "RAISE" buttons. The circuit seals in using an auxiliary contact of the motor starter until the pedestrian gates are raised. Observe that both the red and green indicator lights are illuminated when the gates begin to move. Releasing the button at any time will halt gate movement the gates can be either raised or lowered at this time. The red indicator lights turns off when the pedestrian gates are fully up and the green indicator lights glow steady.

.16 Push the "WALK" button to turn the pedestrian lights from "DON'T WALK" to "WALK" and deactivate the warning bells.

.17 Push and release the Southeast (SE) and Northeast (NE) barrier gates "RAISE" buttons. The circuit seals in using an auxiliary contact of the motor starter until the barrier gates are raised. Observe that both the red and green indicator lights are illuminated when the gates begin to move. Releasing the button will not halt gate movement. The red indicator lights turns off when the barrier gates are fully up and the green indicator lights glow steady. This indicates that the Southwest (SW) and Northeast (NE) traffic gates are enabled.

.18 Push and release the Southwest (SW) and Northeast (NE) gates "RAISE" buttons. The circuit seals in using an auxiliary contact of the motor starter until the Southwest (SW) and Northeast (NE) gates are raised. Observe that both the red and green indicator lights are illuminated when the gates begin to raise. Releasing the button will not halt gate movement. The red lights turns off when the off going gates are fully up and the green lights glow steady. This indicates that the Southeast (SE) and Northwest (NW) gates are enabled.

.19 Push and release the Southeast (SE) and Northwest (NW) gate "RAISE" buttons. The circuit seals in using an auxiliary contact of the motor starter until the Southeast (SE) and Northwest (NW) gates are raised. Observe that both the red and green indicator lights are illuminated when gates start to raise. Releasing the button at any time will no halt gate movement. The red

3.1 REQUIRE CONTROL AND OPERATION SEQUENCE (Cont'd)

.2 (Cont'd)

.19 (Cont'd) light turns off when each gate is fully up and the green light glows steady. This indicates that the traffic lights can be changed from red to green.

.20 Alternative, push and release the "GATE GROUP RAISE" button, the circuit seals in using an auxiliary contact of the motor starter until all gates are raised. The northeast and southeast barrier gates, southwest, northeast, northwest, and southeast traffic gates will raise in sequence as they are automatically enabled. Barrier gates proven raised enable traffic gates. Northeast and southwest gates proven raised enable the northwest and southeast gates. All gates can be raised individually as described in Sections 3.1.1.18 and 3.1.1.19 and 3.1.1.20. Observe that both the red and green indicator lights are illuminated when gates start to raise. Releasing the button will not halt gate movement. The red light turns off when each gate is fully up and the green light glows steady. This indicates that the traffic lights can be changed from red to green.

.21 Turn the traffic light switch from the "RED" position to the "GREEN" position. The traffic signals turn to green, traffic gate arm lights stop flashing and gongs stop.

.22 After the completion of each raise/lower span operation cycle the controls shall alternate the master/slave pair of drives to be used for the next operation cycle.

3.2 ALARMS

.1 The PLC shall transmit the alarm message number to the HMI (Human Machine Interface). The HMI alarm tone shall sound with each message until the acknowledge button has been pushed. The HMI shall be programmed to display and record the date and time of the message and the date and time when the alarm was acknowledged.

.2 It will be required to add up to 20 percent additional alarms and messages during the shop testing, installation and final testing and commissioning.

.3 The list of alarms is as follow: (Alarm (A), Condition (C))

.1 A: PLC FAULT

.1 C: Internal watchdog timer times out or external watchdog timer times out.

3.2 ALARMS (Cont'd)

.3 The list of alarms is as follow:(Cont'd)

.2 A: PLC RACK IN CONTROL DESK RACK-1 FAULT

.1 C: Rack fault bit is detected.

.3 A: PLC RACK IN CONTROL PANEL RACK-2 FAULT

.1 C: Rack fault bit is detected.

.4 A: PLC RACK IN SOUTH I/O PANEL RACK-3 FAULT

.1 C: Rack fault bit is detected.

.5 A: PLC RACK IN NORTH I/O PANEL RACK-4 FAULT

.1 C: Rack fault bit is detected.

.6 For the following alarms, refer to .8.1 condition below.

.1 A: TRAFFIC GATE TG-SE NOT READY

.2 A: TRAFFIC GATE TG-NE NOT READY

.3 A: TRAFFIC GATE TG-NW NOT READY

.4 A: TRAFFIC GATE TG-SW NOT READY

.5 A: BARRIER GATE BG-NE NOT READY

.6 A: BARRIER GATE BG-SE NOT READY

.7 A: PEDESTRIAN GATE PD-NW NOT READY

.8 A: PEDESTRIAN GATE PD-SW NOT READY

.1 C: The traffic gate control input is off.

.7 For the following alarms, refer to .8.1 condition below.

.1 A: TRAFFIC GATE TG-SE STARTER TROUBLE

.2 A: TRAFFIC GATE TG-NE STARTER TROUBLE

.3 A: TRAFFIC GATE TG-NW STARTER TROUBLE

.4 A: TRAFFIC GATE TG-SW STARTER TROUBLE

.5 A: BARRIER GATE BG-NE STARTER TROUBLE

.6 A: BARRIER GATE BG-SE STARTER TROUBLE

.7 A: PEDESTRIAN GATE PD-NW STARTER TROUBLE

.8 A: PEDESTRIAN GATE PD-SW STARTER TROUBLE

.1 Lower gate output is turned on, the auxiliary contact input is turned on, and gate full up limit switch input remains turned on for more than 2 seconds, or the lower gate output is turned on, the auxiliary contact input is turned on and gate down limit switch input remains turned off after 10 seconds or raise gate output is turned on, the auxiliary contact input is turned on, and gate down limit switch input remains turned on for more than 2 seconds or raise gate output is turned on, the auxiliary contact input is turned on, and gate full up limit switch input remains turned off after 10 seconds, or the Lower gate output is turned on and the starter auxiliary contact input remains turned off for more than 2

3.2 ALARMS (Cont'd)

.3 The list of alarms is as follow:(Cont'd)

.7 (Cont'd)

seconds or the raise gate output is turned on and the starter auxiliary contact input remains turned off for more than 2 seconds.

.8 For the following alarms, refer to .8.1 condition below.

.1 A: TRAFFIC GATE TG-SE RAISE TROUBLE
.2 A: TRAFFIC GATE TG-NE RAISE TROUBLE
.3 A: TRAFFIC GATE TG-NW RAISE TROUBLE
.4 A: TRAFFIC GATE TG-SW RAISE TROUBLE
.5 A: BARRIER GATE BG-NE RAISE TROUBLE
.6 A: BARRIER GATE BG-SE RAISE TROUBLE
.7 A: PEDESTRIAN GATE PD-NW RAISE TROUBLE
.8 A: PEDESTRIAN GATE PD-SW RAISE TROUBLE

.1 C: The gate starter auxiliary contact input is turned on, the gate full up limit switch input is turned off and the gate motion or travel timer times out.

.9 For the following alarms, refer to .9.8.1 condition.

.1 A: TRAFFIC GATE TG-SE LOWER TROUBLE
.2 A: TRAFFIC GATE TG-NE LOWER TROUBLE
.3 A: TRAFFIC GATE TG-NW LOWER TROUBLE
.4 A: TRAFFIC GATE TG-SW LOWER TROUBLE
.5 A: BARRIER GATE BG-NE LOWER TROUBLE
.6 A: BARRIER GATE BG-SE LOWER TROUBLE
.7 A: PEDESTRIAN GATE PD-NW LOWER TROUBLE
.8 A: PEDESTRIAN GATE PD-SW LOWER TROUBLE

.1 C: The gate starter auxiliary contact input is turned on, the gate full down limit switch input is turned off and the gate motion or travel timer times out.

.10 For the following alarms, refer to .10.8.1 condition.

.1 A: TRAFFIC GATE TG-SE RAISE BYPASS ON
.2 A: TRAFFIC GATE TG-NE RAISE BYPASS ON
.3 A: TRAFFIC GATE TG-NW RAISE BYPASS ON
.4 A: TRAFFIC GATE TG-SW RAISE BYPASS ON
.5 A: BARRIER GATE BG-NE RAISE BYPASS ON
.6 A: BARRIER GATE BG-SE RAISE BYPASS ON
.7 A: PEDESTRIAN GATE PD-NW RAISE BYPASS ON
.8 A: PEDESTRIAN GATE PD-SW RAISE BYPASS ON

.1 C: The respective gate full down input is off the related traffic gate

3.2 ALARMS (Cont'd)

.3 The list of alarms is as follow:(Cont'd)

.10 (Cont'd)

full down input is off, the trouble acknowledge is on, and the master bypass input is on.

.11 For the following alarms, refer to .8.1 condition below.

.1 A: TRAFFIC GATE TG-SE LOWER BYPASS ON
.2 A: TRAFFIC GATE TG-NE LOWER BYPASS ON
.3 A: TRAFFIC GATE TG-NW LOWER BYPASS ON
.4 A: TRAFFIC GATE TG-SW LOWER BYPASS ON
.5 A: BARRIER GATE BG-NE LOWER BYPASS ON
.6 A: BARRIER GATE BG-SE LOWER BYPASS ON
.7 A: PEDESTRIAN GATE PD-NW LOWER BYPASS ON
.8 A: PEDESTRIAN GATE PD-SW LOWER BYPASS ON

.1 C: The respective gate full up input is off the related traffic gate full up input is off, the trouble acknowledge is on, and the Traffic Gate, Barrier gate or Pedestrian gate bypass input is on.

.12 For the following alarms, refer to .16.1 condition below.

.1 A: TRAFFIC GATE TG-SE RAISE TROUBLE ACKNOWLEDGE
.2 A: TRAFFIC GATE TG-SE LOWER TROUBLE ACKNOWLEDGE
.3 A: TRAFFIC GATE TG-NE RAISE TROUBLE ACKNOWLEDGE
.4 A: TRAFFIC GATE TG-NE LOWER TROUBLE ACKNOWLEDGE
.5 A: TRAFFIC GATE TG-NW RAISE TROUBLE ACKNOWLEDGE
.6 A: TRAFFIC GATE TG-NW LOWER TROUBLE ACKNOWLEDGE
.7 A: TRAFFIC GATE TG-SW RAISE TROUBLE ACKNOWLEDGE
.8 A: TRAFFIC GATE TG-SW LOWER TROUBLE ACKNOWLEDGE
.9 A: BARRIER GATE BG-NE RAISE TROUBLE ACKNOWLEDGE
.10 A: BARRIER GATE BG-NE LOWER TROUBLE ACKNOWLEDGE
.11 A: BARRIER GATE BG-SE RAISE TROUBLE ACKNOWLEDGE
.12 A: BARRIER GATE BG-SE LOWER TROUBLE ACKNOWLEDGE
.13 A: PEDESTRIAN GATE PD-NW RAISE TROUBLE ACKNOWLEDGE
.14 A: PEDESTRIAN GATE PD-NW LOWER TROUBLE ACKNOWLEDGE

3.2 ALARMS (Cont'd)

.3 The list of alarms is as follow:(Cont'd)

.12 (Cont'd)

.15 A: PEDESTRIAN GATE PD-SW RAISE TROUBLE ACKNOWLEDGE

.16 A: PEDESTRIAN GATE PD-SW LOWER TROUBLE ACKNOWLEDGE

.1 C: Alarm acknowledge input is turned on.

.13 For the following alarms, refer to .2.1 condition below.

.1 A: SOUTH SPAN LOCK NOT READY

.2 A: NORTH SPAN LOCK NOT READY

.1 C: The Span Lock control input is off.

.14 For the following alarms, refer to .2.1 condition below.

.1 A: SOUTH SPAN LOCK STARTER TROUBLE

.2 A: NORTH SPAN LOCK STARTER TROUBLE

.1 C: Span Locks lock output is turned on, the auxiliary contact input is turned on, and the Span Lock unlocked limit switch input remains turned on for more than 2 seconds, or the Span Lock unlock output is turned on, the auxiliary contact input is turned on and Span Locks locked limit switch input remains turned off after 2 seconds or Span Locks lock output is turned on, the auxiliary contact input is turned on, and unlocked limit switch input remains turned off for more than 15 seconds or Span Locks unlock output is turned on, the auxiliary contact input is turned on, and the locked limit switch input remains turned off after 15 seconds.

.15 For the following alarms, refer to .2.1 condition below.

.1 A: SOUTH SPAN LOCK UNLOCK TROUBLE

.2 A: NORTH SPAN LOCK UNLOCK TROUBLE

.1 C: The Span Lock unlock starter auxiliary contact input is turned on, the Span Locks unlock limit switch input is turned off and the Span Locks motion or travel timer times out.

.16 For the following alarms, refer to .2.1 condition below.

.1 A: SOUTH SPAN LOCK LOCK TROUBLE

.2 A: NORTH SPAN LOCK LOCK TROUBLE

.1 C: The Span Locks lock starter auxiliary contact input is turned on, the Span Locks lock limit switch input is turned off and the Span Locks motion or travel timer times out.

3.2 ALARMS (Cont'd)

.3 The list of alarms is as follow:(Cont'd)

.17 For the following alarms, refer to .2.1 condition below.

.1 A: SOUTH SPAN LOCK LOCK BYPASS ON

.2 A: NORTH SPAN LOCK LOCK BYPASS ON

.1 C: The respective Span Locks lock input is on, the Span Locks unlocked limit switch input is off, the trouble acknowledge is on, and the Span Lock bypass input is on.

.18 For the following alarms, refer to .2.1 condition below.

.1 A: SOUTH SPAN LOCK UNLOCK BYPASS ON

.2 A: NORTH SPAN LOCK UNLOCK BYPASS ON

.1 C: The respective Span Lock unlock input is on, the Span Locks locked limit switch input is off, the trouble acknowledge is on, and the Span Lock bypass input is on.

.19 For the following alarms, refer to .4.1 condition below.

.1 A: SOUTH SPAN LOCK UNLOCK TROUBLE ACKNOWLEDGE

.2 A: NORTH SPAN LOCK UNLOCK TROUBLE ACKNOWLEDGE

.3 A: SOUTH SPAN LOCK LOCK TROUBLE ACKNOWLEDGE

.4 A: NORTH SPAN LOCK LOCK TROUBLE ACKNOWLEDGE

.1 C: Alarm acknowledge input is turned on.

.20 For the following alarms, refer to .2.1 condition below.

.1 A: SOUTH SPAN LOCK OVERLOAD TRIPPED

.2 A: NORTH SPAN LOCK OVERLOAD TRIPPED

.1 C: The respective Span Lock overload tripped input is on.

.21 For the following alarms, refer to .2.1 condition below.

.1 A: SOUTH SPAN LOCK OVERLOAD TRIPPED ACKNOWLEDGE

.2 A: NORTH SPAN LOCK OVERLOAD TRIPPED ACKNOWLEDGE

.1 C: Alarm acknowledge input is turned on.

.22 For the following alarms, refer to .8.1 condition below.

.1 A: MACHINE BRAKE S2 NOT READY

.2 A: MACHINE BRAKE S3 NOT READY

.3 A: MACHINE BRAKE N2 NOT READY

.4 A: MACHINE BRAKE N3 NOT READY

.5 A: MOTOR BRAKE S1 NOT READY

.6 A: MOTOR BRAKE S4 NOT READY

.7 A: MOTOR BRAKE N1 NOT READY

3.2 ALARMS (Cont'd)

.3 The list of alarms is as follow:(Cont'd)

.22 (Cont'd)

.8 A: MOTOR BRAKE N4 NOT READY

.1 C: The machine or motor brake control input is off.

.23 For the following alarms, refer to .8.1 condition.

.1 A: MACHINE BRAKE S2 MANUALLY RELEASED
.2 A: MACHINE BRAKE S3 MANUALLY RELEASED
.3 A: MACHINE BRAKE N2 MANUALLY RELEASED
.4 A: MACHINE BRAKE N3 MANUALLY RELEASED
.5 A: MOTOR BRAKE S1 MANUALLY RELEASED
.6 A: MOTOR BRAKE S4 MANUALLY RELEASED
.7 A: MOTOR BRAKE N1 MANUALLY RELEASED
.8 A: MOTOR BRAKE N4 MANUALLY RELEASED

.1 C: The brake manually released limit switch input is off.

.24 For the following alarms, refer to .4.1 condition below.

.1 A: MACHINE BRAKE S2 TROUBLE
.2 A: MACHINE BRAKE S3 TROUBLE
.3 A: MACHINE BRAKE N2 TROUBLE
.4 A: MACHINE BRAKE N3 TROUBLE

.1 C: The machine brake release output is turned on, the release auxiliary contact input is turned on, and the machine brake limit switch input remains turned on for more than 2 seconds, or the machine brake set output is turned on, the set auxiliary contact input is turned on and machine brake release limit switch input remains turned off after 2 seconds or machine brake release output is turned on, the release auxiliary contact input is turned on, and machine brake release limit switch input remains turned off for more than 15 seconds or machine brake set output is turned on, the auxiliary contact input is turned on, and the machine brake set switch input remains turned off after 15 seconds.

.25 For the following alarms, refer to .4.1 condition.

.1 A: MOTOR BRAKE S1 TROUBLE
.2 A: MOTOR BRAKE S4 TROUBLE
.3 A: MOTOR BRAKE N1 TROUBLE
.4 A: MOTOR BRAKE N4 TROUBLE

.1 C: The motor brake release output is turned on, the release auxiliary contact input is turned on, and the motor brake limit switch input remains turned on for more than 2 seconds, or the motor set output is

3.2 ALARMS (Cont'd)

.3 The list of alarms is as follow:(Cont'd)

.25 (Cont'd)

turned on, the set auxiliary contact input is turned on and motor brake release limit switch input remains turned off after 2 seconds or motor brake release output is turned on, the release auxiliary contact input is turned on, and motor brake release limit switch input remains turned off for more than 15 seconds or motor brake set output is turned on, the auxiliary contact input is turned on, and the motor brake set switch input remains turned off after 15 seconds.

.26 For the following alarms, refer to .4.1 condition below.

.1 A: MACHINE BRAKE S2 FAILED TO SET
.2 A: MACHINE BRAKE S3 FAILED TO SET
.3 A: MACHINE BRAKE N2 FAILED TO SET
.4 A: MACHINE BRAKE N3 FAILED TO SET

.1 C: The brake set limit switch input is off and the brake thruster output is off.

.27 For the following alarms, refer to .4.1 condition below.

.1 A: MOTOR BRAKE S1 FAILED TO SET
.2 A: MOTOR BRAKE S4 FAILED TO SET
.3 A: MOTOR BRAKE N1 FAILED TO SET
.4 A: MOTOR BRAKE N4 FAILED TO SET

.1 C: The MASTER drive and SLAVE drive running input is off and the motor brake set limit switch input is off.

.28 For the following alarms, refer to .4.1 condition below.

.1 A: MACHINE BRAKE S2 DID NOT RELEASE
.2 A: MACHINE BRAKE S3 DID NOT RELEASE
.3 A: MACHINE BRAKE N2 DID NOT RELEASE
.4 A: MACHINE BRAKE N3 DID NOT RELEASE

.1 C: The brake released limit switch input is off and the brake thruster output is on.

.29 For the following alarms, refer to .4.1 condition below.

.1 A: MOTOR BRAKE S1 DID NOT RELEASE
.2 A: MOTOR BRAKE S4 DID NOT RELEASE
.3 A: MOTOR BRAKE N1 DID NOT RELEASE
.4 A: MOTOR BRAKE N4 DID NOT RELEASE

.1 C: The brake released limit switch input is off and the MASTER Drive Running or the SLAVE Drive running input is on.

3.2 ALARMS (Cont'd)

.3 The list of alarms is as follow:(Cont'd)

.30 For the following alarms, refer to .4.1 condition below.

.1 A: DRIVE 1E-SL NOT READY
.2 A: DRIVE 3E-MA NOT READY
.3 A: DRIVE 2W-MA NOT READY
.4 A: DRIVE 4W-SL NOT READY
.1 C: Motor drive run input is off.

.31 For the following alarms, refer to .4.1 condition below.

.1 A: DRIVE 1E-SL TROUBLE
.2 A: DRIVE 3E-MA TROUBLE
.3 A: DRIVE 2W-MA TROUBLE
.4 A: DRIVE 4W-SL TROUBLE
.1 C: The Drive Run input is on and the Drive Trouble input is on.

.32 For the following alarms, refer to .5.1 condition below.

.1 A: SPAN LEAF SEATING TROUBLE
.2 A: SE SPAN SEATING TROUBLE
.3 A: SW SPAN SEATING TROUBLE
.4 A: NE SPAN SEATING TROUBLE
.5 A: NW SPAN SEATING TROUBLE
.1 C: The SPAN SE, SW, NE or NW full closed limit switch input is off, the bridge RAISE command input is off, the control power input is on, and the SPAN seating timer is greater than 5 to 15 seconds.

.33 For the following alarms, refer to .5.1 condition below.

.1 A: SPAN SEATING TROUBLE ACKNOWLEDGE
.2 A: SE SPAN SEATING TROUBLE ACKNOWLEDGE
.3 A: SW SPAN SEATING TROUBLE ACKNOWLEDGE
.4 A: NE SPAN SEATING TROUBLE ACKNOWLEDGE
.5 A: NW SPAN SEATING TROUBLE ACKNOWLEDGE
.1 C: The SPAN seating trouble input is on, the control power input is on, the span seating bypass input is off, and the alarms acknowledge input is on.

.34 For the following alarms, refer to .2.1 condition below.

.1 A: SPAN SEATING BYPASS ON
.2 A: SPAN SEATING BYPASS ON
.1 C:C: The generator trouble input is on. The span locks locked input is off, the raise bridge command input is off, the control power input is on, the seating trouble acknowledge input

3.2 ALARMS (Cont'd)

.3 The list of alarms is as follow:(Cont'd)

.34 (Cont'd)

is on, and the master bypass input is on.

.35 A: MAIN BREAKER OPEN

.1 C: The main breaker closed input is off.

.36 A: BRIDGE ON GENERATOR POWER

.1 C: The ATS generator power input is on.

.37 A: GENERATOR TROUBLE

.1 C: The generator trouble input is on.

3.3 AUXILIARY MOTOR OPERATION

.1 The auxiliary motor can be manually engage by utilizing the handle located by the auxiliary motor in the sheave room. By manually engaging the auxiliary motors, the main drive motors will be electrically isolated. The main control console will indicate when either of the two auxiliary drive motors are engaged.

3.4 CANAL NAVIGATION LIGHTING

.1 Canal Navigation signal controls will use hardwired relay controls in CP-6. Pushbuttons on CP-5 are used for "Small Craft East", "Small Craft West", or "Small Craft Both." The buttons energize blue flashing signal lights on the east, west, or both sides. The red lights of the red/green navigation lights on the east and west side of the lift span remain energized. The two blue lights on south pier are approximately half way from the span to the ends of pier in both directions.

.2 Both east and west red lights of the red/green lift span mounted navigation lights are initially red. CP-5 has a selector switch for "Flashing Red" on the side from which a vessel is approaching (east or west). The red light of the red/green navigation light on the selected side starts flashing and the red light on the other side stays on steady. When the lift span reaches 109-feet, the flashing red light on the vessel approach side de-energizes and the green light on that side energizes. The red light on the opposite side stays on steady. When lowering, as the 109-foot point is passed, the green light is de-energized, the red light comes on steady for the rest of the lowering operation - remaining red when fully lowered.

3.4 CANAL NAVIGATION LIGHTING (Cont'd)

.3 CP-5 has a selector switch designated "Red Flashing." When the lift span is fully raised, the green signal lights can be transferred from one side to the other by operating the "Red Flashing" switch to select east or west. The signal light that was green then becomes steady red.

.4 The blue flashing lights are turned off by depressing the "Reset" pushbutton on CP-5.

3.5 SPAN SKEW REQUIREMENTS

.1 Configure the bridge skew control system to operate as described herein:

.1 When a longitudinal difference in height of four (4) inch (102 mm) exists (skew) between the north and south span ends, the PLC shall sound and indicate an alarm.

.2 When a longitudinal difference in height of six (6) inches (152 mm) exists (skew) between the north and south span ends, the PLC will decelerate and stop the span motion in a normal controller manner and the PLC shall sound and indicate an alarm.

.3 When a longitudinal difference in height of twelve (12) inches (305 mm) exists (skew) between the north and south span ends, the ultimate skew trip developed from twelve (12)rotary limit switch inputs to the PLC shall cause an emergency stop (E-stop) to halt span motion and the PLC shall sound and indicate an alarm.

.4 When a transverse difference in height of four (4) inch (102 mm) exists (skew) between the east and west span sides, the PLC shall sound and indicate an alarm.

.5 When a longitudinal skew of four (4) inches (102 mm) exists between the biaxial force balance inclinometer and the span position resolvers, the PLC shall sound and indicate an alarm.

.6 When the lift span is stopped due to longitudinal skew, the operator will use the skew bypass switch on CP-1 to correct the span position to remove the skew. When the skew bypass switch is put in the "Bypass" position, the PLC and drive systems will respond to the Master Controller but will only allow operation at creep speed and only in the direction that will correct the skew. All brakes will be released by the PLC and drives when correcting for skew.

3.6 BRIDGE CONTROL SYSTEM FIELD TESTING

.1 Demonstrate to the Departmental Representative, the correct operation of all bridge functions and indications.

.2 Provide a test plan stating how the test is to be performed and how the individual system faults will be simulated, and a test procedure stating all the steps to operate the bridge functions for review 30 days prior to start of field test. Testing shall include verification of all interlocks and emergency stop circuits. Out-of-sequence testing shall be performed to verify all interlocks are working. Testing shall be performed to verify interlocks are fail-safe. Testing in this section shall be in addition to the requirements of the Section for Startup and Commissioning.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes dry type transformers comprising of, but not limited to, furnishing all labour, materials, tools, equipment, and appurtenances necessary to supply, install and test all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation.

1.2 REFERENCES

.1 CSA International
.1 CAN/CSA-C22.2 No.47-M90(R2007), Air-Cooled Transformers (Dry Type).
.2 CSA C9-02(R2007), Dry-Type Transformers.
.3 CAN/CSA-C802.2-06, Minimum Efficiency Values for Dry Type Transformers.

.2 National Electrical Manufacturers Association (NEMA)

.3 American National Standards Institute (ANSI) C57.12.22 - American National Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers With High-Voltage Bushings, 2500 kVA and Smaller; High Voltage, 34 500 GrdY/19 920 Volts and Below; Low Voltage, 480 Volts and Below.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for dry type transformers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
.1 Indicate on drawings:
.1 Make, model and type.
.2 Load classification.

1.4 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for dry type transformers for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:
.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Store and protect dry type transformers from nicks, scratches, and blemishes.
.3 Replace defective or damaged materials with new.

1.6 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

PART 2 - PRODUCTS

2.1 DESIGN DESCRIPTION

.1 Design 1, Type: ANN, 3 phase, 15 kVA, 600 V input, 208/120 V output, 60 Hz.
.1 Voltage taps: standard.
.2 Insulation: Class 220, 150 degrees C temperature rise.
.3 Basic Impulse Level (BIL): standard.
.4 Hipot: standard.
.5 Average sound level: standard
.6 Impedance at 17 degrees C: standard
.7 Enclosure: CSA Type 2, removable metal front panel.
.8 Mounting: floor.
.9 Finish: in accordance with Section 26 05 00 - Common Work Results for Electrical.
.10 Copper windings.
.11 Winding configuration to be as noted on drawings.

2.1 DESIGN DESCRIPTION (Cont'd)

.1 Design 1, Type:(Cont'd)
.12 Harmonic Mitigating Phase Shifting transformers as indicated on drawings.
.13 KL-Rated Transformers as indicated on drawings.
.14 Voltage Regulation to be 4% or better.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for dry type transformers installation in accordance with manufacturer's written instructions.
.1 Visually inspect substrate in presence of Departmental Representative .
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative .

3.2 INSTALLATION

.1 Mount dry type transformers up to 75 kVA as indicated.

.2 Mount dry type transformers above 75 kVA on floor.

.3 Ensure adequate clearance around transformer for ventilation.

.4 Install transformers in level upright position.

.5 Remove shipping supports only after transformer is installed and just before putting into service.

.6 Loosen isolation pad bolts until no compression is visible.

3.2 INSTALLATION (Cont'd)

.7 Make primary and secondary connections in accordance with wiring diagram.

.8 Energize transformers after installation is complete.

.9 Make conduit entry into bottom 1/3 of transformer enclosure.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
.1 Remove recycling containers from site and dispose of materials at appropriate facility.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by dry type transformers installation.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes panelboards comprising of, but not limited to, furnishing all labour, materials, tools, equipment, and appurtenances necessary to supply, install and test all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation.

1.2 REFERENCES

.1 CSA International
.1 CSA C22.2 No.29-11, Panelboards and Enclosed Panelboards.
.2 CSA C22.1-2012, Canadian Electrical Code,Part I (22nd Edition), Safety Standard for Electrical Installations.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for panelboards and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
.2 Include on drawings:
.1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.4 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for panelboards for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:
.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Store and protect panelboards from nicks, scratches, and blemishes.
.3 Replace defective or damaged materials with new.

1.6 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

PART 2 - PRODUCTS

2.1 PANELBOARDS

.1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
.1 Install circuit breakers in panelboards before shipment.
.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 250 V panelboards: bus and breakers rated for 25 kA (symmetrical) interrupting capacity or as indicated.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Minimum of 2 flush locks for each panel board.

.6 Two keys for each panelboard and key panelboards alike.

2.1 PANELBOARDS (Cont'd)

.7 Copper bus with neutral of same ampere rating of mains.

.8 Mains: suitable for bolt-on breakers.

.9 Trim with concealed front bolts and hinges.

.10 Trim and door finish: baked enamel as per colour schedule.

.11 Isolated ground bus.

.12 Include grounding busbar with 3 of terminals for bonding conductor equal to breaker capacity of the panel board.

2.2 BREAKERS

.1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to Departmental Representative.

.5 Lock-on devices for receptacles, fire alarm clock outlet, emergency, door supervisory, intercom, stairway, exit and night light circuits.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for panelboards installation in accordance with manufacturer's written instructions.
.1 Visually inspect substrate in presence of Departmental Representative.
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.

.3 Connect loads to circuits.

.4 Connect neutral conductors to common neutral bus with respective neutral identified.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by panelboards installation.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes motor control centres comprising of, but not limited to, motor control centres including all supports and hardware necessary for a complete installation.
.1 Furnish and install two (2) Intelligent Motor Control Centres (MCC), complete with all equipment and appurtenances as shown in the Contract Documents.
.2 Demolish existing Motor Control Centres.

1.2 RELATED SECTIONS

.1 Section 26 05 81 - Motors.

.2 Section 26 09 17 - Bridge Control System.

.3 Section 26 29 23 - Vector Variable Frequency Drives.

1.3 QUALITY ASSURANCE

.1 The manufacturer of the motor control centres shall supply only equipment and materials which have been successfully tested to meet all applicable industry standards, and have been certified by the manufacturer of the vector controlled motor drives as compatible.

1.4 REFERENCES

.1 CSA C22.1-2012, Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations.

.2 CAN/CSA-Z462-12, Workplace Electrical Safety.

1.5 DEFINITIONS

.1 ODVA: Open DeviceNet Vendors Association

1.6 SUBMITTALS

.1 In accordance with Section 01 33 00.

.2 Submit manufacturer's data for the motor control centres as follows:
.1 One-line diagram.
.2 Three-line diagram including metering section.
.3 Provide a coordination evaluation report for overcurrent protection devices, conductors,

1.6 SUBMITTALS (Cont'd)

.2 (Cont'd)

.3 (Cont'd)
and transformers. The report shall coordinate device trip settings for the devices to be installed.

.4 Submit the report to the Departmental Representative for review prior to purchasing equipment. Report review comments by the Departmental Representative shall be implemented by the Contractor.

.5 Submit arc flash calculations as required by CAN/CSA-Z462-12, and label electrical equipment accordingly.

.6 Schematic diagrams for each cubicle.

.7 Wiring and Interconnection Diagrams for both starter cubicles and terminal only cubicles. Schematic diagrams shall include field wiring. Wire numbers for field wiring shall be as shown in the Contract Documents. Field terminals on wiring diagrams shall also indicate these numbers. It is preferred that the Contract Documents wire numbers be used for internal wiring as well. However, if different numbers are used, terminals for field wiring shall be marked "panel wire number/field wire number."

.8 Elevation plan and dimensioned outline drawings detailing cubicle arrangement, wireway and conduit entry, hoisting details and grounding terminals.

.9 Equipment schedule detailing all components of each cubicle.

.10 Engraving schedule.

.11 Descriptive data for all components.

.12 Test results that demonstrate meeting industry standards.

.13 Vector controlled motor drive compatibility certification.

.14 Operations and maintenance manual.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Deliver MCC individually wrapped factory shipping sections with lifting devices on each section.

.2 Handle MCC carefully to prevent internal component damage, and denting or scoring of factory finish enclosure finish. Do not install damaged MCC. Store MCC in a clean, dry space. Protect units from damage from dirt, fumes, water, construction debris, and traffic prior to and during and after installation.

1.8 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

PART 2 - PRODUCTS

2.1 MOTOR CONTROL CENTRES

.1 The Intelligent Motor Control Centers (MCC) shall consist of vertical sections 25 inches (635 mm) wide as shown in the Contract Documents. The overall dimension of the MCCs shall not exceed the dimensions shown in the Contract Documents. The MCC shall incorporate horizontal and vertical power bus. The MCC shall consist of vertical sections bolted together to form a rigid, free standing assembly and shall be so designed as to permit future additions of vertical sections and interchanging of units by the user. The MCCs shall be built to the latest published NEMA/EEMAC and ULC/CSA standards.

.2 The MCC enclosure shall be NEMA 3R.

.3 Supply DeviceNet to ControlNet linking device with appropriate power supply.

.4 The MCC shall have network cabling integrated throughout the vertical sections. Each motor starter, AC drive, and soft starter in the MCC shall be supplied with a means to communicate via the DeviceNet to ControlNet.

.1 Per CSA C22.1-2012, the DeviceNet cable shall have an insulating rated equal to at least the maximum circuit voltage applied to any conductor within the enclosure or raceway, that is no special separation, barriers, or internal conduit is required for the device network conductors.

.2 The DeviceNet cable used for the trunk line shall be flat cable rated 8.0 amps, 600 V a.c., Class I.

.3 The DeviceNet cable used for the droplines shall be round cable rated 8.0 amps, 600 V a.c., Class I.

.4 DeviceNet Cable Layout:

.1 A DeviceNet trunkline shall be routed through the MCC lineup, behind barriers that isolate the trunkline from the unit space and wireways to prevent accidental mechanical damage during MCC installation.

.2 Six DeviceNet ports shall be provided in the rear of each full height vertical wireway to simplify installation,

2.1 MOTOR CONTROL CENTRES (Cont'd)

.4 (Cont'd)

.4 DeviceNet Cable Layout:(Cont'd)

.2 (Cont'd)
relocation, and addition of plug-in MCC units.

.3 The DeviceNet component within each plug-in unit shall be connected to one of the six DeviceNet ports in the vertical wireway with cable outlined above in the device network cable section.

.4 The addition or removal of a unit from the DeviceNet system shall not interrupt the operation of other units within the system.

.5 Power Supply:

.1 The DeviceNet system in the MCC shall include a power supply that conforms to DeviceNet requirements and has the ODVA checkmark. The power supply shall provide 24V d.c. and shall be rated no less than 8.0 amps.

.2 The power supply unit shall be provided with a buffer module to provide a minimum 500 ms ride-through at full load.

.3 The power supply unit shall be provided with a buffer module to provide a minimum 500 ms ride-through at full load.

.6 Scanner Modules:

.1 The DeviceNet system in the MCC shall include a DeviceNet scanner module that conforms to the DeviceNet requirements.

.7 DeviceNet System Performance

.1 The DeviceNet system shall be designed to operate at 500 kbaud to maximize the system performance, unless precluded by the cumulative length of the trunk and drop lines. To achieve best performance, 250 kbaud shall be the minimum communication rate.

.2 The DeviceNet system shall be qualified to communicate and perform under normal and adverse MCC electrical environments (for example, contactor electrical operation, contactor jogging duty, and unit short circuit fault).

.3 The DeviceNet system shall be capable of the following scan modes: Polled, Change of State (COS), Strobe, and Cyclic.

.4 The DeviceNet system shall be capable of transmitting and receiving data via I/O and explicit messaging.

.5 System shall be 600-V a.c. class, three phase, three wire, 60 Hz. Each vertical section shall have 300 A tin plated copper bus from top to

2.1 MOTOR CONTROL CENTRES (Cont'd)

.5 (Cont'd)
bottom. A horizontal 600A tin plated copper bus shall connect the vertical sections. Bus work shall be braced for 65,000 A. RMS asymmetrical. A ground shall be furnished in each vertical section and a connecting horizontal bus. Circuit breakers shall be rated for 65,000 AIC minimum.

.6 Main Breaker:
.1 Breaker shall be sized as shown in the Contract Documents. Incoming section shall include power metering, and all required transformers. The power metering shall provide a meter display on the front of the MCC and have provisions for a remote display on the control console. The incoming section shall a have a Transient Voltage Surge Suppressor with a 240 kA surge rating.

.7 Combination Motor Starters:
.1 Across-the-line, non-reversing and reversing combination starters for motors up to 40 hp, 600 V a.c. Combine motor starters with disconnecting means, Motor Circuit Protector (MCP) or MCP with current limiter, as indicated on drawings, in common enclosure. They shall be built and tested in accordance with the latest NEMA standards.
.2 Combination motor starters shall be equipped with three overload relays or electronic overload relays. Starter shall provide for field installation of up to 3 N.O. and 4 N.C., auxiliary contacts in addition to the hold-in interlock. Reversing starters shall have provisions for up to 4 N.O. and 4 N.C. contacts.
.3 Operating handle shall always remain connected to the MCP. The operating handle shall not be mounted in the door of the enclosure, but to the side of the door for safe "stand-aside" operation. Position of the operating handle will indicate On, Off, or Tripped condition of switch or MCP. Interlock provision shall prevent unauthorized opening or closing of the starter door with the disconnect in the On position as well as turning breaker On with the door open. Operating handle shall be padlockable in the Off position.
.4 Coils shall be a hot molded construction to protect the coils from mechanical and environmental damage. Coils shall be protected from overheating.
.5 Supply and install neatly typed label inside each motor starter enclosure door identifying motor served, nameplate, horsepower,

2.1 MOTOR CONTROL CENTRES (Cont'd)

.7 Combination Motor Starters:(Cont'd)
.5 (Cont'd)
full load amperes, code letter, service factor, and voltage/phase rating. Provide a schematic diagram inside each starter enclosure.
.6 Supply and install neatly typed label inside each motor starter enclosure door arc flash labels.
.7 Supply and install indicator lights for "OPEN", "CLOSE", "RAISE", "LOWER", "PULL", "DRIVE" and "O.L. TRIPPED STATUS" as shown on the Contract Documents.
.8 Supply and install a Transient Voltage Surge Suppressor for each motor starter as shown on the Contract Documents.

.8 Overload Relays:
.1 Overload relays shall be ambient compensated, single phase sensitive, block-type bimetallic trip, with a push-to-test feature.
.2 Supply and install an external reset button on the starter enclosure door. Overload heaters shall be sized for actual nameplate full load amps.

.9 Electronic Overload Relays:
.1 Electronic overload relays shall be provided as shown in the Contract Documents. Each motor starter with an electronic overload relay shall have the following features:
.1 On-board DeviceNet communication.
.2 LEDs for status indication.
.3 Test/Reset button.
.4 Adjustable trip class (5 to 30).
.5 General purpose I/O (2I/1O), rated for 120V a.c. or 24V d.c. as specified on the Contract Documents.
.6 Unconnected Message Manager to allow the proxying of more than one master device.
.7 Protective functions with programmable trip level, warning level, time delay, and inhibit window:
.1 Thermal overload.
.2 Underload.
.3 Jam.
.4 Current imbalance.
.5 Stall.
.6 Phase loss.
.8 Current monitoring functions:
.1 Phase current.
.2 Average current.
.3 Full load current.
.4 Current imbalance percent.

2.1 MOTOR CONTROL CENTRES (Cont'd)

.9 Electronic Overload Relays:(Cont'd)
.1 (Cont'd)
.8 (Cont'd)
.5 Percent thermal capacity utilized.
.6 Voltage and energy measuring capabilities.
.9 Diagnostic information:
.1 Device status.
.2 Warning status.
.3 Time to reset.
.4 Trip status.
.5 Time to overload trip.
.6 History of last five trips.

.10 Feeder Disconnects:
.1 Fusible disconnect and circuit breaker feeder circuits shall have a DeviceNet I/O Module containing at least two inputs and one output. The inputs of the DeviceNet I/O module shall be rated for 120V a.c. or 24V d.c. as specified on the Contract Documents.

.11 Motor Circuit Protector:
.1 Provide circuit breakers with integral instantaneous magnetic trip in each pole. The manufacturer shall size MCP according to motor horsepower (hp) as shown in the Contract Documents.
.2 Supply instruction manuals which include the theory of operation, maintenance information and laminated plastic schematics on all units within the MCC. A storage pocket shall be furnished and installed on the inside of the cabinet door for these schematics.

.12 Control Wiring:
.1 Control wiring shall be 90°C, VW-1 rated, copper, conductor size number 12 AWG minimum.

.13 Terminal Blocks:
.1 Terminal blocks, shall be mounted within the unit insert in a horizontal plane up front for accessibility. Control terminal blocks shall be pull-open on plug-in units and fixed on non plug-in factory-mounted units.
.2 A pull-apart terminal block assembly shall consist of a male and female component held together with captive screws. The assembly shall be designed to withstand the effects of vibration, yet able to be pulled apart without difficulty. The terminals of both portions of the assembly shall be recessed to isolate them from accidental contact when withdrawn. Terminal

2.1 MOTOR CONTROL CENTRES (Cont'd)

.13 Terminal Blocks:(Cont'd)
.2 (Cont'd)
markings shall be furnished and installed to identify terminations.
.3 Control pull-apart blocks shall be 5-pole, rated 25A, 600 V a.c., 90 °C with a maximum wire size of 12 AWG.

.14 Unit Door:
.1 Each unit shall be furnished and installed with a removable door mounted on removable pin type hinges which allow the door to swing open at least 110°. Doors shall be removable from any location in the center without disturbing any other doors.
.2 The unit doors shall be fastened to the stationary structure so that it can be closed to cover the unit space when the insert has been removed. The unit doors shall be held closed with 1/4 turn panel type latches designed to resist forces during fault conditions. Each starter door shall be furnished and installed with an external low profile overload reset button.
.3 Units furnished with pushbuttons, selector switches or pilot lights shall be furnished and installed with a door-mounted control station. The control station shall be removable for the purpose of mounting and wiring the pilot devices and shall be held in place with captive mounting screws.
.4 Space permitting, contact blocks of the pilot devices shall be mounted in a recessed control station housing to minimize the hazard of accidental contact when the unit door is open.
.5 Each door shall be provided with a print pocket.

2.2 CONSTRUCTION REQUIREMENTS

.1 The MCCs shall be sized, installed, and oriented as shown in the Contract Documents.

.2 Provide a 2 inch (51 mm) high housekeeping concrete pad to mount the MCCs on. The house keeping pad shall be a minimum of 2 inches (51 mm) larger than the MCCs base on each side.

2.3 FIELD QUALITY CONTROL

.1 Prior to energization of MCCs, megger check phase-to-phase and phase-to-ground insulation for proper resistance levels. Prior to energizing circuitry, check MCC electrical circuits for continuity and for short-circuits. Subsequent to wire and cable hook-ups, energize MCC and demonstrate functioning in accordance with requirements.

2.4 SPARE PARTS

.1 Furnish the following items as specified herein. Deliver to the Departmental Representative, as directed, with an itemized list in the letter of transmittal accompanying each shipment.

.1 Special tools and accessories:

.1 Supply special tools, and accessories for maintaining the MCCs and components requiring periodic adjustment.

.2 Supply special lifting and handling devices for equipment requiring such devices.

.2 Spare Parts:

.1 Two(2) complete assembly comprising chassis, circuit breaker, starter and electronic overload relay for each type and size motor starter provided.

.2 Supply (4) four overload relay through-the-door reset button push rods.

.3 Supply (12) twelve replacement lamps for the pilot lights.

.4 Supply (2) two thermal overload relays for each type and size motor starter provided.

PART 3 - EXECUTION

3.1 SHOP TESTING

.1 The motor control center and other apparatus supplied, assembled or fabricated by the vendor of the electric control system shall be subjected to shop inspection to demonstrate compliance with all specified requirements. The inspection is intended as a means of facilitating the Work and avoiding errors, and it is expressly understood that it will not relieve the Contractor of responsibility for imperfect material or workmanship.

.2 The motor control center and other apparatus supplied shall be completely assembled at the manufacturer's factory, and shall be subjected

3.1 SHOP TESTING (Cont'd)

.2 (Cont'd)
to the manufacturer's standard inspection and testing. The manufacturer's standard testing for the enclosed control panels and control console shall comprise at least the following:
.1 Inspection of materials fit of parts, finishes and adjustments.
.2 Wire continuity test, either visual or verified with continuity tester.
.3 Operational check of devices to determine proper pick-up and drop-out voltages and contact operation.
.4 Operational check of circuits to determine proper interlocking of circuits and operator's devices.
.5 Polarity of connections to instruments and other polarity-sensitive devices.
.6 Copies of the test results will be submitted to the Departmental Representative of record for review.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes disconnect switches comprising of, but not limited to, supplying and installing, where indicated, heavy-duty disconnect switches having electrical characteristics, ratings, and modifications shown on the Contract Documents. Supplying and installing fuses for fused disconnect switches.

1.3 REFERENCES

.1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)
.1 ANSI/IEEE C37.13-2008, Low Voltage AC Power Circuit Breakers Used in Enclosures.

.2 CSA International
.1 CSA C22.2 No. 5-09, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 01 33 00.

.2 Provide catalogue data, installation instructions, and replacement parts list for each type switch. Include voltage and ampere ratings, construction material, NEMA classification, and dimensioned outline drawing in the catalog data. Include a replacement parts list.

1.5 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Enclosures: to NEMA Type 4X, stainless steel Type 316.

.1 Equip with metal factory nameplates, front cover mounted, that contain a permanent record of switch type, catalogue number, and horsepower rating.

.2 Equip with visible blades, reinforced fuse clips, non-teasible, positive, quick make-quick break mechanisms with a handle whose position is easily recognizable and is padlockable in the OFF position. Switch assembly plus operating handle as an integral part of the enclosure base. Provide switches that are horsepower load break rated and to NEMA Specifications. Provide switches with defeatable door interlocks that prevent the door from opening when the operating handle is in the ON position. Provide heavy-duty switches with line terminal shields.

.3 Fusible switch assemblies: to NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class R fuses.

.1 Fuses: time delay, current-limiting type with 200 kA interrupting rating at 600 V a.c. Use only rejection type fuses, UL listed to minimize short circuit damage and be applied as follows: UL Class RK1 - Service entrance, transformer feeder and panelboard feeder; UL Class RK5 - Motor branch circuit.

.4 Non-fusible switch assemblies: NEMA KS 1 construction Type HD with quick-make, quick-break, load interrupter enclosed knife switch. Handle lockable in OFF position. Supply non-fusible switches with one N.C. (normally closed) and one N.O. (normally open) set of auxiliary contacts.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install disconnect switches where indicated in on drawings or where required. Install switches plumb at a height with the top not exceeding 6 feet (1829 mm) above the floor.

.2 Do not use switch enclosure as a pull box for wiring other than the load it serves.

END

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

.1 Work of this Section includes Air Circuit Breakers comprising of furnishing all labour, materials, tools, equipment, and appurtenances necessary to supply, install and test all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation.

1.2 REFERENCES

.1 CSA International
.1 CSA C22.1-2012, Canadian Electrical Code,Part I (22nd Edition), Safety Standard for Electrical Installations.
.2 CSA C22.2 No. 5-09, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 and 26 24 19.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for air circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
.1 Indicate on drawings:
.1 Time-current phase protection co-ordination characteristic curves for breakers.

1.4 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for air circuit breakers for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:
.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Store and protect air circuit breakers from nicks, scratches, and blemishes.
.3 Replace defective or damaged materials with new.

1.6 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

PART 2 - PRODUCTS

2.1 AIR CIRCUIT BREAKER

.1 Air circuit breaker: to ANSI/IEEE C37.13 and CSA C22.2 No.5.

.2 Fixed type, 600 V class.
.1 Continuous current rating: 800 A.
.2 Trip rating: 600 A.
.3 Interrupting rating: 25 kA, RMS symmetrical.
.4 Retrofit kit and accessories for existing Switchboard-2 (Switchboard-2 is CDP type manufactured by Federal Pioneer LTD).

.3 Solid-state tripping system consisting of 1 current sensor per pole, 1 solid-state trip unit and self-powered trip actuator. Equipped with long short instantaneous ground fault function and phase overload short circuit and ground fault indication.

.4 Breakers with normal stored energy, closing mechanism to provide quick-make operation as indicated for all ratings.

.5 Breakers with motor charged, stored energy, quick-make, closing mechanism with emergency manual spring charging handle and isolating

2.1 AIR CIRCUIT BREAKER (Cont'd)

.5 (Cont'd) switch to isolate power supply to spring charging motor as indicated.

.6 Breakers with on-off indicator and spring charged/discharged indicator.

.7 Interlocks to prevent circuit breaker drawout when in closed position and to prevent closing unless fully engaged or in test position.

.8 Interrupting capacity of breakers to be met without current limiting fuses.
.1 Include anti-single-phasing coils which act on tripper bar in parallel with current limiting fuses to prevent single phasing.
.2 Co-ordinate time current limiting characteristics of fuses with time current tripping characteristics of circuit breaker.

2.2 OPTIONAL FEATURES

.1 Lockout devices.

.2 Padlocking provision.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air circuit breakers installation in accordance with manufacturer's written instructions.
.1 Visually inspect substrate in presence of Departmental Representative.
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

.1 Install air circuit breakers as indicated, and in compliance with manufacturer's instructions and recommendations..

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

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

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes Variable Frequency Drives comprising of,

.1 Furnishing all labour, materials, tools, equipment, and appurtenances necessary to supply, install and test all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation.

.2 Demolition of the Existing Span Drive System including but not limited to: Resistor/Reactor Panels, and Drive Cabinets in each unit incorporated into work.

1.2 SUMMARY

.1 The intent and purpose of this specification is to define the minimum design, material and construction requirements of the main span drive motors and controls which are not otherwise defined on the Contract Plans. Further, it is the intent of this specification to define the testing, installation, and adjustments necessary to put into approved working order.

.2 Provide and install two (2) motor drive systems, consisting of four (4) 200 hp heavy duty 600 V a.c., four-quadrant, dynamic braking vector-controlled pulse width modulated motor drive, with an 18 pulse configuration, in a master/slave configuration. The drive systems shall be suitable for the control of the vector duty rated induction motors specified in Section 26 05 81.

.3 Any device, material, labour or effort not specified by name in the contract drawings or herein, yet required to complete or make the drives operate as specified, shall be furnished by the Contractor at no extra cost to the PWGSC.

1.3 RELATED SECTIONS

.1 Section: 26 05 81 Motors

.2 Section: 26 24 19 Motor Control Centers

.3 Section: 26 09 17 Programmable Controllers (Bridge Control System)

1.4 REFERENCES

.1 Institute of Electrical and Electronics Engineers (IEEE) Standard 519-1992 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

.2 NFPA National Fire Protection Association
.1 NFPA 79-2012 Electrical Standards for Industrial Machinery

.3 Canadian Standards Association (CSA)
.1 CSA C22.1-2012, Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations.

.4 NEMA National Electrical Manufacturers Association
.1 NEMA ICS 3.1-2009 - Guide for the Application, Handling, Storage, Installation, and Maintenance of Medium-Voltage AC Contactors, Controllers, and Control Centers
.2 NEMA ICS 6-2011 - Industrial Controls and Systems: Enclosures.
.3 NEMA 250-2008 Enclosures for Electrical Equipment (1000V maximum).
.4 NEMA ICS 7-2006 Adjustable Speed Drives.
.5 NEMA MG-1-2011 Motors and Generators.

.5 UL Underwriters Laboratories
.1 UL 508 Standards for Industrial Control Equipment.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Drawings: The Contractor shall furnish installation drawings with information such as weights, lifting instructions, storage instructions, mounting data, ventilation requirements, locations of electrical connections, location and sizes of ground terminations, locations and recommended use of shielded wire where required.

.3 Shop Drawings:
.1 Provide shop drawings: in accordance with Section 01 33 00.
.1 Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

1.5 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.3 Shop Drawings:(Cont'd)
.1 Provide shop drawings:(Cont'd)
.2 Preliminary setting values for all adjustable parameters.
.3 Schematic and wiring diagrams for field connections.

.4 Product Data: Provide catalogue sheets showing voltage, controller size, ratings and size of switching and over current protective devices, short circuit ratings, dimensions, and enclosure details.

.5 Qualifications information required in Section 26 05 00.

.6 Test Reports: Submit for review to the Departmental Representative, field test and inspection procedures and test results.

.7 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

.8 Manufacturer's Field Reports: Indicate start-up inspection findings. Tabulated setting values for all adjustable parameters.

1.6 OPERATION AND MAINTENANCE DATA

.1 Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

.2 Maintenance Data: Include routine preventive maintenance schedule.

.3 Instruction Manuals: The Contractor shall furnish instruction manuals with manufacturer's information and recommendation covering:
.1 Controller characteristics such as: ratings, conditions for applications and service, control functions, protective functions, and options available or included.
.2 Safety precautions and procedures before and during installation, starting adjustments, and maintenance.
.3 External control and power wiring, including grounding.

1.6 OPERATION AND MAINTENANCE DATA (Cont'd)

.3 Instruction Manuals:(Cont'd)

.4 Recommendations to optimize immunity to electrical noise.

.5 Listings of phenomena external to the controller that can cause malfunctions or dangerous conditions, with suggested corrective actions.

.6 Troubleshooting procedures with symptom cause-effect and corrective recommendations, based on manufacturer's recommended SRUs (Smallest Replaceable Units).

.7 Replacement Parts List: Include annotated views to show all component locations, nomenclature and part numbers.

1.7 NAMEPLATES

.1 Each piece of equipment and apparatus shall have a permanent, corrosion resistant, metal nameplate on which is stamped the name of the manufacturer, the catalogue or model number, and the ratings of the equipment or apparatus.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00.

.2 Deliver shipping sections individually wrapped in factory fabricated fiberboard type containers and with lifting angles on each structure.

.3 Handle distribution and control equipment carefully to prevent internal component damage, and denting or scoring of enclosure finish. Do not install damaged equipment.

.4 Store equipment in a clean, dry space. Protect units from dirt, fumes, water, construction debris and traffic.

.5 Packaging Waste Management: remove for reuse and return of pallets and packaging materials in accordance with Section 01 74 20.

1.9 QUALIFICATIONS

.1 The manufacturer shall be specialized in the manufacturing of the materials specified in this section and posses a minimum of 5 years documented successful experience in control of movable bridges. The manufacturer shall have service facilities within 1000 miles of Project.

1.10 CONSTRUCTION REQUIREMENTS

.1 All electrical and electronic components, including logic control, comprising this drive system shall be supplied by a single manufacturer and shall bear the same brand name and trade mark unless specifically stated otherwise.

1.11 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

.2 Measure spare Variable Frequency AC Motor Drive in each unit incorporated into Work.

PART 2 - PRODUCTS

2.1 MOTOR DRIVE

.1 The motor drive shall be a reversing, four quadrant with dynamic braking, vector-controlled pulse width modulated PWM controller for a vector duty rated induction motor with an 18 pulse configuration.

.2 The input voltage shall be 600 V a.c., +/-10 percent 3-phase, 60 Hz output rating shall be 200 hp, heavy duty, 60 Hz. The drive shall be provided with line side circuit breakers, current limiting fuses and contactors with overload protection on the outputs.

.3 Drives shall be digitally controlled. Programming shall be by means of a keypad/display on the enclosure door.

.4 The drive system shall be equipped with a universal feedback encoder option.

.5 Speed regulation shall be capable of holding speed within 0.01 percent of set speed using encoder feedback. However, actual settings shall be + 5 percent initially and shall be adjusted in the field for optimum performance of the bridge machinery. The following performance parameters shall be programmable:

.6 Speed- A minimum of 2 preset speeds forward and 2 preset speeds reverse for normal operation plus automatic adjustment for high torque conditions.

2.1 MOTOR DRIVE (Cont'd)

.7 Acceleration and deceleration rates shall be independent of each other. Adjustment range shall be 0.1 - 60 seconds or more.

.8 Rate of Change- The speed control response time shall be tunable to allow speed corrections without "jerking" the machinery.

.9 Torque- Programmable to provide 150 percent of rated torque for 1 minute, 180 percent upper limit.

.10 Torque Proving - The drive shall be programmable to provide a contact closure output to release the motor brake only when the motor is producing torque. The torque setting shall be programmable from 0 to 50 percent.

.11 The drive shall be provided with automatic testing and tuning software.

.12 Drive shall be programmable to operate with an encoder feedback signal and providing A and B channel quadrature pulses plus a Z channel marker pulse.

.13 Dry contact relay outputs shall be provided for status indication of READY/RUNNING, TROUBLE and SHUTDOWN (See also alarms from drive logic controller).

.14 Power Transmitters: The drive shall be equipped with a watt transmitter to measure input power. The transmitter shall provide a 0-10 V d.c. output signal which is proportional to the kilowatts input from zero to the full rated input of the drive plus 10 percent.

.15 The drive shall be provided with a separate enclosure. The enclosure shall be free standing NEMA 12 cabinet. The enclosure shall include an external operating handle for the drive circuit breaker. The handle shall be padlockable in the off position and shall include a mechanical interlock to prevent the enclosure door from being opened with the breaker in the on position.

.16 The enclosure shall be provided with a filtered, forced air cooling system sized per the manufacturer's requirements for the equipment. The cooling system failure alarm shall be provided.

2.1 MOTOR DRIVE (Cont'd)

.17 The Contractor shall be responsible for all final fitting of the components provided.

2.2 DRIVE CONTROL

.1 A control system shall be provided as an interface between the bridge control system and the motor drive.

.2 The drive control system shall include the safe torque off option.

.3 The manufacturer shall provide standard logic control components. There shall be no prototypic or undocumented assemblies, firmware, or software, allowed.

.4 The drive control panel shall interface with the bridge control system by means of dry contact inputs and outputs.

.1 Inputs:

.1 Run - normally open contact; close to run.

.2 Open (Forward) normally open contact; close to operate.

.3 Close (Reverse) normally open contact; close to operate.

.4 Emergency Stop - normally closed contact; open for emergency stop.

.5 Limit Switch - full closed position: normally closed contact; open to stop when span is fully closed.

.6 Limit Switch - nearly closed position: normally closed contact; open to slow down.

.7 Limit Switch - nearly open position: normally closed contact; open to slowdown.

.8 Limit Switch - full open position: normally closed contact; open to stop when span is fully open.

.9 Motor Brake Set.

.10 Motor Brake Released.

.11 Motor Brake Manually Released.

.12 Differential lock position not proven. Prohibit drive run if the differential lock is not proven to be either fully locked or fully unlocked.

.2 Outputs:

.1 .1 Drive System Running.

.2 Drive System Running normally open, closed to run.

.3 Drive System Trouble, normally closed, open when trouble.

.4 Drive System Shutdown, normally closed, open to shutdown.

2.2 DRIVE CONTROL (Cont'd)

.4 (Cont'd)

.2 Outputs:(Cont'd)

.5 Release Motor Brake, normally open, close to release.

.6 Drive System Control OFF, normally closed, open to turn off.

.3 Manual Controls shall be provided on the cabinet door. Manual control shall include:

.1 OPEN - AUTOMATIC - CLOSE: Momentary position selector switch spring return to center position.

.2 EMERGENCY STOP - Maintained position mushroom head operator. Push to stop, turn and pull to reset.

.5 Operation Requirements:

.1 All of the vertical lift span motion shall be controlled ultimately by the drive logic controller in response to discrete commands from the Bridge Control System and feedback from the encoder and limit switches. That is, the Bridge Control System provides contact closures for RUN, OPEN, and CLOSE, and contact openings for EMERGENCY STOP. The position limit switches, connected directly to the logic controller provide FULLY SEATED, NEARLY LOWERED, NEARLY RAISED and FULLY RAISED provide contact openings for slow down and stop. The drive assembly logic control detects the command signal as well as the span position limit switches and in turn provides control inputs to the active drive. The drive on-board control controls acceleration, deceleration, direction and speed of the motor. In addition, the logic controller controls and monitors the operation of the motor and machinery brakes.

.1 For complete description of the bridge operation overall see Section 26 09 17 Bridge Control System.

.6 Communication: ControlNet

.7 Drive Operating Sequence:

.1 Normal Operation:

.1 When the RUN command input is closed, the drive shall energize and go to a state of readiness.

.2 When the drive is ready the logic controller shall provide a contact closure output to indicate DRIVE RUNNING.

.3 When both RUN and OPEN request input are closed, (regardless of the state of the

2.2 DRIVE CONTROL (Cont'd)

.7 Drive Operating Sequence:(Cont'd)

.1 Normal Operation:(Cont'd)

NEARLY LOWERED and FULL SEATED limit switches), the drive assembly controller shall energize and provide torque (adjustable to 100 percent) at zero speed before it energizes the motor brake starter. Upon sensing the motor brake released, the drive shall accelerate the main motor per the acceleration ramp setting to full operating speed.

.4 If the OPEN request input should open during operation the drive shall decelerate the motor, according to the deceleration ramp setting, to a stop, hold the vertical lift span at zero speed and de-energize the motor brake.

.5 If the drive is running, (both RUN and OPEN request inputs are closed) when the NEARLY RAISED limit switch opens the motor shall be decelerated per the ramp setting to creep speed (10 percent of full operating speed).

.6 If the OPEN request input should open while the drive is running, the drive shall decelerate and stop the motor as in step D. When the RUN and OPEN request inputs are reclosed, if the NEARLY RAISED limit switch contacts are open, the drive shall accelerate the motor directly to creep speed.

.7 If the RUN and OPEN request inputs are closed, the NEARLY RAISED limit switch is closed, and the motor is stopped, the drive shall accelerate the motor, in the forward direction to full speed. If the motor is running in reverse when the request inputs change to OPEN, and the NEARLY RAISED limit switch is closed, the drive shall decelerated the motor, per the ramp setting, to a complete stop then accelerate the motor to forward full operating speed.

.8 If the drive is running (both RUN, OPEN, request inputs are closed), and the NEARLY RAISED is open, when the FULLY RAISED limit switch contacts open, the drive assembly controller shall de-energize the motor brake releases and de-energizes the motor.

.9 If the CLOSE request input should open during operation the drive shall decelerate the motor, according to the

2.2 DRIVE CONTROL (Cont'd)

.7 Drive Operating Sequence:(Cont'd)

.1 Normal Operation:(Cont'd)

deceleration ramp setting, to a stop and de-energizes the motor brake release.

.10 If the drive is running, (both RUN and CLOSE request inputs are closed) when the NEARLY LOWERED limit switch opens the motor shall be decelerated per the ramp setting to reverse creep speed.

.11 If the CLOSE request input should open while the drive is running, the drive shall decelerate and stop the motor as in step D. When the RUN and CLOSE request inputs are closed, and the NEARLY LOWERED limit switch contacts are open, the drive shall accelerate the motor directly to reverse creep speed.

.12 If the RUN and CLOSE request inputs are closed, the NEARLY LOWERED limit switch is closed, and the motor is stopped, the drive shall accelerate the motor to reverse full speed. If the motor is running in the forward direction when the request inputs change to CLOSE, and the NEARLY LOWERED limit switch is closed, the drive shall decelerated the motor, per the ramp setting, to a complete stop then accelerate the motor to reverse full operating speed.

.13 As the bridge is landing, (both RUN, and CLOSE inputs are closed and the NEARLY LOWERED limit switch is open), when the FULLY SEATED limit switch opens the drive assembly controller shall instantaneously de-energize the motor brake starter and de-energize the motor.

.2 Emergency Stop:

.1 If the RUN input should open during operation, the main motor and brake shall be de-energized. THE MOTOR SHALL COAST TO A STOP. The brakes shall be adjusted to stop the bridge in 5 to 6 seconds.

.3 Abnormal Conditions:

.1 If the motor brake is manually released, the drive shall not accelerate the bridge over 10 percent of speed.

.2 If the motor brake is manually released during operation, the drive shall decelerate the motor to 10 percent of speed.

.3 If the drive energizes the output and the motor brake do not release within 1 second, drive shall shut down.

.4 If the motor current exceeds 150 percent of running current for more than 10

2.2 DRIVE CONTROL (Cont'd)

.7 Drive Operating Sequence:(Cont'd)

.3 Abnormal Conditions:(Cont'd)

seconds the drive shall automatically ramp the speed down until motor current is 100 percent then ramp speed up to no more than 50 percent of speed. Speed shall reset to normal upon request to operate in the opposite direction.

.5 The motor shall be fitted with an encoder. Upon sensing loss of encoder signal, the drive shall be shutdown and the trouble contact shall close.

.4 Alarm Output:

.1 TROUBLE and SHUTDOWN alarms shall be indicated by a light on the enclosure door. The alarm conditions shall be indicated by an alphanumeric display on the door or by calling up an alarm register on a programming terminal. All alarms shall be latched on until manually cleared. A normally closed auxiliary contact shall be provided for a remote indicating light on the control console.

.2 The Drive assembly controls indicate DRIVE TROUBLE if:

.1 Either drive internal trouble exists.

.2 Drive assembly is de-energized.

.3 The Drive assembly shall shutdown the drive, indicate DRIVE SHUTDOWN on the enclosure door, and shall close the DRIVE TROUBLE contact if either drive has operational or electrical line conditions out of tolerance, reverse phase rotation, line synch loss, or mechanical failures such as encoder loss, over speed, etc.

2.3 SPARE PARTS

.1 Provide, in their original boxes or containers, the following spare parts:

.1 One (1) complete drive module.

PART 3 - EXECUTION

3.1 SHOP TESTING

.1 Prior to shipment, the complete drive assemblies shall be functionally tested to assure completeness and correct operation. The Contractor will provide a test plan and test procedure for review 30 days prior to start of shop test. Shop tests shall include a dynamometer testing, using the actual drive motor. As a minimum requirement, the motor tests shall demonstrate the motor and drive is capable of operating at the manufacturers' nameplate ratings, factory furnished motor curves for torque and speed, and as required by the Contract Plans and Special Provisions. The tests shall demonstrate that the drive is capable of providing acceleration torque at 150 percent overload for 1 minute. The dynamometer testing shall also simulate a 150 percent overhauling load which the drive shall decelerate to a stop.

.2 The functional testing shall be witnessed by the Departmental Representative and PWGSC designated representative. A test results report shall be submitted to the Departmental Representative for review. The report shall outline the test procedure and provided motor speed and torque curves. The Contractor shall provide 14 calendar days prior notice to the Departmental Representative for scheduling purposes.

.3 Upon completion of the factory testing and the review by the Departmental Representative, the Contractor shall ship the drives to the bridge control system vendor's shop for testing as an integrated system.

3.2 INSTALLATION REQUIREMENTS

.1 The motors and controllers shall be installed per the manufacturer's recommendations. The Contractor shall be responsible for a complete installation.

3.3 FIELD SET UP

.1 Arrange to have the manufacturer's field engineer at the site for pre-start up inspection, start up, and final adjustment of all of the equipment in this specification item.

3.3 FIELD SET UP (Cont'd)

.2 Responsible all of the costs associated with having this person on site.

.3 Touch up scratched or marred surfaces to match original finish.

3.4 FIELD TESTING

.1 Demonstrate operation of controller including simulation of all normal as well as failure modes.

.2 The drive machinery shall smoothly accelerate the span, maintain control of the span during load reversal, smoothly decelerate the span to creep and stop.

.3 Refer to the Sections for Bridge Control System Field Testing, and Startup and Commissioning.

3.5 DOCUMENTATION

.1 The Contractor shall supply test results to confirm that the controller has been tested to substantiate designs according to applicable ANSI and NEMA standards. The tests shall verify not only the performance of the unit and integrated assembly, but also the suitability of the enclosure venting and rigidity. In addition, the unit shall be factory tested in accordance with NEMA standards listed under Section 1.3.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Work of this Section includes Automatic Transfer Switch comprising of furnishing all
.1 Furnishing all labour, materials, tools, equipment, and appurtenances necessary to supply, install and test all items as indicated in the Contract Documents including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation.
.2 Demolition of Automatic Transfer Switch.

1.2 GENERAL REQUIREMENTS

.1 Supply and install Automatic Transfer Switch for switching between the normal aerial cable feed and the emergency aerial cable feed.

1.3 REFERENCES

.1 CSA International
.1 CSA C22.1-2012, Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations.
.2 CSA C22.2 No.5-09, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).
.3 CSA C22.2 No.178.1-2012, Transfer Switch Equipment.
.4 CAN/CSA-C60044-1-07, Instrument Transformers.

.2 Institute of Electrical and ELectronic Engineers (IEEE)
.1 IEEE 446-1995 - IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.

.3 National Electrical Manufacturers Association (NEMA)
.1 NEMA ICS 2 PART 8-1996(R2009), Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC Or 750 Volts DC part 8: Disconnect Devices For Use In Industrial Control Equipment.
.2 NEMA ICS 10-2005 - Industrial control and systems part 1: electromechanical AC transfer switch equipment (Includes 2006 errata).

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Sections 01 33 00 and 26 24 19.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switch and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
.1 Indicate on drawings:
.1 Make, model and type.
.2 Load classification.
.3 Single line diagram showing controls and relays.
.4 Schematic.
.5 Description of equipment operation including:
.1 Automatic starting and transfer to standby unit and back to normal aerial cable.
.2 Test control.
.3 Manual control.
.4 Automatic shutdown.

1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for transfer switch for incorporation into manual.

.3 Detailed instructions to permit effective operation, maintenance and repair.

.4 Technical data:
.1 Schematic diagram of components, controls and relays.
.2 Illustrated parts lists with parts catalogue numbers.
.3 Certified copy of factory test results.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.

1.6 DELIVERY, STORAGE AND HANDLING (Cont'd)

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

.3 Storage and Handling Requirements:

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

.2 Store and protect transfer switch from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

1.7 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

.1 Voltage, Frequency and Phase Rotation Sensing:

.1 Voltage and frequency on both the normal and emergency aerial cable feeds(as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout Trip	Pickup/ Reset
Undervoltage	N&E,3Ø	70 to 98%	85 to 100%
Overvoltage	N&E,3Ø	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage	N&E	5 to 20%	1% below unbalance dropout

.2 Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

.3 Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

2.1 DESIGN CRITERIA (Cont'd)

.4 The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency aerial cable feed. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC, or as verified in the field).

.5 Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

.6 The controller shall include a user selectable algorithm to prevent repeated transfer cycling to a source on an installation which experiences primary side, single phase failures on a Grounded Wye - Grounded Wye transformer which regenerates voltage when unloaded. The algorithm shall also inhibit retransfer to the normal (utility) source upon detection of a single phasing condition until a dedicated timer expires, the alternate source fails, or the normal source fails completely and is restored during this time delay period. The time delays associated with this feature shall be adjustable by the user through the controller keypad and LCD.

.7 Time Delays

.1 A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

.2 Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

.3 A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

.1 Prior to transfer only.
.2 Prior to and after transfer.
.3 Normal to emergency only.
.4 Emergency to normal only.
.5 Normal to emergency and emergency to normal.

2.1 DESIGN CRITERIA (Cont'd)

.7 (Cont'd)

.3 (Cont'd)

.6 All transfer conditions or only when both feeds are available.

.4 All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

.5 All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

.6 The following feature shall be built - into the controller, but capable of being activated through keypad programming or the communications interface port.

.1 Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

.7 The following feature shall be built - into the controller, but capable of being activated through keypad programming or the communications interface port.

.1 Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

.2 System Status - The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position.

.8 Self Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

.1 Communications Interface - The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific

2.1 DESIGN CRITERIA (Cont'd)

.7 (Cont'd)

.8 (Cont'd)

.1 (Cont'd)

for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

.9 Data Logging - The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss.

.10 Communications Module - A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices.

.8 Prior to a transfer, the automatic transfer switch should go to a "null" position for 60 seconds to ensure main motors are de-energized and brakes are set. Upon restoration of the normal aerial cable feed source to a pickup level of 90%, the logic shall initiate automatic retransfer of the load circuits to the normal aerial cable feed source provided the main drive motors are not energized. The Automatic Transfer Switch shall obtain its operating current from the source to which the load is being transferred.

.9 The automatic transfer switch shall have withstand, closing, and interrupting ratings sufficient for voltage of the system and the available short circuit at the point of application on the Contract Documents.

.10 The automatic transfer switch shall be mechanically and electrically interlocked so that a neutral position shall not be possible when under electrical operation. It shall not be possible for load circuits to be connected to normal aerial cable feed and emergency aerial cable feed sources simultaneously, regardless of whether the switch is electrically or manually operated. The automatic transfer switch shall have a neutral position for load circuit maintenance.

2.2 AUTOMATIC TRANSFER SWITCH

.1 600 Amps, 3 Pole, 347/600 Va.c., 3 Phase.

.2 Digital display controller.

.3 Data logging.

.4 Load on normal aerial cable feed and load on emergency aerial cable feed lights.

.5 Three phase voltage sensing. Under frequency sensor on emergency aerial cable feed.

.6 Time delays. Neutral position delay.

.7 Programmable output contacts - 5.

.8 Local power fail simulation test pushbutton. Provisions for remote test switch input.

.9 Automatic transfer switch shall be electrically-operated, mechanically-held in both normal power and stand-by position. The unit shall be capable of transferring under full load operation. A visual indicator shall be provided to determine whether the main contacts are open or closed. ATS controls shall be mounted in a dead front swing-out panel which, when opened, shall expose all system components.

.10 The automatic transfer switch shall be fully rated to protect all types of loads, inductive and resistive, from loss of continuity of power, without derating, either open or enclosed. The automatic transfer switch shall provide complete protection with field adjustable solid-state voltage sensing logic.

.11 Set and calibrate the automatic transfer switch in accordance with the manufacturer's specifications. Adjust the following: voltage sensing relays, and transfer time delay relay.

.12 The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

.13 All main contacts shall be silver composition.

.14 Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switch shall have front removable and replaceable contacts. All

2.2 AUTOMATIC TRANSFER SWITCH (Cont'd)

.14 (Cont'd) stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

.15 Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

2.3 ENCLOSURE

.1 The automatic transfer switch enclosure shall be sized to fit in the North Motor Control Centre as shown in the Contract Documents.

.2 All pilot devices and relays shall be of the industrial type rated 10 A with self-cleaning contacts. Indicating, pilot, and monitoring devices:

.1 Indicating Lights:

.1 Mount in cover of enclosure to indicate NORMAL AERIAL FEED SOURCE AVAILABLE, EMERGENCY AERIAL FEED SOURCE AVAILABLE, SWITCH POSITION.

.2 All indicating lights shall be LED 16 mm industrial grade, type 12.

.2 Test Switch: Mount in cover of enclosure to simulate failure of normal aerial cable feed source.

.3 Normal Aerial Cable Feed Source Monitor:

.1 Monitor each line of normal aerial cable feed source voltage and frequency, initiate transfer when voltage drops below 90% or frequency varies more than 3% from rated nominal value.

.2 Emergency aerial cable feed source monitor:

.4 Monitor stand-by source voltage and frequency, inhibit transfer when voltage is below 85% or frequency varies more than 5% from rated nominal value.

2.4 CONTROLLER DISPLAY AND KEYPAD

.1 A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

2.4 CONTROLLER DISPLAY AND KEYPAD (Cont'd)

.1 (Cont'd)

.1 Nominal line voltage and frequency.

.2 Three phase sensing.

.3 Operating parameter protection.

.4 Transfer operating mode configuration (Open transition, Closed transition, or Delayed transition).

.2 All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.5 MICROPROCESSOR CONTROLLER

.1 The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

.2 A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency sensing shall be accurate to ± 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

.3 The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

.4 All connections shall be wired to a common terminal block to simplify field-wiring connections.

2.6 MATERIALS

.1 Instrument transformers: to CAN/CSA-C60044-1.

.2 Contactors: to NEMA ICS 2 PART 8-1996(R2009).

2.7 CONTACTOR TYPE TRANSFER EQUIPMENT

.1 Contact Type Transfer Equipment: to CSA C22.2 No.178.1.

.2 Two-3 pole contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, with CSA enclosure.

.3 Rated: 600 V, 60Hz, 600 A. 3 wire.

.4 Main contacts: silver surfaced, protected by arc disruption means.

.5 Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance from front of panel without removal of switch panel or disconnection of drive linkages and power conductors.

.6 Auxiliary contact: silver plated, to initiate emergency generator start-up on failure of normal power.

.7 Fault withstand rating: 35 kA symmetrical for 3 cycles.

.8 Lever to operate switch manually when switch is isolated.

2.8 SOURCE QUALITY CONTROL

.1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Departmental Representative.

.2 Notify Departmental Representative 5 days minimum in advance of date of factory test.

.3 Tests:
.1 Operate equipment both mechanically and electrically to ensure proper performance.
.2 Check selector switch, in modes of operation Test, Auto, Manual and record results.
.3 Check voltage sensing and time delay relay settings.
.4 Check:
.1 Automatic starting and transfer of load on failure of normal power.

2.8 SOURCE QUALITY CONTROL (Cont'd)

.3 Tests:(Cont'd)
.4 Check:(Cont'd)
.2 Retransfer of load when normal power supply resumed.
.3 Automatic shutdown.
.4 In-phase monitor operation.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for transfer switches installation in accordance with manufacturer's written instructions.
.1 Visually inspect substrate in presence of Departmental Representative.
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
.3 Proceed with installation only after unacceptable conditions have been remedied and after reviewed by the Departmental Representative.

3.2 CONSTRUCTION REQUIREMENTS

.1 Set and calibrate the automatic transfer switch in accordance with the manufacturer's specifications.

.2 Adjust the following: voltage sensing relays, and transfer time delay relay.

.3 The automatic transfer switch enclosure shall be sized to fit in the Motor Control Centre as shown in the Contract Documents.

3.3 INSTALLATION

.1 Locate, install and connect automatic transfer switch equipment as indicated in the Contract Documents.

.2 Check solid state monitors and adjust as required to ensure correct operation.

3.4 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.2 Energize transfer equipment from normal power supply.
.1 Perform automatic transfer by simulating loss of normal power and return to normal power.
.2 Monitor and verify correct operation and timing of: normal voltage sensing relays, engine start sequence, time delay upon transfer, alternate voltage sensing relays, automatic transfer operation, interlocks and limit switch function, timing delay and retransfer upon normal power restoration, and engine shut-down feature.

.3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.
.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Geotechnical report included in Appendix D Report No. SM135013-G April 23, 2013 by Soil-Mat Engineers and Consultants Ltd.

1.2 REFERENCES

.1 ASTM International
.1 ASTM D 698-07e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600kN-m/m^3).

.2 CSA International
.1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.3 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS 1004-05, Material Specification for Aggregates-Miscellaneous.
.2 OPSS SP 110F13-03, Material Specification for Aggregates - Base, Subbase, Select Subgrade, and Backfill Material.

.4 U.S. Environmental Protection Agency (EPA)/Office of Water
.1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
.1 Erosion and Sedimentation Control: submit erosion and sedimentation control plan in accordance with EPA 832/R92-005.
.2 Construction Waste Management:
.1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
.3 Showing, sheeting, bracing submit design for excavation bracing as required. Design shall bear the stamp of a Registered Professional Engineer in Ontario. Design shoring for loading in soils report.

1.4 MEASUREMENT PROCEDURES

.1 Excavation - cubic metres.

.2 Backfill - cubic metres.

.3 Excavation shoring - square metres.

.4 Grading and restoration - square metres.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Granular B to OPSS SP 110F13. Sand to OPSS 1004.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions:
.1 Examine soil report included in Appendix.
.2 Before commencing work establish locations of buried services on and adjacent to site.

.2 Evaluation and Assessment:
.1 Arrange with appropriate authority for relocation of buried services that interfere with execution of work. Pay costs of relocating services.
.2 Testing of materials and compaction of backfill, and fill will be carried out by testing laboratory designated by Departmental Representative.
.3 Not later than 1 week before backfilling or filling, provide to designated testing agency, 23 kg sample of backfill fill materials proposed for use.
.4 Not later than 48 hours before backfilling or filling with approved material, notify Departmental Representative so that compaction tests can be carried out by designated testing agency.
.5 Before commencing work, conduct, with Departmental Representative, condition survey of existing structures, trees and plants, lawns, fencing, service poles, wires, rail tracks and paving, survey bench marks and monuments which may be affected by work.

3.2 PREPARATION

.1 Temporary Erosion and Sedimentation Control:

.1 Use temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, in accordance with sediment and erosion control plan, specific to site, to EPA 832/R-92-005 and requirements of authorities having jurisdiction..

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

.2 Protection of in-place conditions:

.1 Protect excavations from freezing.

.2 Keep excavations clean, free of standing water, and loose soil.

.3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative's approval.

.4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.

.5 Protect buried services that are to remain undisturbed.

.3 Removal:

.1 Remove obsolete buried services within 2 m of foundations. Cap cut-offs.

.2 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

.3 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

.4 Remove trees, stumps, logs, brush, shrubs, bushes, vines, undergrowth, rotten wood, dead plant material, exposed boulders and debris within areas designated on drawings.

.5 Remove stumps and tree roots below footings, slabs, and paving, and to 600 mm below finished grade elsewhere.

3.3 EXCAVATION

.1 Shore and brace excavations, protect slopes and banks and perform work in accordance with Provincial and Municipal regulations.

.2 Topsoil stripping:
.1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected.
.2 Strip topsoil to depths as directed by Departmental Representative. Avoid mixing topsoil with subsoil.
.3 Strip topsoil over areas to be covered by new construction, over areas where grade changes are required, and so that excavated material may be stockpiled without covering topsoil.
.4 Stockpile in locations as directed by Departmental Representative .
.5 Dispose of excess topsoil off site.

.3 Excavate as required to carry out work, in all materials met.
.1 Do not disturb soil or rock below bearing surfaces. Notify Departmental Representative when excavations are complete.
.2 If bearings are unsatisfactory, additional excavation will be authorized in writing and paid for as additional work.
.3 Fill excavation taken below depths shown without written authorization with concrete of same strength as for footings.
.4 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
.5 Obtain Departmental Representative approval of completed excavation.

.4 Excavate trenches to provide uniform continuous bearing and support for 150 mm thickness of pipe bedding material on solid and undisturbed ground. Trench widths below point 150 mm above pipe not to exceed diameter of pipe plus 600 mm.

.5 Excavate for slabs and paving to subgrade levels.
.1 Remove topsoil, organic matter, debris and other loose and harmful matter encountered at subgrade level.

3.4 SITE QUALITY CONTROL

.1 Fill material and spaces to be filled to be inspected and approved by Departmental Representative.

3.5 BACKFILLING

.1 Start backfilling only after inspection and receipt of written approval of fill material and spaces to be filled from Departmental Representative.

.2 Remove snow, ice, construction debris, organic soil and standing water from spaces to be filled.

.3 Lateral support: maintain even levels of backfill around structures as work progresses, to equalize earth pressures.

.4 Compaction of subgrade: compact existing subgrade under walks, paving, and slabs on grade, to same compaction as specified for fill. Fill excavated areas with selected subgrade material compacted as specified for fill.

.5 Placing:
.1 Place backfill, fill and basecourse material in 150 mm lifts. Add water as required to achieve specified density.
.2 Place unshrinkable fill in areas as indicated. Consolidate and level unshrinkable fill with internal vibrators.

.6 Compaction: compact each layer of material to following densities for material to ASTM D 698:
.1 To underside of basecourses: 100%.
.2 Basecourses: 100%.
.3 Elsewhere: 90%.

.7 In trenches:
.1 Up to 300 mm above pipe or conduit: sand placed by hand.
.2 Over 300 mm above pipe or conduit: native material approved by Departmental Representative.

.8 Under seeded and sodded areas: use site excavated material to bottom of topsoil except in trenches and within 600 mm of foundations.

.9 Against foundations (except as applicable to trenches and under slabs and paving): excavated material or imported material with no stones larger than 200 mm diameter within 600 mm of structures.

3.6 GRADING

.1 Grade to ensure that water will drain away from buildings, walls and paved areas, to catch basins and other disposal areas approved by Departmental Representative. Grade to be gradual between finished spot elevations as indicated.

3.7 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
.1 Dispose of cleared and grubbed material off site daily.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal comply with all MOE requirements for disposal of excavated material. See soils report.

3.8 RESTORATION

.1 Upon completion of work, remove waste materials and debris in accordance to Section 01 74 21 - Construction/Demolition Waste Management and Disposal, trim slopes, and correct defect as directed by Departmental Representative.

.2 Replace topsoil as directed by Departmental Representative.

.3 Reinstate lawns to elevation which existed before excavation.

.4 Reinstate pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.

.5 Clean and reinstate areas affected by work as directed by Departmental Representative.

.6 Protect newly graded areas from traffic and erosion and maintain free of trash and debris.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 Work of this Section includes Lift Bridge Machinery comprising of, but not limited to,

.1 Furnishing all labour, tools, services, equipment and materials (including spare parts) required to perform the installation, relocation, adjustment, span balance, demolition, painting, lubricating and testing of the mechanical elements as specified in the Contract Documents to place in correct, satisfactory operating condition the mechanical elements required to operate the lift bridge, including materials and labour which are not shown in the Contract Documents, but which are required to complete the installation.

- .1 Gearbox with Pedestal Base.
- .2 Motor Brake with Pedestal.
- .3 Floating Shaft.
- .4 Demolition of Slip Couplings.
- .5 Demolition of Brake Wheels.
- .6 Demolition of High Speed Gearing, Gear Frame and Support.
- .7 Relocation of the Brake Assembly.
- .8 Removal, Rework, and Salvage as spare of the Floating Shaft Coupling Assemblies.
- .9 Removal and Salvage as spares of the Brake Assembly.
- .10 Span Balance.

1.2 SECTION INCLUDES

.1 Technical specifications for the mechanical components required to operate the vertical lift span and testing of performance of same.

1.3 MEASUREMENT PROCEDURES

.1 Work will not be measured separately for payment.

.2 Measure the spare Differential Locking/Unlocking Electrical Actuator in each unit incorporated into Work.

1.4 REFERENCES

.1 American National Standards Institute (ANSI).

.1 ANSI/ASME B4.1-1967 (R1999), Preferred Limits and Fits for Cylindrical Parts.

.2 ANSI/ASME B46.1-2009, Surface Texture (Surface Roughness, Waviness, and Lay).

1.4 REFERENCES (Cont'd)

.1 (Cont'd)

.3 ANSI/AGMA 6013-A06 (R2011), Standard for Industrial Enclosed Gear Drives.

.4 ANSI B17.1-1967 (R1998), Keys and Keyseats.

.2 American Society of Testing Materials (ASTM).

.1 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.

.2 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.

.3 ASTM A666 - 10 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

.4 ASTM A668/A668M-04(2009), Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.

.5 ASTM A709/A709M-11, Standard Specification for Structural Steel for Bridges.

.6 ASTM C579-01(2012), Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

.7 ASTM C882/C882M-12, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

.8 ASTM D1002-10, Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to- Metal).

.9 ASTM D2566-86, Test Method for Linear Shrinkage of Cured Thermosetting Casting Resins During Cure.

.10 ASTM F436-11, Standard Specification for Hardened Steel Washers.

.3 American Welding Society (AWS).

.1 AASHTO/AWS D1.5M/D1.5-2010, Bridge Welding Code.

.4 Canadian Standards Association (CSA).

.1 CAN/CSA-S6-06, Canadian Highway Bridge Design Code.

.1 CSA S6S1-10, Supplement #1 to CAN/CSA-S6-06, Canadian Highway Bridge Design Code.

.2 CSA S6.1S1-10, Supplement #1 to S6.1-06, Commentary on CAN/CSA-S6-06, Canadian Highway Bridge Design Code.

.3 CSA S6.1S2-11, Supplement #2 to S6.1-06, Commentary on CAN/CSA-S6-06, Canadian Highway Bridge Design Code.

.4 CSA S6S2-11, Supplement #2 to CAN/CSA-S6-06, Canadian Highway Bridge Design Code.

1.4 REFERENCES (Cont'd)

.5 National Electrical Manufacturers Association (NEMA).
.1 NEMA ICS 1:2000 (R2008), Industrial Control & Systems General Requirements.

1.5 DESIGN CRITERIA

.1 Fabricate and install mechanical systems in accordance with CAN/CSA-S6-06.

1.6 SHOP DRAWINGS

.1 Submit shop drawings of each item specified in accordance with Sections 01 33 00 and 01 78 00.

.2 Shop drawings shall be submitted for all mechanical components:
.1 Submit complete procedures for all elements of the mechanical work including; demolition, fabrication, assembly, installation, and testing. Include all steps required to perform the work with supporting drawings, pictures, catalog cuts, and calculations. Include design details for any temporary or permanent structures, supports, or material handling systems required to perform the work. The designs for such systems shall be signed and sealed by an engineer licensed in the province of Ontario. Fully detail the means and methods that will be used to perform the work. Include staffing requirements and the duration of time required to perform each element of work.

1.7 QUALITY ASSURANCE

.1 Products used in this Work shall be produced by manufacturers regularly engaged in the manufacture of the specified products.

.2 Where two or more units of the same class of equipment are required, these units must be products of the same manufacturer.

.3 For the fabrication, installation, cleaning, aligning, testing, and all other Work required for the mechanical systems, use adequate numbers of skilled, trained, and experienced Heavy Machinery Mechanics.

.4 The installation of the machinery shall be directly supervised by a representative of the Heavy Machinery Manufacturer.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Delivery, storage, and handling of materials and equipment shall be in strict accordance with manufacturer's recommendations.

.2 Coat finished metal surfaces and unpainted metal surfaces that might be damaged by corrosion as soon as practical after disassembly or finishing with a corrosion - preventative compound. Remove coating from all surfaces prior to assembly and painting after installation.

.3 Protect all machinery parts from weather, dirt and all other injurious conditions during disassembly, manufacture, shipment and while awaiting erection. Protect all shaft journals that are shipped disassembled from their bearings or hubs during shipment and before erection by a packing of oil-soaked fabric secured in place by burlap and covered with heavy metal thimbles or heavy timber lagging securely attached. Take every precaution to ensure that the journal surfaces will not be damaged and that all parts shall arrive at their destination in satisfactory condition.

.4 Mount assembled units on skids or otherwise crated for protection during handling and shipment.

.5 Store all mechanical components indoors in a climate controlled environment. Store in a clean, dry location with factory packaging intact, and with as nearly a constant temperature as possible. Elevate a minimum of six inches (152 mm) above the floor level. Avoid areas that are subject to extremes in temperature, vibrations, and humidity.

.6 If the gearboxes are to be stored more than 30 days, fill units completely to the top of the housing with the recommended oil type for operation of the unit. Eliminate any air pockets. Rotate the high speed shaft slowly by hand a minimum of eighty revolutions, at least once every four weeks. Inspect unit periodically and spray or add rust inhibitor suitable for anticipated storage conditions, as required. Before start-up, lower the oil level to the correct operational level.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 All equipment and materials furnished under the items specified herein shall be new. All new equipment, materials and workmanship shall be first class in every particular, and shall be manufactured and installed to the satisfaction of the Departmental Representative.

2.2 FORGINGS

.1 All forgings shall be reduced to size from a single bloom or ingot until perfect homogeneity is secured. The blooms or ingots shall have a cross-sectional area at least three times that required after finishing. No forging shall be done at less than a red-heat. Forged rounds for shafts shall be true, straight, and free from all injurious flaws, seams, or cracks. Forgings shall provide adequate material allowance for machining to finish dimensions. All forgings shall be thoroughly annealed before being machined.

.2 All shafts shall be accurately finished, round, smooth, and straight; and when turned to different diameters, they shall have rounded fillets at the shoulders. All journal bearing areas on shafts and pins shall be accurately turned, ground, and polished with no trace of tool marks or scratches on the journal surface or adjoining shoulder fillets. Journal diameters shall be finished to the limits specified in CAN/CSA-S6-06 requirements.

2.3 STRUCTURAL STEEL

.1 Steel components of manufactured items shall conform to the materials recommended by the manufacturer in accordance with Section 05 12 00.

.2 Provide suitable supports, structurally adequate. Structural steel for machinery pedestals shall meet the requirements of ASTM A709/A709M.

.3 Mill top surfaces of all new supports after fabrication to provide a uniform surface. All surfaces requiring milling shall have adequate material allowance for milling to the minimum finish dimensions required.

2.3 STRUCTURAL STEEL (Cont'd)

.4 Weldments for machinery base supports shall be neat and shall have all exposed sharp corners and edges removed. Mounting surfaces of the frames shall be straight and flat such that full contact with the equipment being supported is obtained.

.5 All welding required herein or called for on the plans shall be done in accordance with the requirements of AWS D1.5M/D1.5-2002.

.6 Treat all welding and weldments supporting machinery as main members and all welding as joining primary components. All welds shall be performed and inspected as welds subject to both tension and compression.

.7 Weldments shall be stress relieved by heat prior to final machining. The fitting up and welding procedure shall be such that distortion of the work will be a minimum. If necessary to obtain this result, suitable welding fixtures shall be used.

.1 Submit welding procedures, together with the working drawings for the parts to the Departmental Representative for review.

.8 Inspect all welds by magnetic particle tests on at least 10% of the length of each size and type weld. Location of tests shall be selected at random so as to be typical for each size and type of weld. Inspection of welds and basis of acceptance shall be in accordance with the requirements of Section 6 of AWS D1.5M/D1.5-2002.

.9 Stress relieve all welds by peening unless otherwise indicated within the Contract Documents or unless specific written permission is granted to omit the peening process for each particular weld.

.1 Submit proposed weld procedures for all field welds. Proposed peening procedures will be required to be included in the weld procedures before approval will be granted. In addition, any existing structural steel being field welded shall be tested to determine its chemical composition. Consider the actual chemistry of the existing steel when developing the proposed field welding procedures. The chemistry of each and every existing plate or shape shall be determined. No field welding shall begin until the reviewed weld procedures are available.

2.4 GEARBOXES

.1 Gearboxes shall comply with CAN/CSA-S6-06 Section 13.8.17.6.4.

.2 Manufacture gearboxes and designed to meet all the requirements of ANSI/AGMA 6013-A06 (R2011). The AGMA durability ratings shall be based on a torque equal to 250% of the rated full load torque of the main drive motor and the auxiliary drive motor respectively. In addition, no component or element of the gearbox shall be stressed to more than 75% of the material yield strength at 285% of the required name plate torque.

.3 Provide stainless steel nameplates permanently affixed to the gearboxes. The nameplates shall give the rated horsepower, exact ratios, input and output speeds, service factor, thermal rating, and AGMA symbols.

.4 Housings shall be cast steel or welded plate. Stress relieve welded housings. Provide inspection ports for inspection of all gears, bearings, clutches, and other internal components. Locate the ports above the oil level so that draining is not required for inspection. Size the ports such that minor repairs can be made to the gearboxes without requiring housing disassembly. Properly sealed ports with seals that do not have to be replaced when the ports are opened.

.5 Gearbox bearings shall be of the rolling element type and shall have an L-10 life of 40,000 hours.

.6 Gearing shall be through hardened and shall conform to an AGMA accuracy of A7 or better for spur, helical, and herringbone gearing and an AGMA Class Q8 or better for bevel gearing.

.7 Mount oil level indicators in locations that can be easily viewed by maintenance personnel. Vent the indicator back to the gearbox.

.8 Locate oil drains at the lowest point possible.

.9 Locate oil sampling cocks in accessible positions on the gearboxes. Provide two sampling cocks, one located at the lowest level of oil and one located just below the upper oil level.

.10 Bearings which are grease lubricated shall be fitted with grease fittings readily accessible by maintenance personnel. Internal seals between

2.4 GEARBOXES (Cont'd)

.10 (Cont'd)
the bearing housing and the gear oil shall prevent interaction between them.

.11 A bath lubrication system shall be used. All components in the gearbox requiring lubrication shall be partially submerged in the oil bath.

.12 Provide dual lip spring loaded seals for shaft extensions. Provide grease and relief fittings for greasing between the lip seals.

.13 Install couplings and brake wheels on the shafts in the gearbox manufacturer's shop.

.14 The primary main drive gearboxes shall have a load equalizing differential at the output shaft that can be locked and unlocked by an electrically operated clutch.
.1 The clutch shall operate from the bridge's control console.
.2 The clutch must engage and disengage in any shaft position.
.3 The operating mechanism for the clutch must be manually lockable in the engaged and disengaged positions.
.4 The clutch must be capable of operating (engaging and disengaging) with the gear box loaded to 180% of the rated full load motor torque of the main drive motor.
.5 The clutch shall be operated with an electric actuator.
.1 The actuator shall have a short lead Acme screw that will prevent back driving.
.2 The actuator shall be actuated by a 600 Volt, 3 phase, 60 Hz motor.
.3 The actuator shall be pinned at both ends.
.4 The rated stalled thrust of the actuator shall not be less than 150% of the thrust actually required to release the clutch with the gearbox loaded to 180% full load torque of the main drive motor.
.5 Each gearbox shall be supplied with a spare electric actuator for the differential clutch.

.15 The primary main drive gearboxes shall have a manually operated clutch for engaging the auxiliary drive.
.1 The operating mechanism must lock in the engaged and disengaged positions.
.2 The clutch must engage and disengage in any shaft position.

2.4 GEARBOXES (Cont'd)

.15 (Cont'd)
.3 The clutch must be capable of operating (engaging and disengaging) with the gear box loaded to 180% of the rated full load motor torque of the auxiliary drive motor.

.16 Manufacture each gearbox as left-hand and right-hand as indicated on the Contract Documents.
.1 Left-hand gearboxes shall have the auxiliary motor mounted on the left side of the gearbox.
.2 Right-hand gearboxes shall have the auxiliary motor mounted on the right side of the gearbox.

2.5 BRAKES

.1 Motor brakes and motor brake wheels shall be manufactured by Mondel Engineering. Brakes shall be shoe type with an electro/hydraulic thruster type actuator; AC thruster type shoe brake, spring set and electrically released.

.2 Supply brakes completely assembled with type "Ed" thruster actuator.

.3 Motor brakes shall have a maximum torque rating of 700 ft-lbs (950 Nm). Brakes shall be factory set at 475 ft-lbs (645 Nm).

.4 The Hy-Thrust actuators must be type "Ed" actuator.
.1 The actuator shall be actuated by a 600 Volt 3 phase 60 Hz, totally enclosed, squirrel cage ball bearing motor with moisture proof windings and cast-iron conduit box.
.2 The actuator motor shall be of ample capacity for the intended application.
.3 The rated stalled thrust of each actuator shall be not less than 135% of the thrust actually required to release the brake with the torque adjusted to the maximum continuous rated value.
.4 Brakes are to set automatically when for any reason power is removed from the actuator motor.

.5 Oil used in the thruster-operating chamber of the brake shall be hydraulic oil specifically recommended by the thruster manufacturer for low temperature operation. It shall have a free operating temperature range between -13°F (-25° C) and 122°F (50°C). Throughout this temperature

2.5 BRAKES (Cont'd)

.5 (Cont'd)
range there shall not be any material change of operating characteristics.

.6 All thrusters shipped, either mounted or as a spare, must be filled with hydraulic fluid at the factory prior to shipment.

.7 The external thruster material shall be aluminum for light-weight and corrosion protection.

.8 Thruster motors shall be rated for inverter duty operation. The motor shall be located in a separate dry section of the thruster, and air-cooled. Motors immersed in oil are not acceptable.

.9 Each type "Ed" thruster shall be supplied with independent time delay valves adjustable between 0 and 5 seconds for both setting and releasing the brake. Only an internal time delay valve constructed of stainless steel is acceptable. Adjustment must be infinitely adjustable between the minimum and maximum settings. These adjustments must be allowable with the brake in full service. A single time delay for both setting and releasing is not acceptable. The release delay shall be factory set at one second. The set delay shall be factory set at three seconds. The reserve stroke of the actuator shall be properly set at the factory.

.10 Provide each brake with a manual release lever and a latching type device for holding the brake in the released position.
.1 Mount hand release attachment permanently on the brakes and arrange so that the brake can be released easily and quickly without the use of apparatus not permanently attached to the brakes. Hand release shall not affect any torque setting or brake adjustment.
.2 Hand release shall be capable of being released without removing the brake cover.
.3 Mechanism shall latch in both the released and non-active positions.
.4 It shall provide, at a minimum, 90% of the power release stroke and not inhibit the working stroke of the actuator when fully retracted.

.11 Each brake shall contain 3 lever type limit switches for use in control and indicating circuits.
.1 The limit switches shall be oil and watertight (NEMA 4).

2.5 BRAKES (Cont'd)

.11 (Cont'd)

.2 All limit switches shall be NEMA rated and have two N.O. and two N.C. contacts.

.3 One limit switch shall actuate on positive setting of the brake shoes on the drum to indicate brake fully set.

.4 The second limit switch shall actuate on positive electrical release of the brake to indicate that the brake is electrically fully released.

.5 A third limit switch shall actuate when the latching hand release is engaged to indicate that the brake is manually released.

.12 Each brake shall be furnished with an enclosed external torque spring.

.1 This shall provide stepless torque adjustment down to 40% of the maximum brake torque. The actual setting must be visible from permanently mounted calibrated torque indicator provided on the torque spring assembly. The calibrated torque indicator shall be stainless steel or brass. At a minimum the torque indicator shall show the maximum, minimum, and recommended torque settings. The indicator shall show evenly space graduations between the minimum and maximum torque settings.

.13 Include Auto Equalization to insure that the brake shoes and brake wheel have an equidistant air gap between them. Auto equalization shall be adjusted by the brake manufacturer.

.14 Brakes shall not have an automatic adjustment for lining wear.

.15 Stainless steel or brass nameplates permanently affixed to each brake must be engraved with, but not limited to, the following information:

.1 Manufacturer.
.2 Model number.
.3 Maximum rated brake torque.
.4 Recommended brake torque.
.5 Brake lining material.
.6 Recommended reserve stroke setting.

.16 Stainless steel or brass nameplates permanently affixed to each brake actuating device must be engraved with, but not limited to, the following information:

.1 Manufacturer.
.2 Model number.
.3 Push capacity of actuator.
.4 Stroke of the actuator.
.5 Volts, phase, Hz, watts.

2.5 BRAKES (Cont'd)

.16 (Cont'd)
.6 Type of fluid required in reservoir.

.17 Information provided on nameplates and torque scales shall be shown in imperial units.

.18 Brakes shall be manufactured as left-hand and right-hand as shown on the Contract Documents.
.1 Left-hand brakes shall have the torque scales and manual release on the left side of the brake.
.2 Right-hand brakes shall have the torque scales and manual release on the right side of the brake.
.3 Two left-hand brakes and three right-hand brakes shall be provided.
.4 Supply one right-hand brake as a spare.

.19 Motor brake wheels shall be ASTM A536-84(2009)grade 65-45-12 ductile iron. This alloy must have a minimum tensile strength of 65,000 psi (448 MPa), minimum yield strength of 45,000 psi (310 MPa) and 12% elongation in 2 inches (51 mm). Steel and cast grey iron wheels are NOT acceptable. Motor brake wheels shall have a nominal 15 inch (381 mm) diameter.

2.6 COUPLINGS

.1 All couplings and shaft fits and finishes: to CAN/CSA-S6-06. Couplings shall, in general, be finish-bored and have keyways cut by the coupling manufacturer to dimensions and tolerances established on the shop drawings and then shipped to the manufacturers of the various components for shop installation on the shafts.

.2 Couplings shall have provisions for lubricating all contact surfaces and the housings shall be oil-tight under all operating conditions.

2.7 KEYS AND KEYWAYS

.1 New keys and keyways shall be provided between couplings, hubs, wheels, or clutches and their respective shafts. Key material shall conform to the requirements of ASTM 668/A668M-04(2009).

.2 Keys and keyways shall conform to the dimensions and tolerances for square keys of ANSI B17.1-1967(R1998).

.3 All keys shall be effectively held in place, preferably by setting them into closed-end keyways milled into the shaft. The ends of all

2.7 KEYS AND KEYWAYS (Cont'd)

.3 (Cont'd) such keys shall be rounded to a half circle equal to the width of the key.

2.8 SHIMS

.1 Where required for leveling and alignment of equipment, machinery shims packs shall be neatly trimmed to the dimensions of the assembled parts and drilled for all bolts that pass through the shims. In general, sufficient thickness shall be furnished to secure 0.003 inch (0.076 mm) variations of the shim allowance plus one shim equal to the full allowance. Spare shim packs shall be provided for each individual components. The material for the shim packs shall conform to the requirements of ASTM A666-10.

2.9 FASTENERS

.1 Bolts, nuts, studs, cap screws, and washers shall meet the requirements of CAN/CSA-S6-06 Section 13.8.17.8., except where otherwise called for herein.

.2 All bolts for connecting machinery parts to each other or to supporting members shall be either high-strength bolts or structural turned bolts.

.3 High strength turned bolts shall meet the requirements of CAN/CSA-S6-06 Section 13.8.17.8. for high strength turned bolts.

.4 All nuts shall be hexagonal and finished meeting the requirements of ASTM A563-07a. Two nuts and two flat-washers shall be used on all bolts. Washers shall meet the requirements of ASTM F436-11.

.5 Structural turned bolts shall meet the requirements of CAN/CSA-S6 Section 13.8.17.8. for finished high strength bolts.

.6 Positive locks shall be furnished for all nuts. If double nuts are used, they shall be of standard thickness. Double nuts shall be used for all connections requiring occasional opening or adjustment.

2.10 LUBRICATION, LUBRICANTS AND CHARTS

.1 Fit all locations requiring grease lubrication for a pressure system of lubrication using button head fittings of the same type and size as currently used on the bridge.

.2 Locate all grease fittings conveniently for greasing. If necessary, they shall be connected to the points requiring lubrication from convenient lubrication stations by 3/8 inch (9.5 mm) galvanized steel piping with a minimum bursting pressure of 12,000 psi (83 MPa).

.3 Securely supported all pipe and locate so that it shall be protected from injury and excessive vibration.

.4 Install all lubricating equipment in perfect working condition.

.5 Where multiple lubrication fittings are tied into one station each fitting shall identify its point of lubrication by being labelled. Labels shall be made of laminated micarta or textolite with chamfered edges, and shall be engraved to show black letters on a white background. They shall be mounted with stainless steel screws.

.6 Furnish sufficient lubricant to provide for the initial lubrication of each component on the structure requiring lubrication and such additional lubricant for normal maintenance requirements for a period of at least one year.

.7 Furnish all equipment necessary for routine maintenance lubrication of the equipment on the bridge. Each grade or class of grease shall be provided with its own separate grease guns or other equipment normally used for application of the lubricant. Coordinate the grease requirements with the various suppliers to attempt to limit the different greases to no more than two. Furnish two cartridge style grease guns suitable for the furnished lubrication fittings. Each grease gun shall be provided with a fitting suitable for the grease fitting installed. If more than one type of grease fitting is used for the same lubricant, grease applicators shall be provided for each type of fitting. Each device shall have a permanently attached nameplate listing the specific lubricant within.

.8 Store maintenance lubricants where specified by the Departmental Representative.

2.11 PAINT

.1 Paint all surfaces of the new operating machinery using a system conforming to all requirements stated elsewhere for Painting of Structural Steel.

.2 All unfinished machinery surfaces shall be made free of all chips, dirt, rust, scale, sand, grease, and other foreign matter by sandblasting, wire brushing, or other approved means.

.3 After proper surface preparation, all unfinished machinery surfaces, except for those inside gearbox housings, shall be given one shop coat of primer.

.4 After installation is complete, all machinery surfaces remaining exposed, except rubbing surfaces, shall be thoroughly cleaned and given two field coats of paint.

.5 After completion of the operating tests and acceptance of the machinery, all accumulated oil, grease, dirt, and other foreign matter shall be solvent cleaned from exposed machinery surfaces, except rubbing surfaces.

.6 Nameplates on all manufacturer's components shall be readable, clean and free of all paint before acceptance of the machinery.

2.12 NON-SHRINK EPOXY LEVELING GROUT MATERIAL

.1 Non-shrink epoxy leveling grout for use under machinery supports shall be a high flow pumpable epoxy designed for long-term support and alignment of industrial machinery. The grout shall have the following properties:

.1 Pour Depth: 1 - 4 inches (25 mm - 102 mm) per manufacturer's literature.

.2 Minimum Compressive Strength: 12,000 psi (83 MPa) per ASTM C579-01(2012) MOD.

.3 Linear Shrinkage: less than 0.0001 in/in per ASTM D-2566-86.

.4 Minimum Bond for Steel: 2,000 psi (14 MPa) per ASTM D1002-10.

.5 Minimum Bond for Concrete: 1,500 psi (10 MPa) per ASTM C882/C882M-12.

.6 Approximate cure rate of 3,000 psi (20 MPA) at 70°F (21°C) in 24 hours or faster per manufacturers literature.

.7 Approximate Minimum Working Time: 120 minutes per manufacturers literature.

.8 Application Temperature: 60°F - 90°F (15°C - 32°C) per manufacturers literature.

2.12 NON-SHRINK EPOXY LEVELING GROUT MATERIAL (Cont'd)

.1 (Cont'd)
.9 Minimum Service Temperature: 120°F (49°C) per manufacturers literature.

.2 Store and apply grout in strict accordance with manufacturers recommendations. Finish exposed grout of grout pads smooth and free of sharp edges, breaks, or trip hazards. Provide a minimum of 1 ½ inches (38 mm) chamfers on all exposed edges and corners.

2.13 TESTS AND INSPECTIONS

.1 Give two weeks notice to the Departmental Representative prior to the beginning of work at the foundries, forge, and machine shops so that inspection may be provided. No materials shall be cast, forged, or machined before the Departmental Representative has been notified where the orders have been placed.

.2 Furnish all facilities for the inspection of material and workmanship in the foundries, forge, and machine shops; and the Departmental Representative shall be allowed free access to necessary parts of the premises. Work done while the Departmental Representative has been refused access will automatically be rejected.

.3 The Departmental Representative shall have the power to reject materials or workmanship, which do not fulfill the requirements of these Contract Documents.

.4 Inspection at the foundries, forge, and machine shops is intended as a means of facilitating the work and avoiding errors; and it is expressly understood that it will not relieve the Contractor from any responsibility in regard to imperfect material or workmanship and the necessity for replacing the defective materials or workmanship.

.5 Furnish the Departmental Representative with as many copies of orders covering work as the Departmental Representative may direct.

.6 Furnish test specimens, as specified herein, and all labour, testing machines, tools, and equipment necessary to prepare the specimens and to make the physical tests and chemical analyses. Copies of all test reports and chemical analyses shall be furnished to the Departmental Representative.

2.13 TESTS AND INSPECTIONS (Cont'd)

.7 The acceptance of any material or finished parts by the Departmental Representative shall not bear their subsequent rejection if found defective. Rejected material and workmanship shall be replaced or corrected by the Contractor in a manner satisfactory to the Departmental Representative at no additional cost.

.8 Shop and field testing of materials and components shall demonstrate compliance with the Contract Documents, and applicable standards.

2.14 BRAKE SHOP TESTING AND INSPECTION

.1 Submit detailed procedures for shop testing of the brakes for review by the Departmental Representative. Shop testing shall not commence until comments have been resolved.

.2 Inspect and test all brakes in the manufacturer's shop prior to shipment in accordance with approved written procedures. Contractor shall give no less than ten (10) working days notice to the Departmental Representative of when the brakes will be ready for inspection and testing. All brakes shall be inspected and tested at the same time. For each brake, the Contractor shall successfully demonstrate the following:

.1 Proper adjustment of the engage and disengage delays.

.2 Proper adjustment of the actuator reserve stroke.

.3 Proper fluid level in the actuator.

.4 Proper adjustment of the shoe gap and auto equalization.

.5 Proper function of the manual disengage mechanism with locking in both the engaged and manually disengaged position.

.6 Proper electrical and mechanical function of the limit switches.

.7 Proper calibration of the torque scale shall be demonstrated by establishing the accuracy of the maximum rated holding torque, 40% of the maximum rated holding torque, and design holding torque scale readings. The measurements shall be repeated no less than ten times at each of the three scale readings for each brake. The measured static holding torque measurements shall be within 5% of the torque scale reading for all ten measurements at all three scale positions. All testing shall be performed on calibrated rotating testing equipment. The brake shall set to the required torque. The testing equipment shall increase the

2.14 BRAKE SHOP TESTING AND INSPECTION (Cont'd)

.2 (Cont'd)

.7 (Cont'd)

torque on the drum until the drum begins to rotate. The testing equipment shall record the maximum static break-away torque at the point the drum begins to rotate.

.3 Upon successful completing of testing, the brake manufacturer shall set the brake to the required as-installed torque setting and provide a certificate of compliance. The certificate of compliance shall show the date, final brake torque setting, final set and release delay settings, final actuator reserve stroke setting, actuator fluid level, final shoe gap measurements, brake serial number, and all measured torque values. The certificate must certify that the brake has been properly adjusted and passed all tests before leaving the factory.

2.15 GEARBOX SHOP TESTING AND INSPECTION

.1 Prior to operational testing, the gearbox manufacturer shall apply bluing compound to demonstrate proper gear tooth contact. A machinist bluing compound shall be applied to all gear teeth. The bluing compound shall be of the type that indicates face contact through the removal of the compound during operation. The manufacturer shall use hard dykem blue for tooth contact testing. The type of bluing compound to be used for face contact measurements shall be submitted to the Departmental Representative for review prior to testing. Tooth contact shall be evaluated after load testing. No tooth shall indicate a face contact of less than 85% of the full width of the tooth. Contact shall be documented with digital photographs.

.2 The gearbox manufacturer shall shop test each gearbox by running it at the rated operating speed in the presence of the Departmental Representative. The tests shall be run with the electric actuator for the differential clutch installed. This test shall be run with the gearbox filled to the recommended mark with new oil of the viscosity the manufacturer recommends on his lubrication chart for normal operation. Immediately before the start of the test, and at fifteen minute intervals thereafter, the following measurements shall be made and

2.15 GEARBOX SHOP TESTING AND INSPECTION (Cont'd)

.2 (Cont'd)
recorded and the records shall be submitted with the Certificate of Compliance:
.1 Temperature of ambient air.
.2 Temperature of oil near bottom of crankcase.
.3 Surface temperature of each shaft extension adjacent to shaft seal.
.4 Surface temperature of each bearing cap.
.5 Sound level on each of the four sides at a point one meter distant from the side surfaces of the unit (four measurements).
.6 All input and output shaft speeds.

.3 The test shall be run for two hours of continuous operation as follows:
.1 One hour as follows:
.1 Forward direction.
.2 Power applied at first main input shaft extension at no load.
.3 Differential locked.
.2 One hour as follows:
.1 Forward direction.
.2 Power applied at first main input shaft extension at no load.
.3 Differential unlocked.

Monitor shaft speed continuously during testing. With the differential locked, there shall be no detectable difference is shaft speed between the two output shafts at anytime during testing.

Repeat test in the reverse direction with input at the second shaft extension. The auxiliary drive shall then be tested at no load and full rated speed for one hour in each direction (two hours of continuous operation).

Demonstrate proper operation of the differential during testing by varying the speed of the output shafts by at least 10% to allow the differential to slip. For this testing, the differential shall be locked and unlocked using the electric actuator. The differential shall be allowed to slip for at least five minutes. This differential testing shall be performed in both directions for both the no load and load testing.

.4 During testing, each gearbox shall be checked for unusual noise (thumping, pinging or any non-uniformity), excessive shaft movement and any other unusual operating characteristics. The shop testing should be done with components oriented in a similar position and supported in

2.15 GEARBOX SHOP TESTING AND INSPECTION (Cont'd)

.4 (Cont'd)
the same manner as the final construction installation. The units shall operate smoothly, and without excessive vibration or temperature rise. All malfunctions shall be recorded and corrected, and the units retested before release from the manufacturer's shop.

.5 The temperature of the oil shall not rise more than 55°F (30°C) from the ambient during this test and no shaft shall experience a temperature rise more than 70°F (40°C) from the ambient. The noise level of the reducer shall not exceed 90 decibels with a sensor held 3-feet (1-meter) from the reducer housing. The gearboxes shall not leak.

.6 Upon completion of the initial operational testing the internal components of the gearbox shall be visually inspected. The gear teeth and bearings shall not exhibit any noticeable evidence of wear or damage including; pitting, scoring, scratching, cracks, or plastic flow.

.7 After successful completion of the initial tests, the testing shall be repeated by running each gearbox at 180% rated full load motor torque of the main drive and auxiliary drive motors respectively. The same inspection and measurements shall be performed as in the initial testing. Inspections criteria are the same for both series of tests. All malfunctions or operation out of allowable specifications shall be recorded and corrected, and the units retested satisfactorily before released from the manufacturer's shop. After the units have passed the tests, a Certificate of Compliance for each gearbox shall be submitted to the Departmental Representative.

.8 The proper operation of the lubricating system shall be demonstrated during the shop test.

.9 The gearbox manufacturer shall demonstrate proper function of the differential locking/unlocking clutch, electric actuator and the auxiliary drive engagement/disengagement clutch. The gearboxes shall be loaded with the differential locked at 180% rated full load torque and then electrically unlocked under load. The load shall be removed and one output shaft extension rotated through three complete revolutions while preventing the other output shaft extension from rotating. The load shall be reapplied and then the differential electrically

2.15 GEARBOX SHOP TESTING AND INSPECTION (Cont'd)

.9 (Cont'd) locked under load. The output shaft shall then be rotated through three complete cycles. This test will be repeated five times to demonstrate proper operation of the differential clutch.

.10 The auxiliary drive clutch will be tested in the same manner. The auxiliary drive shall be engaged and loaded at 180% rated full load torque of the auxiliary motor and then the auxiliary drive clutch will be disengaged under load. The auxiliary drive clutch input shaft shall then be rotated through five complete revolutions. The auxiliary drive shall be reengaged and the input shaft rotated through five complete revolutions. The test shall be repeated five times to demonstrate proper operation of the auxiliary drive clutch.

.11 Install the gearbox permanent coupling hubs and brake wheels in the gearbox manufacturer's shop. Run the gearbox at full speed under no load for fifteen minutes in each direction with the hubs and wheels installed. During testing, check each gearbox for unusual noise (thumping, pinging or any non-uniformity), excessive shaft movement and any other unusual operating characteristics. The units shall operate smoothly without excessive vibration. Record and correct all malfunctions. Retest the units before release from the manufacturer's shop. Repeat the no load testing with hubs and wheels installed with the auxiliary drive engaged. Run the gearbox at full speed of the auxiliary drive for fifteen minutes in each direction. The same evaluation criteria shall apply.

2.16 SPAN BALANCE

.1 Measure the balance condition using the dynamic strain gauge method as described under Balance Testing prior to any construction activities.

.2 Construction activities shall not affect the balance condition of the bridge. No materials shall be placed or stored on the movable span or counterweights at anytime except for aerial cables during demolition and installation and on a case by case basis with prior authorization by the Departmental Representative. The movable span and counterweights shall not be used as anchors for hoisting materials at anytime.

.3 Measure the balance condition of the bridge during initial functional testing of the span.

2.16 SPAN BALANCE (Cont'd)

.3 (Cont'd) The balance condition shall be checked by implementing the same equipment, methods, and procedures used to test the balance condition prior to construction.

.4 Make any necessary adjustment to the counterweights required to achieve a balance condition equal to that measured prior to construction (plus or minus 5%). Following each balance adjustment, the contractor shall repeat the balance testing to verify the balance condition. The contractor shall repeat the adjustments and testing until the desired balance condition has been achieved.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install the new machinery specified and as approved on the shop drawings and related electrical equipment according to best millwright practice. Submit detailed procedures for installation of the machinery for review by the Departmental Representative. Installation shall not commence until comments have been resolved.

.2 Coordinate the work with subcontractors to provide for the necessary shop assembly and field installation of all the equipment. Machinery Manufacture and installation shall conform to all applicable requirements in CAN/CSA-S6-06 and all applicable requirements with special requirements and additions as specified herein.

3.2 SUGGESTED CONSTRUCTION SEQUENCE

.1 Field verify all dimensions prior to the start of any and all work.

.2 Shop drawings, work plans, and test procedures to be submitted prior to the commencement of of any work.

.3 All mechanical equipment to be fabricated, shop tested, and staged prior to bridge shutdown.

.4 Construction tools, grout, paint, lubricants, and miscellaneous equipment to be staged at the jobsite prior to shutdown.

3.2 SUGGESTED CONSTRUCTION SEQUENCE (Cont'd)

.5 Access platforms, safety netting, temporary structural supports, and material handling equipment to be installed prior to bridge shutdown.

.6 Gearbox pedestals, motor pedestals, brakes, brake wheels, and couplings may be staged in the motor room as indicated on the structural plans prior to bridge shutdown.

.7 Once the bridge has been shut down for the season, contractor to work continuous shifts around the clock until the new equipment is installed and the bridge is fully operational. Work shall be performed on both towers simultaneously.

.8 The bridge shall be fully lowered with the span locks locked. Span locks shall be electrically locked out to prevent accidental operation.

.9 Release all existing brakes to allow the drive machinery to relax and dissipate any residual torque in the system. Manually rotate motor shafts with strap wrench or similar to achieve backlash on both sides of gear teeth in primary gear set to insure no potential energy remains in the drive system.

.10 Remove existing mechanical equipment as indicated on the mechanical demolition plan.

.11 Measure floating shafts to be reused and have keys and gear couplings finish machined to match.

.12 Prepare the motor room and sheave room floors for the new equipment in accordance with the structural plans.

.13 Perform initial installation and alignment of mechanical equipment using undersized mounting holes and fasteners. Equipment to be installed in the following order:

.1 Gearbox pedestal.
.2 Gearbox.
.3 Floating shaft coupling assemblies.
.4 Machinery brakes.
.5 Motor pedestals.
.6 Motors.
.7 Motor brakes.

.14 Perform final alignment of mechanical equipment working backwards from floating shaft couplings.

3.2 SUGGESTED CONSTRUCTION SEQUENCE (Cont'd)

.15 Final drill and ream mounting holes.

.16 Pour grout pad under motor pedestals.

.17 Final tension mounting fasteners.

.18 Mount auxiliary drive motor.

.19 Lubricate all equipment.

.20 Perform static field inspection and testing.

.21 Perform dynamic field inspection and testing.

.22 Repair motor room and sheave room floor in accordance with structural plans.

.23 Paint all equipment.

.24 Remove temporary access platforms, safety netting, temporary structural supports, and material handling equipment.

.25 Submit as-built documentation. Submit operation, inspection, and maintenance manuals.

.26 Perform training.

3.3 PREPARATION

.1 The Contractor shall remove and dispose of the existing operating machinery; furnish and install new machinery; align, adjust and paint as required all mechanical components in accordance with the Contract Documents so that the bridge will be placed in satisfactory operating condition.

.2 Where removal of material is called for, such materials and equipment shall become the property of the Contractor and shall be legally disposed of off site.

.3 Protect existing equipment form damage or displacement.

3.4 FIELD TESTING AND INSTALLATION

.1 Prior to any work being performed on the machinery, the Contractor shall submit for review a detailed mechanical work procedure. This procedure shall give in detail the methods for installation and testing of new machinery. Procedures shall include duration of time involved with the work and shall show

3.4 FIELD TESTING AND INSTALLATION (Cont'd)

.1 (Cont'd)
coordination with structural, electrical and architectural work which will be coinciding with the mechanical work.

.2 Install all parts of the machinery in accordance with installation marks and match marks. Before final drilling or reaming, all parts shall be adjusted to exact alignment by means of shims furnished for each part. Align components to the installation tolerances listed in the coupling manufacturers regularly published literature. After final alignment and bolting, all parts shall operate smoothly.

.3 Bolt holes in structural steel for connecting machinery shall, in general, be drilled from the solid after final alignment of the machinery. Sufficient installation holes, sub-drilled 1/4 inch (6 mm) undersize for undersize temporary bolts, may be used for installation and alignment of the machinery. After the machinery has been aligned in its final position, full-size holes for the remaining bolts shall be drilled or sub-drilled and reamed, the full-size bolts installed, and the temporary bolts removed. The undersize holes used for temporary bolts shall then be reamed full size and full-size bolts installed.

.4 The machinery shall be installed and adjusted by competent mechanics skilled in the type of work involved. They shall be provided with all necessary measuring and leveling instruments as may be required including but not limited to dial indicators, feeler gauges, calipers, machinist levels, and laser alignment equipment. Contractor shall provide all necessary equipment and methods to the Departmental Representative to verify proper alignment of all machinery has been obtained to the satisfaction of the Departmental Representative.

.5 Install machinery with the utmost care in the field. Carefully place ropes, slings or other equipment used for installation to prevent scratches, abrasions or other damage.

.6 The alignment of all components shall be checked by the use of laser alignment tools, dial indicators, gauge blocks, and/or feeler gages both before and after final bolting up of the machinery in the presence of the Departmental Representative. Installation tolerances listed in the coupling manufacturer's

3.4 FIELD TESTING AND INSTALLATION (Cont'd)

.6 (Cont'd) regularly published literature shall be considered maximum values. The installation shall be such that the installed tolerances are no more than those recommended unless otherwise approved by the Departmental Representative. Any re-adjustment after final bolting required by the Departmental Representative in order to conform to this requirement shall be made by the Contractor at no additional cost.

.7 After installation is complete, make a thorough inspection to insure that all gears are clean and free of obstruction, that all parts are aligned and adjusted as closely as practicable without actual operation, and that all bolts are properly tightened. All gear housings shall be filled with lubricant to the proper level, and all rotating and sliding parts shall be supplied with lubricants recommended by the suppliers of the units.

.8 The lubricants listed on the lubrication charts shall conform to the recommendations of the Manufacturers of the units and shall be coordinated with the products normally stocked by the Departmental Representative. Information required from the Maintenance Department shall be obtained through the Departmental Representative.

.9 When the equipment is ready for testing, the operating machinery shall be operated through not less than six complete cycles.

.10 During the foregoing test runs, all parts shall be inspected to detect overheating, misalignment, or incorrect adjustment. All such defects shall be corrected at no cost to the Departmental Representative before final acceptance.

.11 Inspect and test all brakes in the field after installation and prior to operation in accordance with written procedures. Contractor shall give no less than ten (10) working days notice to the Departmental Representative of when the brakes will be ready for inspection and testing. All brakes shall be inspected and tested at the same time. For each brake, the Contractor shall successfully demonstrate the following:

.1 Proper adjustment of the engage and disengage delays.

3.4 FIELD TESTING AND INSTALLATION (Cont'd)

.11 (Cont'd)
.2 Proper adjustment of the actuator reserve stroke.
.3 Proper fluid level in the actuator.
.4 Proper adjustment of the shoe gap.
.5 Proper adjustment of the torque setting through the use of the torque scale.
.6 Proper function of the manual disengage mechanism with locking in both the engaged and manually disengaged position.
.7 Proper electrical and mechanical function of the limit switches.

.12 The contractor shall demonstrate proper operation of the gearboxes. Normal operation is with the differential locked. The contractor shall completely cycle the bridge six times to demonstrate proper operation. During each operation the bridge shall be stopped approximately 12 inches (305 mm) above the live load supports. The differential shall be unlocked and the bridge fully lowered. Once the bridge is fully lowered, the differential shall be locked. Operation of the differential locking mechanism shall be from the main control panel.

.13 The contractor shall demonstrate proper operation of the auxiliary drive. The bridge shall be fully cycle six times with the auxiliary drive. Between operations the auxiliary drive clutch shall be disengaged and reengaged.

.14 During testing, each gearbox shall be checked for unusual noise (thumping, pinging or any non-uniformity), excessive bearing clearance and any other unusual operating characteristics. The units shall operate smoothly, and without excessive vibration or temperature rise. All malfunctions shall be recorded and corrected, and the units retested.

.15 The temperature of the oil shall not rise more than 55°F (30°C) from the ambient during this test and no shaft shall experience a temperature rise more than 70°F (40°C) from the ambient. The noise level of the reducer shall not exceed 90 decibels with a sensor held 3-feet (1-meter) from the reducer housing. The gearboxes shall not leak.

.16 Upon completion of the operational testing the internal components of the gearbox shall be visually inspected. The gear teeth and bearings shall not exhibit any noticeable evidence of

3.4 FIELD TESTING AND INSTALLATION (Cont'd)

.16 (Cont'd) wear or damage including; pitting, scoring, scratching, cracking, or plastic flow.

.17 The proper operation of the lubricating system shall be demonstrated during the field test.

3.5 BALANCE TESTING

.1 Balance testing shall be performed at sunrise at a time with sustained winds below 10 miles per hour (16 kilometers per hour). Balance measurements shall be taken at each tower simultaneously. The contractor shall prepare a balance spreadsheet tool to quickly determine the affect of weight changes on span imbalance in preparation for calculating weight changes in the field. Two strain gauges shall be welded on each main pinion (P1) shaft. These are the main drive sheave pinions (four locations on each tower). The gauges shall be spaced 180 degrees circumferentially on the shafts and wired in a Wheatstone bridge configuration so as to measure torsion only. The gauges shall be connected to a data acquisition system capable of providing a permanent record of the strain in the shafts versus span position.

.2 Span position shall be recorded using an event marker mounted to an appropriate shaft. The output for the span position shall be recorded simultaneously and on the same data acquisition system with the imbalance strain.

.3 The data acquisition system shall be capable of recording and displaying the strain for each shaft separately and also providing the additive total strain for all shafts at any given point.

.4 The lift span shall be tested through at least three complete cycles and a permanent record of each test shall be maintained. The data collected shall be used to determine the overall span imbalance.

.5 Testing and all related balance calculations shall be performed by a professional engineer registered in the province of Ontario or by a professional engineer registered in the United States. The engineer shall have successfully conducted strain gauge testing and analysis on a minimum of five vertical lift bridges. A complete test procedure along with the resume of the engineer conducting the tests shall be submitted to the departmental representative for

3.5 BALANCE TESTING (Cont'd)

.5 (Cont'd)
review prior to testing. All comments on the procedure shall be resolved prior to testing. The test procedure shall include the following:
.1 Test method.
.2 List of equipment.
.3 Complete calculations.
.4 Report format.

.6 After the balance tests have been completed, the contractor shall submit a formal report signed and sealed by the professional engineer who conducted the tests. One report shall be submitted for the preconstruction testing and one report for the post construction testing. The reports shall include the following:
.1 Introduction.
.2 Test procedure and equipment.
.3 A figure identifying location of strain gages, relevant ratios and other imbalance variables.
.4 Method of analyzing recorded data.
.5 Discussion of results.
.6 Conclusions.
.7 Calculations deriving balance results from strain gauge data.
.8 Strip charts of raw strain gauge data (strain and span position versus time).
.9 Graphical representations of span balance and friction versus span position through the entire range of motion.

.7 Along with the report, the contractor shall provide the raw data used in the span balance analysis. This includes time, span position, opening leaf torque, closing leaf torque, imbalance, and friction, for each shaft, for each test run in Microsoft Excel format. Provide Excel tables of processed balance results. The following outputs will be provided:
.1 Opening leaf torque about sheave trunnion for each shaft.
.2 Closing leaf torque about sheave trunnion for each shaft.
.3 Total opening leaf torque about sheave trunnion.
.4 Closing leaf torque about sheave trunnion.
.5 Leaf imbalance torque about sheave trunnion.
.6 Leaf friction torque about sheave trunnion.

3.6 TRAINING

.1 Provide five (5) days of instruction to the Departmental Representative. The instruction shall include all aspects of inspection, maintenance, and operation of all machinery components including but not limited to the following:

.1 Normal maintenance.
.2 Checking and adding lubricants.
.3 Purging and replacing lubricants.
.4 Normal operation.
.5 Gearbox shaft seal replacement.
.6 Coupling seal replacement.
.7 Instrument drive adjustment.
.8 Adjustments to machinery components.

END