October 25, 2012

RFP #12-011

JOHNSON STREET BRIDGE REPLACEMENT PROJECT

ADDENDUM NO. 9

This Addendum is issued under Section 3.10 of the RFP.

1. In Schedule 3 – Draft Contract to the RFP delete Appendix E – Specifications as attached to the Draft Contract by Addendum No. 7 in its entirety and replace it with the attached Appendix E – Specification.

2. In Schedule 3 – Draft Contract to the RFP delete Appendix I – Supplementary General Conditions as attached to the Draft Contract by Addendum No. 7 in its entirety and replace it with the attached Appendix I – Supplementary General Conditions.

Yours Truly,

Keith Hennessey

Keith Hennessey,
Contact Person
This document has been compiled to describe the Architect’s requirements and should be integrated in the project specification completed by MMM Group.

All information to be read in conjunction with Structural Engineer’s Specification.

**Particular Interfaces**

a) Complete the Detailed Design of all interfaces with adjoining trades prior to commencement of manufacture.

b) Ensure that all interfaces are fully co-ordinated prior to commencement.

c) The Contractor shall be responsible for the accurate setting out of all works described herein relative to the superstructure and substructure of the bridge and its approaches at the abutments. This will require the determination of exact, consistent and specific modules for repeated elements.

d) Lighting units which are described in Design Drawings from the Lighting Designer and specified are to be installed beneath grilles, within barrier housings and luminaire housings and are to be generally coordinated with other finishes described herein. It is important that all electrical installation, including all associated wires and conduits are fully coordinated.
Clarification of materials referenced to within the Architectural Requirements.

Stainless steel (grade 1.4404 with a 2K finish and surface roughness of 0.5 microns Ra all to BS EN 10088)

<table>
<thead>
<tr>
<th>AISI Grade</th>
<th>EN</th>
<th>(old) BS</th>
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<tbody>
<tr>
<td>Grade 316L</td>
<td>1.4404</td>
<td>316S11</td>
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These are for guidance only (the exact equivalent should be checked against relevant EN Standards as we cannot accept responsibility for grade selection)

**Metal Components**

The Detailed Design of sections, material thicknesses and the dimensions shown on the Design Drawings shall be maintained within specified tolerances. All materials and components shall be durable and to the minimum standards set out in the Specification. For each material or component, the total quantity shall be obtained from the same supplier or manufacturer unless otherwise agreed with the Architect. All inaccessible steel shall be properly protected against corrosion for the design life of the Works. All support systems shall be of adequate thickness and strength, to meet the structural requirements and eliminate risk of distortion in finished surfaces. Protection shall be provided until handover to avoid any blemishes on the finished elements. Any cut edges shall be treated to ensure that the level of protection is maintained.

**Mild Steel**

Fabrication of steelwork shall be in accordance with the Specification. Before and after making permanent connections in frames and other structural elements, which are assembled before delivery to Site, the fit shall be checked for accuracy. Welding procedures shall be such that distortion is reduced to a minimum and local distortion rendered negligible in the final fabrication. Corrections, if necessary, shall be undertaken by a method which has been agreed to by the Architect. No welds other than those shown on the Working Drawings, even for temporary attachments or repairs, shall be acceptable unless agreed in advance by the Architect. Vent holes in hollow sections shall be sealed in a manner that shall prevent the ingress of moisture. The proposed method of achieving this requirement shall be submitted for review by the Architect. External visible lines and depressions caused by the internal welding of hollow section steelwork shall be positioned in the works so as to be non-visible.
Aluminium

Unless specified otherwise, aluminium sheeting shall be a minimum of 3mm thick; only appropriate grades, strengths and thicknesses of aluminium shall be used to ensure that all structural and finishing requirements of the Specification are met. The wall thicknesses of aluminium extrusions shall be sufficient to ensure their rigidity in the lengths required in the final installation. All exposed aluminium shall be protected with low tack adhesive film during construction and prior to handover. Where aluminium is to be anodised, aluminium sheeting and flat panels shall be manufactured using alloy grade J57S, or acceptable equivalent, and aluminium extrusions shall be manufactured using alloy grade 6063, or acceptable equivalent. Aluminium panels shall be manufactured such that the grain on each runs in the same direction. Issue "Die Drawings" to the Architect for review. These shall be considered as Working Drawings. The "Die Drawings" shall indicate polished surfaces and shape. Aluminium extrusions containing score lines resulting from poorly polished surfaces shall not be acceptable. Aluminium sheets shall not suffer bowing, dimpling, oil canning, sagging, pillowing, rippling, warp, abrupt transitions or other visible deformation or irregularity.

Stainless Steel

Unless otherwise specified, stainless steel shall be austenitic, non-magnetic, using either grade 1.4301 (304) or grade 1.4401 (316) to BS EN 10088 and BS EN 10095, BS EN 10029, BS EN 10048, BS EN 10051, BS EN 10258 and BS EN 10259 for plate, sheet and strip and Grade 1.4408 (316) or Grade 1.4308 (304) to BS EN 10283 for castings and also to BS 970 and BS EN 10084 where relevant. Specific grade designations shall be either as specified in the relevant sections of the Specification or, where not identified specifically, selected to meet the performance criteria specified for the particular element or components. Stainless steel fasteners, bolts, screws, nuts and other fixings shall be either grade A2 or grade A4 to BS EN ISO 3506: Parts 1 and 2. The property class of fastenings shall be selected to meet the performance requirements as specified.

Stainless steel castings:

Shall be of austenitic stainless steel and the casting alloy shall be determined by the Contractor to meet the requirements of the Specification but shall be equal or superior to grade 1.4408 with respect to corrosion resistance.

Shall be manufactured using the lost wax process or such other process as may be proposed by the Contractor and accepted by the Architect.

Exposed feeder ports and die lines shall not be acceptable in the finished castings.

The surface finish of the castings shall be determined by the submission of samples for review and acceptance by the Architect. Samples once accepted should be the standard required for all subsequent castings to be used in the works.
The surface roughness of the casting surface prior to any subsequent finishing process shall be SCRATA A2 (Steel Castings Research and Trade Association) or better.

Make allowance for two post production finishing processes to be utilised. The processes shall be agreed with the Architect and shall include blast finishes (including bead blasting) and electropolishing or acid pickling.

Timber
Timber species for slats to be Cumaru or acceptable equivalent. All timber to be heartwood only – sapwood will not be acceptable.

Main Structural Components

Tolerance
The Detailed Design of sections, material thicknesses and the dimensions shall be maintained within specified tolerances.

All materials and components shall be durable and to the minimum standards set out in the Specification.

For each material or component, the total quantity shall be obtained from the same supplier or manufacturer.

All inaccessible steel shall be properly protected against corrosion for the design life of the Works.

All support systems shall be of adequate thickness and strength, to meet the structural requirements and eliminate risk of distortion in finished surfaces.

Fabrication Generally
Fabricate components carefully and accurately to ensure compliance with the Design and the Specification.

Do not permit contact between dissimilar metals in components that are to be fixed where moisture may be present or occur.

Finished components shall be rigid and free from distortion, cracks, burrs and sharp arises. Moving parts shall move freely and without binding.

All corners and edges of all structural steelwork to receive a painted finish shall be finished with a 3mm radius.
Treatment of Stainless Steel Welds

Welds to visible areas of stainless steel shall be ground smooth to achieve a seamless surface. Heat tints shall be removed using light abrasives, pickling paste, wire brushing or similar to achieve continuity with the specified finish. Areas difficult to access shall be manually finished if necessary.

The contractor shall check that the residual section of steelwork at the weld following grinding is sufficient for loads to be transmitted.

Ponding

The Contractor shall develop their steelwork model for fabrication to ensure that there are no horizontal surfaces on any part of the bridge. Ponding on any surface shall not be acceptable.

Finishing Welded/Brazed Joints:

Visible butt joints in completed work shall be smooth, flush with adjacent surfaces.

Visible fillet joints in completed work shall be executed neatly. Grind smooth where specified. Where drawings indicate that a weld is to be ground flush, a belt-grinder is to be used. The contractor shall check that the residual section of steelwork at the weld following grinding is sufficient for loads to be transmitted.

Paint Colour:

The following items of structure shall be painted RAL 9001/RAL 9002 (BS 22 B 15) (Light Grey):
- Bascule Super Structure
- Diagonal truss members
- Approach span beams
- Floor beams of bascule and approach spans
- Outriggers
- Longitudinal structural boxes of cantilevered decks
- Transverse beams of cantilevered decks
- Longitudinal beams of Galloping Goose Overpass
- Visible luminaries fittings

The following items of structure shall be painted RAL 7037/RAL 7046 (Dark Grey):
- Soffit of Orthotropic deck
- Parapet post plates
- Cable trays and luminaries fittings held below the decks.

Paint Colour:
The following items of structure shall be painted RAL 9001/RAL 9002 (BS 22 B 15) (Light Grey):
Bascule Super Structure  
Diagonal truss members  
Approach span beams  
Floor beams of bascule and approach spans  
Outriggers  
Longitudinal structural boxes of cantilevered decks  
Transverse beams of cantilevered decks  
Longitudinal beams of Galloping Goose Overpass  
Visible luminaries fittings

The following items of structure shall be painted RAL 7037/RAL 7046 (Dark Grey):
Soffit of Orthotropic deck  
Parapet post plates  
Cable trays and luminaries fittings held below the decks.

Paint finish:
All finishes shall be stable, fade resistant and not affected by ultraviolet light. Provide data and samples for review by the Architect.

All finishes shall be durable, of uniform texture and colour and be resilient to all known and/or specified environmental and pollution effects. This shall include scratching and cigarette smoke and burns, etc. Submit data and samples for review by the Architect.

Minor scratches and blemishes shall be repaired using the coating manufacturer's recommended products and system, matching original finish for colour, texture and gloss. Repair coatings shall be visually acceptable to the Architect. Confirmation shall be provided that the damaged finish complies in all respects to the requirements of the Specification. Guarantee in writing that the damaged or defective coating is satisfactory for the proposed remedial paint system. Employ an independent finishing consultant to carry out an inspection and any necessary tests and supply a full report to the Architect.

All finishes shall be within the limits of the agreed samples and without irregularities or distortions. Fixings, stiffeners, etc. which are not intended to be visible shall be treated so that there is no discontinuity in the finished surface appearance.

Paint gloss/sheen finish should be in the region of 30%.

Exposed Concrete:
This finish shall be achieved by the use of high quality concrete and formwork. The concrete shall be thoroughly compacted and all surfaces shall be true, with clean arrises. Only very minor surface blemishes shall occur and no staining or discoulouration from the release agent shall be permitted.

Comply with the visual intent shown on the Tender Drawings and criteria stated in the Specification.

Johnson Street Bridge, City of Victoria  
25/10/2012
Propose suitable materials and procedures prior to Contract award to demonstrate compliance with the visual intent and performance criteria stated.

Provide Working Drawings showing all formwork and temporary works details. Details of all fittings, features, associated formwork and temporary works for installation shall be included. Typical details shall not be accepted.

All interfaces shall be shown on the Working Drawings, particularly in respect to corner junctions, services and interfaces with other Trades.

For all critical finishes, the three-dimensional geometry, setting out and relationship to the next panels shall be clearly conveyed for comment by the Architect.

Making good: Apart from the making good allowed for in the Structural Engineer's specification, making good shall be minimal and consistent to an accepted sample. As far as possible the finished surface shall be achieved without making good. The improvement of the surface finish by the Contractor (e.g. filling noticeable surface blemishes) shall be agreed with the Architect, prior to any work being carried out. Blowholes shall be filled and all irregularities stoned off. After at least three weeks curing, the visible facework shall be rubbed down to produce a smooth, even surface. Continuity of personnel for making good, where required, shall be provided by the Contractor, to the complete satisfaction of the Architect.

Formwork tie holes shall be in an accepted regular pattern, or as indicated on the Tender Drawings, filled with an exactly matching prepared cement/fine aggregate paste to an accepted sample as specified. Nail spacing shall be to an agreed regular layout co-ordinated with tie hole centres.

Where rebates or features are shown these shall also be the panel joints. No other joints are permissible. The design of panel joints, rebates, striking pieces and other elements are the responsibility of the Contractor but shall be subject to the acceptance of the Architect. Features shall be bedded on mastic, but no mastic is permitted on the finished facework.

The consistency of the concrete colour is deemed to be of great importance on the project. Select all suppliers, materials and all methods to ensure the specified finish and consistency.

A wax based clear sacrificial anti-graffiti coating shall be applied to exposed precast panelling.

**BAL  Balustrading:**

**BAL 101 Vertical Maintenance Parapet System to East and West Pier Maintenance Gantries:**

Bespoke galvanised fabricated steel parapet system, including vertical galvanised single plate steel baluster posts, continuous circular galvanised handrail at 1100mm height. Infill to comprise of two galvanised steel rods welded between baluster posts at equal distance. The parapet is to be located on the steel West Pier Maintenance Gantry and is to be bolted to a galvanised C section steel edge profile of the platform in this instance. The parapet is to be located on the East Pier Maintenance Gantry which
are located on the North and South walls of the pier beneath the bascule wheels. The parapet balusters are to be bolted to the edge of the concrete platform in this instance. Refer to drawing 5012802-100-A-PLN-905 and 5012802-100-A-PLN-511 for setting out. The parapet is to be located on the internal access gantries and access stairs within the West Pier and should be bolted to a galvanised C section steel edge profile of the platform or stair in this instance.

**BAL 102 Vertical Parapet with Integrated Seating and Glazed Wind Protection:**

Bespoke fabricated galvanised and painted mild steel and stainless steel parapet system with integrated stainless steel and timber bench with glazed protection, including vertical twin plate galvanised and painted mild steel baluster posts and continuous circular stainless steel handrail at 1100mm height.

**Mounting of Glazed Panels at Parapet:**

Glazed screens are mechanically mounted to the vertical baluster posts as shown in Design Drawings. It is anticipated that the design for the mounting assembly will utilise bespoke lugs which will be mechanically fixed between the twinned baluster posts of the bridge parapet system. Design Drawings show a point-fixed system to hang the glass panels whereby the lower corners of each panel and the middle portion of the vertical edge are secured to the adjacent baluster posts via proprietary adjustable spider-type fixings. The top half of each glass panel is cantilevered vertically above the upper fixings. The glass panels and mounting assembly including all lugs to be clamped at the baluster post shall be the responsibility of the specialist glazing Subcontractor. However, it will be the responsibility of the parapet Subcontractor to coordinate holes in the baluster posts and/or handrail lugs of the parapet to which the glazing systems are to be clamped. Consequently, baluster posts adjacent to glass panels shall be non-standard as highlighted in Design Drawings.

In addition to making allowances for the mounting of glass panels at the parapet, the bolts which clamp the twin baluster posts to the lug at the deck edge shall be different to those used for the general parapet condition. Larger bolts are required for baluster posts which support glass panels. This means that the holes in lugs at the deck edge and in the base of the baluster posts shall be larger. Refer to separate drawings from Structural Engineer relating to lugs welded at the deck edge.

**Interface with Benches**

Parapet posts which support glazing also support bespoke fabricated stainless steel and timber bench assemblies. The posts behind the benches shall receive a diaphragm plate which forms part of the subframe to the bench assembly. This will require additional countersunk holes to be drilled so that the diaphragm plate can be clamped between parapet posts as indicated in Design Drawings. The provision of stainless steel threaded barrels and spacers necessary to secure the diaphragm plate shall be similar to those used for other elements elsewhere in the parapet system and shall form part of the parapet package.
Each baluster post is formed from two identical tapered galvanized and painted mild steel flat plates twinned at each parapet post location and clamped at low level around a painted steel lug which is permanently welded at the edge of the bridge deck. Each parapet post shall be fabricated with holes for bolted lug connections at the base and at the handrail. Pin-head hexagon socket security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable. Bolts to be screwed into threaded barrel spacers as indicated in Design Drawings. Size, grade and property class of bolted connections to be confirmed by the Structural Engineer.

Bespoke fabricated stainless steel and timber bench assembly to comprise galvanized and painted mild steel subframe, stainless carrier frames, timber slats and demountable stainless steel panels.

Set Out and Location:
Each bench is arranged parallel to the surface of the bridge deck. The cross fall of the bench seat is parallel to the cross fall of the deck. The longitudinal incline of the seat is also parallel to the longitudinal incline of the bridge deck beneath the bench. Because the incline on the bridge deck varies according to location, each bench assembly is therefore different.

Bespoke galvanized and painted mild steel Subframe:
Each bench is supported on a bespoke subframe fabricated from mild steel plate. Subframes consist of diaphragms arranged transversely. These are clamped between the twin posts of the adjacent parapet system. Slotted holes shall be used as appropriate to enable tolerance. A series of mild steel profiles span longitudinally between diaphragms. All longitudinal profiles are curved on plan to suit the curves of the finished bench. Some profiles are fabricated, others are standard. Refer to Design Drawings. The profiles support a stainless steel carrier frame that supports the timber bench surface. In addition, further discrete members span diagonally to brace adjacent diaphragms.

Subframe Interfaces:
All visible joints in the subframe shall be welded. Only joints that will be concealed within the body of the bench can be bolted. Bolted joints should utilise slotted holes to allow tolerance for installation. All welded joints that are visible at the external surface of the bench assembly shall be ground smooth to achieve a continuous surface.

Continuous Fabricated Channel:
A bespoke fabricated channel with parallel flanges forms the leading edge of the bench. It is important that this member describes a continuous curve and that it is not faceted and that joints between adjacent
sections of the member are not expressed. This member shall therefore be welded to the front edges of the diaphragm members or shall be bolted via lugs pre-welded to the rear of the flange such that the bolts are not visible in the final assembly. Butt joints between adjacent lengths of the member shall be welded and shall be ground flush at exposed surfaces.

**Outstand to Outer Subframes:**

The diaphragms at each end of the seated area of the bench have a galvanized and painted mild steel outstand plate applied to them. The purpose of this plate is to trim the ends of the seated portion of the bench to conceal the void behind the adjacent warping slatted transition. The front edge of the outstand plate shall align with the front face of the first timber slat of the warping transition piece.

**Interfaces with other elements of the Assembly:**

The subframe shall be formed with holes (some countersunk, some tapped), cleats and lugs to suit connections to other elements of the bench assembly such that all elements of the assembly are fully coordinated prior to fabrication.

**Bespoke Stainless Steel Carrier Frame:**

Each carrier frame supports timber slats and each has a width that corresponds to the width of the parapet bay of the adjacent parapet system. Carrier frames are not rectangular on plan but are radial to suit the plan curve of the bridge deck. It is intended that carrier frames and associated timber slats for a full parapet bay can be individually demounted for maintenance and for enhanced access to the void beneath the benches.

**Horizontal Members:**

At the leading edge of the seat is a stainless steel angle which is curved to follow a curved plan profile. The flange of this angle shall align with the leading edge of the fabricated channel which forms part of the subframe assembly below. The purpose of this angle member is to enable the carrier frame to span between diaphragm members and to trim and protect the ends of the timber slats. A fabricated T-section similarly trims and supports the top edge of the backrest adjacent to the handrail. This member has an extended top flange as indicated in Design Drawings which extends backwards towards the adjacent glazing panel to trim the top of the bench.

There is an additional fabricated horizontal member where the base of the backrest meets the rear of the bench seat. All horizontal members described here follow a plan curve as shown on Design Drawings.

**Other Members:**
In addition to the longitudinal members described above, additional plates are required to stiffen the carrier frame and for the support of the timber slats. Towards the front edge of each carrier frame, a flat plate spans parallel to the angle at the leading edge of the bench. Additional flat plates span laterally between longitudinal members so that the whole carrier frame is a homogenous unit. Lateral plates are aligned directly below timber slats so that they are not visible from above through the voids between adjacent slats.

**Pre-formed Holes:**

Longitudinal members are fabricated with countersunk holes at regular intervals to suit the interval of timber slats which are secured to the carrier frames. Holes shall be arranged such that there shall be no discernible joint between adjacent carrier frames – the timber slats attached to one carrier frame appear to run seamlessly into those attached to the adjacent carrier frame. Holes are countersunk at their underside to receive self-tapping woodscrews which will secure each timber slat to the carrier frame.

**Connection to Subframe:**

Carrier frames are bolted into pre-tapped holes in the flanges of the subframe at parapet post locations and at regular centres along longitudinal members that span between diaphragm members of the subframe at the font and rear of the bench seat. It is intended that the bolted connection of each carrier frame down to the subframe shall be concealed in the void between timber slats such that they are generally not visible at the surface of the bench assembly. Security fixings shall be used to discourage tampering and unauthorised removal of carrier frames from the subframe.

**Interface with Subframe:**

In order to promote free drainage of rainwater, to prevent ponding and to eliminate load-induced noise between the carrier frame and the subframe, a series of neoprene strips shall be bonded to the upper/outer faces of the subframe where the carrier frame is supported. Each strip where applied shall be discontinuous to promote drainage through the front of the bench of water that falls between the slats and onto the acrylic sheet. Neoprene strips shall be designed and arranged such that they do not interfere with mechanical fixings.

**Timber Slats:**

Timber slats shall be “secret-fixed” to the carrier frames which support them. Mechanical fixings shall be located at the underside of the slats and shall be installed while the carrier frame is demounted such that all mechanical fixings to slats are concealed.

**Slat Members:**
Timber species for slats to be Cumaru or acceptable equivalent. All timber to be heartwood only – sapwood will not be acceptable. Slats to be 40mm wide x 40mm deep in lengths cut to suit their installed location in the carrier frame. The gap between adjacent slats shall be nominally 10mm although this gap will vary because the horizontal slats which form the bench seat are arranged radially in theory. Timber slats at the back rest of the bench shall be arranged vertically when viewed in elevation and shall not be arranged perpendicular to the bench seat or the handrail. This means that cut ends to timber slats shall not be orthogonal.

All timber edges shall have a 5mm chamfer. Slats shall be neatly mitred at the back edge of the seat / lower edge of the backrest and bonded at the interface so that horizontal and vertical elements shall be visually homogenous.

Interface with Acrylic Sheets:

Two sheets of translucent acrylic shall be installed onto each carrier frame beneath the timber slats - one sheet behind the backrest, one sheet beneath the bench seat. The purpose of the acrylic sheet is to provide a uniform back-lit glow behind the timber slats. Acrylic sheets shall have nominal thickness 10mm and shall be cut from a single sheet to match the outline of the carrier frame. Acrylic sheets shall have the following specification, or equal approved by the Architect:

- Panel Manufacturer: Perspex.
- Finish: Polar White
- Opacity: 030 Frost

Acrylic sheets shall be drilled with oversized holes to suit the locations of mechanical fixings which pass through the acrylic sheet to secure the timber slats to the carrier frame. The holes shall be oversized to allow for adjustment of the line and orientation of individual timber slats.

A neoprene (or equal approved material) gasket or washer shall be used at the interface between the rear of the timber slats and the acrylic sheet. Refer to Design Drawings. This element might take the form of individual washers at discrete locations to suit mechanical fixings, or might be a continuous strip with preformed oversized holes. The purpose of this neoprene element is to avoid timber slats being clamped directly against acrylic panels.

Demountable Stainless Steel and Acrylic Panels:

At low level, demountable panels give access to electrical equipment and light fittings concealed within the void beneath the bench. Panels are mounted both horizontally beneath the front edge of the bench seat and vertically adjacent to the surface of the deck.

Panel Build Up:
Panels (horizontal and vertical) are formed from stainless steel plate cut with slotted holes. Slotted holes have width 10mm such that they are aligned generally with voids between the timber slats above. The slots are infilled with translucent acrylic sheet such that the exposed outer face of the acrylic infill is flush with the exposed face of the demountable panel. This could be achieved by machining a sheet of acrylic such that it has an outstand profile which matches the slots to be filled.

**Horizontally Mounted Panels:**
Panels have a curving shape to suit the curved geometry of the benches generally. Panels shall be bolted using countersunk security fixings to discrete tabs welded to longitudinal members of the subframe. The tabs shall be drilled and tapped to receive the bolted connection so that to remove the panels requires access to the external face only.

**Vertically Mounted Panels:**
A series of stainless steel lugs will be welded to the surface of the bridge deck by the steelwork fabricator. Each lug is provided with slotted hole(s). Refer to drawing STR/515 from the Structural Engineer. The Sub-contractor responsible for the bench assemblies shall provide a continuously curved stainless steel angle which is bolted at low level to the lugs at the surface of the bridge deck. There shall be a consistent 5mm gap between the underside of this angle and the finished surface of the bridge deck for drainage. The angle shall protrude nominally 5mm beyond the face of the panel over to help protect the panel from glancing impacts. This angle shall support a second stainless steel angle which shall be used as a substrate to the vertically mounted demountable panels. Slotted holes shall be used where possible to allow adjustment to line and level. All exposed bolt heads shall be countersunk and all nuts shall be concealed on the inside of the bench assembly.

The second stainless steel angle shall be drilled and tapped to suit regular countersunk holes along the lower edge of the demountable panel. Countersunk security fixings shall be used to secure the panel to the substrate.

The upper edge of the demountable panel is restrained via a longitudinal plate which spans between diaphragm members of the subframe. This plate is also to be drilled and tapped to suit regular countersunk holes along the upper edge of the demountable panel. Again, countersunk security fixings shall be used to secure the panel to the backing plate. Fixings along the upper and lower edges of the demountable panel shall be vertically aligned.

Vertical panels shall additionally support light fittings at their rear surface. The specialist Subcontractor for the bench shall assume that light fittings shall be supplied and installed by others. Refer to concurrent specification from the Electrical Engineer.

Care shall be taken in the fabrication of all bespoke components to ensure that all corners and edges shall be completely safe to the touch. Sharp arises shall not be acceptable. There shall be no sharp edges or corners, which might cause even the slightest injury. All dissimilar metals to be electrically isolated to avoid electrolytic corrosion.
Lighting and Electrical Interface:

As described in the Design Drawings lighting units are to be mounted beneath the benches. These are intended to back-light the acrylic panels located behind the timber slats so that the seated portion of the bench appears to glow from within. Additional light fittings mounted at low-level behind the demountable stainless steel panels provide additional illumination to the deck at low level in the vicinity of the benches. Electrical junction boxes and associated conduits and cabling will also be concealed beneath the benches. Refer to concurrent drawings and specification from the Electrical Engineer. Because there is so much electrical equipment and structural members associated with the support of the bench in these areas, the effect of the shadows on the lighting equipment is impossible to determine until the physical bench can be scrutinised on site. Therefore, we suggest that the first completed bay of the bench seat assembly is used as a prototype so that the interface with the electrical systems and the effects of the light fittings can be tested. Consequently, any electrical equipment and light fittings shown on any architectural Design Drawings for the bench assembly are indicative only.

Coordination with Superstructure:

It is the responsibility of the Sub-Contractor to ensure that the bench assemblies described herein are thoroughly coordinated with the superstructure of the bridge as a whole and that all interfaces have been designed to account for tolerances and relative movement.

Preservative Treatment of Timber Elements:

The Sub-contractor shall take advice from the specialist timber supplier regarding the treatment or otherwise of timber elements procured for use in the bench assembly. The recommendations of the specialist supplier shall be conveyed to the Architect and the main Contractor for acceptance. Where samples are required of proposed timber elements, these shall be provided with the intended preservative treatment so that the sample gives a true and accurate representation of the actual finish proposed for the bench assemblies.

BAL 103 Vertical pedestrian parapet (1.1m) South side pedestrian deck:

Bespoke fabricated galvanized and painted mild steel and stainless steel parapet system, including vertical twin plate painted mild steel baluster posts and continuous circular stainless steel handrail at 1100mm height. Infill to comprise of stainless steel wire mesh system between baluster posts. The
tapered twin painted baluster plates should be mechanically attached with steel hexagon socket countersunk head painted steel plates which will be welded perpendicular to the structural beam.

Each baluster post is formed from two identical tapered painted mild steel flat plates twinned at each parapet post location and clamped at low level around a painted steel lug which is permanently welded at the edge of the bridge deck. Each parapet post shall be fabricated with holes for bolted lug connections at the base and at the handrail. Pin-head hexagon socket security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable. Bolts to be screwed into threaded barrel spacers as indicated in Design Drawings. Size, grade and property class of bolted connections to be confirmed by the Structural Engineer.

The handrail is to be fabricated from 59mm diameter stainless steel tube and there should be an integrated recess to receive continuous linear LED with a prismatic cover: refer to lighting consultant's information. The stainless steel handrail, of diameter 59mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet. The top surface of the handrail should be set at 1100mm above the level of the adjacent landing and 1,150mm above the nosing to each stair. The transition between the inclined portion of each rail and the portion adjacent to the landing at the top of the stair shall be made with a simple welded mitred joint. All welds to be ground flush and satin polished to match the finish to the handrail generally.

Installation of Handrail:

It is important that the handrail is visually smooth. The handrail is to be continuously curved to suit the slight curve to the deck edge and shall not be faceted. Lengths of handrail must be pre-curved to suit the horizontal and vertical profile indicated in the Design Drawings. Joints between adjacent sections of pre-curved rail shall be accurately aligned. A stainless steel circular spigot should be used, the external dimension of which should match the internal dimension of the rails to be joined. All welds to be ground flush and satin polished to match the finish to the handrail generally.

Connection of Handrail to Baluster Posts:

Pre-shaped segments of the handrail to be site welded to stainless steel lugs which are mechanically secured between the twinned plates of the baluster posts. Parapet lugs to include slotted holes to allow for adjustment to line and level of handrail to facilitate a smoothly curved profile. Male/Female security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable.

Parapet Mesh Infill:

The mesh system is to be continuous over all parapet posts between bridge joint locations and is to be anchored at posts adjacent to the bridge joints. The tensioned mesh is to be supported on a stainless steel frame using tubes or rods interlaced with the mesh. The horizontal supporting frame members are
to be provided at the top and bottom of the mesh system and aligned parallel with the handrail on the bridge deck; any fixings or brackets to the mesh should be of stainless steel. Ensure that no chemical or electrolytic action takes place where dissimilar metals come together.

X-Tend Stainless Steel Tensioned Parapet Infill Mesh System by Carl Stahl GMBH or a similar approved system. The following companies supply / manufacture stainless steel wire mesh type products. However, the contractor is also free to source alternative suppliers which meet the design intent of the Architect.

- Amron Associates Limited
  Amron House, 9 Bolton Hill Road, Doncaster, South Yorkshire, DN4 6DQ, UK
  Tel: 01302 533 111

- Carl Stahl Evita Limited
  Carl Stahl House, Farfield Park Estate, Rotherham, S63 5DB
  Tel: 0845 130 2299

- Belmont Architectural Products
  Optima House, Askern Road, Toll Bar, Doncaster, DN5 0QY, UK
  Tel: 01302 874 128

- Jakob UK (Operated by MMA Architectural Systems)
  Broadway House, Unit 5, Second Avenue, Westfield Industrial Estate, Midsomer Norton, Somerset, BA3 4BH
  Tel: 0845 1300 135

**BAL 104 Vertical pedestrian and cyclist parapet (1.4m) Mixed use deck:**

Bespoke fabricated galvanised and painted mild steel and stainless steel parapet system, including vertical twin plate painted mild steel baluster posts with continuous circular stainless steel handrail at 1100mm height and a continuous circular stainless steel cycle rail at 1400mm height. Infill to comprise of stainless steel wire mesh system between baluster posts. The tapered twin painted baluster plates should be mechanically attached with steel hexagon socket countersunk head to galvanise and painted steel plates which will be welded perpendicular to the structural beam.

Each baluster post is formed from two identical tapered painted mild steel flat plates twinned at each parapet post location and clamped at low level around a painted steel lug which is permanently welded at the edge of the bridge deck. Each parapet post shall be fabricated with holes for bolted lug connections at the base and at the handrail. Pin-head hexagon socket security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable. Bolts to be screwed into threaded barrel spacers as indicated in
Design Drawings. Size, grade and property class of bolted connections to be confirmed by the Structural Engineer.

The handrail is to be fabricated from 59mm diameter stainless steel tube and there should be an integrated recess to receive continuous linear LED with a prismatic cover: refer to lighting consultant's information. The stainless steel handrail, of diameter 59mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet. The top surface of the handrail should be set at 1100mm above the level of the adjacent deck. All welds to be ground flush and satin polished to match the finish to the handrail generally. The stainless steel cyclerail, of diameter 48mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet using the same lug plate holding the handrail. The top surface of the cyclerail should be set at 1400mm above the level of the adjacent deck. All welds to be ground flush and satin polished to match the finish to the handrail generally.

Installation of Handrail and Cyclerail

It is important that the handrail and cyclerail are visually smooth. The handrail and cyclerail are to be continuously curved to suit the slight curve to the deck edge and shall not be faceted. Lengths of handrail and cyclerail must be pre-curved to suit the horizontal and vertical profile indicated in the Design Drawings. Joints between adjacent sections of pre-curved rail shall be accurately aligned. A stainless steel circular spigot should be used, the external dimension of which should match the internal dimension of the rails to be joined. All welds to be ground flush and satin polished to match the finish to the handrail and cyclerail generally.

Connection of Handrail and Cyclerail to Baluster Posts:

Pre-shaped segments of the handrail and cyclerail to be site welded to stainless steel lugs which are mechanically secured between the twinned plates of the baluster posts. Parapet lugs to include slotted holes to allow for adjustment to line and level of handrail and cyclerail to facilitate a smoothly curved profile. Male/Female security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable.

Parapet Mesh Infill:

The mesh system is to be continuous over all parapet posts between bridge joint locations and is to be anchored at posts adjacent to the bridge joints. The tensioned mesh is to be supported on a stainless steel frame using tubes or rods interlaced with the mesh. The horizontal supporting frame members are to be provided at the top and bottom of the mesh system and aligned parallel with the handrail on the bridge deck; any fixings or brackets to the mesh should be of stainless steel. Ensure that no chemical or electrolytic action takes place where dissimilar metals come together.
X-Tend Stainless Steel Tensioned Parapet Infill Mesh System by Carl Stahl GMBH or a similar approved system. The following companies supply / manufacture stainless steel wire mesh type products. However, the contractor is also free to source alternative suppliers which meet the design intent of the Architect.

Amron Associates Limited  
Amron House, 9 Bolton Hill Road, Doncaster, South Yorkshire, DN4 6DQ, UK  
Tel: 01302 533 111

Carl Stahl Evita Limited  
Carl Stahl House, Farfield Park Estate, Rotherham, S63 5DB  
Tel: 0845 130 2299

Belmont Architectural Products  
Optima House, Askern Road, Toll Bar, Doncaster, DN5 0QY, UK  
Tel: 01302 874 128

Jakob UK (Operated by MMA Architectural Systems)  
Broadway House, Unit 5, Second Avenue, Westfield Industrial Estate, Midsomer Norton, Somerset, BA3 4BH  
Tel: 0845 1300 135

**BAL 105 Inclined pedestrian parapet (1.1m) South side pedestrian deck:**

Bespoke fabricated galvanised and painted mild steel and stainless steel parapet system, including inclined twin plate painted mild steel baluster posts with continuous circular stainless steel handrail at 1100mm. Infill to comprise of stainless steel wire rope system between baluster posts.

Each baluster post is formed from two identical inclined tapered painted mild steel flat plates twinned at each baluster post location and clamped at low level around a painted steel lug which is permanently welded at the edge of the bridge deck. Each parapet post shall be fabricated with holes to tensioned suit wire rope and bolted lug connections at the base and at the handrail. Additional holes are required in some posts to suit equipment mounted at the parapet. Pin-head hexagon socket security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable. Bolts to be screwed into threaded barrel spacers as indicated in Design Drawings. Size, grade and property class of bolted connections to be confirmed by the Structural Engineer.

The handrail is to be fabricated from 59mm diameter stainless steel tube and there should be an integrated recess to receive continuous linear LED with a prismatic cover: refer to lighting consultant's information. The stainless steel handrail, of diameter 59mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet. The top surface of the handrail should be set at 1100mm above the level of the adjacent landing and 1,150mm above the nosing to each stair. The
transition between the inclined portion of each rail and the portion adjacent to the landing at the top of the stair shall be made with a simple welded mitred joint. All welds to be ground flush and satin polished to match the finish to the handrail generally.

Installation of Handrail:
It is important that the handrail is visually smooth. The handrail is to be continuously curved to suit the slight curve to the deck edge and shall not be faceted. Lengths of handrail must be pre-curved to suit the horizontal and vertical profile indicated in the Design Drawings. Joints between adjacent sections of pre-curved rail shall be accurately aligned. A stainless steel circular spigot should be used, the external dimension of which should match the internal dimension of the rails to be joined. All welds to be ground flush and satin polished to match the finish to the handrail generally.

Connection of Handrail to Baluster Posts:
Pre-shaped segments of the handrail to be site welded to stainless steel lugs which are mechanically secured between the twinned plates of the baluster posts. Parapet lugs to include slotted holes to allow for adjustment to line and level of handrail to facilitate a smoothly curved profile. Male/Female security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable.

Wire Rope Infill System:
The parapet infill is formed from eleven tensioned wire ropes, arranged parallel to one other and to the longitudinal incline of the adjacent bridge deck at nominal 100mm centres. The incline of the wire ropes relative to a horizontal plane therefore varies between a maximum gradient of 1:21 and horizontal. Refer to Design Drawings.
Rope diameter to be 10mm. Wire rope to be stainless steel (grade 1.4404). Because the wire rope will follow a straight line between parapet posts, the infill will be faceted to suit the continuous curve to the deck edge. Consequently the line of each wire rope will change at each baluster post location. The design and installation shall accommodate all variations in angle for all conditions of the parapet system. The holes formed in parapet posts for the wire rope by the Subcontractor shall be of sufficient size to allow tolerance for installation and to prevent fretting and fraying of the rope despite the kink of the rope at the post.
All secondary components for anchoring and tensioning the wire rope to be stainless steel.

Swaged Stainless Steel End Stops:
The Design Drawings indicate tension posts located at discrete intervals to coincide generally with the locations of splices in the primary fabricated steel deck box. Parapet posts at these locations incorporate threaded barrels welded permanently between twinned baluster posts. Lengths of wire rope will terminate at each side of a tension post. Each wire rope shall terminate at a bespoke swaged stainless steel end stop. The design of the end stop shall accommodate variations in angle between the line of the tension wire and the plane of the baluster post both vertically (because of the variable longitudinal slope of the bridge deck) and horizontally (because the parapet system is faceted to the curve of the deck edge).

Tensioning:
The end stops described above shall incorporate the tensioning mechanism for each individual wire rope. Each end of each wire rope shall be individually tensioned at its termination. The tensioning device shall be designed and installed to take up any slack in the wire rope that might result due to differences between the precambered shape of the bridge deck and its shape as finally installed. Ropes shall be tensioned sufficiently such that the parapet system conforms to all codes and regulations relating to applied loads and deflection.

Wire rope and ancillary system components to be approved by Architect from samples provided by specialist sub-contractor prior to any orders being placed.

BAL 106 Inclined pedestrian and cyclist parapet (1.4m) Mixed use deck:
Bespoke fabricated galvanised and painted mild steel and stainless steel parapet system, including inclined twin plate painted mild steel baluster posts with continuous circular stainless steel handrail at 1100mm height and a continuous circular stainless steel cycle rail at 1400mm height. Infill to comprise of stainless steel wire rope system between baluster posts.

Each baluster post is formed from two identical inclined tapered painted mild steel flat plates twinned at each baluster post location and clamped at low level around a painted steel lug which is permanently welded at the edge of the bridge deck. Each parapet post shall be fabricated with holes to tensioned suit wire rope and bolted lug connections at the base and at the handrail. Additional holes are required in some posts to suit equipment mounted at the parapet. Pin-head hexagon socket security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable. Bolts to be screwed into threaded barrel spacers as indicated in Design Drawings. Size, grade and property class of bolted connections to be confirmed by the Structural Engineer.

The handrail is to be fabricated from 59mm diameter stainless steel tube and there should be an integrated recess to receive continuous linear LED with a prismatic cover: refer to lighting consultant's information. The stainless steel handrail, of diameter 59mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet. The top surface of the handrail should be set at 1100mm above the level of the adjacent deck. All welds to be ground flush and satin polished to match the finish to the handrail generally. The stainless steel cyclerail, of diameter 48mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet using the same lug plate holding
the handrail. The top surface of the cyclerail should be set at 1400mm above the level of the adjacent deck. All welds to be ground flush and satin polished to match the finish to the handrail generally.

**Installation of Handrail and Cyclerail:**

It is important that the handrail and cyclerail are visually smooth. The handrail and cyclerail is to be continuously curved to suit the slight curve to the deck edge and shall not be faceted. Lengths of handrail and cyclerail must be pre-curved to suit the horizontal and vertical profile indicated in the Design Drawings. Joints between adjacent sections of pre-curved rail shall be accurately aligned. A stainless steel circular spigot should be used, the external dimension of which should match the internal dimension of the rails to be joined. All welds to be ground flush and satin polished to match the finish to the handrail generally.

**Connection of Handrail and Cyclerail to Baluster Posts:**

Pre-shaped segments of the handrail and cyclerail to be site welded to stainless steel lugs which are mechanically secured between the twinned plates of the baluster posts. Parapet lugs to include slotted holes to allow for adjustment to line and level of handrail and cyclerail to facilitate a smoothly curved profile. Male/Female security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable.

**Wire Rope Infill System:**

The parapet infill is formed from eleven tensioned wire ropes, arranged parallel to one other and to the longitudinal incline of the adjacent bridge deck at nominal 100mm centres. The incline of the wire ropes relative to a horizontal plane therefore varies between a maximum gradient of 1:21 and horizontal. Refer to Design Drawings.

Rope diameter to be 10mm. Wire rope to be stainless steel (grade 1.4404). Because the wire rope will follow a straight line between parapet posts, the infill will be faceted to suit the continuous curve to the deck edge. Consequently the line of each wire rope will change at each baluster post location. The design and installation shall accommodate all variations in angle for all conditions of the parapet system. The holes formed in parapet posts for the wire rope by the Subcontractor shall be of sufficient size to allow tolerance for installation and to prevent fretting and fraying of the rope despite the kink of the rope at the post.

All secondary components for anchoring and tensioning the wire rope to be stainless steel.

**Swaged Stainless Steel End Stops:**

The Design Drawings indicate tension posts located at discrete intervals to coincide generally with the locations of splices in the primary fabricated steel deck box. Parapet posts at these locations incorporate threaded barrels welded permanently between twinned baluster posts. Lengths of wire rope will terminate
at each side of a tension post. Each wire rope shall terminate at a bespoke swaged stainless steel end stop. The design of the end stop shall accommodate variations in angle between the line of the tension wire and the plane of the baluster post both vertically (because of the variable longitudinal slope of the bridge deck) and horizontally (because the parapet system is faceted to the curve of the deck edge).

**Tensioning:**
The end stops described above shall incorporate the tensioning mechanism for each individual wire rope. Each end of each wire rope shall be individually tensioned at its termination. The tensioning device shall be designed and installed to take up any slack in the wire rope that might result due to differences between the precambered shape of the bridge deck and its shape as finally installed. Ropes shall be tensioned sufficiently such that the parapet system conforms to all codes and regulations relating to applied loads and deflection.

Wire rope and ancillary system components to be approved by Architect from samples provided by specialist sub-contractor prior to any orders being placed.

**BAL 107 Inclined pedestrian and cyclist parapet (1.4m) Overpass West Bank:**
Bespoke fabricated galvanised and painted mild steel and stainless steel parapet system, including inclined twin plate painted mild steel baluster posts with continuous circular stainless steel handrail at 1100mm height and a continuous circular stainless steel cycle rail at 1400mm height. No infill panels are necessary due to the high level of the structural beams.

Each baluster post is formed from two identical inclined tapered painted mild steel flat plates twinned at each baluster post location and clamped at low level around a painted steel lug which is permanently welded at the edge of the bridge deck. Each parapet post shall be fabricated with holes for bolted lug connections at the base and at the handrail. Pin-head hexagon socket security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable. Bolts to be screwed into threaded barrel spacers as indicated in Design Drawings. Size, grade and property class of bolted connections to be confirmed by the Structural Engineer.

The handrail is to be fabricated from 59mm diameter stainless steel tube and there should be an integrated recess to receive continuous linear LED with a prismatic cover: refer to lighting consultant’s information. The stainless steel handrail, of diameter 59mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet. The top surface of the handrail should be set at 1100mm above the level of the adjacent deck. All welds to be ground flush and satin polished to match the finish to the handrail generally. The stainless steel cycle rail, of diameter 48mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet using the same lug plate holding the handrail. The top surface of the cyclerail should be set at 1400mm above the level of the
adjacent deck. All welds to be ground flush and satin polished to match the finish to the handrail generally.

**Installation of Handrail and Cyclerail:**

It is important that the handrail and cyclerail are visually smooth. The handrail and cyclerail is to be continuously curved to suit the slight curve to the deck edge and shall not be faceted. Lengths of handrail and cyclerail must be pre-curved to suit the horizontal and vertical profile indicated in the Design Drawings. Joints between adjacent sections of pre-curved rail shall be accurately aligned. A stainless steel circular spigot should be used, the external dimension of which should match the internal dimension of the rails to be joined. All welds to be ground flush and satin polished to match the finish to the handrail generally.

**Connection of Handrail and Cyclerail to Baluster Posts:**

Pre-shaped segments of the handrail and cyclerail to be site welded to stainless steel lugs which are mechanically secured between the twinned plates of the baluster posts. Parapet lugs to include slotted holes to allow for adjustment to line and level of handrail and cyclerail to facilitate a smoothly curved profile. Male/Female security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable.

**BAL 108 Road bridge balustrading: Cyclist metal parapet integrated with PL2 crash barrier and roadway lighting:**

Bespoke fabricated galvanised and painted mild steel and stainless steel parapet system, including inclined twin plate painted mild steel baluster posts with continuous circular stainless steel cyclerail at 1400mm height above road bed. Lower section to be made up of a PL2 rated vehicle barrier system.

Each baluster post is formed from two identical inclined tapered painted mild steel flat plates twinned at each baluster post location and clamped at mid level around the H section post of the PL2 crash barrier system. Each parapet post shall be fabricated with holes for bolted lug connections at the base and at the cyclerail. Pin-head hexagon socket security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable. Bolts to be screwed into threaded barrel spacers as indicated in Design Drawings. Size, grade and property class of bolted connections to be confirmed by the Structural Engineer.

The cyclerail is to be fabricated from 48mm diameter stainless steel. The stainless steel cyclerail, of diameter 48mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet. The top surface of the cyclerail should be set at 1400mm above the level of the adjacent road bed. All welds to be ground flush and satin polished to match the finish to the cyclerail generally.
Installation of Cyclerail:

It is important that the cyclerail is visually smooth. The cyclerail is to be continuously curved to suit the slight curve to the deck edge and shall not be faceted. Lengths of cyclerail must be pre-curved to suit the horizontal and vertical profile indicated in the Design Drawings. Joints between adjacent sections of pre-curved rail shall be accurately aligned. A stainless steel circular spigot should be used, the external dimension of which should match the internal dimension of the rails to be joined. All welds to be ground flush and satin polished to match the finish to the handrail generally.

Connection of Cyclerail to Baluster Posts:

Pre-shaped segments of the cyclerail to be site welded to stainless steel lugs which are mechanically secured between the twinned plates of the baluster posts. Parapet lugs to include slotted holes to allow for adjustment to line and level of cyclerail to facilitate a smoothly curved profile. Male/Female security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable.

Integrated Linear Light fitting:

Integrated linear light fitting fixed to the balustrading. To lighting consultant specification.

External Access Stair to Control room:

Bespoke stair

Steps:

A purpose made non-slip extruded aluminium plank system with integrated bolt on aluminium nosing with color differentiation. Designer Planks crossmilled, non slip sections, length cut to suit the width of the stair as manufactured by Alcan Extruded Products Ltd (www.stepsandplanks.com) or acceptable equivalent, to Architect Approval. Section depth to Structural Engineer’s Specification.

Framing:

Panels shall be cut accurately on a band-saw to suit the alignment of stair. The cut longitudinal edges of each panel are to be framed with nominal aluminium angle which is welded to aluminium extrusions to trim the system at the deck edge and at the interface with the stringer.

Fixings:

To manufacturer's recommendation. Fixings to be hidden throughout.
Stringer:
Fabricated galvanised painted “Channel steel section” to Structural Engineers size and specification cranked to suit landing and stringer geometry. Refer to Architects drawings.

Balustrade: BAL103
Bespoke fabricated galvanised and painted mild steel and stainless steel parapet system, including vertical twin plate painted mild steel baluster posts and continuous circular stainless steel handrail at 1100mm height. Infill to comprise of stainless steel wire mesh system between baluster posts. The tapered twin painted baluster plates should be mechanically attached with steel hexagon socket countersunk head to painted steel plates which will be welded perpendicular to the structural beam.

Each baluster post is formed from two identical tapered painted mild steel flat plates twinned at each parapet post location and clamped at low level around a painted steel lug which is permanently welded at the edge of the bridge deck. Each parapet post shall be fabricated with holes for bolted lug connections at the base and at the handrail. Pin-head hexagon socket security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable. Bolts to be screwed into threaded barrel spacers as indicated in Design Drawings. Size, grade and property class of bolted connections to be confirmed by the Structural Engineer.

The handrail is to be fabricated from 59mm diameter stainless steel tube and there should be an integrated recess to receive continuous linear LED with a prismatic cover: refer to lighting consultant's information. The stainless steel handrail, of diameter 59mm shall be mechanically secured between the twin baluster posts at the upper level of the parapet. The top surface of the handrail should be set at 1100mm above the level of the adjacent landing and 1,150mm above the nosing to each stair. The transition between the inclined portion of each rail and the portion adjacent to the landing at the top of the stair shall be made with a simple welded mitred joint. All welds to be ground flush and satin polished to match the finish to the handrail generally.

Installation of Handrail:
It is important that the handrail is visually smooth. Joints between adjacent sections of pre-curved rail shall be accurately aligned. A stainless steel circular spigot should be used, the external dimension of which should match the internal dimension of the rails to be joined. All welds to be ground flush and satin polished to match the finish to the handrail generally.

Connection of Handrail to Baluster Posts:
Pre-shaped segments of the handrail to be site welded to stainless steel lugs which are mechanically secured between the twinned plates of the baluster posts. Parapet lugs to include slotted holes to allow for adjustment to line and level of handrail to facilitate a smoothly curved profile. Male/Female security fixings are to be used which are countersunk at all surfaces being connected. Bolt heads or nuts which sit proud of the surface of the parapet post will not be acceptable.

**Parapet Mesh Infill:**

The mesh system is to be continuous over all parapet posts between bridge joint locations and is to be anchored at posts adjacent to the bridge joints. The tensioned mesh is to be supported on a stainless steel frame using tubes or rods interlaced with the mesh. The horizontal supporting frame members are to be provided at the top and bottom of the mesh system and aligned parallel with the handrail on the bridge deck; any fixings or brackets to the mesh should be of stainless steel. Ensure that no chemical or electrolytic action takes place where dissimilar metals come together.

X-Tend Stainless Steel Tensioned Parapet Infill Mesh System by Carl Stahl GMBH or a similar approved system. The following companies supply/manufacture stainless steel wire mesh type products. However, the contractor is also free to source alternative suppliers which meet the design intent of the Architect.

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Amron House, 9 Bolton Hill Road, Doncaster, South Yorkshire, DN4 6DQ, UK  
Tel: 01302 533 111

Carl Stahl Evita Limited  
Carl Stahl House, Farfield Park Estate, Rotherham, S63 5DB  
Tel: 0845 130 2299

Belmont Architectural Products  
Optima House, Askern Road, Toll Bar, Doncaster, DN5 0QY, UK  
Tel: 01302 874 128

Jakob UK (Operated by MMA Architectural Systems)  
Broadway House, Unit 5, Second Avenue, Westfield Industrial Estate, Midsomer Norton, Somerset, BA3 4BH  
Tel: 0845 1300 135

**AM 101 Framed Aluminium Decking System**
Proprietary aluminium floor decking system, framed along longitudinal edges to incorporate concealed mechanical fixings. Several panels at each abutment shall be modified to include an aluminium backing plate which makes the standard panel imperforate.

Set Out:
The aluminium decking spans transversely between longitudinal beams. The planks should be predominantly perpendicular to the supporting beam unless otherwise described in design drawings.

System:
Designer Planks crossmilled, non slip sections width 400mm, length cut to suit the width of the deck as manufactured by Alcan Extruded Products Ltd (www.stepsandplanks.com) or acceptable equivalent, to Architect Approval. Section depth to Structural Engineer’s Specification.

Framing:
Panels shall be cut accurately on a band-saw to suit the curves of the bridge deck. The cut longitudinal edges of each panel are to be framed with nominal aluminium angle which is welded to aluminium extrusions to trim the system at the deck edge and at the interface with the fabricated steel deck box.

Fixings:
To manufacturer’s recommendation. Fixings to be hidden throughout. Fixings shall be designed such that the deck can be dismounted after installation without access to the underside of the panel. All maintenance activity must be possible from the top surface of deck panels.

AM 102 Framed Aluminium Decking to mixed use deck:
Proprietary aluminium floor decking system, framed along longitudinal edges to incorporate concealed mechanical fixings. Several panels at each abutment shall be modified to include an aluminium backing plate which makes the standard panel imperforate. The mixed use deck should allow for loading of light weight maintenance vehicle, to Structural Engineers Specification.

Set Out:
The aluminium decking spans transversely between longitudinal beams. The planks should be predominantly perpendicular to the supporting beam unless otherwise described in design drawings. The planks should be split along centre line of deck to allow for split use indication and solar powered deck lighting, to Lighting Consultants Specification.
System:
Designer Planks crossmilled, non slip sections width 400mm, length cut to suit the width of the deck as manufactured by Alcan Extruded Products Ltd (www.stepsandplanks.com) or acceptable equivalent, to Architect Approval. Section depth to Structural Engineer’s Specification.

Framing:
Panels shall be cut accurately on a band-saw to suit the curves of the bridge deck. The cut longitudinal edges of each panel are to be framed with nominal aluminium angle which is welded to aluminium extrusions to trim the system at the deck edge and at the interface with the fabricated steel deck box.

Fixings:
To manufacturer's recommendation. Fixings to be hidden throughout. Fixings shall be designed such that the deck can be dismounted after installation without access to the underside of the panel. All maintenance activity must be possible from the top surface of deck panels.

AM 201 Internal fixed Metal Decking in West Pier:

Fabricated Mild Steel Walkways
Non-proprietary fabricated walkway system comprising support framework, decking, companionway steps and step flights with all fittings and fixings to follow closely the visual intent of the Contract Drawings.

Walkway system located within the Main Piers.

Walkway system shall be designed for the imposed loading requirements of relevant codes and regulation and be appropriate for general duty access.

Frame:
Fabricated mild steel brackets and deck frame for galvanising in accordance with the Specification. Outside edge of frame to provide 150mm upstand to perimeter of decking.
Deck:
Galvanised mild steel grate.

Treads:
Fabricated durbar tread plates.

Parapets:
BAL 101

Fixings:
Deck fixings to manufacturer’s recommendation. Setting-out and type of all fixings to the approval of the Architect

AM 202 External Fixed metal decking to East Pier:
Fabricated Mild Steel Walkway
Walkway system located at the top of the West Pier.
Walkway system shall be designed for the imposed loading requirements of relevant codes and regulation and be appropriate for general duty access.

Frame:
Fabricated mild steel brackets and deck frame for galvanising in accordance with the Specification. Outside edge of frame to provide 150mm upstand to perimeter of decking.

Deck:
Galvanised mild steel grate.

Parapets:
BAL 101
Fixings:
Deck fixings to manufacturer’s recommendation. Setting-out and type of all fixings to the approval of the Architect

AM 301 Internal collapsible Metal decking in West Pier:
Fabricated Mild Steel Walkway located in the front of the East Pier and provides access to the roller bearing assembly with the bridge in the closed position.

Walkway system shall be designed for the imposed loading requirements of relevant codes and regulation and be appropriate for general duty access. Is should be fabricated from galvanised mild steel and fold out of the bobtail rotation zone while the bridge is in operation. This should be automated or gas strut assisted for safe deployment.

Parapet;
The parapet should be collapsible so that it fold out of the way along with the platform.

Fixings:
Deck fixings to manufacturer’s recommendation. Setting-out and type of all fixings to the approval of the Architect

Floor finish to over path bridge:
Exposed concrete finish with chevron pattern to enable lateral drainage.

Control Room and East Pier General:
Reference Documentation
- British Columbia Building Code
- CRCA Roofing Reference Manual
- CRCA Specification Manual
SYSTEM DESCRIPTIONS

Architectural and Functional Requirements

General

Fully-supported standing seam and profiled aluminium stucco-embossed sheet roofing. The components of the entire assembly shall be covered by a single source warranty. Single length sheets shall be used. End laps shall not be acceptable unless specified otherwise or indicated on the Design Drawings. Tapered and/ or curved sheets shall be used, where required, to achieve the configuration indicated on the Design Drawings. Lightning protection and electrical continuity shall be provided by welting of joints. Where applicable, isolating tape, plastic washers or other suitable means shall be used to prevent bi-metallic corrosion between dissimilar metals. Seam centre lines shall be co-ordinated with openings, penetrations and other relevant elements to minimise the number of special interface details. Movement joints shall be provided as necessary, using supported upstands fixed either side of gaps coinciding with structural movement joints. The gap width shall match the structural movement requirements and shall be suitably protected by cover flashings. Systems shall include closure pieces, flashings, trims, cills, gutters, fillers, spacers, tapes, sealants, fixings, and all other components/ accessories necessary to complete the works. Where not specified, they shall be suitable for the service conditions, and to the acceptance of the Architect.

Secondary Support

Secondary support/ framing shall be configured as indicated on the Design Drawings, suitably fixed back to the primary structure using methods acceptable to the Architect. Where the Contractor deems that secondary support is required in addition to that indicated on the Structural Engineer's drawings and the Design Drawings, inform the Architect at Tender return and propose a suitable structural support system for acceptance.

Pressed Metal Components/ Accessories
Systems shall incorporate all necessary pressed metal accessories including flashings, collars, copings, cappings, cills, reveals and returns. Components shall be formed from fully-welded and/or sealed pressed aluminium sheet. Systems shall include special prefabricated corner pieces for changes in direction as indicated on the Design Drawings. Cut corners at changes in direction shall not be acceptable. Concealed support shall be provided as required. Profiles of joints shall be to the acceptance of the Architect and shall maintain the performance requirements. Locations shall be as indicated on the Design Drawings, or to the acceptance of the Architect. Joints shall be assembled centrally over bracketry. In all conditions simple butt straps shall not be acceptable. Joints shall include concealed continuous sealed gaskets with recessed/folded interconnecting joints to provide a neat flush external appearance.

**Gutters**

Sizes and profiles of gutters shall be as indicated on the Design Drawings. Joints/laps in the guttering shall be fully supported. Sheeting material used for gutters shall match that used for the roofing for texture and colour.

**Profile Fillers**

Profile fillers shall accurately match the support decking/backing sheet profile. Where indicated on the Design Drawings and/or where required, corrugation cavities shall be closed off from the outside and inside of the building. Profile fillers shall maintain the performance of the covering system and systems with which they interface.

Fabrication shall be based on Site measurements to accommodate construction tolerances. Dimensions given on the Design Drawings shall be considered to be indicative only and should not be used for fabrication unless confirmed by the Architect as suitable. Where applicable and practical, fabrication and assembly of materials/components shall take place in properly equipped workshops with sitework restricted to fixing as far as possible. Sections shall be formed true to shape, accurate in size, square, free from distortions, irregularities and defects to profiles indicated on the Design Drawings. Materials/components that are damaged or have any other physical imperfections shall not be used in the works. Joints shall be fabricated so that the assembly shall be tight and close fitting to produce rigid materials/components free from distortion.

**Indicative Aluminium Standing Seam Roof System**

**Double glazed units: Capless Aluminium Curtain Wall System**

Structural silicone glazed curtain walling system with steel support structure and mechanically fixed glazing, silicone jointed externally. Mullion and transom extrusions shall be sized to provide minimum sight lines. The framing system to be ‘capless’. Glazed Fixed Panels mechanically fixed with a mechanical ‘toggle’ to retain the glass to the cladding support frame to appear frameless externally. All cable/conduit routes to be concealed. Indicative Product: Raico Therm +A-1 SG2 curtain wall system, Tel: 02392 368 73. Glass to be safety glass. **Type of glass**
Capless Aluminium Curtain Wall System – Opaque
Same as Capless Aluminium Curtain Wall System. The glazing is to have enamelled frit applied to the inner face to provide a fully opaque glazed panel or section of.

Opaque Infill Panels
Opaque infill panels shall be integral to the external envelope systems.
Single glazed laminated safety glass with back-painted finish and metal panel enclosed insulation cassette to the rear. Insulation to meet the performance requirements shall be encapsulated with pressed metal sheeting, finished to match the interfacing framing.
Metal Cassette: Polyester powder coated finish, colour to be confirmed from RAL range.

Manual Double Glazed Frameless Pivot Single Door
Double glazed manually operated frameless clear safety glass door integrated into the external capless aluminium curtain wall system.

Structural components:
Roof build-up
Primary/secondary/metal deck/Aluminium Standing Seam System
Slab build-up
Wall structure

Internal Fit-out:
Wall construction
Floor finish
Vinyl sheet safety floor
Wall finish
Ceiling
Plasterboard
Internal Doors
Sanitary Ware
Insulation
Kitchen Unit
Internal Lighting
See lighting consultant’s Specification. Spiers and Major.

Canopy:
Refer to design drawings 5012802-100-A-PLN-610 / 611 in conjunction with Structural and Electrical Engineer’s drawings.

Envelop:

Roofing:
Aluminium Standing seam roof system
Double glazed units:
Standard Double glazed Units. Stick system with aluminium extruded mullions and transoms.
Glass to be safety glass.
U value:
Acoustic DB rating
Type of glass
Back painted glass insulated panels
Glass entrance door
Gutters

Structural components:
Roof build-up
Slab build-up
Wall structure

Pier Ironmongery:

Metal doors / Double
Proprietary external steel, double door hinged security doorset with Zinc coated mild steel door leafs and reinforced and insulated core.
Door frame to be profiled, insulated core door frame.
Metal doors / Single
Proprietary external steel, single door hinged security doorset with Zinc coated mild steel door leafs and reinforced and insulated core.
Door frame to be profiled, insulated core door frame.

Louvered Metal doors
A manually operated un-insulated double leaf door set including factory finished aluminum horizontal louver assembly generally as Type LVR-01. The louvers across the door shall provide a visually consistent appearance of adjacent louver blades LVR-01.

Louvered Insulated Metal doors
A manually operate -insulated double leaf door set including factory finished aluminum horizontal louver assembly generally as Type LVR-01. The louvers across the door shall provide a visually consistent appearance of adjacent louver blades LVR-01.
REFERENCE DOCUMENTS

0.1 Reference to Master Municipal Specifications Document (MMCD)

All Civil Works shall be carried out in accordance with the latest edition of Master Municipal Specifications Document (MMCD).

0.2 Reference to Substitution of MMCD Standard Drawings

For all subsections of the Applicable Master Municipal Specifications, replace references to “Standard Detail Drawing(s)” with relevant “Supplementary Standard Drawings” from the City of Victoria Subdivision and Development Servicing Bylaw No.12-042.

0.3 Reference to City of Victoria Supplementary Specifications from the City of Victoria Subdivision and Development Servicing Bylaw No.12-042.

For all subsections of the Applicable Master Municipal Specifications, the requirements and specifications, per “City of Victoria Subdivision and Development Servicing Bylaw No.12-042” and any applicable Amendments, will supersede any conflicting MMCD specifications and/or Standard Detail Drawings.

0.4 The references under this specification section only pertain to the civil site and infrastructure works, such as roadway, curb and gutter, grading, storm drainage and municipal utilities. Contractor shall refer to the appropriate reference sections for any Work outside the scope of civil and infrastructure works.

0.5 Other references not specifically mentioned or contained within the MMCD or the City Bylaw, but implied by the nature or type of work, shall reference the latest edition of the Standard Specifications of the B.C. Ministry of Transportation and Infrastructure (BC MoTI).

Where conflicts exist, the following shall be the order of precedence of technical specifications from highest to lowest:

- City of Victoria Subdivision and Development Servicing Bylaw No.12-042
- MMCD
- B.C. MoTI

0.6 Clauses of the Master Municipal Construction Documents and the B.C. MoTI Standard Specifications with the heading “Measurement and Payment or similar,” do not apply to this RFP.

0.7 The following Table 1.0 references the applicable MMCD Specifications applicable to this Project.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
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<tbody>
<tr>
<td>03 30 20</td>
<td>Concrete Walks, Curbs and Gutters</td>
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<tr>
<td>03 30 53</td>
<td>Cast-In-Place Concrete</td>
</tr>
<tr>
<td>03 40 01</td>
<td>Precast Concrete</td>
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<tr>
<td>Code</td>
<td>Description</td>
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<tr>
<td>25 56 01</td>
<td>Roadway Lighting</td>
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<tr>
<td>31 05 17</td>
<td>Aggregates and Granular Materials</td>
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<tr>
<td>31 11 01</td>
<td>Clearing and Grubbing</td>
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<tr>
<td>31 15 60</td>
<td>Dust Control</td>
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<tr>
<td>31 22 01</td>
<td>Site Grading</td>
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<tr>
<td>31 22 16</td>
<td>Reshaping Granular Roadbed</td>
</tr>
<tr>
<td>31 22 16.1</td>
<td>Reshaping Existing Subgrade</td>
</tr>
<tr>
<td>31 23 01</td>
<td>Excavating, Trenching and Backfilling</td>
</tr>
<tr>
<td>31 23 23</td>
<td>Controlled Density Fill</td>
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<tr>
<td>31 24 13</td>
<td>Roadway Excavation, Embankment and Compaction</td>
</tr>
<tr>
<td>32 01 11</td>
<td>Pavement Surface Cleaning and Removal of Pavement Marking</td>
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<tr>
<td>32 01 16.7</td>
<td>Cold Milling</td>
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<td>Pavement Crack Cleaning and Filling Prior to Overlay</td>
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<td>Granular Subbase</td>
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<td>32 14 01</td>
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<td>32 31 13</td>
<td>Chain Link Fences and Gates</td>
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<td>Topsoil and Finish Grading</td>
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<td>33 40 01</td>
<td>Storm Sewers</td>
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<td>33 44 01</td>
<td>Manholes and Catchbasins</td>
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<tr>
<td>34 41 13</td>
<td>Traffic Signals</td>
</tr>
</tbody>
</table>
GENERAL

The electrical power and control system work shall be as indicated on the Contract Drawings and as specified herein. The work shall consist of providing electric service equipment including coordinating the provision of electric services with B.C Hydro and the allowance for service entrance and metering equipment in the standby generator housing, standby generator, switchgear, automatic transfer equipment and associated ancillary equipment all installed in a skid mounted weather and acoustic housing, standby generator load bank, motor control centre, span drive motors, VFD drive controllers including dynamic braking resistors, motor and machinery brakes, disconnect switches, span position rotary cam limit switch and span position resolver, span drive motor VFD feedback encoder, span lock actuator with associated rotary cam limit switch and railroad type span lock end of travel limit switches, span seated limit switches, inclinometer, moving span and fender navigation lights, bridge aircraft obstruction lights, bridge and operator’s house lighting and receptacles, machinery spaces and operators house heating, ventilating and air conditioning installation, lighting panel and dry type transformer, traffic lights, traffic gates, audible navigation warning air horn, operator’s control console, bridge PLC and relay logic control system, communications backbone system, bridge CCTV system, intercom system, bridge fire/smoke detection and alarm system, ship to shore radio system, UPS, laptop and desktop computers, cable reel system for the new lift span, bridge approaches, towers and operator’s control house.

The Contractor shall be responsible for the coordination of the electrical power and control system work with all other contract work items of all other trades as necessary to produce completed systems which meet the requirements of the Contract Documents. This work shall include furnishing all labour, materials, tools, services and equipment required to perform the installation, carry out adjustments and testing of the electrical power and control systems shown on the Contract Drawings and as indicated herein.

Standards

All new electrical power and control system items specified herein and required for the defined bridge operating functionality must meet the requirements of the National Standard of Canada CAN/CSA-S6-06 Canadian Highway Bridge Design Code, hereinafter referred to as CHBDC.

Standards referred to herein and on the Contract Drawings are published by the following organizations and are directly applicable to the material, workmanship and operating requirements for the complete installation and specified performance of the bridge electrical power and control systems:

a) ASTM - American Society for Testing and Material
b) ANSI - American National Standards Institute
c) CSA - Canadian Standards Association
d) CSA C22.1 – Canadian Electrical Code
e) IEEE – Institute of Electrical and Electronics Engineers
f) IPCEA – Insulated Power Cable Engineers Association
g) NEMA – National Electrical Manufacturers Association
h) AASHTO - American Association of State Highway Transportation Officials
i) UL - Underwriters Laboratories, Inc
j) CANOSH – Canadian Occupational Health and Safety

Conformance
All electrical equipment and its installation shall conform to the requirements of the latest revision of CHBDC and the Standard Specifications for Movable Highway Bridges of the American Association of State Highway and Transportation Officials, except as may be otherwise provided herein.

Materials and construction shall conform to the requirements of the current Canadian Electrical Code (CSA C22.1), National Electrical Manufacturer’s Association (NEMA), Underwriters Laboratory (UL), and to all applicable local rules and ordinances. The Contractor shall obtain all required permits and approvals from all Departments or Agencies having jurisdiction for the specified electrical power and control work.

All equipment and materials shall be new. All equipment, materials, and workmanship shall be first-class in every defined way and shall be manufactured and installed to the satisfaction of the Engineer and in accordance with these Contract Documents. The Contractor shall warrantee the in-service working of the electrical installations for five-years following bridge and bridge operating systems acceptance. If the Contractor has any objection to any feature of the electrical equipment as designed, laid out and specified herein or as indicated on the Contract Drawings, he must state his objection at once in writing to the Engineer, otherwise his objection will be ignored if offered as an excuse for malfunctioning of the equipment or for defective or broken apparatus.

Each piece of electrical equipment and apparatus shall have a corrosion-resisting metal nameplate on which is stamped the name of the manufacturer and the rating or capacity of the equipment or apparatus.

All metal parts of the installation, except structural steel, shall be of corrosion-resisting material, such as aluminium, bronze, or stainless steel as specified herein. Cast-iron, malleable iron or steel with a hot-dip galvanized finish shall be used where specified herein.

All mounting hardware and all wire and cable terminals shall be vibration proof.

If any departures from the Contract Drawings or the Specifications are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Engineer for approval as soon as possible. No such departures shall be made nor work started without the approval of the Engineer.

Substitutions

Items specified by manufacturer name or part number as specified herein may be replaced by an equivalent item produced by another manufacturer, subject to approval by the Engineer, with the understanding that all changes required by the substitution shall be made by the Contractor at no additional cost to the City. Item equivalency shall be determined at the sole discretion of the Engineer and may be based on one or more of the following: quality, function, ease of maintenance, physical size, reliability, value, electrical load capacity, durability, standardized components, availability and other criteria as deemed appropriate by the Engineer.

SUBMISSION REQUIREMENTS

Shop Drawings, Catalogue Cuts, Final Record Drawings, Certified Drawings, Operation and Maintenance Manuals, Electrical Installation details, Testing and Calibration Procedures and other required submittals specified herein shall be submitted to the Engineer for review. Submittals that do not meet the minimum requirements identified herein will be considered non-responsive and will be returned to the Contractor without review. Submittals that have not been approved or require correction shall be resubmitted until such time as they are acceptable to the Engineer, and such procedure shall not be considered cause for delay by the Contractor. The Contractor shall bear all costs for damages which may result from ordering or the fabrication of any materials or sub systems prior to acceptance of the Shop Drawings of such fabricated items or materials. The Contractor may
request in writing from the Engineer approval to order materials or devices of the correct type for later installation from approved Shop Drawings after they have been accepted. Such approval by the Engineer shall be in writing. No installation or assembly of electrical equipment or sub systems shall commence without approved installation and testing procedures and supporting installation details and electrical Working Drawings.

Material Submittals

The Contractor shall submit copies of vendor, producer or manufacturer data for materials, devices and sub systems or standard or proprietary products. These shall include specifications, testing requirements, and installation instructions for the following items, but not excluding other items or materials not specifically mentioned.

a) Electric Service Entrance and Electric Service equipment.
b) Standby Generator, associated switchgear and automatic transfer equipment and Ancillary Systems including its weather and acoustic housing.
c) Generator Load Bank.
d) Motor Control Centre.
e) Span Drive Motor VFD Controllers.
f) Dynamic braking resistors.
g) Span Drive Motors.
h) Machinery Brakes.
i) Motor Brakes.
j) Span Position Rotary Cam Limit Switches with Resolver.
k) Absolute Position Encoder for use with the specified VFD.
l) Span Drive Motor VFD Dynamic Braking Resistors.
m) Span Lock Actuator with Rotary Cam Position Limit Switch.
n) Span Lock End of Travel Railroad Type Limit Switch.
o) Span Seated Limit Switches.
p) Span Over Travel Raised Limit Switch.
q) Inclinometer.
r) Navigation Lights.
s) Bridge Aircraft Obstruction Lights.
t) Lighting Fixtures.
u) Floodlights.
v) Vehicular and Pedestrian Traffic Lights.
w) Vehicular and Pedestrian Traffic Warning Gates.
x) Operator’s Control Consoles.
y) Bridge Control System (PLC).
z) Laptop/Desktop Computers.
   aa) Communication Backbone Equipment.
   bb) UPS.
   cc) CCTV System Equipment.
   dd) Fire/Smoke Detection and Alarm System.
   ee) Bridge Intercom System.
   ff) Disconnect Switches.
   gg) Cable Reel System.
   hh) Dry Type Transformers.
   ii) Panelboard.
   jj) Air Horn.
   kk) Ship to Shore Marine Radio.
   ll) Hoist in the machinery space.

Any submittals that do not contain all documents specified herein and required for the manufacture, assembly and installation of the specified electrical power and control system will be returned without review.

**Drawing Submittals**

Installation drawings shall be prepared to depict all work to be performed as part of this Contract. Shop and Assembly Drawings shall be submitted for all components that are custom built for this project. Any deviations from the work depicted herein and on the Contract Drawings or alterations proposed by the Contractor for the electrical power and control systems of the bridge shall be signed and sealed by a Professional Engineer licensed in British Columbia, Canada.

Under no circumstance shall any of the proposed electrical power or control systems be fabricated, assembled, or wired directly from the Contract Drawings. Working drawings which are reproductions of the Contract Drawings, both in part or in their entirety, shall be considered non-responsive and will be returned without review.

The Contractor shall submit six copies of all working drawings, unless otherwise directed, that include Shop, Assembly, and schematic and wiring Drawings. All working drawings shall conform to the following:

- a) All dimensioned drawings for standby generator its associated equipment and weather and acoustic housing, motors, brakes, rotary cam limit switches, operator control console, VFD controller, transitioning cables between the moving and fixed structures, etc. shall be drawn to scale or provided in schematic form that fully describes the proposed system. All details of given devices or components shall be clearly visible at the scale selected for that part with the exception enlarged views drawn to capture small details part of fabrication, such as those that may be used to improve clarity and prevent excessively large drawings.

- b) Separate details shall be provided for all opposite hand electrical devices used to conform to the mechanical configuration of the machinery.

- c) Dimensioned drawings shall be prepared using the SI system of units. This shall apply to all dimensions of devices, and fits, mountings panel dimensional and fabrication drawings. The
Contractor may include English units parenthetically if so desired but SI units shall be the governing units used.

d) Drawings shall be prepared for all electrical power and control systems and sub systems proposed for the bridge and shall describe in physical, functional, schematic and wiring terms the configuration of the power and control system as well as the logic associated with the system.

e) Proprietary devices, components and parts shall be shown in outline on the drawings with sufficient information and data to determine the form of installation, functionality and operation.

f) A number of the items of equipment specified as part of the electrical work are to be provided to others for mechanical installation. These items shall consist of main drive motors, motor and machinery brakes, span lock actuator, encoders, span position rotary cam limit switches and lock actuator limit switches. The dimensions of these items are critical for their installation and integration into the bridge mechanical system. Their dimensions indicated on the mechanical Contract Drawings have been obtained from information provided by various equipment manufacturers. The dimensions have not been obtained from certified drawings (certified drawings are drawings certified by the manufacturer to be dimensionally accurate and which contain sufficient details to determine if the requirements of the contract documents have been satisfied). The Contractor shall, as part of its procurement process obtains certified drawings for these items and utilize them in the preparation of the Shop and Erection Drawings for the bridge machinery. The certified drawings shall be submitted in support of the Shop Drawings. The Contractor shall notify the Engineer of any dimensional deviations from the Contract Drawings.

g) The Contractor shall identify any conflicts between manufacturers’ instructions, shop drawings, recommended installation details and application and the Contract Documents and submit proposed resolution for review and approval by the Engineer.

h) The Contractor shall identify variations between Contract Documents and product or system limitations or functionality that may be detrimental to the successful performance or operation of the completed work.

i) Comprehensive shop Bills of Material shall be included for each of the proposed major items of equipment and systems and sub-systems including standby generator and all equipment and weather and acoustic housing, motor control centres, standby generator, VFD drives, panels, operator’s control console, PLC’s and system communications network, etc. The computed shipping and operating weights of each piece of electrical equipment shall be stated on the Shop Drawings upon which it is detailed.

j) Complete Assembly and installation drawings shall be furnished. These drawings shall clearly indicate how the work is to be performed in the field including foundation requirements, cable entry details for all freestanding equipment and any special installation procedures required.

k) Assembly and installation Drawings shall be given identifying marks and essential dimensions for locating each piece of equipment or assembled unit with respect to the bridge and its required equipment foundation. Each unit shall be cross-referenced to the Shop Drawing on which it is detailed.

l) Final “As-Built” Shop, Assembly and Installation Drawings shall be submitted at the completion of the project. Any deviations from the approved Shop Drawings shall be clearly
indicated. Reproducible drawings shall be made on the Project standard title block. These drawings shall be stamped "As Built", immediately above the title block.

m) The Contractor shall sequentially number all transmittal forms. Re-submittals shall be numbered with original submittal number and an alphabetic suffix.

**Procedure Submittals**

The Contractor shall submit procedures providing a step-by-step breakdown of all installation activities for each major item of work associated with the electrical power and control systems. The procedures should clearly indicate the order in which each item and sub system is to be installed and should accurately reflect the flow of overall bridge construction in the field. The procedures should constitute a suitable working document for construction and installation supervision in the field.

The procedures shall address all power and control installation means and methods. The procedures shall contain sufficient detail to demonstrate to the Engineer that the Contractor has full knowledge and understanding of the systems to be installed, and all other work to be performed as part of this Contract.

Installation procedures for devices, components or sub systems of standard products shall contain the manufacturer’s recommended installation instructions, which will be the basis for acceptance of the installation of such items.

Submittal quantities and acceptance guidelines shall be per the Drawing Submittals requirements.

**Schedule Submittals**

The Contractor shall submit a detailed work schedule identifying the progression of his proposed installation work to be performed under this Contract. The schedule shall include, as a minimum, all major items of work identified on the Contract Drawings and as specified herein. When work is to be performed during a marine traffic outage, the schedule shall provide a daily or hourly task breakdown clearly identifying those tasks on the critical path to return the marine waterway to service within the allotted outage period. All tasks shall be referenced to the main work items and the overall project schedule in the approved work procedures.

Submittal quantities and acceptance guidelines shall be per the Drawing Submittals requirements.

**Operating and Maintenance Manuals**

The Contractor shall provide Operation and Maintenance Manuals for all electrical power and control systems and sub systems provided.

Six preliminary copies of the Manual shall be submitted prior to shipment of the equipment to the site. The preliminary manuals shall be complete in all respects with regard to material content, organization and legibility for review by the Engineer. Preliminary copies need not comply with presentation requirements including page size, paper weight, paper reinforcement and protection including oil, moisture and wear resistant covers, and copy method but shall contain all technical data being proposed as part of the manuals.

Preliminary copies of the O&M Manuals will be reviewed by the Engineer and the changes made will be incorporated into the final manual. Six final hard copies of the Manual and one electronic copy (PDF or alternative format selected by the Contractor and approved by the Engineer) shall be submitted after the electrical power and control systems have been installed but prior to the bridge being placed into service or the training of City staff in the operation and maintenance of the bridge. This manual will form part of and be used as instruction documentation by the contractor in performing the required training of operations and maintenance personnel. The final manual shall
incorporate all of the Engineer’s comments on the preliminary manual and all field changes made during construction, installation and field settings during testing and start up of all devices and sub systems including MCC, standby generator, VFD’s, PLC logic, limit switch settings, timer relay settings, communications transmission backbone system, etc. Final copies shall also comply with all manual physical quality and presentation requirements to ensure permanence of the manuals.

The Operating, Maintenance, and Lubrication Manual shall include the following items:

a) Table of contents prepared in numerical order.

b) Index prepared in alphabetical order.

c) Manufacturer's literature that describes each piece of equipment, giving manufacturer's model number and drawing number for standard manufactured units.

d) Manufacturer's operating and maintenance manuals that describes the complete instructions relative to assembly, installation, operation, adjustment, lubrication, maintenance, and carrying complete parts lists. Manuals may be manufacturer's standard publications for standard manufactured units provided that they comply with specified requirements relative to quantity and quality of information and data.

e) Copies of all warranties on equipment supplied to the project.

f) Copies of all approved electrical installation drawings, descriptions of adjustments, calibration and testing procedures.

g) Copies of all shop drawings; these drawings to be the “as built” in the final version of the manual and be as approved by the Engineer.

h) Complete details and procedures for adjusting all items that have adjustments such as VFD drives, standby generator controls, limit switches, encoders, electronic equipment and all installed protective devices and instrumentation.

i) Details describing steps required for cursory inspection that should be carried out on the electrical power and control systems on a weekly, monthly and annually basis.

j) Details describing steps required for in-depth inspection that should be carried out annually. These shall include but not be limited to calibration of drives, limit switches and other devices, electrical testing of the installed power system including current and voltage injection testing of protective devices, insulation resistance testing, current, voltage and power recordings of the bridge operating system and all manufacture recommended annual inspections of the PLC’s, VFD drives, standby generator communications network, fire alarm and CCTV systems.

k) List of nearest local suppliers of all equipment, devices and sub systems provided as part of the bridge power and control system.

l) List of spare parts together with an estimation of their mean-time-to-replace (MTTR) and supplies as described herein that is to be furnished as part of the Contract.

m) Name, address, and telephone number of the local manufacturer's representative and of the service company for each piece of equipment so that prices or future services and spare parts can easily be obtained.

The covers and title page shall be neatly imprinted with a descriptive title and shall contain the name of the bridge, owner, and location. The title page shall also contain the names of the Engineer, the Contractor, and the date of issue. Divider pages with tabs shall separate the various sections which comprise the Manual. All parts information shall be correct for the equipment provided under this
Contract. If standard device or sub-system drawings are used, they shall be modified to be suitable and irrelevant material shall be blocked out or removed. All general information used as text shall be modified where necessary to show pertinence to the equipment furnished under this Contract, and irrelevant material shall be removed. The arrangement of the manual, method of binding, including material and text shall be submitted to the Engineer for approval.

Illustrations shall be clear. Printed matter, including notes and descriptions, dimensions, wiring and termination designations and lettering on drawings, shall be easily legible. If reduced sized drawings are incorporated into the manuals, the original lines and letters shall be darkened if necessary to retain their legibility after reduction. Larger drawings may be folded into manuals to the page size of the manual. Diagrams and prints used in the manual shall be reproduced to a size not to exceed 279 mm by 432 mm and shall be complete and legible in all respects. Diagrams shall be made on white paper and vacuum sealed in transparent plastic material impervious to moisture and oil, and resistant to abrasion. Other formats which are equal in clarity, sharpness, durability and permanence will be considered.

Manuals shall be prepared from the following materials:

a) Tear, water, and grease resistant paper.
b) Page size shall be 216 mm by 279 mm.
c) Fold out diagrams and illustrations as required.
d) Reproducible shall be by dry copy xerography method.
e) Covers shall be plastic oil, moisture and wear resistant.

QUALIFICATIONS

Only individuals with proven experience and with high competence shall be utilized to perform the specified electrical power and control installation work required by this Contract. Competence shall be evaluated through the following criteria:

Supervising Personnel

The installation, adjusting, calibrating and testing of all electrical power and control work as defined herein shall be supervised and directed by foremen and/or supervising engineers who shall be on-site on a daily basis while the work is on-going. Personnel proposed for this role shall have a minimum installation and design experience of 10 years that includes two movable bridge electrical power and control projects and extensive experience installing and testing similar equipment to that specified herein. Evidence of experience shall be submitted in resume format to the Engineer for approval and shall include the following:

a) Description of two movable bridge electrical power and control projects to include the type of bridge and power and control technology, bridge PLC system, communications network and drive system associated with the project
b) Duration of each project including start and completion dates
c) Position held for each project
d) Geographic location of each project
e) References, including names and current contact information for each project

Bridge Control System Vendor

All apparatus and equipment comprising the bridge control system, including, but not limited to,
drives, motors, brakes, limit switches, motor VFD drive controls, control console, special control panels, programmable logic controllers, bridge communications network, interfacing equipment, PC software and hardware for on-site adjustments, testing and troubleshooting, and other apparatus required to provide a complete functioning and maintainable system, shall be furnished and/or manufactured and assembled by a single qualified control system vendor. The vendor shall assemble the control panels and console at an Underwriters Laboratory approved Facility in accordance with UL 508.

The control system vendor shall have experience in providing electrical control systems for movable bridges of various types, including bascule, vertical-lift, swing bridges, and control systems, including intelligent motor control centre’s, flux vector regenerative motor drives and programmable controllers similar to those specified herein. Such experience shall be demonstrated by identifying a minimum of five movable bridges of which two (2) shall have been bascule bridges for which the system vendor has provided complete systems, including solid-state drive motor control and programmable controller logic within the past 5 years.

The control system vendor shall assume complete system responsibility for the integrated functioning of all components to provide a satisfactory assembled system that operates in accordance with specified performance requirements. The control system vendor shall be responsible for the preparation of the detailed proposed one line diagrams, three line and wiring diagrams, schematics, bridge control logic diagrams (in a format to be approved by the Engineer) and fabrication details of the total control system to ensure compatibility of equipment and suitability for the intended system functionality. The system vendor shall also be fully responsible for developing the program of the Programmable Logic Controller (PLC). This programming shall be based on the sequence of operation, code compliant safety interlocks and performance specification herein described for the bridge. The vendor shall provide supervisory assistance during the installation of equipment to ensure maximum reliability and ease of maintenance of the completed operating power and control system for the bridge.

During testing of the electrical systems, it may be found that minor deviations from the performance specification are required for optimum bridge operation, all hardware and software required for these modifications shall be included in the control system vendor scope of work at no additional cost to the City.

The system vendor shall provide a field service staff having the capability of providing services for field coordination of construction and final adjustments for the MCC, standby generator, drive system, PLC and communications network. Upon final acceptance of the bridge, the system vendor’s staff shall provide on-call warranty service for a period of 1 year. Field staff shall be capable of responding to any bridge emergency within 12 hours.

The Contractor shall provide written certification of compliance with the herein specified requirements for his control system vendor. This certification shall be included in the tender documents and shall be subject to approval by the Engineer and the City.

**MATERIALS**

**Conduits**

Supply all necessary material for an electrically continuous conduit system sized as noted and as required by CSA 22.1 and local ordinance for feeder cables, branch circuits and control cabling.

a) Size of conduits shall be as indicated. Where size is not indicated, it shall be in accordance with the requirements of the Canadian Electrical Code.

b) Unless otherwise indicated, the minimum size conduit shall be 21 mm.

All conduits shall be plastic coated rigid heavy wall hot dipped galvanized steel conduits, routed as described on the Contract Drawings, as dictated by field conditions and as necessary for coordination with the other disciplines as proposed by the Contractor and approved by the Engineer and as specified
Manufactured conduits shall meet or exceed the following requirements:

a) The galvanized conduit prior to plastic coating shall conform to Federal Specifications WW-C-581D, ANSI Standard C80.1, UL Standard No. 6 and NEMA RN1 latest edition.

b) The conduit shall be hot dipped galvanized inside and out with hot dipped galvanized threads.

Underground conduits shall be hot dipped galvanized plastic coated.

Flexible conduit shall be installed of at least 450 mm length for leads and taps as necessary for connections to equipment that is subject to vibration or may require movement for adjustment and meet the following requirements:

a) Flexible conduits shall be hot dipped galvanized steel core, conforming to UL Standard No. 1. In addition, flexible conduits shall be made liquid-tight by covering the steel core with a smooth, abrasion resistant, liquid-tight polyvinyl chloride cover, which shall be resistant to sunlight, and ozone, shall be suitable for wet and oily locations and be suitable for temperatures between –20 Degrees and 80 Degrees C.

All conduits, conduit bodies, connectors, support systems and accessories above and below ground for interior and exterior work shall be plastic-bond as produced by Robroy Industries or Engineer approved equal and meet or exceed the following requirements:

a) Before coating, the galvanized surface shall be coated with an epoxy-acrylic primer to provide a bond greater than the tensile strength of the coating.

b) The plastic coating shall be applied by the plastisol dip method.

c) The minimal thickness of the coating is to be 1 mm.

d) The plastic coating shall be factory applied by the same manufacturer who produces the hot dip galvanized conduit. The coated conduit shall conform to NEMA Standard No. RN1-Latest Edition (Type 40).

e) Every female opening shall have a plastic sleeve extending one pipe diameter or 50 mm whichever is less beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the pipe used with it. The wall thickness of the sleeve shall be the same as the plastic coating.

Conduits shall be installed in practical alignment with the structure, with uniform pitch draining toward boxes, properly formed bends, and securely attached to the bridge structure. Ends shall be reamed prior to installation and open ends plugged following installation. Each run shall be thoroughly swabbed prior to pulling of wires. Conduits shall enter boxes squarely and conduit ends shall be secured with approved bushings and locknuts.

**Conduit Fittings**

Conduits to motors and other electrical vibrating equipment shall terminate in conduit fittings on the motors and equipment, the final connection being made with liquid-tight flexible conduit as described above and suitable liquid-tight connectors.

Each underground joint shall be sealed and made liquid-tight.

Liquid-tight unions shall be installed where standard threaded couplings cannot be used.

Stainless steel screws shall be furnished and used to attach the cover to the conduit fittings. All coated material shall be installed and patched according to the manufacturer’s latest printed recommended installation and patching instructions and as approved by the Engineer.

All conduits shall be secured to outlet boxes, junction boxes or cabinets by placing approved stainless
steel locknuts on outside of box, and stainless steel locknuts and bushings on inside of box.

All conduit terminations shall be equipped with insulating bushings.

Coupling, connectors and fittings used for the installation shall be of a type specifically designed and manufactured for use with the supplied plastic coated conduit. Flexible liquid-tight conduit and connectors shall be used where final connection to equipment with rigid conduit is not practicable, such as to equipment with adjustable mountings or subject to vibration. Where used the flexible conduit runs shall be no less than 72 mm in length or as approved by the Engineer.

Where indicated on the Contract Drawings the installation shall be explosion proof, but the form of the conduit installation shall be as herein defined.

**Wireways**

Wireways where indicated on the Contract Drawings shall be constructed in accordance with NEMA 12/3R wireways, auxiliary gutters, and associated fittings as indicated. Every component, including straight lengths, connectors, adapters, and fittings shall be UL listed. The wireway shall have available adapters to facilitate attachment to other NEMA 12/3R enclosures.

Wireway shall be constructed with no gasket that can rip or tear during installation or will not provide the rain-tight capability of the NEMA 12/3R wireway.

The wireway shall be constructed so that no connector screw or removable drip shield cover screw protrudes into the trough area so that it is capable of damaging installed wire insulation.

The NEMA 12/3R wireway shall be manufactured of temperature and chemical resistant fiberglass, all seams shall be continuously sealed and there shall be no holes or knockouts. All hardware shall be stainless steel to prevent corrosion.

The wireway material shall have a flammability rating of UL 94-5V and meet UL cold impact test for temperatures to -35 Degree C.

The wireway system shall be of Hoffman manufacture or Engineer approved equal.

The Contractor shall submit shop drawings of all proposed wireway layouts, routing and details to the Engineer for review and approval prior to manufacture in accordance with the provisions of the Contract.

**Cable Ladder and Channel**

Low smoke, zero halogen, non-metallic cable ladder and channel tray shall meet or exceed the following requirements:

a) Furnish non-metallic cable trays, of types, classes, and sizes as described herein and indicated on the Contract Drawings.

b) The tray system shall be furnished complete with splice plates and stainless steel bolts, nuts and washers for connecting the units.

c) All component parts shall be constructed with rounded edges and smooth surfaces.

d) Straight section structural elements of the cable tray system; side rails, rungs and splice plates shall be pultruded from glass fibre reinforced zero halogen resin.

e) Pultruded shapes shall be constructed with a surface veil to insure a resin-rich surface and ultraviolet resistance.

f) The cable tray shall be capable of carrying a uniformly distributed load of 12kg/m on a 3,000mm support span with a factor of safety of at least 1.5 when supported as a simple span and tested per NEMA VE 1.

g) The constructed pultruded shapes shall meet or exceed the following requirements:
i) Flexural Strength – 172Mpa, Min
ii) Flexural Modulus – 6,880Mpa, Min
iii) Tensile Strength – 117Mpa, Min
iv) Tensile Modulus – 6,192Mpa, Min
v) Impact Strength – 25 ft-lb/in., Min
vi) Dielectric Strength – 170 volts/mil, Min
vii) Arc Resistance – 180 seconds, Min
viii) Water Absorption – 0.2%, Max
ix) Thermal Expansion – 0.000007 in/in/Degree F
x) Flame Spread Index – 60, Max
xi) Flame Resistance – UL 94 V-0, Min
xii) Tracking resistance – 600 minutes, Min @ 2,500 volts
xiii) Specific Optical Smoke Density – 200 Max within 4 minutes after start of test.
xiv) Smoke Toxicity:
   1) Hydrogen Chloride – 10 ppm
   2) Hydrogen Bromide – 10 ppm
   3) Hydrogen Cyanide – 10 ppm
   4) Hydrogen Sulphide – 10 ppm
   5) Vinyl Chloride – 10 ppm
   6) Ammonia – 500 ppm
   7) Aldehydes – 30 ppm
   8) Oxides of Nitrogen – 100 ppm
   9) Carbon Dioxide – 15,000 ppm
  10) Carbon Monoxide – 1,000 ppm
h) The ladder cable trays shall consist of two longitudinal members (side rails) with transverse members (rungs) mechanically fastened and adhesively bonded to the side rails. The ladder cable tray shall be of Cooper B-Line manufacture or Engineer approved equal.
i) Contractor shall provide test reports witnessed by an independent testing laboratory of tests of the “worst case” loading conditions outlined above and performed in accordance with the latest revision of NEMA FG 1.

Stress Relieving Cable Grips
Stress relieving cable grips shall be furnished and installed to relieve strain on cables mounted installed such that stress is imposed on the cable.

The stress relieving cable grips shall be of the wire mesh type of stainless steel construction. The grips shall be appropriately sized based on the size weight and breaking strength for the defined application.

The cable grips shall be QPL 22992 certified and be Defense Federal Acquisition Regulation Supplement (DFARS) compliant and meet the requirements of MIL-STD-790 and also meet QC
System MIL-I-45208(A).

The stress relieving cable grips shall be of AMTEC manufacture or Engineer approved equal.

The cable grips shall be installed in accordance with manufacturer’s recommendations and with stainless steel hardware.

The Contractor shall submit outline-dimensioned drawings; of his proposed stress relieving cable grips, and specification in the form of catalogue cuts and data sheet of proposed cable grips to the Engineer for approval prior to procurement.

**Wiring Devices**

Outlet, Junction and Pull Boxes shall meet or exceed the following requirements:

a) Switch and outlet boxes installed indoors, surface or concealed shall be cadmium plated, or zinc-coated, sheet metal type, provided with screw-fastened covers.

b) All exposed junction and pull boxes whether installed indoors, or in machinery spaces shall be cast iron - hot dipped galvanized heavy walled with cast iron covers or Engineer approved equal. The boxes shall be furnished complete with neoprene type packing for gasket, four mounting lugs on standard spacing, bronze hinges, bosses for five threads, interior mounting buttons tapped blind and tapped and stainless steel protect cap screws. Each box shall be sized per CSA 22.1 with regards to volume per number of conductors or as conduit sizes dictate. Boxes shall not be less than 65 mm deep or as indicated on the Contract Drawings.

c) Ceiling and bracket outlet boxes shall not be less than 100 mm octagonal. Switch and receptacle boxes shall be approximately 100 mm square. Telephone outlet boxes shall be 100 mm square. Boxes for installation in concealed raceway systems shall be provided with extension rings or plaster covers, permitting setting flush with the finished surfaces.

All junction boxes shall be furnished complete with terminal blocks sized in accordance with the Contract Drawings and provided with 20 percent spare terminals. The terminals shall be of the test circuit type as manufactured by Phoenix Contact, Inc. or Engineer approved equal. The terminals shall be of the universal type with separate ground terminals, fuse terminals and relay terminal blocks (relay plug ST-REL) as specified herein and on the Contract Drawings. Each terminal shall be identified with the Phoenix Contact Inc. “Zack” marking system or Engineer approved equal.

Duplex receptacles: Only duplex receptacles shall be furnished and the duplex receptacles shall be rated for the defined duty and shall be three-wire grounded type with polarized tandem slots and u-shaped ground slot. The receptacles shall conform to the requirements of CSA Standard WD-1. Bodies shall be of brown phenolic compound supported by mounting yoke having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacles shall be side-wired with two screws per terminal. The third grounding pole shall be internally connected to the grounding yoke.

Weatherproof receptacles: weatherproof receptacles shall consist of a receptacle as specified complete with a cast metal box with a gasketed, weatherproof, cast-metal cover plate and cap over each receptacle opening or Engineer approved equal. The cap shall be a spring-hinged flap with neoprene gasket.

Other receptacles shall be of types indicated on the Contract Drawings.

Wall switches shall be of the totally enclosed tumbler, 120 volt, 60 Hz, quiet type. Bodies shall be phenolic compound. Handles shall be brown. Wiring terminals shall be of the screw type or of the solderless pressure type having a suitable conductor release arrangement. Switches shall be rated for the defined duty. Switches shall be “off” in the down position.
Weatherproof switches: weatherproof switches shall consist of a switch as specified above, mounted in a cast metal box with a gasketed, weatherproof, cast-metal cover plate, an operating handle and cap over the switch operating handle or Engineer approved equal. The cap shall be a spring-hinged flap with neoprene gasket.

Explosion proof switches shall consist of a switch as specified above, mounted in a cast metal box and be of type as indicated on the Contract Drawings or whose function is specified herein.

**Fastening Materials**

Expansion anchors for fastening equipment to concrete surfaces shall be double, machine bolt expansion shields of stainless steel. Holes for expansion shields shall be drilled to the size recommended by the manufacturer, using carbide-tipped masonry drills.

Mounting bolts, nuts, washers and other detail parts used for fastening boxes, disconnect switches, limit switches, conduit clamps, cable support, brackets and other electrical equipment shall be bronze or stainless steel. Bolt heads and nuts shall be hexagonal, and shall be provided with medium series lock washers. Bolts that are smaller than 9.5 mm diameter shall not be used, except as may be necessary to fit the mounting holes in small limit switches, outlet boxes and similar standard devices.

**Conductors**

Conductors shall be soft annealed copper, stranded, Class B.

Conductor insulation except for Motor Control Centre (MCC), VFD’s traffic warning gate control panels, and Operators Control Console and all other panels indicated herein and on the Contract Drawings shall be moisture and heat resistant cross-linked synthetic polymer, NEC Type XHHW or as otherwise herein indicated or as approved by the Engineer.

Conductor insulation for wiring in the MCC, VFD’s traffic warning gate control panels and Operators Control Console and all other panels indicated herein and on the Contract Drawings shall be CSA Type SIS or as otherwise specified herein or as approved by the Engineer.

Conductors shall not be smaller than No. 12 AWG, or unless otherwise indicated on the Contract Drawings.

Conductors shall be coded. Each wire shall be coded so that it can be easily identified. Insulated grounding conductors shall be coloured green or green with one or more yellow stripe. Conductors for the 3-phase, A.C. Power system shall have a white neutral with black, red and blue phase conductors. Color-coding shall be throughout the thickness and length of the conductor. Painting or color marking conductors will not be permitted.

Control conductors shall be color coded with at least twenty (20) different colour and trace combinations used. As far as possible, different colours shall be used in the same conduit. If more than twenty (20) conductors are used in a conduit, repetitive colours may be used which are widely separated in the bundle.

Each conductor shall be tagged at every termination and connection, and in every pull box through which the conductor passes. Tagging shall conform to Article 2.10.49 of the AASHTO Standard Specifications for Movable Highway Bridges and be of Phoenix Contact, Inc. manufacture, their type; Conductor Marker Collar LBH or Engineer approved equal.

Flexible cables shall be extra flexible general-purpose cables, rated 600 volts, 105 Degrees Celsius to minus 40 Degrees Celsius, oil, sunlight, ultraviolet, ozone, salt, chemical, and moisture resistant. The cables shall be multi-conductor sized as indicated and be Type SOW-A/SO with flexible copper conductors and stranding in accordance with Class K. The jacket shall be flame resistant and be
resistant to oil, water, abrasions and mechanical abuse and of yellow color. Conductors shall be fully annealed stranded bare copper.

In-line splices of any conductors will not be permitted unless otherwise indicated herein or on the Contract Drawings or as approved by the Engineer.

Cables shall be delivered to the project site in original packaging or on factory reels, fully identified with tags or labels, indicating the manufacturer’s name and date of manufacture. In addition, the name of the manufacturer, insulation type, voltage rating, and wire size shall be clearly and permanently imprinted throughout the length of each cable.

**Connectors, Terminals and Tape**

Connectors, terminal lugs and fittings shall be UL 486 with the following additional requirements.

a) For No. 10 AWG and smaller conductor cable shall be pressure type tin-plated copper connectors having non-flammable and self-extinguishing insulation with temperature rating equal to that of the conductor insulation.

b) For No. 8 AWG to 4/0 AWG conductor cable shall be compression type tin-plated copper connectors and termination lugs having conductor insulation grip.

c) For 250 MCM and larger conductor cable shall be long barrel double compression type tin-plated copper connectors and terminal lugs with two hole pads in accordance with NEMA CC1.

Bundling Straps shall be self-locking steel barb on one end, with tapered strap of self-extinguishing nylon of minus 54 to 122 degrees Celsius temperature rating. For outdoor use: ultraviolet and ozone resistant nylon strap with the above characteristics.

Insulating Tape shall consist of the following:

a) Plastic tape: Vinyl plastic with rubber-based pressure sensitive adhesive, pliable at a temperature of minus 18 Degrees Celsius and having following minimum properties when tested in accordance with ASTM, D1000-77:

   i) Thickness: 0.2 mm
   ii) Breaking strength: 3.6 kg per cm (width).
   iii) Elongation: 200 percent.
   iv) Dielectric breakdown: 10,000 volts
   v) Insulation resistance: 10 Meg-Ohms. (Indirect method of electrolytic corrosion)

b) Rubber Tape: Silicon rubber tape with silicon pressure sensitive adhesive and having following minimum properties when tested in accordance with ASTM D1000-77:

   i) Thickness: 0.4 mm
   ii) Breaking Strength: 2.3 kg per cm (width)
   iii) Elongation: 525 percent.
   iv) Dielectric breakdown: 13,000 volts
   v) Insulation resistance: 10 Meg-Ohms. (Indirect method of electrolytic corrosion)
c) Arc proof Tape: Flexible and conformable organic fabric tape, coated one side with flame-retardant flexible elastomeric, self-extinguishing, non-combustible, and having following minimum properties when tested in accordance with ASTM D1000-77:

   i) Thickness: 1.5 mm
   ii) Breaking strength: 8.9 kg per cm (width)
   iii) Thermal conductivity: 0.00478 BTU per hour per square foot per degree F
   iv) Electric arc: withstand 200 amperes arc for 30 seconds.

**ELECTRICAL INSTALLATION METHODS**

**Conduit Installation**

Flexible conduit shall be used for final connections to motors; limit switches, control devices and all other devices and equipment subject to vibration, adjustment or subject to removal for maintenance or inspection and is at least 450 mm in length.

Liquid tight flexible vinyl-jacketed conduit shall be used for all final flexible connections.

Conduit outside of finished spaces shall be run exposed. Conduits shall preferably not be visible to the public, and shall not obstruct access for operation, inspection or maintenance. Where changes in direction cannot be made with standard radius bends as at columns or beams, galvanized conduit fittings plastic coated as specified herein shall be used. Conduits shall be free from blisters, cracks, damage to the plastic coating or injurious defects, and shall be reamed at each end after being threaded. Sections shall be connected to each other with screw couplings, made up so that the end of both conduits will butt squarely against each other inside of coupling. Each threaded end of conduit shall be coated with zinc rich paint immediately before the parts are screwed together and covered with plastic coating in accordance with the manufacturers recommendation. Conduits shall be installed so as to be continuous and water tight between boxes and equipment. Conduits shall be protected at all times from the entrance of water or other foreign matter by being well plugged overnight or when the work is temporarily suspended.

Bends shall be long sweep, free from kinks and of such easy curvatures as to permit the drawing in of conductors without injury or their damage. Conduit runs shall be made with as few couplings as standard lengths will permit, and the total angle of all bends between any two (2) boxes shall not exceed two (2) quarter bends, unless otherwise approved by the Engineer. The radius of curvature of pipe bends shall not be less than eight (8) times the inside diameter of said conduit. Long running threads will not be permitted. Pull boxes shall be used wherever necessary to facilitate the installation of the wires and be sized in accordance with CSA 22.1 or as approved by the Engineer.

Except for wiring to lighting fixtures and receptacles, or where otherwise specified or called for on the Contract Drawings, condulets shall not be used for pulling conductors or for making turns in conduit runs, or for branching conductors. Condulets, where permitted, shall consist of malleable iron casting with gasketed covers of the same material, and fastened with stainless steel cover screws. Condulets, shall be hot-dipped galvanized, and shall be equal to the threaded conduit bodies for rigid conduit.

Where conduits pass through floors, walls, or roadway, galvanized pipe sleeves shall be provided for free passage of the conduits. After the conduits are installed, the openings shall be caulked with an elastic compound and escutcheon plates provided as approved by the Engineer. Core drilling openings shall be made for sleeves in an approved manner.

Conduit runs exposed on the structure shall be securely clamped to the steelwork. The clamps, in general, shall consist of U-bolts attached to structural steel supports and assemblies as approved and
directed by the Engineer. Conduit runs exposed on concrete surfaces shall be securely bolted to the concrete by stainless steel U-bolts connected to structural steel brackets. Bolts for fastening the brackets to the concrete shall be held by stainless steel expansion anchors.

U-bolts shall be stainless steel and shall be provided with medium-series lock washer and stainless steel hexagonal nuts. The bolts shall be not less than 10 mm in diameter.

The ends of conduits projecting into boxes and equipment enclosures shall be provided with grounded-type insulated bushings of malleable iron, hot-dipped galvanized. The insulated portion shall be of moulded phenolic compound, and each fitting shall have a screw-type combination lug for bonding. The bushing shall be O-Z/Gedney type BLG, Spring City Type GB, or Engineer approved equal. Bushings in every box and enclosure shall be bonded together with bare copper wire.

Conduits shall be installed so that they will drain properly, and drainage tees shall be provided where required.

Conduits shall be carefully cleaned both before and after installation. Upon completion of the conduit and box installation, each conduit shall be cleaned by snaking with a steel band, to which shall be attached an approved tube cleaner equipped with a mandrel of a diameter not less than 85 percent of the nominal inside diameter of the conduit, and then the cable drawn in.

Conduit bends shall be carefully made with suitable bending tools so that no kinking or reduction of internal diameter results. Use large radius gradual sweeps where possible. Hickey bends will not be acceptable on 25 mm and larger conduits.

Empty conduits shall be capped or plugged immediately after installation. No. 10 Nylon pull wires shall be provided in all spare and empty conduits.

Conduits shall be braced or anchored sufficient to resist displacement when wires are being pulled.

Elbows shall be of the same material as the conduit unless otherwise noted.

Conduit connections to electrical equipment with knockouts shall be provided with a locknut on the outside of the knockout and a locknut and bushing on the inside of the knockout. Conduits shall have insulated bushings.

Exposed conduits shall run parallel to or at right angles with the lines of the structure. Conduits shall be of ample dimensions to permit the pulling in and withdrawal of the wires and cables without abrasion.

All conduits shall be carefully run to coordinate with other structural members and mechanical equipment.

In installing exposed conduits, particular care shall be taken in cutting to the proper lengths, so that the ends will fit exactly into the outlet boxes and cabinets. Where conduits terminate in cabinets they shall be at the same level, flush, and with locknut inside and outside the bushing.

Cable sealing compound shall be non-hardening “DUXSEAL” adhesive.

Both ends of each conduit run shall be provided with a brass tag having a number stamped thereon to identify the destination of the conduit, and these tags shall be securely fastened to the conduit ends with copper wire. All conduit threads shall be coated with zinc rich paint before assembly.

All threaded connections for corrosion-coated conduits shall be further treated with field patching compounds and plastic applied in strict conformance with manufacturer’s application instructions. This coating shall be applied to all scratches on the corrosion resistant conduit.
The Contractor shall produce a complete set of conduit installation drawings describing his proposed routing of all conduits for approval by the Engineer prior to the start of installation work and in accordance with this specification. These drawings shall be based on the above defined requirements and follow the physical layout of the bridge structural members and all conduits shall be identified on the drawings with the above defined tagging.

**Conductor Installation**

Wires shall be installed in conduit except where otherwise indicated on the Contract Drawings. No conductor shall be pulled into any conduit before joints are made tight and the entire run secured in place. Where required to ease the pulling of wires into conduit, use of commercial compounds specially approved by the wire or cable manufacturer and subject to Engineer’s approval will be allowed.

In equipment and pullboxes, lace and tie off conductors in groups of three phase and neutral, where used, to limit conductor unbalance loading.

Leave wires with sufficient slack at terminal ends for convenient connections and for convenient servicing.

Conductors inside junction boxes and at the Operators Control Console, Motor Control Centres, VFD’s, standby generator and Traffic Warning Gates shall be neatly trained into cables and laced with approved cable ties except where enclosed in plastic wire duct with the individual conductors leaving the cable or wire duct at their respective terminal points. These conductors shall be looped to allow not less than 75 mm of free conductor when disconnected. The trained cables shall be held securely away from the terminals and from contact with the enclosure by means of approved insulating supports.

Conductors shall terminate on terminal blocks except where the Contract Drawings specifically allow cross connections in junction boxes. These generally occur only where one 3 phase, 4 wire circuit is used to supply lights, heaters, and receptacles. The common neutral for the one (1) multi-wire circuit may be spliced in a junction box.

Splicing of wires will not be permitted except for wiring to service lighting fixtures and receptacles and as specified above. Wherever it becomes necessary to join or branch conductors, terminal blocks shall be used and wires shall be clearly tagged.

**Fastening**

All, receptacles, boxes, panels, outlets and similar equipment furnished or installed under this item shall be firmly secured in place.

Use expansion shields or concrete inserts in concrete; stainless steel screws in wood.

Spacing of conduits and wireway supports shall be 1000 mm max. The spacing of cable ladder rack supports shall be 2,000 mm max.

Secure specified items to the structure independently. Do not secure to work of other trades such as ceiling lath, or piping racks, unless specified or approved by the Engineer.

Supports for conduits, wireways, cables, boxes, cabinets, disconnect switches, small limit switches and other separately mounted electrical equipment shall be fabricated from structural steel not less than 10 mm thick and shall be hot-dipped galvanized.

Structural steel brackets, boxes and other equipment mounted on concrete surfaces shall be provided with a neoprene pad 12 mm thick between the equipment and the surface of the concrete.
The installation of cable ladder racking shall be in accordance with the manufacturer’s recommendations, and with recognized industry practices to ensure that the cable ladder rack system complies with the requirements of the Canadian Electrical Code and the applicable portions of NFPA 70B and NEMA VE 2. Coordinate the installation of the cable ladder racking with all other electrical work and the work of other trades as necessary to properly integrate the bridge electrical installation. In installing the cable ladder racking sufficient space shall be allowed to permit access for installing and maintaining cables.

**Service Aisles, Walkways, Access Space**

In locating equipment in the machinery space and operators control house, the Contractor shall pay particular attention to furnishing easy access to equipment. An effort has been made to indicate aisles, walkways and service areas around all items of equipment on the Contract Drawings.

In construction, all such aisles shall be preserved. In general and as otherwise indicated on the Contract Drawings, conduit and equipment shall be kept above head level or on the walls where it will not interfere with passage through “In Service” aisles, stairways, and walkways. No conduits shall be run on the floor. Conduits shall be racked against the wall or to one side for this purpose.

The Contractor shall disassemble and relocate at his own expense any conduit, supports or assemblies that he has installed that interferes with freedom of passage for operation, maintenance or inspection. Where any doubt exists as to the adequacy and width of such a passageway, the Contractor shall verify the condition with the Engineer and obtain his approval before proceeding.

**Equipment Connections**

Unless specified otherwise, the Contractor shall provide complete electrical connections to all equipment, including equipment furnished under other items or by other trades.

Unless specified otherwise, the Contractor shall provide the complete electrical connections required for final installation of all such equipment for each piece of equipment, which is furnished under other items.

The Contractor shall exercise special care in handling and protecting equipment. The Contractor shall be responsible for any furnished work or equipment, which are damaged by reason of mishandling or failure to protect.

**Installation of Equipment**

Install all equipment securely, with provision for proper access and clearance in accordance with the Canadian Electrical Code (C22.1).

**Shop Drawings**

The following shop and working drawings shall be submitted to the Engineer for review and approval prior to installation in accordance with the provisions of the Contract. No installation of equipment, conduits or wiring shall take place until the Engineer approves their associated shop and proposed working drawings. The shop and working drawings shall consist but not be limited to:

a) Layout, elevation and detail drawings indicating location of every power and control cable, piece of equipment installed under this contract, all conduit, cable ladder racks and wireway runs, the sizes of conduits, cable ladder racks, wireways and cable installation associated with this contract.

b) Contractors developed staging plan.

c) A complete set of wiring diagrams of the electrical installation for each specified item.
d) Schedule of equipment, conduits and cabling.

e) All additional shop and working drawing information requested under other contract items for the bridge electrical power and control installation.

Test of Electrical Installation

The testing of the electrical installation shall be carried out during and following complete installation of the electrical items. The requirements of this testing work shall be as specified herein.

ELECTRICAL EQUIPMENT

General

This section covers the electrical equipment, components, and systems to be provided and installed at the bridge. The requirements of each item of equipment include the associated specification of the item together with performance requirements, functional characteristics, specific manufacturing standards and submittals required under the contract.

Equipment

Electrical Utility Service

Electric power for operation of the bridge and its auxiliaries will be supplied by BC Hydro at a nominal voltage of 600/346 volts. The electric service shall terminate in an automatic transfer switch in the standby generator weather and acoustic housing as indicated on the Contract Drawings. The service shall be rated at 600 Ampere, three-phase, four-wire, 60 Hertz. All equipment, materials, and work in connection with the electric services shall be in strict accordance with BC Hydro current regulations and construction standards and shall meet with their approval and the requirements of the Canadian Electrical Code (C22.1) and meet the following requirements:

a) The service shall be provided by BC Hydro as indicated on the Contract Drawings. This service shall be run from the BC Hydro service transformer located near Pandora Avenue on the east approach to the bridge to the standby generator weather and acoustic housing located under the sidewalk overhang on the north east side of the bridge. The BC Hydro electric service to terminate in the BC Hydro service and metering equipment to be installed in the standby generator housing as indicated on the Contract Drawings. The routing of the electric service conduits from the BC Hydro service transformer to the Generator location will be furnished and installed by BC Hydro. From this location, the Contractor shall be responsible for furnishing and installing one 100 mm electric service conduit and one 100mm spare conduit suspended from the underside of sidewalk overhang and bridge approach deck utilizing a “Unistrut” trapeze hanger system with threaded rods and anchor bolts. This will provide normal electric service to the bridge.

b) This normal electric service to the bridge shall be supplemented with backup power in the form of a 600 kW standby generator housed in a purpose made skid mounted weatherproof and acoustic housing as specified herein and described on the Contract Documents.

c) The Contractor shall be responsible for providing the City with all pertinent technical and installation scheduling information for them to enter into an agreement with BC Hydro for the defined electric service. This information shall include the routing of electric service conduit installation, layout and elevation of the standby generator housing and space allowance made for BC Hydro service and metering equipment as well as the timing for the proposed facilities.
d) The Contractor shall coordinate with BC Hydro to ensure that their service provisions meet the bridge construction schedule and that they are provided with all information and construction needs to meet the project schedule. This coordination effort shall be performed in conjunction with the Engineer.

Standby Generator

a) Standby Generator General

A standby generator shall be furnished and installed inside the specified weatherproof and acoustic housing as indicated on the Contract Drawings and as herein specified. The standby generator shall be a completely assembled, diesel engine driven generator and be mounted in the specified weatherproof and acoustic housing and be of Cummins Power Generation manufacture their Model DFGB or Engineer approved equal with the following general ratings, construction requirements, and accessories:

i) The alternator shall be three phase, four wire, 600 volts, 60 Hz with rated power output of 750KVA and operate at a 0.8 Power factor lagging.

ii) The standby generator control cabinet shall be of the digital control type be suitable for the control of non-linear loads and be complete with speed and voltage control equipment, batteries and battery charger, generator breaker and start/stop controls and all associated and specialized protective devices for a complete and fully operational standby generator as herein specified and indicated on the Contract Drawings.

iii) Supply fuel tank with fill cap, fuel level switches, pump with controls and monitoring equipment and all necessary fuel and vent lines shall be furnished and installed at each the bridge tower piers as indicated on the Contract Drawings and as herein specified.

iv) Sub-base fuel tank (day tank)in the skid of the standby generator complete with fuel level switches, pump and controls and monitoring equipment, fuel dump system and all necessary fuel and vent lines shall be furnished and installed for the standby generator as herein specified.

v) Standby generator weatherproof and acoustic housing furnished as part of the standby generator shall be provided to limit the noise of the operating engine and maintain a weatherproof environment inside the housing as specified herein.

vi) Skid mounted radiator complete with blower type fan and necessary skid mounted duct work.

vii) Stainless steel exhaust and silencer including all necessary pipe work hangers and supports etc and be located and installed inside the housing as described on the Contract Drawings and appropriately sized for the specified standby generator.

b) Engine

The standby generator shall be furnished with a diesel engine capable of delivering the specified generator output for standby mode of operation. The engine shall be designed, constructed and furnished as the drive for the alternator and be fully integrated and compatible with the specified generating equipment to achieve the standby generator functionality as herein specified. The engine shall be furnished complete with equipment and meet the following requirements:

i) The engine shall be a rugged 4-cycle industrial diesel designed to provide reliable power, low emissions and fast response to load changes.
ii) The engine shall meet performance specifications when operating on number 2 diesel fuel. Those diesel engines requiring premium fuels will not be considered.

iii) The engine shall be equipped with fuel, lube oil, intake air filters, lube oil cooler, fuel pump, gear-driven water pump, and gauges, including a fuel pressure gauge, a water temperature gauge, and a lubrication oil pressure gauge and all other auxiliary devices necessary to meet the requirements and performance of the defined standby generator.

iv) The engine shall be equipped with an electronic governor that shall provide precise speed regulation.

v) The engine shall be mounted on a structural steel sub-base (sub-base fuel tank) and shall be provided with an Engineer approved form of vibration isolation. The vibration isolation shall be such that it does not allow vibration from the generator set to migrate into the stationary portion of the equipment. Vibration isolation design shall be performed by the standby generator set manufacturer to eliminate at least 95% of the vibration of the operating system from being migrated to the standby generator housing or the bridge structure. Formal vibration design calculations shall be prepared by the manufacturer and shall be submitted to the Engineer for approval prior to the manufacture of the standby generator or its housing.

vi) Safety shutoffs for high water temperature, low oil pressure, over speed, engine over crank, and low water level shall be provided. In addition, alarm sensors shall be provided for approaching high water temperature, low oil pressure, and low fuel for interconnection to the Operator’s control console.

vii) Not withstanding that the engine generator is located in the specified weatherproof and acoustic housing, guards shall be provided over all exposed moving parts as required by CANOSH.

c) Generator

The generator shall be rated for continuous standby service at 600 KW, 750 KVA, at 0.8 Power factor, 600 volts, three phase, four wire, 60 hertz, and 1800 rpm and shall be furnished complete with equipment that meets the following requirements:

i) The generator shall be a three-phase, single bearing synchronous type built to NEMA Standards. Class F insulation shall be used on the stator and rotor, and no materials which will support fungus growth shall be used.

ii) The generator shall be limited to a maximum temperature rise of 105 Degrees C at 40 Degrees C ambient at full 600 kW output and be capable of one-step loading of 360 kW as required by NFPA-110.

iii) A standby generator mounted digital control panel shall be furnished to control the generator. The digital generator control unit shall be microprocessor based and provide generator set monitoring, metering and control. The control shall provide an operator interface with the standby generator, digital voltage regulation, digital speed governing and generator protective relaying functions in one single digital standby generator control system. The digital standby generator control system shall be of Cummins Power Generation manufacture their PowerCommand 3100 or Engineer approved equal and be furnished complete with the following functionality:

1) Engine Speed Control Governor: Isochronous frequency control. The governor shall be arranged to directly control the engine fuel control valve. The isochronous
governor shall control the engine speed within plus or minus 0.25% for any steady state load from no load to full load. Frequency drift shall not exceed plus or minus 0.5% for a 33 Degree C change in ambient temperature over an 8 hour period.

2) Temperature Dynamic Control (TDC): Shall have the ability to modify the engine fuel system (governing) control parameters as a function of engine temperature. TDC shall be implemented to make the engine more responsive when warm and more stable when operating at lower temperature levels.

3) Smart Idle Mode: Engine governing shall have the capability of regulating at an idle speed for a programmed period following an automatic or manual stop of the engine. In an automatic mode, the control shall bypass the idle operating period if the generator was operating at low load prior to shut down for sufficient duration for engine cool down. During smart idle the engine protective functions shall be adjusted for lower engine speed and alternator protective functions disabled. In addition to automatic functioning, idle speed shall be capable of being operated by the bridge operator when the standby generator set is operating in the manual mode such as during load testing with the herein specified load bank.

4) Digital Voltage Regulation: Digital voltage regulation shall consist of an integrated 3-phase line to neutral voltage sensing and regulation that can be used with either shunt or PMG type excitation. The voltage regulator shall be full wave rectified with PWM output to assure good motor starting capability and stability when powering non-linear loads.

5) The voltage regulation system shall be capable of regulating the generator output voltage to within 0.5% for any load between no load and full load. Voltage drift shall not exceed plus or minus 0.5% for a 33Degree C change in ambient temperature over an 8 hour period. On engine start or sudden load application, voltage shall be controlled to a maximum of 5% overshoot over normal level.

6) The regulator shall be capable of regulating the output current of any phase to a maximum of three times rated current under fault conditions for both single phase and three phase faults for motor starting and short circuit coordination purposes.

7) Standby Generator Set Alarm, Monitoring, Control and Protection: The standby generator control system shall provide the following functionality:
   a. Alternator overcurrent protection
   b. Analog and digital metering
   c. Battery status monitoring and alarm
   d. Digital alarm and status message displays
   e. Monitoring and display status of all critical engine and generator functions
   f. Advanced serviceability indication using PC based software service tool
   g. Networking: The standby generator control system shall be provided with networking capabilities to communicate with the automatic transfer switch control system and the bridge networked communications backbone system. The selected communications protocol used shall be capable of communicating totally with the complete networked system in accordance with the model (ISO/OSI) devised by the International Standards Organization (ISO) for
standardization of Open System Interconnection (OSI) as described herein and on the Contract Drawings. The communications system shall be so configured that the ATS and the standby generator control system communicate to monitor and control the transferring from utility to standby power. In addition standby generator monitored and alarmed functionality shall be communicated for alarm and display purposes to the MCC HMI and the operator’s control console HMI.

8) Suitability and Certifications: The standby generator control system shall be suitable for use with the specified standby generator that shall have been designed, manufactured, tested and certified to relevant UL, ISO, IEC and CSA standards and be of Cummins Power Generation manufacture or Engineers approved equal.

iv) Generator shall be equipped with an extension terminal box for connection of output power leads and sized to accept the feeder cables described on the Contract Drawings.

d) Standby Generator Weatherproof Acoustic Enclosure

The standby generator, associated switchgear, BC Hydro electric service and metering equipment shall be housed in a weatherproof and acoustic enclosure to maintain a weatherproof environment inside the housing and minimize noise to the surrounding area to a typical sound pressure level of 82 dB at a distance of 1.0 m from the enclosure. The housing shall be of sheet steel construction that shall be pre-treated and polyester coated. The internal of the housing shall be furnished complete with the following features:

i) The housing shall be sized to house the specified standby generator, associated controls, BC Hydro service and metering equipment, bridge electric service automatic transfer switch, bridge interfacing PLC equipment and all required and specified auxiliary equipment. Note that the housing shall be sized and all equipment located within the housing to meet all minimum clearances in accordance with CCHS and Canada Electrical Safety Regulations.

ii) The interior walls of the enclosure shall be covered with fire-retardant polyurethane foam to minimize the noise from the engine.

iii) Housing door operated lighting shall be provided in each compartment for maintenance and inspection of the engine, generator and electrical power and control equipment. The lighting shall be of the fluorescent type and provide average illumination level of 200 lx.

iv) Anti-condensation heaters and thermostats shall be provided in the enclosure to prevent condensation.

v) Two (2) duplex receptacles shall be located inside the enclosure for maintenance purposes and be located as approved by the Engineer.

vi) A 45 KVA, 600/208-120 volt, Delta-Wye dry type transformer and an associated 42-Way, 208/120 volt, 3-phase, 4-wire panelboard. The transformer shall be floor mounted with the panelboard being wall mounted.

vii) The housing shall be provided with control panel and generator cut outs.

viii) Emergency stop pushbutton shall be located on the outside of the enclosure.

ix) The exhaust tailpipe when transitioning the wall of the enclosure shall be provided with an air gap between the exhaust pipe.

x) Hinged doors shall be fitted with continuous bubble door seal of 16mm diameter.
xi) Bolted access covers to all dry areas shall be neoprene gasketed with minimum dimensions of 50mm X 3mm thick.

xii) The enclosure shall be nitrile rubber gasketed of 6mm minimum thickness.

xiii) The enclosure panel material shall be 12 gage sheet steel to ASTM A569.

xiv) The enclosure shall be provided with horizontal header rails of no more than 150 mm in height and manufactured from 12 gage ASTM A569 and be of no shorter than 1800 mm and shall be installed above vertical panels.

xv) Excepting enclosure extremities ends of header rails shall not align with enclosure vertical panel joints.

xvi) The maximum deflection at panel joints with weight across two joints shall be no more than 0.00005879 mm/kg/mm.

xvii) The enclosure shall be constructed to maintain the structural integrity at locations where doors or apertures are installed with necessary structural reinforcement.

xviii) Corners and return flanges of folded panels and doors shall be fully welded. Welds associated with any mating surface shall be ground flush and finished to grit grade 60.

xix) All external welds shall be finished ground to grit grade 240.

xx) The enclosure shall be constructed with necessary additional structural components for mounting of all internally and externally mounted equipment as herein specified.

xxi) All enclosure panels shall be bolted using flanged lock nuts on 300mm centres.

xxii) Roof panels shall be flange lock nut bolted on 150mm centres using 5mm thick by 45mm diameter load spread stainless steel washers on both sides of the panel joint.

xxiii) The enclosure roof panels shall have two formed 7 gage ASTM A5689 sheet steel C section stringers running the length of the roof. The stringers shall be flange lock nut bolted to each roof panel joint.

xxiv) The enclosure stringers shall be attached to lateral anti-racking bracing and shall be used for suspending the engine exhaust silencer.

xxv) The lateral anti-racking beams shall be manufactured from 7 gage ASTM A569 and shall have a minimum depth of 250 mm.

xxvi) All panels used for the enclosure construction shall have full mating face continuously bonded at assembly following finish coating, using an IC Polyurethane 1800kPa tensile strength (ASTM D 412). Sealant used shall have a 12.5% movement accommodation factor and a continuous temperature service rating of -400 to +900 Degree C. The sealant shall have a 1-hour temperature rating of 1565 Degree C.

xxvii) Access doors of the enclosure shall be suitably braced to prevent excessive torque twisting for both resistance and fatigue stress and the maintenance of the door seal integrity.

xxviii) The enclosure construction shall be provided with lifting points to lift the enclosure complete with the exhaust muffler or other installed components attached to the enclosure.

xxix) The enclosure maximum deflection when supported at its centre of gravity (one pivot point per side) of the supporting fabrication shall be no more than 0.0013 0.133mm/m.
The exhaust muffler heat rejection shall not exceed 0.01% of the generator output kWe. The exhaust system and silencer mounted in the enclosure shall be insulated to achieve the above criteria.

All enclosure internally positioned exhaust pipe work and exhaust flex bellows shall be lagged with exhaust blankets.

The enclosure shall be so constructed such that the maximum temperature rises above ambient at the radiator core is no more than 10 Degree C.

The enclosure shall be so constructed that the static pressure inside the enclosure shall not exceed 12.7mm WC and not withstanding this static pressure shall not exceed the capability of the radiator fan.

The radiator shall be connected to the enclosure using flexible duct of sufficient temperature and pressure rating. The enclosure configuration shall be such that it precludes any recirculation of air.

e) Cooling System

The standby generator cooling system shall consist of a skid mounted radiator and associated fan and be capable of total heat rejection of at least 6.3MJ/min and the installation shall have a maximum cooling air flow static restriction of no more than 0.12kPa. The cooling system shall be furnished complete with equipment and meet the following requirements:

i) The radiator with blower type fan shall be sized to maintain safe operation at a 40 Degrees C ambient temperature without de-rating the unit. This information shall be evident in the manufacturer’s published data and be submitted to the Engineer for approval.

ii) The discharge air shall be arranged to be ducted from the housing using automatically controlled louvers as indicated on the Contract Drawings. Duct work with flexible connecting section between the standby generator and housing. Automatic air inlet louvers shall be provided on the wall of the acoustic housing as indicated on the Contract Drawings and sized in accordance with manufacture’s recommendations. These automatic louvers shall be powered and controlled from the standby generator control panel described above.

iii) The expansion tank of the radiator shall be fitted with a low water level switch and be wired into the safety shutdown system for the standby generator.

iv) The engine cooling system shall be pre-treated by the engine supplier with an approved anti-freeze, with rust inhibitor added, in accordance with the manufacture’s requirements.

f) Standby Generator In-Base Fuel System

The standby generator shall be equipped with an in-base double walled fuel tank of 552litres minimum capacity. The manufacturer of the tank shall have a minimum of ten year’s experience in the design and construction of UL-142 listed in-base tank systems. The tank shall be constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; the Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and Standby Power Systems, NFPA 110. The day fuel system shall be furnished complete with equipment and meet the following requirements:
i) The in-base tank shall be rectangular and include a reinforced steel box channel for generator support and have length and width dimensions compatible with the specified and proposed generator.

ii) The tank shall be pressure washed with an iron phosphate solution. The interior of the tank shall be coated with a solvent-based film rust preventative providing corrosion protection.

iii) The in-base tank shall be pressure tested at completion of construction as follows:
   1) The in-base inner tank and the secondary containment basin shall be pressurized to and provided with leak check to ensure the integrity of the in-base weld seams in accordance with UL-142 standards.
   2) Test the closed top dike inner tank sections by pressurizing and leak check to ensure the integrity of the in-base weld seams in accordance with UL-142 standards. The containment basin shall also be leak checked by means of weld penetrant and ultraviolet light.

iv) The in-base tank shall be provided complete with all required, necessary and Code compliant tank fittings, fuel and vent lines, sight gauge for the proper performance and operation of the in-base day tank.

v) The fuel containment basin shall be welded steel and sized at a minimum of 110% of the in-base tank capacity to prevent the escape of fuel into the environment in the event of a tank rupture.

vi) An Engineer approved fuel containment basin leak detection switch shall be provided and wired into the generator control system to alarm a tank rupture.

vii) Normal venting shall be provided in accordance with the requirements of the American Petroleum Institute Standard No.2000 for venting atmospheric and low pressure storage tanks. The tank shall be provided with atmospheric (normal) vent cap with screen.

viii) Emergency venting shall be provided and sized to accommodate the total capacity of both normal and emergency vents and be not less than that derived from NFPA 30, Table 2-8, based on wetted surface area of the tank (calculated based on 100% of the inner tank). A zinc plated emergency pressure relief vent cap shall be installed on the tank. The vent shall be spring pressure operated. The vent cap shall start opening at a pressure of 3.45 kPa and a full opening pressure of 17.25 kPa.

ix) The fuel tank shall be fitted with a low and high fuel level alarm with contacts for annunciation with the generator control panel.

x) In addition to the standard fuel filters provided by the engine manufacturer, a primary fuel filter/water separator shall also be installed in the fuel inlet line to the engine. The filter shall be a racor simplex or duplex, as required for proper fuel flow. Capped fuel supply and return piping connection shall be provided outside generator enclosure.

g) Standby Generator Fuel Supply Tank and System

A fuel supply tank shall be furnished and installed at in the standby generator compound to serve the standby generator. The supply tank shall be double walled fuel tank of 3,312 litres minimum capacity. The manufacturer of the tank shall have a minimum of ten year’s experience in the design and construction of UL-2085 listed supply diesel fuel tank systems. The tank shall be constructed in accordance with Flammable and Combustible Liquids Code,
NFPA 30; the Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and Standby Power Systems, NFPA 110. The tank and all associated equipment, fittings and piping shall be in accordance with the requirements of UL-2085 Listed Fireguard Main Tank. The tank shall be UL listed fire rated protected design featuring lightweight thermal insulation and be constructed of heavy gauge stainless steel with a welded stainless steel containment basin. The supply fuel system shall be furnished complete with equipment and meet the following requirements:

i) The supply tank shall be coated with an Engineer approved rust inhibitor inside, primed and finish painted outside.

ii) The tank shall be provided complete with all required, necessary and Code compliant tank fittings, fuel and vent lines, sight gauge for the proper performance and operation of the fuel supply tank.

iii) The fuel containment basin shall be welded steel and sized at a minimum of 150% of the tank capacity to prevent the escape of fuel into the environment in the event of a tank rupture.

iv) An Engineer approved fuel containment basin leak detection switch shall be provided and wired into the generator control system to alarm a tank rupture.

v) Normal venting shall be provided in accordance with the requirements of the American Petroleum Institute Standard No.2000 for venting atmospheric and low pressure storage tanks. The tank shall be provided with atmospheric (normal) vent cap with screen.

vi) Emergency venting shall be provided and sized to accommodate the total capacity of both normal and emergency vents and be not less than that derived from NFPA 30, Table 2-8, based on wetted surface area of the tank (calculated based on 100% of the inner tank). A zinc plated emergency pressure relief vent cap shall be installed on the tank. The vent shall be spring pressure operated. The vent cap shall start opening at a pressure of 3.45 kPa and a full opening pressure of 17.25 kPa.

vii) Fuel filter/water separator in the fuel outlet line shall be installed.

viii) The supply fuel system shall be provided complete with an oil fuel pump and associated controls to automatically pump and control the level of fuel in the standby generator in-base day fuel tank. The fuel pump control system shall consist of a microprocessor based unit housed in a NEMA 4X enclosure and located in close proximity to the fuel tank as indicated on the Contract Drawings. The fuel pump control system shall be provided with the following equipment and functionality:

1) A fuel level transducer that provides an LED fuel level indication
2) A high level warning alarm
3) Low level warning alarm
4) Critical low level alarm and shut off.
5) Fuel in basin alarm
6) Pump controls (start pump at day tank 60% of capacity and stop at 100% of capacity)

7) The above alarms shall be provided with contacts for inputs to the MCC PLC I/O rack for annunciation on the MCC HMI and the operator’s control console HMI.
8) The pump control system shall be provided with an Auto-Off-Manual switch and Start/Stop pushbuttons and shall conform in all respects to the requirements of UL-508 and be suitable for 120 volt, single phase, 60 Hz operation.

The fuel supply tank shall be provided with a fuel oil pump sized to pump fuel oil from the supply tank to the in-base standby generator day tank in the standby generator compound. The pump and piping shall be sized to lift the oil at a rate of 7.5 l/min from the supply tank to the in-base day tank in the standby generator a vertical distance of approximately 2 m plus friction loss as defined by the pipe size and pipe routing as described on the Contract Drawings.

h) Exhaust Silencer

A critical type silencer and flexible stainless steel exhaust shall be furnished and installed according to the manufacturer's recommendation inside the standby generator housing to minimize overall noise from the operating standby generator. Mounting of the exhaust system shall be provided by the standby generator manufacturer and the exhaust silencer shall form an integral part of the overall packaged standby generator. The silencer shall be mounted so that its weight is not supported by the engine nor will forces due to exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine manufacturer. So called "spiral" or truck silencers are disallowed and will not be considered.

The silencer shall be fitted with a tail pipe extension terminating in the horizontal plane as indicated on the Contract Drawings and at a 45 degree angle and flap cap to prevent the entrance of rainwater. It shall also be fitted with an expanded metal bird screen.

The Contractor shall submit calculations of his proposed exhaust system that includes the effect of the required tail piping as described on the Contract Drawings.

i) Jacket Water Heater

A unit mounted thermal circulation type water heater incorporating a thermostatic switch shall be furnished to maintain engine jacket water to 32 Degrees Celsius. The heater shall be powered from a 120 volts, single phase, 60 hertz circuit taken from the standby generator panelboard.

j) Engine Block Heater

An engine block heater incorporating a thermostatic control shall be furnished to maintain engine at 32 Degrees Celsius. The heater shall be powered from 120 volts, single phase, 60 hertz circuit taken from the standby generator panelboard.

k) Supply Fuel Tank Heater

A unit mounted supply fuel tank heater incorporating a thermostatic control shall be furnished to maintain fuel oil to 32 Degrees Celsius. The heater shall be powered from 120 volts, single phase, 60 hertz circuit taken from the standby generator panelboard.

l) Fuel Oil Line Heat Tracing

A fuel oil line heat tracing system shall be provided between the supply fuel tank and the standby generator day tank. The heat tracing shall be sized for the prevailing winter weather conditions, provided with appropriate insulation wrap and incorporating a thermostatic switch shall be furnished to maintain engine jacket water to 32 Degrees Celsius. The heat tracing shall be powered from 120 volts, single phase, 60 hertz circuit taken from the standby generator panelboard.
m) Batteries

Lead-acid storage batteries of the heavy duty diesel starting sealed “maintenance free” type shall be provided. Battery size shall be determined by the engine manufacturer, and shall be rated no less than that required for five consecutive starting cycles from cold under the most severe ambient temperature (-18 Degree C) without charging.

n) Battery Tray

The batteries shall be mounted in a battery tray and shall conform to CSA C22.1. It shall be constructed of steel and so treated as to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over of battery electrolyte shall be contained within the tray to prevent a direct path to the ground.

o) Battery Charger

A current limiting, automatic DC charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 Volts per cell and equalize at 2.33 Volts per cell. The battery charger shall include; overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase, 60Hz. The charger shall be sized to recharge the battery bank in no less than 8 hours from a fully discharged state while providing control power for the system. Charger shall be housed in a NEMA 1 enclosure and be U.L. Listed as an industrial control panel. The charger shall be as manufactured in compliance with the requirements of NFPA 110 and U.L. 508. The charger shall be mounted and wired within the enclosure of the generator set.

p) Generator Main Breaker

The generator main breaker shall be mounted within the standby generator control panel enclosure and consist of a moulded case circuit breaker. The breaker shall have a frame size of 800 amps and be installed as a load circuit interrupting and protection device. It shall operate both manually and provide overload and short circuit protection. The trip unit of each pole shall be furnished with elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by Underwriters Laboratories, National Electric Manufacturers Association, and CSA C22.1. The circuit breaker shall be equipped with rear copper stabs and load cable lugs.

q) Shop Drawings

Shop drawings, calculations and catalogue cuts shall be submitted to the Engineer indicating manufacturer’s model numbers, dimensions and weights for engine, generator and major auxiliary equipment. Shop drawings shall also be submitted indicating the following:

i) Engine-generator set and housing including plans and elevations or riser views clearly indicating entrance points for each of the interconnections required.

ii) Complete set of standby generator and housing electrical drawings including single line, three line diagrams, schematic and logic diagrams and wiring diagrams

iii) Schematic diagrams of all standby generator sub systems including fuel system, lubrication system and cooling system

iv) Specification of the proposed engine with manufacturer’s catalogue cuts.
v) Fuel consumption rate curves at various loads, ventilation and combustion air requirements calculations and the sizing calculations of all ductwork openings and fuel pipe work.

vi) Sizing calculations of all heaters

vii) Exhaust silencer sizing calculations and flexible exhaust connector(s) including mounting details.

viii) Noise and vibration data with details of isolation system proposed including all acoustic calculations associated with the standby generator acoustic housing.

ix) Certified proof of parts availability including, percentage requirements.

x) Battery charger and battery sizing calculations, catalogue cuts including the proposed battery rack and proposed location and mounting details.

xi) Fuel day tank, venting, fuel connection points, and fill cap location.

xii) Fuel supply tank system sizing calculations including the fuel oil pump and assumptions made for piping to the in-base standby generator day tank and catalogue cuts and outline drawings for the tank, pump and pump control system.

xiii) Engine-generator control panel catalogue cuts, schematic and dimensional and layout drawings

xiv) Main line circuit breaker catalogue cuts including protective device characteristics.

xv) Schematic and one line diagrams of the generator system.

xvi) Control schematics for generator operation, protection, shutdown and alarm.

xvii) Piping diagrams and schematics of all mechanical subsystems associated with the engine.

**Generator Load Bank**

The standby generator shall be provided with a load bank for exercising and maintenance of the standby generator. The load banks shall be installed outdoors in the standby generator compound and be of weatherproof construction.

Each load bank shall be rated at 200kW, 575 volts, three (3) phase, three (3) wire with load step resolution of 25kW, 50kW, 50kW and 75kW.

The load bank shall be designed for a continuous duty cycle operation with no limitations. The load bank shall operate with an ambient temperature of between -28 Degrees C and +49 Degrees C.

The load bank enclosure shall be constructed of heavy gauge aluminized steel per ASTM A463. The load bank enclosure shall have a baked polyester coated finish with a film thickness of 2.8 ±0.4 mils per coat. A fixed louver shall be provided on the exhaust opening. A permanent base shall be provided with built-in forklift channels and be designed for outdoor mounting as indicated on the Contract Drawings. Resistor control contactors, main input load bus, fuses and blower/control relays shall be provided with a thermostatically controlled, heated enclosure.

The load bank enclosure shall be designed to provide airflow throughout the load bank horizontally. Intake openings shall be designed to prevent objects greater than 1.25 mm diameter from entering the unit.
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Electrical Specification

An exhaust hood of non-corrosive aluminized steel shall be provided and angled downward to provide protection from falling water.

Load elements shall be contained in an integral resistor case. The resistors shall be capable of being individually removed for inspection and service.

The load elements shall be Avtron Helidyne or approved equal, helically wound chromium alloy rated to operate at approximately 50 percent of maximum continuous rating of the wire. Elements shall be fully supported across the entire length within the airflow by segmented ceramic insulators on stainless steel rods. Element supports shall be designed to prevent a short circuit to adjacent elements or to ground.

The resistor elements shall be constructed to minimize change in resistance due to temperature by maintaining conservative watt densities.

The overall tolerance of the load bank shall be -0% to +5% kW at rated voltage.

The load bank shall be cooled by an integral TEFC motor which shall be directly coupled to cooling fan blades. The fan blades shall be of the airfoil design constructed of aluminium. The fan motor shall be provided with overload protection using a motor overload device and short circuit protection using three (3) current limited fuses with an interrupting rating of 200 kA.

A differential pressure switch shall be provided in the load bank to detect loss of airflow. The switch shall be electrically interlocked with the load application controls to prevent load from being applied if cooling air is not present.

An over-temperature switch shall be provided to sense the load bank exhaust in the heater case assembly. The switch shall be electrically interlocked with the load application controls to remove load from being applied in the event of an over-temperature condition.

The load bank shall be provided with appropriate warning/caution signs and statements on access panels. These shall be submitted to the Engineer for approval.

The load bank control panel shall be mounted in the standby generator compound as indicated on the Contract Drawings. The control panel shall be mounted in a NEMA 4X enclosure. The control panel shall contain:

a) Power On/Off switch
b) Blower Start/Stop pushbuttons
c) Master load On/Off switch
d) Load step switches for On/Off application of individual load steps

The control panel shall also be provided with the following visual indication:

a) Power On indication light (Red)
b) Blower On Light (Green)
c) Blower/Air Failure light (Red)
d) Over-Temperature light (Red)

A standard remote load dump circuit shall be provided as part of the load bank control circuit. Provisions shall be provided to remove the load bank off-line from the operation of a remote normally closed set of auxiliary contacts from the automatic transfer switch. In the event of this remote ATS contact opening, all load bank load shall be automatically removed.
The load bank shall be of Avtron Loadbank manufacture or Engineer approved equal.

The Contractor shall submit outline-dimensioned drawings, of his proposed load bank, mounting details, one line and schematic diagrams, schedules of the proposed circuits and specification in the form of catalogue cuts and data sheets of proposed load bank to the Engineer for approval prior to procurement.

**Automatic Transfer Switch**

a) A breaker based automatic transfer switch shall be furnished and installed in the standby generator housing to monitor the main BC Hydro electric service and in the event of a failure or service outside set limits be capable of initiating a standby generator start and automatically transferring bridge power from the BC Hydro service to the standby generator.

The automatic transfer switch shall be housed in a NEMA 12 enclosure and be installed in the standby generator housing as indicated on the Contract Drawings. The automatic transfer switch shall be rated and configured as indicated on the Contract Drawings, be of the break-before-make type and be designed for padlocking in both the “utility” and “standby generator” positions and provided with the following features and requirements:

i) The automatic transfer switch and controls shall conform to the requirements of:

- UL 1008 – Standard for Transfer Switch Equipment & CSA certified to CSA 22.2 No. 178-1978
- 1) IEC 60947-6-1 Low-Voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment
- 2) NFPA 70 – National Electrical Code
- 3) NFPA 99 – Essential Electrical Systems for Health Care Facilities
- 4) NFPA 110 – Emergency and Standby Power Systems
- 5) IEEE Standard 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- 6) NEMA Standard ICS10-1993 (formerly ICS2-447) – AC Automatic Transfer Switches
- 7) UL 508 Industrial Control Equipment

ii) The switch shall consist of two moulded case circuit breakers, be suitable for a transfer of all connected loads and shall be rated for all classes of load. It shall be mechanically held, electrically operated type and rated for continuous duty. The failure of any coil or disarrangement of any part shall not permit a sustained neutral position. The breakers shall be positively locked mechanically on one source or the other without the use of hooks, latches, semi-permanent magnets or springs. Operating current for transfer shall be obtained from the source to which the load is being transferred. 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. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. The switch shall be provided with front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
iii) A control module shall be supplied with a protective cover and be mounted on the front of the ATS. Sensing and control logic shall be solid-state and mounted on plug-in printed circuit boards. Printed circuit board shall be keyed to prevent incorrect installation. Interfacing relays shall be industrial-control-grade, plug-in type with dust covers and locking clips. The control module shall provide all necessary sensing, timing and control functions necessary to achieve the defined automatic transfer of sources. The microprocessor-based control module shall include a panel mounted keypad and a four-line LCD display. The control module shall be provided complete with communications capability and appropriate communications protocol to allow it to communicate with the MCC PLC and the standby generator control panel for both status and control as indicated herein and on the Contract Drawings and as approved by the Engineer. The control module shall be of Eaton Cutler Hammer manufacture and be their ATC-300 controller or Engineer approved equal.

iv) The switch shall be configured to automatically transfer the load circuit from the electric utility power source to the standby generator source when any phase of the utility power source drops below 85% and shall automatically retransfer the load circuit to the electric utility power source when all phases are restored to 90% or more of rated voltage for a defined period of time. Transfer to standby generator shall not occur until standby generator voltage is 90% and frequency is 57Hz or higher. The automatic transfer switch shall be rated to withstand the rms symmetrical short circuit current available at the automatic transfer switch terminals (65kA).

v) The switch, unless otherwise specified herein or as approved by the Engineer, shall be furnished with factory wired components according to the manufacturer’s standards the switch shall include the following basic control function:

1) Full phase sensing of utility voltage with adjustable setting. Factory set to drop out at 85% and picking up at 90%.

2) Adjustable time delay of 1/2 to 6 seconds on engine start to override momentary voltage dips.

3) Engine starting contacts to close after the ½ to 6 second delay specified above.

4) Switch shall include a time delay to ignore momentary outages. It shall delay closing of the engine start contacts for a fixed time of 3 second.

5) Adjustable time delay on transfer to standby generator, 6-60 seconds.

6) Voltage-frequency sensitive relay to lock-out transfer from utility to standby generator source until the generator output is up to 90% of voltage and 57Hz adjustable.

7) Gold plated contacts rated 10 amps, 32 volts DC which close when the utility source fails shall be provided to initiate engine starting.

8) Adjustable time relay of 1 to 30 minutes on retransfer of load from standby generator to utility source after restoration of utility power with adjustable unloaded generator running time of 0-5 minutes. The time delay shall be automatically bypassed if the standby generator source fails and the utility source is available.

9) Test switch function shall be provided to simulate utility power failure, momentary type.
10) Auxiliary contacts on main shaft or operator 1-NO and 1-NC.
11) Automatic exerciser with load/NO load selector.
12) Switch position indicator lights, utility and standby generator.

vi) The ATS shall be rated to close on and withstand the available 65,000 amp RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection indicated on the contract drawings.

The ATS shall be UL listed in accordance with UL 1008 and be labelled in accordance with that standard’s 1-1/2 and 3 cycle, long-time rating.

vii) The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

The manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number of the switch. No exceptions to the specifications, other than those stipulated at the time of submittal, shall be included in the certification.

The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, and installation and servicing in accordance with ISO 9001.

viii) The automatic transfer switch shall be rated 600 volt, 3-phase, and 600 Amp and be of Eaton Cutler Hammer and their breaker based transfer switch or Engineer approved equal.

**Motor Control Centre**

a) Motor Control Centre General Requirements

The motor control centre (MCC) shall be a completely assembled, metal enclosed, free standing unit, with the following specified general ratings, construction and U.L. listing requirements and be of Allen Bradley Manufacture their “Centerline 2100 IntelliCenter MCC” type or Engineer approved equal with the following general features and requirements:

i) The MCC shall be provided with the following rating:

1) Three phase, four wire, 600/346 volts.
2) 600 Ampere main power bus rating.
3) Bus bracing and short circuit current rating 65kA RMS symmetrical.

ii) The MCC shall be designed, manufactured, and tested to meet or exceed the requirements within NEMA ICS-18, UL845, CSA C22.2 No. 14 and EN 60349-1 for motor control centres.

iii) The MCC shall be capable of operating within an ambient of operating temperature of 0-40 Degree C with up to 95% non-condensing humidity.
iv) The MCC shall be designed, manufactured and tested at a facility registered to ISO9001 quality standards.

v) The MCC shall be dead front construction incorporating horizontal and vertical power bus, including a neutral and horizontal and vertical ground bus as required and specified herein.

vi) The MCC shall consist of vertical sections as described herein and on the Contract Drawings. The vertical sections shall be bolted together to form a rigid, free-standing assembly designed to permit future addition of vertical sections and the interchanging of units.

vii) Feeder access – from the top and bottom.

viii) Wiring – Type “B (B-T)”, Class II-S, as defined by NEMA ICS2.322 standards, wherein each control unit is individually factory assembled and wired, with motor, control and communication leads brought out to a terminal board mounted at the side of each modular unit.

ix) Wiring within the motor control centre shall be flame-retardant ethylene-propylene insulated, switchboard wire, Type SIS.

b) MCC Structure

The MCC structure shall consist of the general configuration as described herein and on the Contract Drawings and be of rigid freestanding construction as follows:

i) The MCC shall consist of a number of vertical sections as indicated on the Contract Drawings. Each vertical section shall consist of a number of motor drives, motor controllers, circuit breakers, programmable logic controller with human machine interface (HMI) and miscellaneous equipment units. Each unit shall have all compartments and wiring readily accessible for ease of maintenance, and shall be connected to the vertical bus, by means of self-aligning silver plated connectors having free floating spring construction so as to assume a positive silver contact with both side of the bus at all times. The stationary structure and unit supports shall be designed to support and align the units during removal or replacement and for locking in the connected or disconnected positions. Units shall be of modular height and interchangeable with other units of the same size or multiple of that size. Each unit shall be provided with an automatic shutter mechanism to provide complete isolation from the bus when the unit is removed. The vertical sections shall be constructed to meet the following requirements:

1) Vertical sections shall be rigid, free standing structures with heavy duty internal mounting angles running in a continuous manner within each shipping section. Two clearance holes shall be provided in each section for bolting or welding to the prepared mounting site. External mounting channels of at least 38mm x 76mm shall be provided. A removable continuous steel lifting angle shall be provided at all shipping splits.

2) Each vertical section shall be 2,286 mm High x 508 mm Wide x 381 mm Deep. Where indicated on the Contract Drawings the vertical section may be wider than 508 mm due to larger equipment or extra width vertical wireway being specified.

3) The maximum number of standard width sections per shipping split shall be no more than three (3). For non-standard wide sections the MCC manufacturer shall
determine the number of sections in a shipping split but shall under no circumstances exceed two (2).

4) To minimize the chance of fault propagation to adjacent sections, each section shall be provided with side sheets extending the full height and depth of the section. This requirement may be modified by the vendor to satisfy the specified requirements for arc containment.

5) Each vertical section shall be equipped with a removable one piece top plate. Removable end plates shall be used to cover the horizontal power bus and horizontal wireway openings at each end of the MCC.

6) Vertical sections shall contain 6.0 space factor or 1,981 mm of plug-in space.

7) All enclosure metal work shall have rounded edges and shall be tightly fitted with no visible air gaps. Gasketing made of closed cell neoprene material shall be used. MCC enclosures shall be designed and built according to NEMA standards. The MCC shall be NEMA type 12 rated.

8) All structural metal parts shall undergo a multi-step cleaning, rinsing and painting process resulting in complete paint coverage of uniform thickness. The process shall be maintained and controlled by ISO9001 quality standards.

9) All interior and exterior surfaces shall be painted ANSI 49 medium light grey. The interior vertical wireways and unit back plates shall be painted high visibility gloss white. The exterior of the MCC shall be painted ultraviolet resistant, high gloss white; recognized by UL for outdoor use.

10) All unpainted surfaces shall be plated for corrosion resistance. Stainless steel structural parts shall not be painted.

ii) The MCC shall be designed as an arc containing low voltage MCC to help reduce arc flash hazards in accordance with the requirements of NFPA 70-2002 “Standard for Electrical Safety in the Workplace”, NFPA 70E-2004 and the IEEE. The MCC shall be of the Allen Bradley “Arc Shield” construction design as applied to their Centerline 2100 IntelliCenter MCC or engineer approved equal.

The MCC shall be designed and constructed to reduce arc flash hazard. The arc flash protection shall improve personnel protection against internal arcing faults when the doors and covers are closed and secured and with Type 2 accessibility as defined by ANSI C37.20.7-2007. The designed and installed arc protection shall protect personnel when at the front, side and the rear of the MCC enclosure. Arc resistance baffles shall be furnished to allow required venting as for the specified for the individual MCC components. Arc resistant baffles shall allow air flow to help dissipate the heat and still provide Type 2 accessibility.

The MCC arc flash protection shall consist of but not be limited to:

1) Arc-resistant latches on all doors that provides pressure relief and assists in keeping doors latched to the MCC during an arcing fault.

2) Arc resistant baffles to allow for the full specified range of MCC equipment for the NEMA 12 enclosure.
3) Copper vertical ground bus on all plug-in structures and heavy duty ground stab on plug-in units shall be furnished that provides an effective path for ground fault currents to minimize fault clearing times of installed overcurrent protective devices.

4) Automatic shutters shall be provided to act as protection against potential electrical shock hazards from unused plug-in stab openings.

5) Insulating covers on horizontal bus closing plates shall be provided to assist in preventing “burn through” which potentially could result from arcing faults in the horizontal bus compartments.

A separate, form 1 heavy sheet door shall be provided for each control unit and satisfy the requirements above. Doors shall be secured to the vertical section frame by screws fastened, concealed hinges and bolted door fasteners, capable of being tightened by hand or screwdriver and in accordance with the defined requirements for arc flash protection. Doors shall be gasketed dust tight all around and shall possess mechanically interlocked disconnect operating handles.

A disconnect handle mounted on the door of each control unit shall be provided to operate the device circuit breaker or motor circuit protector through adjustable linkage and shall have clearly marked “On” and “Off” designations, with trim added in case of circuit breaker. Handle shall be designed for pad locking in both the “On” and “Off” position with one to three padlocks. Mechanical interlock shall prevent opening of door when the handle is in the “On” position. Interlock shall be by-passable with special tool. The interlock shall not inhibit the positive operating action of the circuit breaker or cause nuisance opening of the circuit breaker.

The Contractor shall provide at least four (4) duplicate special tools with each MCC for the bypassing of the interlock.

c) MCC Wireways

The MCC shall be provided with both horizontal and vertical wireways for control wiring, communications and interconnection between units. The wireways shall be constructed to meet the above specified arc protection and following requirements or as approved by the Engineer:

i) Top and bottom horizontal wireways shall extend the full depth of the MCC. Horizontal wireways shall be 150 mm high and extend the length of the MCC with at least one 16,000 mm² opening between sections or as limited by code requirements for the herein specified arc protection. To prevent damage to cable insulation, the wireway openings between sections shall have rounded corners and the edges shall be rolled back. Horizontal wireways shall be isolated from all power bus bars. Horizontal wireways shall have removable covers held closed by captive screws.

ii) Horizontal wireways for incoming line sections shall be 150 mm x 180 mm isolating the wireway from the incoming line area.

iii) An integral 1,981 mm full height vertical wireway shall be provided in each standard vertical section isolated from the horizontal and vertical power bus. A permanent vertical wireway wall shall separate the units from the vertical wireway, and remain intact when the units are removed. If a permanent vertical wireway wall cannot be provided, tie bars shall be included in each vertical wireway. Standard vertical wireways shall be 110 mm wide x 180 mm deep. A removable hinged door with ¼-turn pawl type
latches shall cover the vertical wireway. Tie bars shall be provided for the vertical wireway.

d) MCC Power Bus System

The MCC power bus system shall be supported, braced and isolated by a bus support that shall be moulded of high mechanical strength, high dielectric strength, low moisture absorption, high impact strength and non-tracking glass polyester material. Horizontal and vertical power bus shall be fastened together with bus clamp assemblies. Minimum bus bracing shall be 65 kA rms symmetrical.

Busses shall be hard drawn copper of 98% conductivity and silver-plated. The power bus system shall be furnished and constructed to satisfy the following requirements or as approved by the Engineer:

i) The horizontal power bus shall be continuous in each shipping section and mounted near the vertical center of the structure, providing optimum heat distribution, power distribution and for ease of maintenance and splicing. The horizontal power bus shall be mounted on-edge in a vertical plane providing maximum strength to magnetic forces under normal and short circuit conditions. The horizontal power bus shall be mounted in recessed channels of the bus support system to protect against accumulation of dust and tracking between phases.

ii) The horizontal power bus shall be 600 amperes, Copper with silver plating.

iii) Splicing horizontal power buses shall be accomplished using a splice kit of the same ampere rating as the horizontal power bus. Double stud clamp assemblies made up of flat washers and pre-assembled nuts and conical washers shall be used. These assemblies shall provide a minimum of two (2) 9.52 mm bolted connections on each side of the splice. The splice connection shall be front accessible for servicing. The location of the splices shall be indicated by a label on the inside of the vertical wireway door.

iv) Vertical power bus bars shall be cylindrical to provide optimum contact with the unit plug-in stabs or Engineer approved equal. Vertical power bus bars shall be continuously braced by a high strength, non-tracking glass polyester material and sandwiched by glass filled polycarbonate moulded bus cover isolating the vertical power bus from the other vertical phases and the horizontal power bus. The vertical power bus shall be isolated from personnel by a red non-metallic full voltage rated moulded cover.

v) The standard vertical power bus may be a copper tube rated 300 Amps above and below the horizontal power bus for as long as it provides an effective 600 Amps rating. The manufacturer shall submit calculations to the Engineer substantiating this effective rating or provide 600 Amp rated power bus throughout.

vi) The vertical power bus shall be silver-plated. The plating of the vertical power bus shall match the plating of the horizontal power bus.

vii) Shutters shall automatically open when a unit is inserted and automatically close when a unit is removed, to ensure that personnel are not exposed to live vertical power bus bars and also ensuring that the bus is isolated from arcing faults.

viii) A horizontal ground bus shall be provided. The horizontal ground bus shall be tin-plated, 98% conductivity copper and shall be located in the top and bottom horizontal wireway.
ix) The horizontal ground bus shall have an effective 500 Amp continuous rating.

x) The horizontal ground bus shall have various sized holes evenly spaced along its length for making ground connections.

xi) A pressure type mechanical lug shall be mounted on the horizontal ground bus in the incoming line section of the MCC.

xii) Outgoing equipment ground lugs shall be provided and mounted on the horizontal ground bus.

xiii) A 4.74 mm x 19.05 mm zinc-plated vertical plug-in ground bus shall be provided in each standard vertical section. The vertical plug-in ground bus shall be mechanically connected to the horizontal ground bus, forming a complete internal grounding system.

xiv) The vertical plug-in ground bus in combination with the unit ground stab shall establish a first make, last break operation of the ground connection with respect to the power connections for plug-in units.

xv) The vertical unit load ground bus shall be mechanically connected to horizontal ground bus.

xvi) The vertical unit load ground bus in combination with the unit load connector shall provide a termination point for the load ground cable at the unit. This fixed connection shall not need to be removed when withdrawing the unit from the MCC.

xvii) A horizontal neutral bus shall be provided and located above or below the horizontal power bus and its location shall be submitted to the Engineer for approval. Connections to the horizontal neutral bus shall be made through neutral connection plates mounted in the horizontal wireways of the various vertical sections. An incoming neutral bus riser shall be provided for the termination of the incoming neutral line.

xviii) A vertical neutral bus shall be provided. This vertical neutral bus shall be located in a 228 mm wide vertical wireway and shall be mechanically connected to the horizontal neutral bus.

e) MCC Main Breaker

The MCC shall be provided with an incoming main circuit breaker. The main breaker shall be of the electronic protective relaying type circuit breaker. The units shall be front accessible and have removable protective barriers on their line side reducing the possibility of accidental contact with line terminals. The circuit breaker shall be moulded case, be provided with quick make, quick break, trip free and trip indicating on overload or short circuits, with a trip rating readily visible and On-Trip-Off indication on the cover. The circuit breaker shall have a common trip mechanism for all three (3) poles. The circuit breaker short circuit interrupting rating shall be not less than 65,000 amperes rms, symmetrical at 600 volts.

The main breaker shall be furnished complete with a microprocessor based digital meter for integrating measured and calculated power parameters. The unit shall be of Allen Bradley manufacture and be their Power Monitor II or Engineer approved equal and consist of a master module located in the MCC, a display module located on the door of the circuit breaker compartment and a communications card for communications of data to the bridge control system PC and control console mounted displays as herein specified and as indicated on the Contract Drawings.

f) Feeder Circuit Breakers
The MCC shall be provided with feeder circuit breakers as indicated on the Contract Drawings. The breakers shall be of the electronic protective relaying type circuit breaker. The units shall be front accessible and have removable protective barriers on their line side reducing the possibility of accidental contact with line terminals. The feeder circuit breaker units shall be frame mounted and shall be located in sections and locations in the MCC as described on the Contract Drawings.

The circuit breakers shall be moulded case, be provided with quick make, quick break, trip free and trip indicating on overload or short circuits, with a trip rating readily visible and On-Trip-Off indication on the covers. The circuit breakers shall have a common trip mechanism for all three (3) poles. The circuit breakers short circuit interrupting rating shall be not be less than 65,000 amperes rms symmetrical at 600 volts.

g) Across the Line Starters

Starters both full voltage reversing (FVR) and full voltage non-reversing (FVNR) shall be of the magnetic across the line type furnished complete with the following features and requirements:

i) Long life pilot lights, Local-Off-Remote selector switch and associated local control pushbuttons all mounted on the door of the starter unit in a polyester control station or Engineer approved equal and provided in quantities as indicated on the Contract Drawings.

ii) Starter units shall be of the plug-in type assembly with a unit pan and door assembly.

iii) Starter units shall be furnished with removable doors. The starter unit doors shall be fastened to the MCC structures such that the door can be closed when the starter unit is removed.

iv) Starter disconnecting means shall be furnished with each starter and shall be of the motor circuit protector (MCP) type and shall be sized based on the available fault current and nameplate full load current of the respective motor in accordance with the NEC as specified herein and on the Contract Drawings and as approved by the Engineer.

v) The MCP shall be furnished based on the rules and requirements of UL 845, NEMA ICS-18 and NFPA 70 and CSA C22.2 No.14.

vi) The MCP shall be furnished with one normally open and one normally closed auxiliary contact.

vii) Each starter shall be furnished complete with an electronic overload relay to provide expanded protection, control and preventative maintenance functions. These function shall include:

1) Thermal overload protection
2) Phase loss protection
3) Stall/jam monitoring
4) Under load monitoring
5) Current imbalance
6) Remote trip
7) Motor diagnostics
8) DeviceNet communications interface

The electronic overload relay shall be of Allen Bradley manufacture their bulletin 193/592 E3 or Engineer approved equal.

h) Programmable Logic Controller (PLC)

A PLC system shall be furnished in the MCC to provide control for the MCC controllers, monitor status of all MCC devices and monitor electrical parameters of each circuit breaker, and starter unit in the MCC.

The PLC equipment shall be installed in the MCC such that it is afforded immunity from all adverse EMF generated by the equipment housed in the MCC including all electronic power devices such as those associated with the VFD.

The PLC equipment installed in the MCC shall be such that it is compatible with the Centerline 2100 IntelliCENTER MCC specified DeviceNet MCC communications highway.

The PLC equipment to be installed in the MCC shall be as specified herein under Programmable Logic Controller section of the specification.

i) MCC Intelligent Communications System

The MCC shall be provided with an integrated communications network distributed throughout each vertical section of each MCC. Each motor starter, main and feeder circuit breaker shall be furnished with a means of communicating through the installed communications network. The communications network shall be of Allen Bradley manufacture their “DeviceNet” system or Engineer approved equal and provided complete with the following requirements and functionality:

i) In accordance with the Canadian Electrical Code (Rule 12-904), the DeviceNet cable shall have an insulating rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure or raceway, i.e., no special separation, barriers or internal conduit shall be required for the DeviceNet conductors.

The DeviceNet cable used for the trunk line shall be flat cable rated 8.0 Amp, 600V, Class 1.

The DeviceNet cable used for the droplines to connect DeviceNet units shall be round cable rated at 8.0Amp, 600 V, Class 1.

ii) The DeviceNet system in the MCC shall include a power supply that conforms to DeviceNet requirements and has the open DeviceNet vendors association (ODVA) checkmark. The power supply shall provide 24 Volt, dc and shall be rated no less than 8.0 Amps.

iii) The DeviceNet system in the MCC shall include a DeviceNet scanner module that conforms to the DeviceNet requirements.

iv) The DeviceNet system shall be furnished to operate at 500k Baud to ensure maximum system performance. The DeviceNet communications performance shall be unaffected by both normal and adverse MCC electrical static and transient environments (contactor electrical switching transients, contactor jogging duty and unit fault and unit and MCC short circuit faults).

v) The DeviceNet system shall be capable of Automatic Device Replacement (ADR).
vi) The DeviceNet system shall be capable of On-Line “Scan list” changes at “Run” allowing network modifications to be performed on a DeviceNet system that is running.

vii) The DeviceNet system shall be capable of the following scan modes: Polled Changed of State (COS), Strobe and Cyclic scanning.

viii) The DeviceNet system shall be capable of transmitting and receiving data via I/O and explicit message.

ix) A DeviceNet trunkline shall be routed through the MCC line-up, behind barriers that isolate the trunkline from the unit space and wireways to prevent accidental mechanical damage during MCC installation.

x) Six DeviceNet ports shall be provided in the rear of each full height vertical wireways in each MCC vertical section to simplify installation, relocation, and addition of plug-in MCC units.

xi) 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 for the DeviceNet cable.

xii) The addition or removal of a unit from the DeviceNet system shall not interrupt the operation of other units within the system.

xiii) The MCC shall be provided with pre-configured IntelliCENTER software. The software shall be capable of viewing multiple MCC line-ups. The IntelliCENTER software communication driver shall allow the software to be installed and operated on Ethernet, ControlNet, or DeviceNet. The IntelliCENTER software shall be capable of functioning as stand alone software package or as an Active X control in a Human Machine Interface (HMI). The IntelliCENTER software shall be capable of displaying the following.

1) Elevation View
   a. Dynamically displays status information based on reading data from devices in MCC line-up
   b. Sizeable view to allow ease of viewing multiple MCC line-ups
   c. Unit nameplate information
   d. Unit status indicator (ready, running, warning, fault, no communication)

2) Unit Monitor View
   a. Pre-configured for a specific unit
   b. Real time monitoring via analog dials and trending
   c. Data configurable for customized viewing
   d. Modifying device parameters

3) Spreadsheet View
   a. User configurable for customized monitoring
   b. Sorting and cascading functions
   c. Custom user fields
4) Event Log
   a. Track history of MCC unit
   b. Automatic logging of trips, warnings and changes
   c. Manual entry of events

5) Documentation
   a. Front elevation drawings
   b. Unit wiring diagrams
   c. User manuals
   d. Spare parts lists

The Contractor shall submit outline-foundation and dimensioned drawings of his proposed motor control centre, MCC layout and elevation drawings, mounting details, One Line and Three (3) Line diagrams, schematic diagrams of each unit and a complete set of wiring diagrams and internal communications distribution and specification in the form of catalogue cuts and data sheets of proposed MCC, communications system and all smart devices proposed and their ratings, MCP and overload schedules to the Engineer for approval prior to procurement.

Span Drive Motor Variable Frequency Drive Controllers

The span drive motor controllers shall be of the variable frequency AC drive type with flux vector control and be of Allen Bradley manufacture and be their 700S type.

The span drive controllers shall be located as indicated on the Contract Drawings.

The drive shall be sized and rated to conform to the specified span drive motor and be capable of satisfying their specified normal, contingency and overload ratings.

The drive shall be provided complete with a communications card (adapter) to enable it to communicate to the MCC PLC via the MCC DeviceNet communications data highway or Engineer approved equal.

The drive controller shall be provided such that it conforms to the following electrical characteristics:

a) Nominal Input Voltage: 600 volt, 3-phase, 60 Hz with a voltage tolerance of ± 10% and frequency tolerance of 57 -63 Hz

b) Nominal DC Link Bus Voltage: 810 volts with a voltage tolerance of ± 10% or as appropriate for the selected drive and specified operating characteristics

c) Displacement Power Factor: 0.98 across the entire speed range

d) Efficiency: 97.5% at rated current and nominal voltage

e) Maximum Drive to Motor Power Ratio: 2:1. Note the rating of the drive controller must be sized to satisfy the full load and short time rated torque output specified requirements of the span drive motor in accordance with AASHTO and as specified herein for the span drive motor.

The drive controllers shall be housed in the electrical room and meet the following environmental requirements:
a) The surrounding air temperature during operation shall range from 0 to 40 Degree C without de-rating the drive controller output in any way

b) The drive controllers shall be capable of being stored at temperatures within the range of -40 to 70 Degree C

c) Relative humidity for both operation and storage of the drive controllers shall be between 5 and 95% non-condensing and the drive controller shall be conditioned for this range of humidity

d) The drive controllers shall be capable of withstanding mechanical shocks of up to 10G peak for 11 ms (± 10ms) duration

e) The drive controller shall be able to withstand vibrations up to 0.152 mm displacement, 1G peak at 5.5 Hz.

The drive controller shall be furnished complete with the following protective functionality:

a) Drive Input Over-voltage Trip: 690 volts, 60Hz on any phase to phase

b) DC link Over-voltage Trip: 1013 volts

c) DC Link Under-voltage Trip: Adjustable based on specific motor loading duty and set in the field

d) Heat Sink Thermistor: Monitored by microprocessor for heat sink over-temperature trip

e) Drive Overcurrent Trip, note these overcurrent trip ratings will dictate the size of the drive controller in conjunction with the motor duties specified for the span drive duty and as defined in AASHTO for overload requirements of span drive motors:

f) Software Current Limit: Calculated value, 105% of motor rated to 200% of drive rated

g) Hardware current limit: 105% of 3 Second rating (158% - 210%)
h) Instantaneous current limit: 143% of 3 Second rating (215% - 287%)
i) Line Transients: Up to 6,000 volts peak in accordance with IEEE C62.41-1991

j) Power Ride Through Capability: 15 milliseconds at full load

k) Logic Control Ride Through: 0.25 Seconds (drive not running)

l) Ground Fault Trip: Phase to ground on drive output

m) Short Circuit Trip: Phase to phase on drive output

The drive controller shall be furnished and be capable of providing the following control functionality when used in combination with the specified span drive motor. Note the Contractor can propose other methods than those described below to achieve the specified functionality but those alternative control approaches shall be submitted to the Engineer for approval prior to developing specific designs or procuring materials and equipment based on those alternative approaches:

a) Shall provide Sine coded PWM with programmable carrier frequency, indirect self-organized, field oriented control and current regulated

b) Output voltage range to the span drive motor 0 to 600 volts

c) Output frequency range to the span drive motor 0 – 320 Hz
d) The drive controller shall be capable of providing speed control for the span drive motor with speed regulation (with feedback) of 0.001% of the base speed across 120:1 speed range and 120:1 operating range with 300 rad/sec bandwidth.

e) The drive controller shall be capable of providing torque regulation (with feedback) for the span drive motor of ±2% with 2,500 rad/sec bandwidth.

f) The drive controller shall be provided with multiple programmable stop modes including; ramp, coast and current limit.

g) The drive controller shall be provided with independent programmable acceleration and deceleration times adjustable from 0 to 6553.5 in 0.1 Second increments.

h) The drive controller shall be provided with an adjustable S-Curve Time from 0.5 to 4.0 Seconds.

i) Intermittent overload output to the span drive motor shall be 150% for up to 10 Seconds at 0 RPM, 180% for up to 10 Seconds and 150% for up to 90 Seconds. Note the absolute values of overload at the motor shall be as specified herein for the span drive motor and as defined in AASHTO and the drive controller shall be rated to satisfy these requirements and provide an additional overload 50% capacity.

j) The drive controller shall be provided with the capability to motor and regenerate and the current limits shall be independently programmed for motoring and regeneration to 800% of rated output current.

k) The drive controllers shall be furnished with electronic motor overload protection. The protection shall be Class 10 protection with speed sensitive response to comply with NEC Article 430 U.L File E59272, volume 12.

The drive controllers shall be provided complete with torque proving capabilities defined as follows:

a) The form of torque proving shall be as Allen Bradley TorqProve™ for the coordination between the span drive motor and the machinery drive braking system.

b) The drive controller TorqProve™ function shall monitor and check motor output prior to commanding a release of the mechanical brakes. This check will include motor output phase continuity and verify proper motor control.

c) The drive shall also be configured to verify that the mechanical brake has control of the load prior to releasing drive control (brake proving).

d) After the drive sets the brake, motor movement shall be monitored to ensure the brakes ability to hold the load.

e) TorqProve functionality with an encoder includes:
   i) Torque Proving (flux up and last torque measurement)
   ii) Brake Proving
   iii) Brake Slip (feature slowly lowers load if brake slips/fails)
   iv) Float Capability (ability to hold full torque at zero speed)
   v) Micro-Positioning
   vi) Fast Stop
vii) Speed Deviation Fault, Output Phase Loss Fault, Encoder Loss Fault.

The proposed operating system shall function as a pair of drives. The drive system shall be used to raise and lower the moving span but under contingency conditions with the failure of one of the drive controllers or its associated drive motor, the system shall be capable of operating with one motor/drive combination to raise and lower the span at reduced speed.

The drives shall normally operate as duty drives and shall be arranged through the VFD’s to share the load. Load sharing shall be achieved using a torque follower arrangement between the drives. The system control shall be based on speed regulation and therefore one of the drives will be in “Speed Mode”, called the “Master”, while in this speed mode, the speed regulator provides a torque output. This torque output shall be arranged to be distributed to the other drive that is called the “Slave” or torque follower. This torque signal shall be scaled at the master output or at the slave input to share the load evenly between the two (2) duty drives.

The drive controller shall be designed and manufactured to meet the requirements of the following certifying agencies:

a) The drive shall be designed to meet the applicable requirements of NFPA 70 and NEMA 250

b) cUL listed to UL 508 and CAN/CSA – 22.2 No. 14-95

The Contractor shall submit outline-dimensioned drawings; of his proposed Variable frequency drive controller, including system schematic diagrams, wiring diagrams, schedule of key components, mounting details and specification in the form of catalogue cuts and data sheets of proposed VFD with confirming documentation that the variable frequency drive controller satisfies the herein specified operating parameters to the Engineer for approval prior to procurement.

Span Drive Motors

A total of two (2) span drive motors shall be provided. The span drive motor shall be of the squirrel cage type and be vector drive duty motors. The motors shall be 200 HP, 1200 RPM, 30-minute duty with 449T frame and be suitable for 600 volt, 3-phase, and 60 Hz operation in combination with the specified variable frequency drive.

The span drive motor shall be totally enclosed and non-ventilated with a service factor of 1.0. Insulation of windings shall be class H with special treatment consisting of impregnation with a moisture-resisting compound to retard the decrease in insulation resistance due to exposure to excessive moisture.

The locked-rotor and breakdown torques of the motors shall be as specified by NEMA and in accordance with AASHTO standard specifications for movable bridges.

The motor shall be built in strict accordance with NEMA standards publication MG-1 and designed for use with an IGBT AC closed loop vector controlled drive for integral horsepower A.C. squirrel cage motors and their design and construction shall be strictly first class in all respects.

All motor windings shall be copper. The motor shall be capable of having a minimum breakdown torque of 300 percent of full load torque. The motor shall have a speed range of 1000:1 and be capable of producing 180 percent full load torque at zero speed.
The rotor shall be balanced mechanically and electrically. Rotor and stator shall be so constructed as to be proof against all disturbing effects incidental to normal operation and wear.

The motor shall have a special extended shaft as indicated on the Contract Drawings to accommodate the motor coupling on the one end and a rear mounted encoder on the other end. The motor shafts shall be stainless steel.

Motor encoder shall be an industrial type (aluminium and glass encoder wheels are not acceptable). The encoder shall have a resolution of 1,024 ppr with 12 volt DC power and be compatible with and satisfy the operating functionality of the herein specified flux vector drive.

Motor keys and keyways shall conform to dimensions and tolerances in accordance with ANSI B17.1 including key seat radii and key chamfers and shall meet ANSI Class 2 fit requirements. Keys shall be effectively held in place by closed end keyways milled into the shafts for the motor shafts. Ends of keyways shall be rounded to half circle with a diameter equal to the width of the key. Keys shall be machined from ASTM A668 Class K forgings.

The motor shall be provided at its lowest point with drain holes not less than 12 mm in diameter.

The journals and bearings shall be of proper proportions.

The motor shall be provided with a built-in heater and thermostat; the heaters shall be installed in the lower part of the motor frames beneath the windings. The heaters shall be suitable for 120 volts, single phase, and 60 Hz continuous operation.

The motor shall be furnished with cast conduit boxes, which shall be fully gasketed with lead bushing and threaded conduit hole, size 25 mm. The conduit boxes shall be sized in accordance with the requirements of NEMA MG 1 Part 11.

All motors must be hand wound and assembled.

Motors must be manufactured to IEEE Marine Standards No.45. Modifications necessary to meet the requirements of these special provisions are as follows:

a) All aluminium parts – chemical film (MIL-C-5541) and zinc chromate primer (MIL-P8595)

b) Cadmium plate shaft and hardware (FED-QQ-P-416)

c) Double sealed ball bearings

d) Seal all joints and eye bolt holes

e) Sealed leads in terminal box

f) Shaft seals

g) Removable drain

h) Final coat of epoxy paint

i) Corrosion resistance coating – rotor and stator laminations

j) Stainless steel and/or mylar nameplate

k) Super “H” insulation. Includes protection against fungus growth per MIL-V-173B
The motor frame shall be finished with a corrosion-resistant paint or coating. Exposed unpainted metal surfaces shall be of corrosion-resistant material. The motor shall be suitable for variable frequency drive operation and be compatible with the flux vector drive controller specified herein. It is the Contractor’s responsibility to coordinate with both the variable frequency drive controller manufacturer and the main drive motor manufacturer to ensure compatibility. The Contractor shall submit evidence of the compatibility and the ability of the variable frequency controller and motor combination to achieve the desired bridge operating characteristics to the Engineer for approval.

The Contractor shall submit outline-dimensioned drawings, of his proposed span drive motor, mounting details, and specification, characteristics and data sheet to the Engineer for approval prior to procurement of the motors.

All motors shall be coupled to the herein specified flux vector drives at the motor manufacturers factory and subjected to witnessed full load heat run tests, tests to determine current, power, power factor and efficiency at no-load, 25%, 50%, 75%, 100% and 150% rated load and to routine tests in accordance with the current requirements of NEMA MG 1 Part 12, and IEEE STD 112. The test result data shall be certified and submitted to the Engineer for approval on the IEEE forms.

The tests shall also include the determination of the variation in speed and motor currents with motor torques from zero to the maximum designed torque for the drive system. The speed-current-torque curve shall also be determined for overhauling torque and include the effects of the motor control equipment and dynamic braking. Some of these curves may be developed by the manufacturer’s computer program if approved by the Engineer. Additionally, and with the use of a dynamometer, the tests shall include verifying that the drive controller and motor combination satisfies all drive controller operating parameters specified for the drive controller.

The Engineer shall be notified of the time and place of the testing at least three (3) weeks in advance of the testing. The Engineer shall determine if the motors are as specified and in accordance with requirements and to assess that the motors are substantially identical.

The test result data and reports of the motor tests shall be certified and submitted to the Engineer for approval on the IEEE forms.

**Machinery Brake**

Machinery brakes shall be furnished under this section of the specification but mechanically installed by others and electrically connected under this section of the contract.

Brakes shall be as specified on the Mechanical Contract Documents or Engineer approved equal. All brakes must fit within the constraints of the system as indicated on the Contract Drawings. The number and configuration of the brakes shall be as indicated on the Mechanical Contract Drawings.

Brake wheel shall be mounted on the secondary reducer input shafts by others with an FN2 fit and key furnished under this item but installed by others.

The brake shall be of the shoe type with a special high torque moulded brake lining.

The brake base plate shall be constructed of welded flat steel.

The brake shoe levers shall be designed as a double web lever that shall be flame cut from a single piece.
Uniform shoe operation shall be set by adjustable stops located on the brake levers.
The spacing of the brake shoe on the brake wheel shall be adjustable by an eccentric stop on
the brake lever.

The brake mechanism shall be provided with automatic brake lining wear compensation.
The braking torque shall be adjustable. The brake shall be provided with external torque
springs and a brake torque scale in metric units.
All hinge points shall be equipped with maintenance free bushings.
All pins and bare parts shall be stainless steel.

Provide corrosion-resistant fittings of non-corrodible metal surfaces and hardware.

The brake shall be furnished complete with an electrically driven thrustor type actuator. The
electro-hydraulic thrustor actuator shall be designed to give protection against wear and
corrosion by the provision of double seals for dust protection and double seals in the hydraulic
system oil chamber. Built in lifting and lowering valves shall be provided for step less
adjustment of the lifting and lower times ranging from 0.5 to 8 seconds. Brake time delays for
brake setting shall be set by others following mechanical installation as indicated on the
Mechanical Contract Drawings or unless otherwise directed by the Engineer pending analysis
of peak loading recorded during strain gage testing required as part of the balance and load
testing requirements provided under the Contract.

The operating temperature range of the brakes shall be between –20 degrees Fahrenheit and
130 degrees Fahrenheit (the actuator shall be designed for operation with low temperature oil).

Thrustors shall include stainless steel push rods.

The thrustor motor shall be suitable for 600 volts, 3-phase, and 60 Hz operation.

Each brake shall be suitable for a AISE-NEMA torque of 746 N m.

The brake shall be set at not more than 90 percent and no less than 70 percent of their AISE-
NEMA torque rating.

The torque provided by the brakes shall be set in the shop, verified by a torque wrench (or
comparable method approved by the Engineer) and adjusted to within 10 percent of the
required setting as indicated on the Contract Drawings. The brake torque shall be rechecked at
installation in the field by others per the approved method and adjusted as required.

The brake wheels shall be Chrome plated. Chrome plating shall conform to the requirements
of SAE AMS 2460, Class 2.

The force required to release each brake manually should not exceed 225 N. The hand release
mechanism shall latch in place.

The brakes shall be provided with NEMA 3R enclosure with thermostatically controlled space
heaters suitable for 120 volts, single phase and 60 Hz operation. Covers that permit ease of
inspection of all brake components and easy operation of the hand release shall be furnished
and installed with each brake. The covers shall be of the split vertical type to facilitate easy
removal and access. Each cover shall be bolted to the same support as the brake.

All items to be coated with the 3-coat paint system specified for the machinery under Materials
section in the Mechanical Work Special Provisions. The manufacturer may submit an alternate
coating system that is suitable for a corrosive, high-humidity environment with supporting
information documenting demonstrated performance on at least three comparable installations. If such alternate system is not approved by the Engineer, the specified 3-coat paint system shall be used.

The brake shall be provided with the following stainless steel or brass permanently affixed nameplates:

a) Fixed to each brake and stamped with the following:
   i) Manufacturer
   ii) Model number
   iii) Specified brake torque (per Contract Plans)
   iv) Maximum brake torque
   v) Reserve stroke of the actuator
   vi) Brake lining material

b) Fixed to each brake actuator and stamped with the following:
   i) Manufacturer
   ii) Model number
   iii) Push capacity of actuator
   iv) Recommended reserve stroke of the actuator
   v) Maximum stroke of the actuator
   vi) Volts, phase, Hz, Watt/VA
   vii) Type of fluid required in the reservoir.

The brake shall be equipped with three limit switches; one switch to indicate when the brake is fully set, one to indicate when the brake is fully released and one to indicate when the brake is hand released. Each switch shall be provided with the two double poles, double throw switches. Each switch shall be rated at 10 amps and be suitable for 120 volt, 60 Hz operation.

The Contractor shall submit outline-dimensioned drawings, of his proposed machinery brake unit, mounting details, and specification in the form of catalogue cuts of proposed brake to the Engineer for approval prior to procurement.

The brake shall be of Link Control manufacture type or approved equal from one of the following manufacturers:

a) Mondel Engineering Limited, Mississauga, Ontario, Canada.

b) General Electric, Salem, Virginia.

Proposed brakes including manufacturer, type, rating and dimensions shall be submitted to the Engineer for approval.

**Motor Brake**

Brakes shall be as specified on the Mechanical Contract Documents or Engineer approved equal. All brakes must fit within the constraints of the system as indicated on the Contract Drawings. The number and configuration of the brakes shall be as indicated on the Mechanical Contract Drawings.
Brake wheel shall be mounted on the motor brake shaft with an FN2 fit and key furnished under this item but installed by others.

The brake shall be of the shoe type with special high torque moulded brake lining.

The brake base plate shall be constructed of welded flat steel.

The brake shoe levers shall be designed as a double web lever that shall be flame cut from a single piece.

Uniform shoe operation shall be set by adjustable stops located on the brake levers.

The spacing of the brake shoe on the brake wheel shall be adjustable by an eccentric stop on the brake lever.

The brake mechanism shall be provided with automatic brake lining wear compensation.

The braking torque shall be adjustable. The brake shall be provided with external torque springs and a brake torque scale in metric units.

All hinge points shall be equipped with maintenance free bushings.

All pins and bare parts shall be stainless steel.

Provide corrosion-resistant fittings of non-corrodible metal surfaces and hardware.

The brake shall be furnished complete with an electrically driven thruster type actuator. The electro-hydraulic thruster actuator shall be designed to give protection against wear and corrosion by the provision of double seals for dust protection and double seals in the hydraulic system oil chamber. Built in lifting and lowering valves shall be provided for step less adjustment of the lifting and lower times ranging from 0.5 to 8 seconds. Brake time delays for brake setting shall be set by others following mechanical installation as indicated on the Contract Drawings or unless otherwise directed by the Engineer pending analysis of peak loading recorded during strain gage testing required as part of the balance and load testing requirements provided under the Contract.

The operating temperature range of the brakes shall be between –20 degrees Fahrenheit and 130 degrees Fahrenheit (the actuator shall be designed for operation with low temperature oil).

Thrusters shall include stainless steel push rods.

The thruster motor shall be suitable for 600 volts, 3-phase and 60 Hz operation.

Each brake shall be suitable for a AISE-NEMA torque rating of 136 N m.

The brake shall be set at not more than 90 percent and no less than 70 percent of their AISE-NEMA torque rating.

The torque provided by the brakes shall be set in the shop, verified by a torque wrench (or comparable method approved by the Engineer) and adjusted to within 10 percent of the required setting as indicated on the Contract Drawings. The brake torque shall be rechecked at installation in the field by others per the approved method and adjusted as required.

The brake wheels shall be Chrome plated. Chrome plating shall conform to the requirements of SAE AMS 2460, Class 2.

The force required to release each brake manually should not exceed 225 N. The hand release mechanism shall latch in place.
The brakes shall be provided with NEMA 3R enclosure with thermostatically controlled space heaters suitable for 120 volts, single phase and 60 Hz operation. Covers that permit ease inspection of all brake components and easy operation of the hand release shall be furnished and installed with each brake. The covers shall be of the split vertical type to facilitate easy removal and access. Each cover shall be bolted to the same support as the brake.

All items to be coated with the 3-coat paint system specified for the machinery under Materials section in the Mechanical Work Special Provisions. The manufacturer may submit an alternate coating system that is suitable for a corrosive, high-humidity environment with supporting information documenting demonstrated performance on at least three comparable installations. If such alternate system is not approved by the Engineer, the specified 3-coat paint system shall be used.

The brake shall be provided with the following stainless steel or brass permanently affixed nameplates:

a) Fixed to each brake and stamped with the following:
   i) Manufacturer
   ii) Model number
   iii) Specified brake torque (per Contract Plans)
   iv) Maximum brake torque
   v) Reserve stroke of the actuator
   vi) Brake lining material

b) Fixed to each brake actuator and stamped with the following:
   i) Manufacturer
   ii) Model number
   iii) Push capacity of actuator
   iv) Recommended reserve stroke of the actuator
   v) Maximum stroke of the actuator
   vi) Volts, phase, Hz, Watt/VA
   vii) Type of fluid required in the reservoir.

The brake shall be equipped with three limit switches; one switch to indicate when the brake is fully set, one to indicate when the brake is fully released and one to indicate when the brake is hand released. Each switch shall be provided with two double pole, double throw switches. Each switch shall be rated at 10 amps and be suitable for 120 volt, 60 Hz operation.

The Contractor shall submit outline-dimensioned drawings, of his proposed motor brake unit, mounting details, and specification in the form of catalogue cuts of proposed brake to the Engineer for approval prior to procurement.

The brake shall be of Link Control manufacture type or approved equal from one of the following manufacturers:

a) Mondel Engineering Limited, Mississauga, Ontario, Canada.
b) General Electric, Salem, Virginia.
Proposed brakes including manufacturer, type, rating and dimensions shall be submitted to the Engineer for approval.

**Span Position Rotary Cam Limit Switch with Resolver**

Rotary cam limit switch shall provide limit switch and resolver outputs as indicated on the Contract Drawings and be of Gemco manufacture, their 1980R with 12 circuits and resolver or Engineer approved equal.

The rotary cam limit switch shall be provided with a resolver driven off the rotary cam limit switch drive shaft.

The resolver shall be compatible with the proposed PLC and provide the PLC with analog input data for accurate span position calculation and graphical representation of span position.

The span position resolver shall be powered from the PLC control system and integrated into the bridge control system.

The resolver proposed shall be selected by the bridge control system vendor in coordination with the programmable logic controller vendor to ensure compatibility and conform to the proposed communication protocol philosophy being proposed for the bridge.

The resolver shall be of a rugged type that is environmentally sealed. The resolver connection shall ensure the resolver is completely enclosed and sealed from the ingress of dust and moisture. The unit shall also provide the resolver with isolation from high shock and vibration and it shall be appropriately protected to be immune from static or dynamic electromagnetic fields generated at the bridge.

Each rotary cam limit switch operation shall be field adjustable and be provided with a means of locking the associated cam in the set position. The cams shall be provided with precision adjustment for any angular position of the camshaft. Each cam shall be complete with a vernier-adjusting device providing fine adjustment of the point of switch contact for opening and closing. No tools shall be required for setting the cams.

The limit switches shall be rugged duty snap action. The switches shall be of the single pole, double throw type, rated at 10 Amps for 120 Volts, 60 HZ operation. The rotary cam limit switch shall be provided complete with an internal gear train of a ratio and shaft location as indicated on the Mechanical Contract Drawings.

The complete rotary cam limit switch assembly shall be housed in a NEMA 4X enclosure.

The Contractor shall submit outline-dimensioned drawings of his proposed unit, mounting details, shaft couplings, and specification in the form of catalogue cuts of proposed unit to the Engineer for approval.

**Incremental Position Encoder**

The encoder shall be mounted directly to the output shafts of the drive motors and provide an output as a function of absolute shaft position and be of Stegmann manufacture and provide high resolution feedback for the PowerFlex 700S Phase II Drive. The encoder shall be immune to large amplitude and frequency shock and vibration.

The encoder shall be suitable for operation over the ambient temperature range of –55 Degrees C to + 120 Degrees C.

The unit shall conform to the following characteristics and be suitable as feedback to the above specified span drive motor VFD controller:
a) Encoder Voltage Supply: 11.5 volts DC @ 130mA
b) High Resolution Feedback: Sine/Cosine 1.0 volt P-P with Offset 2.5
c) RS-485 Interface: High resolution feedback card providing the following functionality via the “Hiperface” RS-485 interface:
   i) Address
   ii) Command number
   iii) Mode
   iv) Number of turns
   v) Number of sine/cosine cycles
   vi) Checksum

The encoder shall be furnished complete with an internal gear train (Engineer to confirm gear ratio).

The Contractor shall provide and include in his bid all necessary shafts, couplings, and mounting hardware for the encoders.

The Contractor shall provide a purpose made weatherproof stainless steel enclosure to house the encoder.

The Contractor shall submit outline drawings of his proposed unit, mounting details, shaft couplings, and specification of proposed unit and wiring details to the Engineer for approval.

Span Drive Motor VFD Dynamic Braking Resistor

Each VFD controller shall be furnished complete with a bank of dynamic braking resistors.

The resistors shall be of the grid and ribbon resistor type. The resistors shall be suitable for the defined rated duty and be of stainless steel with 100 mm wide elements in a serpentine formed configuration formed from one continuous strip. A special Type-406 alloy shall be used to limit the increase in resistance to only 6% at rated current at 375°C.

The resistor bank shall utilize heavy 304 stainless terminal plates to provide both mechanical clamping and TIG weld to the element and provide 2-hole NEMA bolt pattern for 12 mm hardware.

The element terminals shall be rigidly supported for high vibration, high temperature applications in corrosive environments. PG ribbon resistors shall be double insulated to ground and rated at 1,500 volts.

The resistor banks shall be housed in galvanized steel well ventilated enclosures and be suitable for freestanding installation.

The dynamic braking resistors shall be rated to provide up to 180% of full load motor rating dynamic braking based on the motor braking from full speed with the resistors connected to the VFD DC link bus. The sizing of the dynamic braking resistors shall be coordinated with the VFD manufacturer and submitted to the Engineer for approval.

The resistor shall be of Post Glover manufacture and be of their FDL series or Engineer approved equal.

The resistor terminals shall be formed at 90° angle to allow the use of flat bus connectors.
The resistors shall conform in all respects to the Canadian Electrical Code.

The Contractor shall submit outline-dimensioned drawings, of his proposed dynamic braking resistors, mounting details, and electrical diagrams of resistor connections and specification in the form of catalogue cuts and data sheets including calculations of resistor sizing for the defined duty of proposed resistors to the Engineer for approval prior to procurement.

Span Lock Actuator

The span lock operator motor shall be of the squirrel cage induction type and be suitable for 575 Volts, 3 phase and 60 Hz operation. The motor shall be constructed with Class H insulation windings.

The span lock actuator shall be of Raco International L.P. Electric Actuator and be of their type N or Engineer approved equal with the following characteristics:

a) Size 5
b) The motor and limit switches shall be provided with NEMA 4X (IP65) enclosure
c) The actuator motor shall be provided with an integral space heater to maintain the actuator and controls within operating temperature tolerances and prevent condensation for an ambient temperature range of -30 Degrees C to +40 Degrees C and relative humidity of 95% non-condensing.
d) The specific configuration and performance of the actuator shall be as described on the Mechanical Contract Drawings.
e) Stearns type brake
f) An integral rotary cam limit switch with six (6) adjustable limit switches. The limit switches shall be rated at 10 Amps inductive, 120 volts and be a single pole double throw snap action switches.
g) Operator with a custom hex shaft extension at the motor shaft to provide access for manual (hand) operation and a hand crank.
h) Cover for the manual operation shaft extension with a limit switch incorporated into the control system to disable the actuator motor when the cover is removed. The limit switch shall be rated at 10 Amps inductive, 120 volts and be a single pole double throw snap action switch.
i) Trunnion mounting bracket
j) Spherical rod end connection
k) Boot for the thrust tube.
l) The span lock actuator, including supports and fasteners, shall be painted in the shop in its entirety except for machined contact surfaces (e.g. friction surfaces, etc.) and corrosion resistant fasteners.

Painting shall be in accordance with the herein defined requirements and with the paint manufacturer’s most stringent specification for surface preparation. If there is a conflict between them the most stringent specification will govern. Detailed instructions for painting, including paint manufacture information and surface preparation of the span lock actuator shall be provided on the Shop Drawings for review by the Engineer.
Painting shall be three coat painting with an inorganic zinc rich paint for corrosive environments in accordance with the paint manufacturer's specifications for all non-machined surfaces that can be blast cleaned. A modified aluminium epoxy mastic primer shall be used for all machined surfaces that require paint (e.g., couplings, shafts, and all other machined surfaces that cannot be blast cleaned). All three coats shall be applied in the shop. All paint surfaces that are damaged after shop painting is complete shall be cleaned and repainted as necessary to achieve the same level of protection provided by the shop painting.

Preparation of surfaces prior to painting shall be as recommended by the paint manufacturer and as approved by the Engineer. Caution shall be exercised during cleaning and painting operations to prevent cleaning and painting materials from entering span lock actuator components and coming into contact with sliding surfaces on components such as bearings, seals, gears, couplings, and other components which would be damaged by such intrusion. Nameplates shall be clean and kept free of paint.

The Contractor shall submit outline-dimensioned drawings, of his proposed span lock actuator, mounting details, electrical schematic and wiring diagrams and specification in the form of catalogue cuts and data sheets of proposed actuator, actuator motor, cover and limit switch for hand operation and rotary cam limit switch to the Engineer for approval prior to procurement.

**Span Lock End of Travel Limit Switch**

The span lock end of travel limit switch shall be of the heavy duty railroad type switch and be furnished as indicated on the Contract Drawings and provided to the mechanical trade for mechanical installation.

The switch shall be housed in a rugged weatherproof cast iron enclosure provided complete with drain and breather and be fully gasketed.

The switch shall be of the cam type and be mechanically actuated through the linkages from the span lock bar.

The switch shaft shall be sealed from the harsh environment and provided with a means of lubrication.

The span lock end of travel limit switches shall be furnished complete with stainless steel mounting hardware to provide a fully functional installation as indicated on the Contract Drawings.

The span lock end of travel limit switch shall be of ALSTOM manufacture and be their Model 7K switch circuit controller or Engineer approved equal.

The Contractor shall submit outline-dimensioned drawings, of his proposed span lock end of travel limit switch, mounting details, wiring and schematic diagrams and specification in the form of catalogue cuts and data sheets of proposed limit switch to the Engineer for approval prior to procurement.

**Span Seated Limit Switches**

Span seated limit switches shall be furnished as described herein and as indicated on the Contract Drawings. The switches shall be so arranged to trip when the respective span corner is fully seated in the fully closed position.

Each span seated limit switch shall be of the plunger operated type, spring return, snap action switches with four independent circuits. The switch circuits shall be rated at 10 Amps
inductive and shall be suitable as inputs to the herein specified PLC. The switch shall be housed in a cast iron, NEMA 4 enclosure. Each switch shall operate with 50mm movement of the operating rod, and the point of actuation shall be adjustable after installation. A spring buffer shall permit 50mm of over travel of the operating rod. The tripping mechanism shall operate to open the switch contacts after a return movement of the operating rod of not more than 75mm from the point that the contacts were closed. The operating rod for each switch shall be fabricated from stainless steel and the plunger shall have a bull-type operator at the end. The joint of the mechanism between the spring buffer and the plunger rod shall be covered with a watertight, neoprene bellows-type boot. The span seated limit switch shall be of B&B Roadway manufacture or Engineer approved equal.

The Contractor shall submit outline drawings, dimensioned layout, switch contact configuration diagram and specification data sheet of the span seated limit switch to the Engineer for approval prior to procurement.

**Span Over Travel Raised Limit Switch**

A span over travel raised limit switch shall be installed to trip when the span exceeds its fully open position. The switch operating target shall be mounted as indicated on the Mechanical Contract Drawings.

The limit switch shall be of the heavy-duty precision, inductive and outdoor (IP68) type and suitable for submersible operation.

The limit switch environmental sealing rating shall be suitable for prolonged periods of submersion as defined for IP 68 rating.

The limit switch enclosures shall be of Polybutylene Terephthalate (PBT) construction and be CSA certified.

The limit switch shall be of the rectangular type with an operating range up to 40 mm.

The limit switch shall be provided complete with a connection plug and socket as a quick disconnect for replacement and trouble shooting.

The limit switch shall be provided with a single pole normally open contact rated at 8 – 50mA and be suitable as an input to the herein specified programmable logic controller.

The limit switch shall also be provided with status indication LED’s.

The Contractor shall inspect each switch location and propose stainless steel mounting brackets and appropriate target for Engineer approval.

The Contractor shall submit outline-dimensioned drawings; of his proposed span fully raised limit switch unit, mounting details, and specification in the form of catalogue cuts and data sheet of proposed switch to the Engineer for approval prior to procurement.

The switches shall be of Pepperl+Fuchs manufacture, their type NJ+U4+W-BHMS3-N.O and the plug and socket shall be their BHMS3 or Engineer approved equal.

**Inclinometer**

An inclinometer shall be provided at the bridge as an alternative or back up form of span position and as an aid to the operator for manual bridge operation. This system will be developed independently of the bridge PLC based control system specified herein and consist of a span mounted inclinometer.

The manual or alternate control system shall have the following features:
a) A means of measuring angular displacement of the bridge moving span (measure of span position from closed).

b) An operator’s control console mounted digital indication of angular displacement.

c) A means of indicating absolute position.

d) A means of interfacing with a PC for system set up, calibration and recording angular displacement for record and troubleshooting purposes.

e) System relay outputs to prevent drive system operation at ends of travel.

f) All items provided as part of the inclinometer and skew control system shall be tested and certified as new by the manufacturer. The system shall be assembled complete at the manufacturers plant and receive a full functional test. Test reports produced describing in detail the tests performed and the results obtained and submitted to the Engineer for approval prior to the equipment being shipped to the bridge.

g) The inclinometer shall be of the liquid capacitive gravity based sensors with integrated sensor and excitation electronics. Thermal drift of the primary sensor shall be further compensated by an electronic equalization of the temperature. An integrated highly stable voltage regulator shall make it possible to supply the inclinometer from an unregulated supply of 30 volt dc. The measuring principle shall assure a linear angle output with 0 – 5v dc calibrated to equal the measuring range of the sensor. The inclinometer shall be arranged to output to the PLC and a separate digital indicator to be mounted on the operator’s control console to be used as an aid for bridge manual control. The inclinometer shall be furnished complete with the required power supply and housed in a NEMA 4X enclosure as indicated on the Contract Drawings. The inclinometer shall be of Rieker Inc manufacture and be their type NG2U with a compatible wireless communications link to communicate between the inclinometer and the PLC located in the Operator’s House or Engineer approved equal.

h) The Contractor shall submit outline-dimensioned drawings, of his proposed inclinometer, mounting details, schematic and wiring diagrams of the inclinometer/skew indication system and specification in the form of catalogue cuts and data sheets of proposed system to the Engineer for approval prior to procurement.

Navigation Lights

Navigation lights shall be furnished and installed as indicated on the Contract Drawings. The navigation lights shall conform to the requirements and be in accordance with the rules and regulations of the Canadian Coast Guard.

The navigation lights shall be pier pedestal type lights and span mounted pivoting type lights. Each pier light shall be a single unit, 203 mm outside diameter lens, 180 Degree, red fresnel lens. Each span mounted pivoting type light shall consist of a green light mounted above a red light. Each of the pivoting red and green lights shall have a 200mm diameter, 180 Degree fresnel lens. The pier lights shall be mounted on a short section of bronze or stainless steel pipe with a flange at the bottom as indicated on the Contract Drawings. The pivoting span lights shall be mounted on a short section of bronze or stainless steel pipe with a pivoting attachment arrangement. The pivoting assembly shall be provided with an anti-swing brake to prevent oscillation under windy conditions. The pivoting span lights shall be provided complete with a bronze or stainless steel retriever chain arranged to allow the navigation light to be raised for inspection. These retriever chains shall be arranged to allow the lights to swing freely and so the light can be readily retrieved for lamp replacement from above.
Each light shall be securely bolted in place with bronze or stainless steel lag screws or bolts of not less than 3/8 inch in diameter. The connections to the lights shall be made with No. 10 AWG conductors. The feeding conduits for the pier lights shall be securely clamped to the piers with two stainless steel anchor bolts.

The navigation lights shall be furnished complete with dual lamps and a transfer relay. The dual lamp arrangement shall consist of two (2) medium base lamp receptacles, two (2) 5-year lamps and a transfer relay. The transfer relay, with built in lamp out indicator circuit, shall be wired to a board and installed in a relay box. The transfer relay box shall be supplied in the same material as the navigation lighting unit. The navigation light shall be of B&B Roadway Manufacture or Engineer approved equal.

All navigation light fittings shall be non-corroding, and the sockets shall be of porcelain mounted on shock absorbers. The housings shall be cast bronze, and two (2) 100 Watt, 120 volt, 5 year lamps or LED equivalent as approved by the Engineer and with brass base shall be installed in each socket.

The Contractor shall submit outline-dimensioned drawings, of his proposed navigation lighting unit, mounting details, and specification in the form of catalogue cuts of proposed lights to the Engineer for approval.

**Bridge Aircraft Obstruction Lights**

Aircraft obstruction lighting shall be installed on the bridge in accordance with the Canadian Aviation Regulations 2010-2, Standard 621.19 – Standards Observation Markings.

The obstruction lighting system shall be of the red obstruction light system used to increase awareness of the bridge during night time.

The obstruction lighting shall be furnished and installed on the tower structure and purpose provided poles as indicated on the Contract Drawings.

The lighting system shall consist of the L-810 type, double obstruction light assembly with LED lamps and be suitable for 120 volt, 60Hz operation. The obstruction lights shall be suitable for operation under the following environmental conditions:

a) Temperature Range: -55 Degrees C to +55 Degrees C  
b) Relative Humidity: 95% non-condensing  
c) Miscellaneous: Withstand exposure to wind-blown rain and snow from any direction and withstand exposure to salt-laden atmosphere

The light shall be designed for steady burning use and operate 24 hours per day and 365 days per year and be RF-hardened design for operation in high-powered utility frequency systems.

The obstruction light output shall provide constant light output that meets or exceeds regulatory requirements across input voltages of ±20% of nominal.

The obstruction light assembly shall be weather/corrosion resistant is installed with a self contained wiring compartment within the base housing of the unit that eliminates the need for an additional junction box.

The light unit shall be provided with a high temperature shock-resistant prismatic glass globe, aluminium housing and stainless steel hardware.

The observation lights shall be of Austin Insulators Inc with red beacons their type A-L810 or Engineer approved equal.
The Contractor shall submit outline-dimensioned drawings of his proposed obstruction light, mounting details, and specification in the form of catalogue cuts and data sheets to the Engineer for approval prior to procurement.

**Lighting Fixtures**

Lighting shall be installed in all areas of the bridge for operation, maintenance and security. The illumination levels for each area shall be in accordance with the requirements of AASHTO and consist of the following:

a) Operators House (Interior): Type “A” fluorescent fixture  
b) Operators House (Exterior): Type “B” wall pack fixture  
c) Machinery Space: Type “C” fluorescent fixture  
d) Staircases and Catwalks etc: Type “B” wall pack fixture  

Each lighting type shall be suitable for 120 volt, 60Hz operation and be in accordance with the following requirements:

a) Type “A” Lighting Fixture: Shall consist of a surface mounted wrap around two (2) lamp fluorescent fixture. The fixture shall be designed to produce the maximum light output with minimum clearance.

   The unit housing shall be of a die formed heavy gauge steel finish in baked white enamel for maximum reflectivity and durability.

   The fixture shall be furnished complete with a clear acrylic prismatic wrap around diffuser with low glare extruded prismatic lens.

   The fixture shall be provided with high power-factor electronic ballast and be energy star rated and use two (2) T8 type 1,219 mm lamps.

   The unit shall be furnished with standard knockouts on the back and sides of the unit

   The fixture shall include an easily removable and replaceable lens latching system for ease of replacement and maintenance.

b) Type “B” Lighting Fixture: Shall consist of an outdoor “Wallpack” unit, for outdoor use and be provided complete with compact fluorescent lamps.

   The unit shall consist of a one-piece polycarbonate lens that shall be internally painted for lasting appearance. Two purpose made fasteners shall be provided to assure, with the use of gasketted covers, a weather tight seal to the housing.

   The fixture housing shall be die cast aluminium for rugged use and heat dissipation. The use of specular reflector, vertically mounted lamps and reflector shall combine to provide an efficient and uniform lighting distribution.

   The unit shall be furnished complete with a 42 watt, CFL lamp (4100K) that shall provide a similar illumination result as a pulse start MH colour.

   The wall pack unit shall be CSA certified to UL 1598 for use in wet locations and be of Hubbell manufacture and be their Egress Perimaliter PVL3 or Engineer approved equal.

c) Type “C” Lighting Fixture: Shall consist of a 1,219 mm two (2) – lamp wall mounted fluorescent lighting fixture that shall be installed in a strip lighting configuration in the bridge machinery space.
The fixture shall be suitable for low to medium mounting heights where dust, dirt, humidity, moisture or corrosive elements may be present.

The unit housing shall be formed from impact resistant, UV stabilized, and fibreglass reinforced polyester with cold-rolled steel enclosed wireway. In manufacture a poured in gasketting process shall be adopted to provide a seal between the housing and the diffuser. Captive, corrosion-resistant cam-action stainless steel latches shall be utilized to secure the diffuser.

The unit parts shall be painted following the process of pre-treating with a five-stage iron-phosphate process to ensure superior paint adhesion and corrosion resistance with a final finish of high-gloss baked enamel.

The optical system shall consist of a high-impact acrylic diffuser with a stippled interior surface to spread lamp image.

The unit shall be provided with a thermally protected, resetting, instant start, Class P, high power factor, non-PCB, UL Listed and CSA Certified ballast with radio interference filter and be of Lithonia Lighting manufacture their type DMW with 2-32 watt, T8 medium, bi-pin linear fluorescent lamps or Engineer approved equal.

The Contractor shall submit outline-dimensioned drawings, of his proposed lighting fixtures, mounting details, and specification in the form of catalogue cuts and data sheets of proposed fixtures to the Engineer for approval prior to procurement.

**Floodlights**

Floodlights shall be furnished and installed on the bridge and directed onto the navigable channel as indicated on the Contract Drawings.

Each floodlight shall be provided with a 150 Watt, metal halide (MH), 120V, 60Hz lamp and pulse start MH magnetic ballast. The flood light shall be furnished with a horizontal flood distribution.

The fixture housing shall be a single piece aluminium cast in a soft barrel form with a one piece extruded gasket mating with the door frame.

The door and lens assembly shall consist of a heat and impact resistant tempered glass lens and a one piece silicone gasket that shall be mechanically secured to the door frame.

A knuckle manufactured from die cast aluminium with an integral splice compartment shall be provided with the fixture. A single captive stainless steel allen-head bolt and stainless steel nut shall be used to securely lock the knuckle aiming teeth in 5 Degree increments. This knuckle assembly shall be gasketted with a removable cover to the splices.

The floodlight optical system shall be of the horizontal wide flood and consist of a homogenous sheet and extruded aluminium, electrochemically brightened, anodized and sealed.

Each HPF ballast shall be of the separate component magnetic type capable of providing reliable lamp starting to an ambient temperature of -29 Degrees C.

The fixture shall be finished with a fade and abrasion resistant, electrostatically applied, thermally cured textured, polyester powder coat finish.

The floodlight shall be CUL listed for wet locations and be of Gardco Lighting/Philips manufacture, their type DF7 or Engineer approved equal.
The Contractor shall submit outline-dimensioned drawings, of his proposed floodlight, mounting details, and specification in the form of catalogue cuts and data sheets of proposed floodlight to the Engineer for approval prior to procurement.

**Vehicular and Pedestrian Traffic Lights**

Furnish and install a completely wired weatherproof traffic light system including poles, cantilevered arms and all necessary hardware as indicated on the Contract Drawings. The operation of which shall be controlled by the bridge control system as herein defined and as indicated on the Contract Drawings.

The traffic light standards and cantilevered arms shall be of aluminium construction and be sized in accordance with British Columbia Standard Specifications for Road and Bridge construction and the Canadian MUTCD. Sets of signal heads shall be mounted off the cantilevered arms and shall have a mounting height of 4,500 mm and a distance from the traffic signal standard to the signal heads as indicated on the Contract Drawings. The signal head array shall be mounted using corrosion resistant hardware that is appropriately sized and configured for the intended application and submitted to the Engineer for approval.

Sets of signal heads shall be mounted off the traffic light standard at a height of 2,500mm as indicated on the Contract Drawings for both vehicular and pedestrian control. The signal head set shall be mounted on the traffic light standard using Engineer approved stainless steel hardware.

Traffic light standards shall be securely bolted to the foundations of the roadway as indicated on the Contract Drawings, and shall be constructed in accordance with British Columbia Standard Specifications for Road and Bridge Construction and shall be erected with sufficient rake as to assume a vertical position after all attachments and appurtenances are in place. Shims shall be installed if and as necessary and the proposed installation shall be approved by the Engineer.

The traffic light heads shall be suitable for 120 volt, single phase, and 60 Hz operation with LED lamp arrays and consist of assemblies of traffic light faces mounted on the arm in the vertical plane in an approved manner. Ray directors shall be installed inside the signal visor; the entire ray director shall be dull black and shall be attached to the visor, after proper aiming, with stainless steel sheet metal screws.

Each traffic light head shall consist of three faces, one red, one amber and one green, the heads shall conform to the requirements for “traffic control at movable bridges” in the Canadian “Manual on Uniform Traffic Control Devices for Streets and Highways”. The traffic light heads with pole, cantilevered arm and mounting accessories shall be manufactured by Aluminous lighting with the traffic signal arrays manufactured by Econolite or Engineer approved equal.

The traffic light heads shall be wired for remote operation from the bridge control system (120 volts, single phase, 60 Hz).

Proposed traffic light manufacturer, type outline and detailed physical drawings and specification data sheets shall be submitted to the Engineer for approval prior to procurement of the traffic lights.

**Vehicular and Pedestrian Traffic Warning Gates**
Motor-operated, single-arms, traffic gates of the railway grade-crossing type shall be furnished and installed at the approach roadways for the bridge for vehicular and pedestrian traffic, as indicated on the Contract Drawings.

The traffic warning gates shall be of B&B Roadway manufacture or Engineer approved equal.

Each gate shall have an arm of the length as indicated on the Contract Drawings, which shall open through an angle of 90 Degrees from the horizontal to the vertical. Each gate shall have a welded steel stand arranged to provide a weather-tight housing for the motor, motor starter, disconnect switch, gear train, and limit switch, fuses for warning lights and all herein defined components. The gate stands shall be hot-dip galvanized after fabrication. The transmission gearing for each gate shall be enclosed and meet all current CANOSH requirements. Weather tight, gasketed doors shall be provided for access to the operating equipment together with 10 Amp inductive door open indication micro-switches that shall be suitable as inputs to the herein specified PLC. A hand crank shall be provided for manual operation of each gate together with a 10 Amp inductive hand crank limit switch that shall be suitable as inputs to the herein specified PLC. The gate arms shall be made of clear, straight-grained, select No. 1 white pine or extra-clear fir. The timber shall be free from all knots, splits, checks or other imperfections and shall be surfaced on all sides or Engineer approved equal. Each gate arm shall be adequately braced transverse to its motion to resist wind loads and to reduce whipping and shall be guyed to prevent sagging. Each assembled gate arm shall be designed for a 120 kph wind load. A bumper rod with compression spring shall be provided near the end of each gate arm to stop the travel at the closed position without undue shock.

All bolts, screws or other fastenings used in the gate arm assembly and for connection to the gate stand shall be corrosion-resisting metal or shall be hot-dip galvanized.

Warning lights shall be furnished on the gate arms. Each warning light shall be a weatherproof, two-way, cast aluminium unit with red fresnel lenses front and back. The lights shall be interconnected with three conductor cables using galvanized rigid steel conduit and watertight connectors at the fixtures or an alternative method to be approved by the Engineer. A 67-watt or LED array as approved by the Engineer, clear traffic signal lamp shall be installed in each fixture. The lights shall be provided with a housing mounted electronic flasher unit and equipment that shall be arranged and connected so that adjacent units will flash alternately. Fuses for the warning lights shall be 10-ampere midget cartridge fuses installed in moulded rubber connection kits of fused terminal blocks as approved by the Engineer.

Warning gongs shall be furnished with warning gates as indicated on the Contract Drawings. Each gong shall be a weatherproof, motor-operated and be 305 mm diameter mounted on the traffic gate housing and provided with a suitable base for fastening to the gate housing. The gong shall be of cast bronze, fire alarm bell metal and shall be held with theft-proof nuts. It shall meet the requirements specified for the traffic signals gongs except with box for mounting on a horizontal surface.

An 8-circuit limit switch shall be provided in each gate. The switch contacts shall be rated at 10 Amps inductive and shall be suitable as inputs to the herein specified PLC and be of the quick-break type with silver alloy buttons. Each limit switch shall be of the rotary cam type and it shall be gear driven from the gate mechanism transmission. The limit switch shaft shall be stainless steel, and cams shall be secured thereto with set screws.

The motor for each traffic gate shall be furnished as part of the gate by the gate manufacturer. Each motor shall be a totally-enclosed, 600 volts, three phase, 60-cycle, ball-bearing induction motor and shall be capable of withstanding instant reversal when running at full speed. Each
motor and gear train shall be capable of opening and closing the gate in 15 seconds plus or minus one (1) second. A motor-mounted, spring set, magnetically-released, disc brake shall be provided for stopping and holding the mechanism. A watertight disconnect switch shall be provided to permit disconnecting the motor and brake from the incoming power. Each gate mechanism shall be furnished complete with space heaters and thermostats and be suitable for 120 volts, 60 Hz operation.

All internal wiring for each gate shall be brought to numbered terminal blocks inside the housing for the connection of existing circuits.

Each wood gate arm shall be striped on both faces with alternate red and white reflectorized stripes 406 mm wide in accordance with Canadian MUTCD requirements, measured parallel to the edge of the gate arm. The stripes shall slope downward at an angle of 45 degrees toward the centerline of the roadway. The galvanized gate stands shall be left unpainted so that the galvanized surfaces can weather. Wiring between the gate arm and housing shall be watertight, flexible and be enclosed with interlocked armour of galvanized steel.

In erecting the gates, the timber arms shall be carefully attached to the supporting members so as to make a rigid connection. The arms shall be counterbalanced and the limit switches adjusted so that the arms are stopped in a truly vertical and the horizontal positions. All traffic gates shall be installed on purpose made foundations as specified elsewhere in the Contract Documents and attached to the bridge roadway and pedestrian walkway foundations with stainless steel or galvanized anchor bolts. Bolts and attachments to the roadway shall be approved by the Engineer in accordance with manufacturer’s recommendations. The traffic gates shall be of B&B Roadway or Engineer approved equal.

No exposed electrical or control wiring shall be permitted. All wiring on the gate arm shall be in rigid metal conduit. Wiring between the gate arm and housing shall be of the armoured flexible type.

The Contractor shall submit outline drawings dimensioned layout, schematic, wiring diagrams, mechanical and electrical data sheets of the traffic gates to the Engineer for approval prior to procurement and fabrication by the gate vendor.

**Operator’s Control Consoles**

Operator's control consoles shall be furnished and installed in the operator's house for operation of the bridge, traffic control equipment and monitoring bridge system status and annunciating fault conditions. Two (2) consoles shall be provided and located as indicated on the Contract Drawings. One console shall be dedicated to the control of vehicular and pedestrian traffic and contain visual aids to indicate presence and status of vehicular and pedestrian traffic. The second console shall be dedicated to the operation of the bridge and monitoring its status. All devices for controlling and monitoring the operation of the bridge span, standby generators, navigation and traffic control equipment shall be mounted in and on the control consoles as indicated on the Contract Drawings and as herein specified.

The control consoles shall be of neat, substantial construction. They shall be fabricated from No. 11 gauge sheet steel properly formed and reinforced to provide adequate strength. The welded console tops shall be fabricated of No. 11 gauge Type 302 stainless steel sheet with a non-glare, satin finish. Removable doors shall be provided in the front of the consoles, pivoted on 90-degree hinges and secured with flush-type latches. The control consoles shall be neatly fitted up with close joints, and all rough edges or corners shall be ground off smoothly, and all projecting edges rounded off. All metal hardware shall be of substantial construction, and shall
have a satin-chrome plate finish. All equipment mounting screws and bolts shall be stainless steel.

The sheet portions of the consoles and all metal reinforcing shall be painted inside with two coats and outside with three coats of paint consisting of one coat of primer followed by two coats of enamel on the outside surfaces, and one coat of primer and one coat of enamel on the inside surfaces. The finish coat shall be of a colour to match the house interior. Colour samples shall be submitted to the Engineer for approval. The stainless steel console top shall not be painted.

Special care shall be taken throughout the construction to insure that the stainless steel console tops and the equipment mounted thereon are completely protected from damage or defacement at all times.

The interior shall be suitably lighted with fluorescent strips and operated by a switch mounted near and controlled by the front doors to produce an illumination level inside the console of 300 lx.

All control switches, pushbuttons, monitors, meters, indicating lights and other control devices shall be mounted within the body of the consoles. The indicating lights for each operation shall be mounted adjacent to the control device governing that operation and provided with a means of lamp test. The means of lamp test proposed shall be submitted to the Engineer for approval. All control and indicating devices shall be compatible with the requirements of the control system and shall be of Allen Bradley manufacture their 800T series or Engineer approved equal, suitable for oil tight/watertight operation and provided complete with transparent boot to exclude harmful contaminants.

Control relays shall be hermetically sealed and be of Allen Bradley manufacture their series 700 HA with tube base, DPDT, 2-pole, 2-form C contacts with LED. The relays shall be furnished with a varistor and LED surge suppressor (700-AV3R) or Engineer approved equal that provides the same level of protection.

Control timer relays shall be hermetically sealed and be of Allen Bradley manufacture their series 700 HT with tube base, DPDT, 2-pole, 2-form C contacts with LED. The timers shall be furnished with a varistor and LED surge suppressor (700-AV3R) or Engineer approved equal that provides the same level of protection.

A bridge status colour human machine interface (HMI) monitor shall be mounted on the operator’s bridge control console. The HMI shall be furnished as part of the programmable logic controller system with compatible communications protocol to assure a fully integrated control system.

The bridge power source status shall be monitored by a configurable real-time power quality monitor mounted on the operator’s bridge control console as indicated on the Contract Drawings. This display monitor shall be of Allen Bradley manufacture type 2711 PanelView standard micro, the monitor shall be capable of displaying in colour all parameters capable of being displayed on the Power Monitor II master module and receive data from the Power Monitor II communications card via the PLC (see the herein MCC section for details) or Engineer approved equal and furnished as part of the MCC.

The escutcheon plates of all control switches, pushbuttons and indicating lights shall be made of aluminium with a satin finish and shall be engraved with an identifying legend as indicated on the Contract Drawings.
The wiring within the control consoles shall be flame-retardant, ethylene-propylene insulated, switchboard wire, Type SIS. The wiring shall be arranged systematically so that all circuits can be readily traced. All conductors shall be terminated on easily accessible terminal blocks mounted inside at the rear. Terminal blocks shall be of Phoenix Contact, Inc. manufacture as specified herein this specification. Spare terminals that total at least 20 percent of those actually used shall be provided. Wiring shall be identified at equipment terminals by marking the adjacent area with bright yellow painted numbers or other Engineer approved means to correspond to conductor designations appearing on the Contractor's wiring diagrams.

Indicating lights shall be mounted on the control consoles to show that the various steps in the sequence of operation have taken place so that the operator may proceed to subsequent steps at the proper time and be able to follow the sequence of operation of the traffic control system and bridge when operating in manual and automatic mode as defined herein. The functions to be indicated, their location and the colour of the lenses shall be as described on the Contract Drawings.

The operator’s control consoles shall operate from a 120 volt, 60 Hz source and be powered from the dedicated operator’s house UPS indicated on the Contract Drawings and as specified herein.

The Contractor shall submit outline drawings including dimensioned layout, schematic and wiring diagrams of the control consoles together with catalogue cuts, dimensional details and descriptive details of all proposed console mounted devices to the Engineer for approval prior to fabrication.

**Programmable Logic Controller (PLC)**

A programmable logic controller (PLC) shall be used as the prime means of supervisory control for all bridge operations but not traffic control which shall be manually controlled by the bridge operator from the bridge traffic control console but status monitored, traffic control interlock functions incorporated into the bridge control system and failure alarmed by the PLC. The bridge shall be furnished with PLC equipment, associated I/O's and communications equipment in the Motor Control Centre (MCC), Operator’s Control Consoles and the standby generator housing.

The PLC system proposed shall be fully redundant with two (2) identical controller chassis designed and functioning as an integrated system. The system shall be configured with primary and secondary designated controllers. The operational primary controller chassis shall be arranged to automatically identify all data changes during its scan and send that data to the secondary controller and hence ensuring that the secondary controller is always ready to seamlessly take over control of the bridge in the event of a failure of the primary controller without any change in outputs. The developed software shall be designed such that it does not need to program messages nor specify certain data transfers and hence eliminate the need for setting up the redundant system.

The provided PLC system shall provide enhanced redundancy and high-availability.

The PLC system and associated components shall be the products of a single manufacturer and shall comply with the applicable provisions of NEMA Standards ICS 2-Z30, IEEE/ANSI C37.90A and UL 508. Equipment shall be suitable for an input voltage of 102-132 volts with a frequency range of between 57 Hz and 63 Hz and a temperature range of 0 to 60 Degrees C with relative humidity of 5 to 95 percent (non-condensing). All PLC equipment (CPU, UPS, I/O frames, input cards, output cards, communications modules, cables, etc) shall undergo a
minimum of 100 hours of continuous burn-in following factory testing and prior to shipment. Burn-in shall be performed while operating at temperatures within the rated limits and while cycling the PLC system through its operating program. PC equipment specified as part of the bridge control system shall be designed, manufactured and tested to operate satisfactorily under the worst radio frequency and electrical noise conditions and meeting RFI immunity per FCC Class A, EMI immunity per MIL-STD-4618 and be capable of withstanding a 2,500-volt surge.

The central processor units (CPU’s) shall permit programming capabilities as required and as defined herein and on the Contract Drawings, but not limited to, internal delay equivalents, counters, timers, real time calendar clock, data functions such as data compare and data transfer, transitional coils which shall allow an output to remain on for a single processor scan only, latch/unlatch relays, storage registers, etc to achieve the described analog and digital logic and operating functionality for the bridge. The CPU shall be of the dual core custom CPU that increases standard scan times, enhances communication rates and provides faster cross-loading for enhanced redundancy application. The processor program memory shall be Complementary Metal Oxide, Semi-conductor (CMOS-RAM) or Engineer approved equal, with internal battery backup power system. The backup battery shall be of the lithium type, sized to support the memory for not less than 3 months without external power and the system shall have a low battery voltage alarm indication. The backup battery shall be capable of being replaced without interruption of the memory integrity with AC power on and shall be provided with a visual indication of battery status.

CPU shall have a key operated selector switch for preventing changes in the stored program while in the “operate” position.

The controller shall be provided with plug in enhanced memory technology cards to provide fast read and write with adequate capacity for the defined PLC functionality with at least 50% spare capacity and be furnished with a spare program and data storage.

The PLC shall also feature on-board display to provide enhanced controller diagnostics and run time information.

The status of inputs and outputs shall be checked by the PLC program at the time they are called for in the program and outputs shall be available to be turned “on” or “off” as soon as the associated logic rung has been scanned. The CPU shall check the parity of each word at the time it scans that word. An alarm contact shall permit indication of trouble whenever a failure occurs in the system and transfer to the standby PLC that takes over the system operating duty. An audible and visual signal of the failure and transfer shall be provided. The standby PLC shall permit continued operation of the bridge from the point of failure of the primary PLC. The CPU shall have trouble lights to indicate memory parity errors or processor malfunction.

The programmable logic controller and associated equipment shall perform all bridge automatic operations and functions including sequential opening, closing, by-pass, motor starts and stops, acceleration and deceleration of the span drive motors. The PLC shall monitor the operation of the bridge and provide alarm conditions by annunciation and status data for real time graphical representation of the bridge operating system on the herein specified human machine interfaces (HMI’s) and provide “Hot” standby functionality all as defined herein.

The furnished PLC shall be manufactured and tested in accordance with the requirements of the applicable NEMA and IEE standards and be installed and grounded in accordance with the requirements of CSA 22.1.
The PLC system power supplies and the input-output (I/O) power supplies shall be designed for operation from a common 120 volt, 60 Hz, UPS source to minimize line interference and reduce the possibility of the PLC receiving faulty input signals. The power supply shall also be furnished complete with a microprocessor controlled power conditioning capable of correcting a voltage input of 25% below nominal to within PLC power supply tolerances within two cycles of 60 Hz.

The PLC shall be arranged to be fully integrated with the herein specified MCC DeviceNet communications system or some other means of interfacing with the MCC internal communications highway with the PLC as approved by the Engineer. Additionally and as approved by the Engineer, the developed communications highway shall be such that its communications protocol is compatible with that of the herein specified VFD’s, standby generator, UPS and all other communicating devices herein specified.

PLC input/output (I/O) modules shall be provided to cover all applications defined herein and as indicated on the Contract Drawings. All I/O’s shall be optically isolated and filters, surge protection and circuitry shall be included in both I/O modules to protect the complete programmable controller against transient voltages from external sources including: lightning strikes, static build-up of electricity or induced voltages generated by the control system inductive devices and the VFD drives. The control system vendor shall facilitate coordination between the PLC manufacturer, the MCC manufacturer, standby generator manufacturer and the VFD manufacturer to ensure that all necessary surge suppression devices are installed in the MCC and generator and ATS equipment and all EMI mitigation measures implemented to protect the PLC and associated control and communications system.

The PLC shall be fully integrated with the herein specified MCC DeviceNet communications system or some other means of interfacing with the MCC internal communications highway with the PLC as approved by the Engineer. Additionally and as approved by the Engineer, the developed communications highway shall be such that its communications protocol is compatible with that of the herein specified VFD’s, standby generator, UPS and all other communicating devices herein specified.

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The PLC input/output (I/O) modules shall be provided to cover all applications defined herein and as indicated on the Contract Drawings. All I/O’s shall be optically isolated and filters, surge protection and circuitry shall be included in both I/O modules to protect the complete programmable controller against transient voltages from external sources including: lightning strikes, static build-up of electricity or induced voltages generated by the control system inductive devices and the VFD drives. The control system vendor shall facilitate coordination between the PLC manufacturer, the MCC manufacturer, standby generator manufacturer and the VFD manufacturer to ensure that all necessary surge suppression devices are installed in the MCC and generator and ATS equipment and all EMI mitigation measures implemented to protect the PLC and associated control and communications system.

The I/O modules shall be mounted on an I/O chassis and be provided complete with interface modules to connect all field side wiring to the I/O’s.

I/O frames shall be provided for the full complement of I/O’s required plus 20% spares of each type of digital and analog I/O’s specified herein or indicated on the Contract Drawings. Facilities for the addition in the field of further boards up to the full capacity of the PLC shall be provided. The provided system shall be such that each I/O card module type is unique so that a card cannot be inadvertently installed in a slot programmed and wired for a different type of unit. All I/O cards shall be replicable without removal of any panel wiring and shall provide at least one common for every two inputs or outputs.

The furnished I/O modules shall satisfy all analog and digital I/O requirements of the herein and Contract Document control system including but not limited to:

a) Digital Input Modules: 16 inputs (8 points per group), 120 volt AC, operating voltage range 74 to 132 volts.

b) Digital Output Modules: 8 diagnostic, electronically fused outputs (4 points per group), 120 volt AC, operating voltage range 74 to 132 volts.

b) Contact Output Modules: 8 normally open, 8 normally closed, individually isolated outputs, (2 points per group) operating voltage range 10 to 265 volts.

d) Analog Input Modules: 6 individually isolated inputs with operating ranges of ±10.25 volts, 0 to 10.5 volts, 0 to 5.25 volts and 0 to 21 mA and 16 bits resolution of; 343µ volts/bit, 171µvolts/bit, 86µvolts/bit and 0.34µvolts/bit respectively.

e) Analog Output Modules: 6 individually isolated current outputs with operating range of 0 to 21 mA and 13 bits resolution across 21mA (2.7µA)
f) Analog Output Modules: 6 individually isolated current outputs with operating range of ±10.5 volts and 14 bits resolution across 21 volts (1.3m volts) (13 bits across 10.5 volts + sign bit)

g) Resolver Input Module: Shall be capable of accepting the input from the defined and/or Engineer approved resolver for moving span position indication and graphic representation.

The PLC control system shall consist of a distributed system with communications network provided between the MCC located units and the operators bridge control console. The communications transmission system shall be compatible with the furnished PLC system and be as specified herein.

The communications networking for the control system shall be as indicated on the Contract Drawings as herein defined.

Human Machine Interfaces (HMI’s) shall be furnished in the MCC and the operator’s bridge control console. The HMI terminals shall consist of a flat-panel colour display with keyboard/touch screen input and antiglare overlay. The HMI’s shall be supplied complete with memory, logic module, a DIN-rail mounted AC-to-DC power supply and communications modules that are compatible with the proposed PLC control system.

The HMI logic module shall be provided with Ethernet and RS-232 built-in communication ports and two USB ports for mouse and keyboard support. The HMI shall be provided with a flash card slot (256 MB) for the transferring of files, logging data and ability to update and upgrade system software and 256 MB SODIMM RAM, AC input and ViewPoint compatible.

The HMI’s shall be of Rockwell Automation manufacture, their PanelView Plus CE Catalogue No. 2711P-B15C4A7 or Engineer approved equal. The HMI shall be furnished complete with FactoryTalk View Studio software with FactoryTalk ViewPoint add-on software to enable real time bridge operation to be viewed remotely from a web browser. The units shall be provided with 10 PanelView Plus firmware licenses.

The bridge control system shall include all interface and interlock equipment and wiring for a complete control system in accordance with the requirements of AASHTO Standard Specifications for Movable Highway Bridges regardless of whether or not specifically indicated or specified herein or on the Contract Drawings.

The PLC and associated equipment shall be provided by the PLC manufacturer for installation by the Motor Control Centre’s vendor and operator’s bridge control console fabricator. This installation shall include all internal wiring between the PLC and devices being controlled, monitored and interlocked by the PLC. The PLC shall be capable of communicating with the Motor Control Centre furnished IntelliCenter (IC) and receiving and transmitting data to the IC as defined herein.

The PLC shall be provided with a hand held key pad for insertion into the PLC equipment mounted in the operator’s control console and MCC. The key pad shall be capable of being used to by-pass interlocks, simulate operating functions, and isolate areas of the logic for maintenance, testing and troubleshooting. The key pad shall also be capable of being used to interrogate any of the field devices connected to the PLC bridge control system to determine their status.

The PLC system shall be provided with a means of connecting the furnished laptop/desktop PC as herein specified into either the PLC equipment mounted in the operator’s bridge control console or the Motor Control Centre. The PC shall be capable of being used to by-pass
interlocks, simulate operating functions and isolate areas of the logic for maintenance and testing. The PC shall also be capable of being used to interrogate any of the field devices to determine their status.

All necessary software shall be furnished by a software specialist in accordance with the requirements of this specification and as approved by the Engineer. The specialist shall have at least ten (10) years documented control systems and systems integration experience on similar movable bridge projects including at least one bascule bridge drive control similar to that proposed herein. The Contractor shall submit documentation of his experience in the field as described above and the qualifications and experience of his proposed software specialist’s with this Bid.

The Contractor shall submit shop drawings consisting of a complete list of equipment and materials being proposed, manufacturer’s descriptive and technical literature, ladder logic diagrams with function and assigned designation descriptions of the developed software, I/O schedule, catalogue cuts and installation instructions for Engineer approval.

The PLC shall be of Allan Bradley manufacture, their Controllogix 1756 or Engineer approved equal.

**Laptop/Desktop Computer**

One (1) laptop computer and one (1) desktop computer (PC’s) shall be furnished as part of the bridge control system. The PC’s shall be configured to be compatible with the specified bridge PLC control system and be suitable for programming the PLC installation. The PC shall be capable of being portable and weigh less than 3 kg.

The laptop PC at a minimum shall contain the following:

a) Intel Core i7-640M Dual Core 2.8GHz, 4MB processor.

b) Windows 7 Professional, 32-Bit operating system or latest compatible operating system at the time of procurement.

c) Microsoft Office Professional 2010 with Adobe Acrobat or latest compatible software versions at the time of procurement.

d) A comprehensive security software package similar to McAfee SecurityCenter with antivirus, anti-spyware, firewall and be their latest version at the time of procurement with a 36 month license.

e) 381 mm wide screen WUXGA RGBLED LED with integrated camera and microphone.

f) A 1.0GB, NVIDIA Quadro FX 3800M graphics card.

g) A 4.0GB, DDR3-1333MHz SDRAM, 2DIMMS RAM memory (Upgradeable to 8GB).

h) A 500GB, 7200rpm, primary hard drive with FFS.

i) Primary and secondary hard drives RAID configured.

j) An 8X DVD +/-RW tray load w/Roxio and Cyberlink Power DVD optical device.

k) A twelve (12) cell battery.

l) A Logitech V470 cordless laser mouse.

m) A Logitech cordless MX 5500 Revolution keyboard.
n) Wireless LAN (802.11) capable with Intel Centrino Advanced-N + WiMAX 6250 802.11a/b/g/n and 802.16e half mini card.

o) An E-Port, port replicator docking station.

The Desktop PC at a minimum shall contain the following:

a) Intel Core i7-640M Dual Core 2.8GHz, 4MB processor.

b) Windows 7 Professional, 32-Bit operating system or latest compatible operating system at the time of procurement.

c) Microsoft Office Professional 2010 with Adobe Acrobat or latest compatible software versions at the time of procurement.

d) A comprehensive security software package similar to McAfee SecurityCenter with anti-virus, anti-spyware, firewall and be their latest version at the time of procurement with a 36 month license.

e) 610 mm wide screen WUXGA RGBLED LED.

f) A 1.0GB, NVIDIA Quadro FX 3800M graphics card.

g) An 8.0GB, DDR3-1333MHz SDRAM, 2DIMMS RAM memory (Upgradeable to 16GB).

h) A 1TB, 7200rpm, primary hard drive with FFS.

i) A 1TB, 7200rpm, secondary hard drive with FFS

j) Primary and secondary hard drives RAID configured.

k) An 8X DVD +/-RW tray load w/Roxio and Cyberlink Power DVD optical device.

l) A Logitech V470 cordless laser mouse.

m) A Logitech cordless MX 5500 Revolution keyboard.

n) Wireless LAN (802.11) capable with Intel Centrino Advanced-N + WiMAX 6250 802.11a/b/g/n and 802.16e half mini card.

For transportation and protection the laptop shall be contained in a nylon carrying case.

The unit shall be an intelligent terminal, functioning as both a programming and a data terminal. It shall be configured for PLC, MCC, inclinometer, CCTV, intercom and fire alarm system programming, including loading, editing, and monitoring ladder diagram programs in memory by entering through the keyboard and monitoring on the display. Program instructions shall be in the form of standard symbols similar to those used for electromagnetic control schematic diagrams. Power for the operation of the laptop shall be from the internal rechargeable battery pack and an AC adaptor shall be furnished for charging. The PC shall be furnished complete with a “starter kit” which shall include surge protectors, DVD disc and disc storage box, tool kit, etc. All software including that provided with the PLC system and all other software packages required for programming, viewing and interfacing and any other software tools required for the control system, communications systems, standby generator controls and the AC drive controllers shall all be pre-installed in the PC. All CD-ROM project and As-Built drawings, O&M manuals and other materials shall be downloaded by the Contractor for permanent storage in the PC. The Contractor shall provide all licenses and original CD-ROMS with the PC for all software installed.
The PC shall be furnished complete with a Standard 10/100 network switch to meet the required PLC, CCTV, fire alarm and intercom switching as described on the Contract Drawings.

The Contractor shall submit outline-dimensioned drawings; of his proposed PC, mounting details and specification in the form of catalogue cuts and data sheets of proposed PC included software and interface firmware to the Engineer for approval prior to procurement.

**Communications Backbone System**

The bridge control system shall be provided complete with a fibre optic and wireless communications transmission system.

The communications backbone system shall be compatible with the specified PLC system and provided with all interfacing and power supply modules to create a fully integrated data transmission system as described herein and on the Contract Drawings.

The communications backbone system shall be configured as a loop system connecting the MCC, VFD’s, operator’s control consoles and standby generator control panel’s as indicated on the Contract Drawings. The proposed system shall be provided with self healing capabilities in the event of loop failure and be immune from any electrical transient conditions.

The fibre cable furnished with the transmission backbone system shall be compatible with respect to the system speed and bandwidth for the specified application and be Corning Cable Systems “FREEDM LST” cable OFNR rated, be UV resistant, fully water blocked indoor and outdoor cable or Engineer approved equal. This “DRY” cable with water blocking technology shall eliminate the need for flooding compound and provide a more efficient cable construction. The cable shall be 50µm and be of the hybrid type.

No splices shall be used for the communications backbone system and all fibre runs shall be continuous between connecting equipment.

The Contractor shall submit his proposed communications backbone system including all interfacing sub-systems, description and schedule of communications protocol interfaces and proposed cables and configuration to the Engineer for approval.

**Uninterruptible Power Supply (UPS)**

Uninterruptible power supplies (UPS) shall be furnished in the operator’s house inside the operator’s control console, in the MCC and in the standby generator enclosure. The UPS’s shall provide power for the following essential loads as indicated on the Contract Drawings.

The UPS’s shall be rated at 1,500 VA with an output voltage of 120 volts, 60Hz.

The UPS shall be of the solid state microprocessor controlled and suitable for operating from either the utility electric service or the standby generator and provide high quality power conditioning, back-up power protection and distribution for the defined essential loads.

The system shall consist of a solid state inverter, power factor corrected rectifier, a 100% rated for continuous duty static switch, an internal maintenance by-pass switch, battery plant, a graphical status and control panel and synchronizing circuitry as described herein.

The UPS units shall meet the requirements of the following codes and standards:

a) UL listed under 1778, Standards for Uninterruptible Power Supply Equipment
b) UL Canada (cUL)

c) FCC Rules and Regulations of Part 15, Subpart j., Class A

d) IEC 1000 (801) Level 4

e) The UPS shall be designed in accordance with the applicable sections of the documents published by:
   i) National Fire Protection Association (NFPA)/Canadian Electric Code (CSA)
   ii) National Electrical Manufacturer’s Association (NEMA)
   iii) Canadian Occupational Health and Safety (CANOSH)

Each UPS shall be suitable for operation under the following environmental conditions:

a) Temperature:
   i) UPS Operating: 0 – 40 Degree C
   ii) UPS Non-Operating: -20 – 45 Degree C

b) Relative Humidity: 0 – 95% non-condensing

c) Audible Noise: 67dBA at 1,000 mm from the UPS

Each UPS battery bank shall be capable of operating at full load for 10 minutes at 0.8 power factor output at a temperature of 25 Degree C on battery power.

The UPS batteries shall be of the valve regulated sealed lead acid (VRLA) type as approved by the Engineer.

The UPS input characteristics shall meet the following criteria:

a) Voltage: 120 volts

b) Frequency: 60 Hz (+8%/−25%)

c) Power Factor: Less than 0.99 lagging

d) Total Harmonic Distortion: Less than 3% at full load

e) Power Walk-in: 0 to 100% over a 10 Second period

f) Input Surge Protection: Equipped with MOV’s to withstand surges per IEEE 587-1990/ANSI C62.41

The UPS output characteristics and capabilities to meet the following:

a) Voltage: 120 volts

b) 60Hz ±1%

c) Voltage Regulation: ±1.0%

d) Voltage Distortion: Maximum of 2% total (THD) and 1% any single harmonic frequency on 100% linear loads

e) Voltage Transient (Step Load) Response:
   i) +3% for 50% step load change
   ii) ±5% for 100% step load change
   iii) ±1.0% for loss or return of AC input power or manual transfer at full load
f) Voltage Recovery Time: Return to within 1.0% of nominal value within 16.67 milliseconds (one cycle)
g) Phase Angle Displacement: 120 Degrees ±1.0 Degrees
h) Non-Linear Load Capability: Output voltage total harmonic distortion shall be less than 3% when connected to a 100% non-linear load with a crest factor not exceeding 3%
i) Slew Rate: 1.0 Hz/Second maximum
j) Power Factor: 0.8 at rated volt-amperes (VA)
k) Inverter Overload Capacity:
   i) 120% of rated load for 1.0 minute
   ii) 145% of rated load for 30 seconds
l) By-Pass Overload Capability: Less than 212% for one cycle and less than 150% for 30 seconds

Battery characteristics:

a) Battery Voltage: 198 volts DC minimum before cut-off; 277 volts DC maximum maintenance charge voltage; 300 volt DC equalization voltage

The UPS shall be configured to operate as a multi-mode device:

a) Normal: Inverter continuously supplies power to critical load
b) Emergency: Upon normal failure, inverter takes over utility critical load
c) Recharge: Upon restoration of normal source the batteries shall be automatically charged
d) By-Pass: Static by-pass transfer switch used to transfer the load to bypass without interruption of power to critical loads
e) Maintenance Bypass/Test: A manual make and break function for maintenance and testing without affecting the operation of the UPS

The UPS shall be of APC manufacture or Engineer approved equal.

The Contractor shall submit outline-dimensioned drawings of his proposed UPS, mounting details, and specification in the form of catalogue cuts and data sheets of proposed UPS to the Engineer for approval prior to procurement.

**CCTV System Equipment**

A CCTV system shall be installed at the bridge to provide the operator with greater and more complete vision of the approaching roadways and waterway, enhance security and as an aid for him in the operation of the traffic control system.

The CCTV cameras shall consist of strategically located and installed as indicated on the Contract Drawings

CCTV cameras shall be mounted as indicated on the Contract Drawings and where indicated, provided with the described and specified aluminium poles.

Pendent dome type PTZ internet protocol (IP) network CCTV cameras shall be provided as indicated on the Contract Drawings.
The cameras shall be weatherproof with IP-66-class protection enclosure and suitable for low temperature operation (-20°C)

The protective dome shall be constructed of optically clear polycarbonate and be vandal-resistant with built-in heater and fan.

Each camera shall be provided with an automatically removable infrared cut filter, which enables colour video in high and low light conditions as well as IR sensitive black/white video at night.

The cameras shall be of AXIS Communications manufacture, their type 225FD complete with the necessary mounting brackets, supports and means of cabling termination, smoked dome glass, AXIS PS-24 outdoor power supplies, AXIS 292 Network Video decoder and AXIS MPEG-4 decoder 10-user license pack or Engineer approved equal.

Standard 10/100 network switches shall be provided to satisfy the CCTV system configuration as indicated on the Contract Drawings.

The CCTV system shall be provided complete with CCTV video management software. The software shall manage video for live monitoring and recording. The management software shall provide the following functionality:

a) Simultaneous viewing and recording of live video from multiple cameras
b) Video motion detection and alarm
c) Alarm management functions
d) Frame rate control
e) Camera management and access control

The CCTV system shall be provided with a high definition colour monitor and controls mounted on the operator’s traffic control console. The monitor shall be sized and configured as indicated on the Contract Drawings.

The Contractor shall submit outline-dimensioned drawings of his proposed CCTV system, mounting details, block, schematic and wiring diagrams of the CCTV system, monitor and PC interface and specification in the form of catalogue cuts and data sheets of proposed system to the Engineer for approval prior to procurement.

Fire/Smoke Detection and Alarm System

The bridge shall be provided with a fire/smoke detection and alarm system. The system shall monitor the status of the machinery space, operators control house, electrical room and the standby generator.

The system shall consist of sensors located in each of the described areas as indicated on the Contract Drawings.

The installed sensors shall be of the multi-criteria detectors that shall be capable of detecting all four (4) major elements of a fire (smoke, heat, CO and flame). The sensors shall be of Notifier manufacturer, their FSC-852 “Inelliquad” advanced multi-criteria detector with automatic drift compensation of smoke sensor and CO cell or Engineer approved equal. The sensor shall have high nuisance alarm initiation immunity and contain six (6) sensitivity levels.

The intelligent fire alarm control panel shall be located in the operator’s house as indicated on the Contract Drawings. The control panel shall be of modular configuration for the devices and
locations indicated on the Contract Drawings. The unit shall be ULC-S527-99 Listed and provided with one isolated intelligent digital communications loop. The display shall consist of an 80 character display and provided complete with Notifier standard network for a system sized as described on the Contract Drawings plus 50% spare capacity. The unit shall be furnished with a built-in alarm, trouble, security, and supervisory relays and provided complete with VeriFire offline programming utility. The fire alarm control panel shall be of Notifier manufacture, their type NFS-320C or Engineer approved equal.

Remote display units shall be located in the electrical room and standby generator enclosure as indicated on the Contract Drawings. The remote display units shall be of the compact 80-character backlit LCD annunciator type and be of Notifier manufacture, their FDU-80 or Engineer approved equal. The display unit shall be capable of mimicking the display of the master control panel and display the complete status of all system points. The remote display unit shall be provided complete with system acknowledge, signal silence drill and reset with enable key.

The Contractor shall submit outline-dimensioned drawings, of his proposed fire/smoke detection and alarm system, mounting and installation details, block, wiring and schematic diagrams, and specification in the form of catalogue cuts and data sheets of proposed fire alarm to the Engineer for approval prior to procurement.

**Bridge Intercom System**

An intercom system shall be furnished and installed at the bridge. The intercom system shall provide a communications link between the operators control house, the machinery space, electrical room, standby generator enclosure and other locations as indicated on the Contract Drawings.

The intercom system shall be a programmable digital and IP-based system. The intercom system shall provide direct and instant two-way communication over a configured TCP/IP network. The technology shall provide voice-quality audio with minimum bandwidth utilization.

The system shall provide the following intercom and paging functionality:

a) Push-to-talk (PTT) access for fast, ease voice connections
b) Remote listening and multi-operator capability
c) Network shall be capable of supporting both PoE and dual RJ45 connections
d) Shared network infrastructure, including session initiation protocol (SIM) connectivity

The intercom system shall be controlled from the operators house PC and be provided with sophisticated user and applications software. The software enables control and monitoring of talk-to-listen, paging and be capable of managing all system intercoms from the operators house PC. The intercom software shall be capable of performing the following functions:

a) Enable selective or master call to page all stations
b) Provide master control and auto detection (integrated UDP polling)
c) Record, log and archive audio sessions
d) Provide audio file playback (.WAV)
e) Provide both local and remote digital volume control
The intercom system shall be of Digital Acoustics manufacture their IP7 intercom and paging system or Engineer approved equal. The system shall utilize dedicated fibres for the main network, # 22 awg shielded 3 and 4- conductor cable and # 18 awg 3 and 4 conductor cables and be configured as indicated on the Contract Drawings.

The system shall consist but not be limited to the following key components:

a) Digital Acoustics TalkMaster-LE software. For installation in the Bridge PC.

b) Standard 10/100 network switch to be proposed by the Contractor based on Digital Acoustics recommendations with PoE capability and be submitted to the Engineer for approval. Furnished for installation as indicated on the Contract Drawings.

c) Digital Acoustics IP 7 – ii3 EDW with PoE; desktop mounted endpoint in a black enclosure with integrated speaker and microphone, PoE and dc powered. Furnished for installation as indicated on the Contract Drawings.

d) Digital Acoustics IP 7 – ST; IP intercom endpoint for DIN Rail mount and provided complete with relay/sensor, PoE/110 volt power. Furnished for installation as indicated on the Contract Drawings.

e) Digital Acoustics IP 7 – PNL-1E intercom panel that incorporates a high quality microphone and is housed in a stainless steel 2 gang moisture resistant enclosure.

f) Digital Acoustics IP 7 – STx; IP intercom endpoint for DIN rail mount and provided complete with 2-port switch, PoE/110 volt power. Furnished for installation as indicated on the Contract Drawings.

g) Digital Acoustics PNL – CIS4; 2-gang weatherproof/vandal resistant surface mount call panel furnished for installation as indicated on the Contract Drawings.

h) Digital Acoustics IP - SS20; IP high power, 20watt IP amplifier for DIN rail mount and provided 24 volt DC volt power to feed the pier mounted paging station and audio signalling device. Furnished for installation as indicated on the Contract Drawings. Digital Acoustics SPKR – 6H16 – T; weather and vandal resistant loudspeaker. Speaker shall be compatible with the IP – SS20 and shall be furnished for installation as indicated on the Contract Drawings.

i) Digital Acoustics ACC PS MDR – 60 – 24; 60watt, 24 volt DC, DIN rail mounted power supply and shall be furnished for installation as indicated on the Contract Drawings.

j) The Contractor shall furnish mechanical surface mounted door switches on the tower machinery hatches as indicated on the Contract Drawings. The switches shall be UL Listed and rated at 3.0Amps inductive, 120 volt, 60Hz and be of a rugged industrial type.

k) The Contractor shall submit outline drawings system block diagram, schematic of proposed intercom system, wiring diagrams, electrical data sheets of all intercom system components and network switch to the Engineer for approval prior to procurement and fabrication by the intercom vendor.

**Disconnect Switches**

Un-fused safety switches, for use as disconnects, shall be installed in-sight of each motor, brake and actuator as indicated on the Contract Drawings.
The switch shall be non-fusible, heavy-duty, safety switch in a NEMA 4X, stainless steel enclosure. Each disconnect shall be furnished with two N.O auxiliary contacts and phenolic or Engineer approved equal nameplate to identify the corresponding device.

The Contractor shall submit outline-dimensioned drawings, of his proposed disconnect switch, mounting details, and specification in the form of catalogue cuts and data sheets of proposed disconnect switch to the Engineer for approval prior to procurement.

**Cable Reel**

A cable reel shall be furnished and installed between the moving span and the bridge fixed Structure as indicated on the Contract Drawings. The cable reel shall electrically connect the bridge drive system, span navigation lights, obstruction indication lights and the inclinometer connections between the moving span and the fixed structure as indicated on the Contract Drawings.

The cable reel shall be of the extra heavy mill duty type for the most rugged performance in the prevailing harsh environment. The cable pull off shall be based on the maximum travel of the moving span from its fully closed position to its fully open position as indicated on the Contract Drawings plus 20 percent over travel.

The cable reel shall consist of multi conductor (20) # 10 AWG type SO cable rated at 600 volts complete with junction box and wiring for ease of termination.

The cable reel shall be of NEMA 4 construction with easily removable. The slip ring enclosure shall permit ease of access to slip rings for quick slip ring inspection, testing or. O-Ring seals shall be provided on the slip ring assembly for water tight and dust tight seal in addition to maintaining the slip ring NEMA 4 environmental rating.

The cable reel junction box shall be fully gasketted and oversized for ease of wiring, testing and maintenance.

The cable reel shall be provided complete with cable protecting hoop guides for effective two way payout and a method of safely changing motor springs without the danger of personnel handling loose and charged springs.

In addition a cable guide of steel roller construction shall be clamped to the hoop guide to correctly align and payout the cable. This cable guide assembly shall be adjustable over the entire circumference of the hoop.

The cable reel shall be provided with parallel spring design to assure that the cable reel will continue to function in the event of a spring failure. In addition the cable reel shall be provided with a spring failure indicator.

The cable reel shall be provided with a dog-and-ratchet mechanism for window shade action and a positive spool lock and freewheeling spring hub and a rotary cam limit switch.

The slip-ring/collector assembly shall be designed for ease of repair and replacement. The assembly shall be provided with a convenient means of disconnecting leads for replacement that consists of two set screws that when loosened allows the slip ring to slide off the shaft. The slip-rings shall be rated as indicated on the Contract Drawings at a voltage of 600 volts, 60Hz.

The Contractor shall provide all necessary stainless steel anchor bolts and hardware for mounting the cable reel to the north pier of the bridge as indicated on the Contract Drawings. The Contractor shall also furnish and install a cable reel junction box on the moving span as
indicated on the Contract Drawings. The cable reel control cable shall be terminated in this junction box and be provided with appropriately sized cable strain relieving grips with stainless steel hardware as herein specified.

The Contractor shall submit outline-dimensioned drawings; of his proposed cable reel unit, mounting details and specification in the form of catalogue cuts and data sheets of proposed reel to the Engineer for approval prior to procurement.

**Dry Type Transformers**

Free standing dry type transformers shall be furnished and installed as described on the Contract Drawings.

The transformers shall be rated at as indicated on the Contract Drawings and be UL Listed, CSA Certified, and low temperature with a maximum temperature rise of 80 Degrees C, with copper windings and busses and terminations.

The dry type transformers shall be encapsulated with positively grounded cores and ground and neutral bars.

The enclosures shall be constructed of heavy-gauge sheet steel and finished using a continuous process of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of a thermosetting polyester powder coating and subsequent baking. The coating colour shall be ANSI 61 and be UL recognized for outdoor use and shall conform to NEMA ST-20.

The transformer windings shall have separate primary and secondary windings. Windings shall be copper and shall have Class H rated insulation for continuous operation at rated kVA with temperature rise of not over 80 Degrees C above a 40 Degree C ambient, with a maximum hot spot temperature of 150 Degrees C. Windings and core and coil assembly shall be treated and built to resist the effects of dirt and moisture.

The transformer construction shall be such that the core and coil shall be mounted on rubber insulation mounting pads.

The transformer shall be provided with full capacity taps. The taps shall be a minimum of two (2) 2-1/2 percent above and two (2) 2-1/2 percent below nominal rated primary voltage.

Noise levels and vibration emitted from the transformer shall be limited to those defined in NEMA ST-20 and IEEE C57.12.01

The Contractor shall submit outline-dimensioned drawings, of his proposed dry type transformer, mounting details, diagrams of connections and certified test reports and specification in the form of catalogue cuts and data sheets of proposed transformer to the Engineer for approval prior to procurement.

**Panelboard**

Wall mounted panelboards shall be furnished and installed as indicated on the Contract Drawings.

The panelboards shall be 120-208 volt, three phase, and 4-wire and be UL Listed, CSA Certified with copper and busses and terminations.

The enclosures shall be constructed of heavy-gauge sheet steel and finished using a continuous process of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of a thermosetting polyester powder coating and subsequent baking. The coating colour shall be ANSI 61 and be UL recognized in accordance with NEMA PB 1; Type 1.
The panelboard front shall be furnished with a screw cover, and hinged door with a flush lock. The panelboard shall have an integrated short circuit rating of 25,000 amperes RMS symmetrical for 208/120 volt.

The panelboards shall be provided with moulded case circuit breakers in accordance with NEMA AB 1. The moulded case circuit breakers shall be furnished and installed with integral thermal and instantaneous magnetic trip in each pole. All circuit breakers shall be of the bolt on type and sized in accordance with that indicated on the Contract Drawings.

The Contractor shall submit outline-dimensioned drawings, of his proposed panelboards, mounting details, schedules of the proposed panelboard circuits and specification in the form of catalogue cuts and data sheets of proposed panelboards to the Engineer for approval prior to procurement.

Air Horn

Furnish one heavy-duty, self-contained dual air horn unit and install on the outside of the operators house as described on the Contract Drawings and as herein specified. The horns shall be oppositely directed and parallel to the channel axis when the span is closed. A welded structural steel mounting bracket, hot-dipped galvanized after fabrication, shall be furnished and installed and the horn unit mounted thereon.

Each horn shall have a free-floating phosphor bronze diaphragm vibrating at approximately 300 Hz when excited by air pressure; the horn shall be rated 120 dB at 3,050 mm for operation on 120 volt and 60 Hz. The mechanism shall be connected to a trumpet-shaped resonant projector of spun brass.

Air shall be applied to each horn by a separate oscillating diaphragm compressor mounted on each end of an integral motor. The motor shall be ¾ HP, 120 volt single-phase and 60 Hz, totally enclosed, non-ventilated suitable for mounting inside the operator’s house and housed in a general purpose NEMA 1 enclosure together with required compressor control and protection devices.

Projectors shall be weatherproof, stainless steel and approximately 405 mm in length.

Interior and exterior mounting plates and fastenings for mounting of the duplex horn and compressors shall be provided as part of this item, with all piping connections and fittings required to interconnect the compressors and horn mechanisms to be 9.5 mm brass pipe.

The Contractor shall submit outline-dimensioned drawings, of his proposed air horn unit, mounting details, and specification in the form of catalogue cuts and data sheets of proposed air horn to the Engineer for approval prior to procurement.

Proposed unit shall be manufactured by B&B Roadway their type AHR-2 or Engineer approved equal.

Ship to Shore Marine Radio

A marine radio of the radiotelephone type shall be furnished and installed in the operators control house. The radiotelephone shall be limited to marine communications use. The radiotelephone shall be designed to transmit on channels provided by the Canadian Coast Guard. It shall have a normal power output of 1.0-watt and a maximum of 10.0-watts. The radiotelephone shall be furnished complete with all appetencies required for proper operation, including power supply, microphone, outdoor antenna, interconnecting cables, support and
installation brackets and connectors, adapters and other equipment necessary to install the radiotelephone as intended.

The Contractor shall submit outline-dimensioned drawings, of his proposed radiotelephone unit, mounting details, and specification in the form of catalogue cuts and data sheets of proposed radio and antenna system to the Engineer for approval prior to procurement.

Hoist

A hoist with a wire rope hoist and monorail system shall be furnished and installed for removing and replacing mechanical machinery in the machinery space and electrical room. The hoist shall be capable of picking the equipment from roadway level for installation in the machinery space, a vertical pick of ± 15 m.

The hoist shall be of Saturn manufacture and be of their single hook, monorail type and furnished complete with the following characteristics:

a) The hoist shall have a capacity of 2,722 kg
b) The rated speed of the lift shall be 9.0 meters/min but be provided with a self contained controller to provide variable speed control
c) The hoist shall have a total lift of 15 meters
d) The reeving type employed for the proposed hoist shall be 2PS
e) The cable diameter for the proposed hoist shall be at least 11.1 mm
f) The hoist motor shall be of the TEFC induction motor rated at 10 HP and a synchronous speed of 1,200 RPM and be suitable for operation from a 575 volt, three (3) phase, and 60 Hz service.
g) The hoist shall be provided with a Stearns type brake capable of holding a load of at least 150% of the rated capacity of the hoist. The brake shall be of the solenoid type.
h) The hoist shall be provided with a hoist mounted control enclosure that contains host motor starter and speed control. The motor control equipment shall be rated in accordance with the rating of the hoist motor and in accordance with the requirements of CSA. The hoist mounted control enclosure shall be constructed of sheet steel with the same finish as the hoist system and be NEMA 12 rated.
i) Hoist status and end of travel control shall be provided by an appropriately sized rotary cam limit switch that shall be gear driven off the hoist drive machinery. The rotary cam limit switch shall be housed in a NEMA 12 enclosure with the same finish as the hoist system.
j) The hoist shall be provided with a weatherproof pendent controller. The pendent controller shall be capable of starting, stopping and changing the speed and changing direction of the hoist. The pendent control enclosure and all enclosure mounted controls shall be weatherproof and be NEMA 4 rated.

The Contractor shall submit outline-dimensioned drawings, of his proposed hoist system, mounting details, wiring and schematic diagrams, and specification in the form of catalogue cuts and data sheets of proposed hoist to the Engineer for approval prior to procurement.

Spare Parts
The Contractor shall at a minimum furnish the following spare parts as part of the bridge electrical power and control work at no additional cost to Transportation and Works:

a) A complete set of manufacturer recommended spare parts for the Motor Control Centre’s and individual combination starters to include at least the following:

   i) Six (6) fuses of each size and type used.
   ii) Two (2) complete sets of stationary and moving contacts for each size of each contactor used.
   iii) Two (2) coils for each size of each contactor used.
   iv) One (1) indicating light unit for each type and colour used.
   v) Two (2) indicating light coloured caps for each type and colour used.
   vi) Twelve (12) indicating light unit lamps for each type used.
   vii) One (1) circuit breaker for each size and type used.
   viii) One (1) complete overload relay for each size and type used.
   ix) Two (2) pushbutton contact blocks for each size and type used.
   x) Two (2)-selector switch contact blocks for each size and type used.
   xi) Two (2)-control relays of each size and type used.

   All motor control centre’s spare parts and a copy of the O&M manual shall be mounted in the designated in each of the Motor Control Centre’s cubicle for spare parts.

b) A complete set of manufacturer recommended spare parts for the operators control console, to included at least the following:

   i) Six (6) fuses of each size and type used in the Operators Control Console.
   ii) One (1) indicating light unit for each type used in the Operators Control Console.
   iii) Two (2) indicating light coloured caps for each type and colour used in the Operators Control Console.
   iv) Twelve (12) indicating light lamps for each type used in the Operators Control Console.
   v) Two (2) pushbutton contact blocks for each size and type used in the Operators Control Console.
   vi) Two (2) selector switch contact blocks for each size and type used in the Operators Control Console.
   vii) Two (2) control relays of each size and type used in the Operators Control Console.

   All Operator Control Console spare parts and a copy of the O&M manual shall be mounted in the operators control console.

c) A complete set of manufacturers recommended spare parts for the bridge PLC control system to include at least the following:

   i) Two (2) CPU modules of each type used
   ii) One (1) processor module
   iii) One (1) Scanner module
iv) One (1) I/O module of each type used
v) Two (2) Power supply modules
vi) One interface module of each type used
vii) Six (6) fuses of each type used

All PLC spare parts and a copy of the O&M manual shall be mounted in a separate wooden enclosure designated spare parts.

d) A complete set of manufacturer recommended spare parts for the variable frequency drive controller to include at least the following:
   i) A complete variable frequency drive unit
   ii) One (1) EMI/RFI filter
   iii) Six (6) fuses of each type used
   iv) One (1) indicating light unit lamps for each type used
   v) Twelve (12) indicating light unit lamps for each type used
   vi) One (1) complete overload relay
   vii) Two (2) pushbutton contact blocks for each size and type used.
   viii) Two (2) selector switch contact blocks for each size and type used.
   ix) Two (2) control relays of each size and type used
   x) One (1) control transformer

All variable frequency drive controller spare parts and a copy of the O&M manual shall be mounted in a separate wooden enclosure designated spare parts.

e) A complete set of manufacturer spare parts for each rotary cam limit switches to include at least the following:
   i) Two (2) cams with shaft mounting hardware.
   ii) Two (2) limit switches of each type used.
   iii) One (1) encoder

All rotary cam limit switch spare parts shall be mounted inside the rotary cam limit switch enclosure.

f) A complete set of manufacturer recommended spare parts for the traffic warning gates furnished under this contract. To include at least the following:
   i) Six (6) control fuses of each type used.
   ii) Two (2) limit switch contact block of each type used.
   iii) One (1) flasher unit.
   iv) Two (2) lamps of each type used.
   v) One (1) heater thermostat.

The traffic warning gate spare parts shall be mounted in separate wooden enclosure designated spare parts.
g) A complete set of manufacturer recommended spare parts for the standby generators furnished under this contract. The spare parts shall be those recommended by the manufacturer and be based on the generator’s running at half full load for 60 hour per year.

Warranty

The Manufacturers and vendors shall warrant all products they supply including hardware, firmware and software to be free of defects in material and workmanship for a period on five (5) years from the date of final acceptance of the completed bridge electrical rehabilitation contract. Final acceptance shall be in accordance with the definitions and requirements of this specification. Any defects within this five (5) year shall be repaired or replaced by the supplying manufacturer or vendor, at total cost to them, including labour, parts and transportation. The Contractor shall provide letters to the manufacturers and vendors with copies to the Engineer, identifying the scheduled date of final acceptance of the bridge electrical systems and therefore the date the warranty shall begin. If the date of final acceptance of the bridge electrical systems gets extended, it shall be the Contractor’s responsibility to extend the commencement of the warranties from the manufacturers and vendors at no additional cost to Transportation and Works.

Transportation and Works reserves the right to receive, on demand a test report from an independent laboratory certifying that the equipment furnished meets the specification, at no cost to Transportation and Works.

Transportation and Works reserves the right to reject an entire shipment of material covered by this specification if an item or items are found to be defective within a 30-day period following receipt of materials.

ELECTRICAL CONSTRUCTION AND INSTALLATION

The Contractor shall construct and install the herein electrical power and control systems in accordance with the standards and codes described in the General section of the specification and in accordance with the requirements of CSA C22.1 and adhere to the health and safety criteria as described in CANOSH.

No electrical installation work shall be undertaken until all shop and working drawings have been approved by the Engineer and all material have been delivered to the site for the described work to be undertaken. All material utilized for the electrical power and control systems shall be in strict accordance with the herein specified materials and methods and quality of installation shall conform to the requirements of CAS C22.1 and as specified herein.

All electrical installation work shall be installed as indicated on the Contract Drawings or as amended by the Engineer approved working and shop drawings for the electrical work.

All associated construction and installation work such as the installation of the specified motor control centre, operator’s control console, motors, lock actuators, brakes, encoders, rotary cam limit switches, bridge status limit switches, navigation and obstruction lighting, general and floodlighting, cable reel, traffic gates and lights, and all control, alarm and indication status sub systems shall be installed using good installation judgement and in accordance with all prevailing national and local coded and ordinances and in complete conformance with manufacturers recommendations.

The Contractor shall prepare a set of “red” line working drawings as the work progresses to indicate all changes made to the approved working and shop drawings during the installation process. These “red” line drawings shall be submitted to the Engineer following installation and form the basis for the development of “As Built” electrical power and control drawings for the bridge.

GROUNDING
The electrical installation for the bridge shall include grounding and bonding of the bridge electrical systems and the bonding of the bridge mechanical the steel and metallic structures.

The installation shall conform to all federal, provincial and local codes, ordinances and laws having jurisdiction over the project.

The grounding system shall meet or exceed the requirements of the relevant sections of CSA C22.1 and the requirements of BC Hydro.

The Contractor shall submit product data of all items of material proposed and specified herein for the specified grounding and bonding system to the Engineer for approval.

The grounding material shall consist but not be limited to the following items:

a) Ground rods for each of the two (2) bridge tower piers and shall be a minimum of 19 mm in diameter copper-clad steel rods, the length shall be as required to achieve a maximum resistance to ground of 5.0 Ohms per ground rod.

b) Ground connectors on the bridge to afford ground continuity shall be of the exothermic type, as manufactured by Erico Products, Inc or Engineer approved equal and be suitable for the metals being connected. Where bolted type connectors are required, Burndy connectors or Engineer approved equal shall be provided.

c) Grounding cable shall be stranded copper conforming to ASTM B3-74 and B8-77.

d) Grounding cables for equipment grounding shall have NBC Type TW, 600 volt insulation and be coloured green.

The grounding and bonding installation shall be such that ground continuity is maintained throughout the bridge metallic structures and ground potential is maintained at all metallic structures, machinery and electrical enclosures and raceway systems under all normal and fault conditions.

**SUPPLY AND INSTALL SUSPENDED DUCT BANK**

**Scope**

This specification covers the requirements for duct banks suspended from the approach span bridge structures.

**General**

Design shall be according to CAN/CSA S6.

**Design and Submission Requirements**

**Design**

The detailed design of the system shall be completed by the supplier. This design shall include the conduit expansion joints, hangers, hanger braces, elbows, and other required components. The suspended duct bank shall be in accordance with the details shown on the Contract drawings.

Cast-in-place anchors shall be used for vertical hanger rods anchored into concrete. These anchors shall be specified by the supplier. The Contractor shall supply and place these anchors prior to placing new concrete.
The nominal conduit diameter shall be 150 mm for the BC Hydro Ducts and 100 mm for all other ducts. Four (4) conduits are required at each duct bank as shown on the Contract drawings.

The maximum weight of cable inside a given conduit is 10.2 kg/m. The maximum total weight of cable in the duct bank is 45 kg/m.

The hanger spacing shall not exceed 2.4 metres. Final hanger spacing to be determined by the supplier with consideration of all design factors and constraints, and shall meet the requirements of Aliant, Eastlink, and BC Hydro.

Ice accretion according to Zone - Extreme (66 mm) of the CHBDC shall be considered in the design.

Submissions

Working Drawings and Calculations
The Contractor shall submit seven (7) copies of working drawings and design calculations for the system at least three (3) weeks prior to intended start of placement of cast-in-place anchors. The working drawings shall provide details of all conduit types and sizes to be used, hangers including anchors, hanger braces including anchors, expansion joints, movement joints, elbows and other required components. Working drawings shall include dimensions and elevations. Working Drawings and calculations shall bear the seal and signature of an Engineer.

An erection drawing of one full run of duct bank shall be included showing the type and size of conduit to be used at various locations, locations of hangers, locations of hangers with braces, locations of expansion and movement joints and other details required to install the system.

The Contractor shall not proceed with the installation until an approved set of working drawings has been received from the Contract Administrator.

Materials

Ducts and Fittings
Conduit shall be manufactured from thermosetting epoxy resin reinforced with glass fibres. Approved products include Heavy Wall black conduit manufactured by FRE Composites. We need to specify conduit type.

Hangers shall consist of galvanized steel or stainless steel vertical support rods and horizontal members of material compatible with the conduit.

Fittings shall be of materials compatible with the conduit.

Braces shall be galvanized steel or stainless steel and shall be placed as recommended by the supplier.

Concrete Anchors
Overhead anchors into new concrete shall be cast-in-place anchors and shall be made of galvanized steel or stainless steel according to ASTM A 276 and A 955M, minimum Grade 420. Nominal dimensions, unit masses, and deformation requirements for metric bar sizes shall be according to CAN/CSA G30.18.

Adhesives
Adhesives shall be compatible with the conduit and fittings and shall be as recommended by the supplier.
Fish Line

Fish line shall be nylon or polypropylene material with minimum test strength of 400 N.

Construction

All electrical conduits must be installed by a registered electrical contractor. The electrical contractor must obtain a permit from the Department of Government Services and Lands or the local municipality as the case may be, prior to commencing work on the conduit. All inspections that are required are to be arranged with the proper authority by the electrical contractor. Copies of the permit and inspection certificates must be provided to the Engineer.

General requirements for electrical work shall be as specified in the Contract Documents.

Ducts shall be installed as specified in the Contract Documents.

Conduit fittings and junction boxes shall be installed in neat straight lines in the locations specified in the Contract Documents.

Appropriate fittings and deflection couplings shall be used for the installation. PVC boxes shall be mounted to provide the least interference with at least two stainless steel bolts and expansion anchors. Duct connection shall be cemented to the PVC box adapters.

Conduits shall be secured at intervals using conduit straps according to Canadian Electrical Code.

Conduit straps and junction boxes shall be fastened to concrete surfaces by drilling and inserting concrete anchors and securing the equipment with stainless steel bolts.

Conduit straps and junction boxes shall be fastened to steel structural members using stainless steel hardware.

Termination

All ducts shall be temporarily plugged or sealed until wiring is installed.

When ducts are specified in the Contract Documents as spare or intended for future use, the duct ends shall be plugged with plastic plugs.

Conduits shall be extended 1 metre past the end of the approach slab, into the embankments, and shall be capped as recommended by the supplier.

Fish Line

Fish line shall be installed in all ducts specified in the Contract Documents as being spare or intended for future use. A 1.5 m length of fish line shall extend out of each end of the duct beside the plastic plug, left coiled, and tied in an accessible location.

Quality Control

Pre-Installation Testing and Inspection

All ducts shall be inspected to ensure that they are as specified in the Contract Documents.
All ducts shall be inspected to ensure they are stamped with the appropriate CSA designation, strength, and type. During installation, all ducts shall be inspected to ensure they are properly coupled or connected to electrical chambers, poles, or other devices as specified in the Contract Documents.

Proof of Performance Testing and Inspection
All ducts shall be inspected and tested to ensure that they are as specified in the Contract Documents. All ducts shall be tested to ensure that they are free of debris, water, breakage, or distortion.

Measurement for Payment

No measurement will be made for the payment of the suspended duct system, including Detailed design of the system as specified including preparation of working drawings; temporary access measures as required; and supply and installation of the system as it is deemed to be included as part of the utility relocation item.

Payment will be made on delivery of all materials in good condition and with adequate storage on site up to the cost of material as substantiated by invoices. The remaining payment will be made when the Engineer is satisfied that installation in accordance with the contract has been carried out.

**ELECTRICAL TESTING**

**General**

The bridge electrical testing shall consist of comprehensive testing of all electrical power and control systems throughout the manufacturing process, installation, functional and installed performance of the installed electrical systems.

The Contractor shall employ the services of an Engineer approved electrical testing company to test the completed bridge electrical installation. The testing company shall be qualified for the defined and specified work and submit his qualifications and electrical testing experience for Engineer approved equal. The proposed electrical testing company shall be experienced in the testing of electrical power, control and instrumentation systems. Shall have at least 5 years experience testing and setting up variable frequency drive systems including those dedicated to constant torque and load sharing applications. The testing company shall furnish all test equipment, materials, labour and technical supervision required to perform all tests necessary to demonstrate that the equipment and installation comply with the requirements of the Contract Drawings and as herein specified. Testing procedures shall conform to applicable standards of the ANSI, IEEE, NEMA, CSA C22.1 and CANOSH.

Test equipment shall include, but not be limited to, the following:

a) 500 and 1500 volt meggers

b) Relay and metering primary injection test set

c) AC and Dc digital and analog multi-meters

d) Ground ohmmeter

e) Multi-channel chart recorder with digital output
f) Power quality recorder

All tests shall be conducted in the presence of and with the approval of the Engineer. Any deviation from the prescribed requirements shall be corrected to the satisfaction of the Engineer. The Contractor shall develop and submit comprehensive test procedures of all tests to be performed on the bridge power; control and instrumentation systems to assure all systems and sub systems are operating within their designed parameters and function as herein specified and in accordance with the manufacturer’s specifications. The test procedures shall be submitted to the Engineer for approval and no tests shall be performed prior to Engineer approval of the procedures. The Contractor shall give the Engineer written notice of the tests at least two (2) weeks in advance of testing.

The Contractor is responsible for all tests and test records. Testing shall be performed by and under the immediate supervision of the Contractor. Test records shall be kept by the Contractor for each piece of equipment. Copies shall be furnished to the Engineer for his approval.

All test equipment shall be calibrated by the Contractor. Tests shall be carried out in a safe and orderly manner. Care shall be taken to insure the safety of all personnel (authorized or unauthorized) who may come in contact with equipment or wires which are energized during tests.

The Contractor shall be responsible for visual inspection of the equipment which shall be made immediately prior to the testing and/or energizing of that equipment.

The Contractor shall prepare and submit to the Engineer for approval an electrical testing schedule including a detailed description of the tests to be conducted prior to carrying out any electrical tests on the system.

No adjustments or performance acceptance tests shall be conducted on the installation until all prescribed electrical tests have been carried out and approved by the Engineer.

**Adjustments**

Test instrumentation: During all adjustments described herein, where instrumentation is required the following data shall be recorded with recording meters equivalent to Fluke 1735 equipment.

a) Line-to-line voltage on one phase at the control panel main bus.
b) Current through one phase of each of the main drive motors.
c) Span drive motor speed, calibrated in revolutions per minute.
d) Total input power to the drive system.
e) Input power and power factor by phase
f) Harmonic data

Adjust rotary cam limit switches, fully open, closed limit switches to operate in accordance with the approved schematic control diagram.

Calibrate and zero all drive system encoders and resolvers.

**Performance Acceptance Testing**

Before the main operating machinery is connected for transmitting power, it shall be given an idle (no load) run for 4 hours. During these idle runs a complete set of operating parameters shall be taken and recorded of each operating motor.

After erection is completed, and after all machinery, electrical equipment and structural work have been installed to the satisfaction of the Engineer, the Contractor shall run tests on the respective
mechanical and electrical systems and controls to demonstrate to the complete satisfaction of the Engineer all components and the complete assembly meet the intended requirements of the drawings and specifications and are capable of performing the work intended. These shall include but not be limited to all power, control (analog and digital) and instrumentation. Evidence of binding, vibration, uneven operation or faulty operation shall be cause for postponement of final acceptance and the Contractor shall make the necessary adjustments and/or replacements required to correct alignment, tolerances or any other defects which may cause improper operation of the machinery and do not satisfy the mechanical operating criteria and have not received the approval for service from the Engineer. All tests must be witnessed by the Engineer and it shall be the duty of the Contractor to submit a detailed testing schedule in advance and to coordinate with the Engineer for the purpose of scheduling test dates. The Contractor shall provide all necessary personnel for carrying out the necessary tests, including complete direction of their duties and programming of the test process. This shall include his own personnel in addition to manufacturer's field personnel, where required and the testing company personnel. As a minimum, for the electrical testing and verification of the satisfactory operation of the installed machinery, the Contractor shall provide an operator for the control console, and two field engineers or technical representatives of the manufacturer of the major electrical equipment. The machinery space shall be manned at all times during the testing. On the first day of performance acceptance testing, the Contractor shall have available 12 copies of the detailed test program, arranged with suitable spaces to record all results, instrument readings, designations to correlate with index markings to be noted on the charts during the tests, pertinent comments, etc. This program shall have been submitted to the Engineer and approval received before finalization of test date. Although the Contractor shall direct the testing, the right is reserved by the Engineer to call for certain notations to be made on the record copy of the test program as the tests proceed and to collaborate in the scope of interpretation of the program depending upon the results which develop. All test instruments or other test equipment required for all of the tests shall be provided by the Contractor. After completion of the performance acceptance tests, the Contractor shall submit records, adequately identified of all data recorded during the tests. The Engineer shall also have the right to request different and/or additional tests when there is any disagreement relative to any test result as having established proof of acceptability/conformance to the specification.

Charts and electronic files shall be made for each test and each one uniquely identified for each test, cycle of test and movement direction of the span. The chart identifications shall coordinate with those as noted on the detailed test program. The Engineer may decide during testing that certain portions of the charts need not be included in the final sets to be processed and submitted by the Contractor. All other hard copy charts, to be submitted, shall be processed by the Contractor as follows:

a) Cut and trim all of the charts and reproductions so that each identified portion is separate from other portions (for example: the span opening portion of the second cycle, from closed to fully open position, would be one identified portion).

b) Fold flat wise to an overall length of 280 mm with the identifying chart number exposed. The identifying numbers shall contain three parts: one pertaining to the chart speed and instrument used; one part pertaining to the index system correlated to the test program; and one part to the direction of span movement.

c) Make reproduction copy sets as required to accompany the report of tests. These shall be high quality reproductions comparable in quality to Xerox prints. Copies with perceptible loss of detail will not be acceptable.

d) Arrange each set of charts sequentially according to the identifying numbers, separated into groups with each group corresponding to the instruments used.
Following completion and acceptance of the performance tests, the Contractor shall furnish copies of a test report to the owner. Each copy shall be suitably bound and include the following information:

a) Title page, table of contents, introduction, electrical test conclusions, machinery and structural test conclusions, test program, summary of results, test identification numbers and charts.

b) The introduction shall include complete description of instruments used, current transformer ratios, and calculation of scale factors, available chart and recorder speeds used during the tests, dates tests were performed and any clarifying comments as appropriate to the full reporting of the tests.

c) The test program will be a reproduction of the programs furnished by the Contractor when the tests were begun with notations as made during the tests including any recordings or chart portions not required to be included in the report.

d) Summary of results shall describe the pertinent measured parameters and observable results for each test. Meaningful information shall be developed not requiring reference to the charts except for supplementary details. In other words, each test shall be described in narrative form giving recorded voltage, currents, power, speed changes and observable results pertaining to that test, including descriptions regarding acceleration, running and deceleration.

e) The test identification numbers section of the report shall give the identifying number used, a list of the charts included in the report and a list of those charts which are not included.

f) The charts portion of the report shall contain a pocket to enclose the reproduced charts, folded and identified as described herein.

The original of the electronic data files and charts (complete, including those not reproduced in the report) shall be furnished to the City.

The acceptance tests of the moving span shall be performed in conjunction with mechanical acceptance testing and shall include, but not be limited to:

a) Normal load test: while recording the test data outlined herein open and close the span through two complete' cycles of operation for each of the duty modes of operation.

b) Overload tests: while recording the test data outlined herein open and close the span through two complete' cycles of operation for each of the duty modes of operation as follows;

Simulated Ice and Wind Loading Test: **Endurance Testing**

Prior to the bridge being placed into service and following performance acceptance testing, the Contractor shall perform a series of endurance tests on the complete bridge operating system. These tests shall be performed over an extended period and fully document the performance of each piece of machinery and electrical equipment including documenting failures and describing in a test report form all remedial actions taken to rectify failure conditions. Following any failure for any of the items indicated below, the Contractor shall repeat the endurance test on that item. The endurance testing of the individual sub systems and bridge operating system shall consist of the following:

a) Ten (10) consecutive full open and close operating cycles of the bridge span. Fifteen minute duration shall be allowed between bridge operations.

b) Fifteen (15) consecutive full drive and pull operating cycles of each bridge span lock. Fifteen minute duration shall be allowed between individual span lock operations.

c) Twenty (20) consecutive full lower and raise operating cycles of each bridge traffic gate. Five minute duration shall be allowed between bridge operations.
Supervision of Operation

The Contractor shall provide a person “on call” to supervise the operation of the bridge for six (6) complete operations of the span on 24 (24) separate days. The schedule for span operation to be determined by the City after the span is completely operable. This person shall be able to operate the bridge, to supervise its operation and to make any adjustments or corrections that may be required in the electrical equipment of the bridge. He shall instruct and qualify during these operations, the employees of the City in the operation of the bridge. Any adjustments or corrections required during these visits shall be at no additional cost.

Following this initial operation, the Contractor shall have qualified personnel on call around the clock to correct or override defects in the new equipment for a period of three months.

BASIS FOR PAYMENT
MISCELLANEOUS METALWORK (LANDSCAPE)
SECTION 05 50 00

1. General

1.1 Documents

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

1.2 Section Includes

All labour, materials, and equipment necessary for fabrication, supply, and installation of metal work, as indicated on Drawings including but not limited to:

Metal Railings: fabricate metal component railings, post stanchions, inset cables and attachments, base plates, and anchor attachment/installation complete with concrete footings for the specified work as shown on Drawings and Specified herein.

Bollards: fabricated stainless steel bollards complete with concrete footings for the specified work as shown on Drawings and Specified herein.

Engineered Shop Drawings of all items must be submitted for approvals by Consultant prior to fabrication.

1.3 References

Meet or exceed Current ASTM and CGSB, CSA standards

Contractors must have minimum 5 years demonstrated experience

1.4 Submittals

Shop Drawings

Submit Shop Drawings signed and sealed by an Engineer licensed to practice in BC for approval by Consultant prior to fabrication.

Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

Provide samples of metal items to be approved by the Consultant prior to commencing fabrication work.

2. Products

2.1 Materials

Steel sections and plates: to CAN/CSA-G40.20/G40.21, Grade 300W.

Seamless hollow structural sections, conforming to CAN3-G40.21, Grade 50W, Type H.

Steel pipe: to ASTM A53/A53M standard weight Grade B.

Welding materials: to CSA W59.

Bolts, anchor bolts, nuts and washers: to ASTM A307 or as indicated on Drawings.
Stainless steel tubing: to ASTM A269, Type 302 Seamless welded with AISI No. 4 satin finish.
Grout: non-shrink, non-metallic, flowable, 15 MPa at 24 hours.
Self-tapping shake-proof oval-headed screws on items requiring assembly by screws or as indicated on drawings.

2.2 Anchors, Bolts and Screws

All fixing and anchorage for miscellaneous metal work shall be supplied as detailed and as required to suit installations and erection.
Provide all the angles, clips, plates etc. required to support or fix items of work.

2.3 Finishes

Primed and Galvanized: Stanchions, base plates, spacers
Stainless Steel: Cables, rail bars, and extension arms, and post bollards. AISI No. 4 satin finish
Anchor bolt base plate to concrete footing complete with non shrink cementitious grout to fill hole.

3. Execution

3.1 Examination

Examine all details of the work as related to this section and other sections. Ensure that all conditions are suitable to provide a complete and satisfactory installation or be responsible for any additional costs involved.

3.2 Erection

Do welding work in accordance with CSA W59 unless specified otherwise.

Execute all metalwork in a thorough and workmanlike manner according to best shop practices. Material cut from stock to the sheared or parted straight and all deburred. Where cuts are burned, grind off clean and true to line. Exposed welding or welding in fitted surfaces to be ground smooth or filleted as required. Fabricate all items accurately, true to line and dimension.

Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.

Provide suitable means of anchorage acceptable to Consultant such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.

Exposed fastening devices to match finish and be compatible with material through which they pass.

Provide components for building by other sections in accordance with shop drawings and schedule.

Make field connections with bolts to CAN/CSA-S16.1, or weld.

Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.

Touch up rivets, field welds, bolts and burnt or scratched surfaces after completion of erection with primer.

Touch up galvanized surfaces with zinc rich primer where burned by field welding.

END OF SECTION
EXTerior SITe Furnishings  
section 12 93 00

1. General

1.1 Documents

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

1.2 Section Includes

Furnish all labour, materials, equipment and services necessary to supply and install: Benches, Trash receptacles including installation and attachment as specified. Refer to Drawings for locations.

1.3 Submittals

All pre-manufactured products must be submitted with complete samples to Consultant 120 days in advance of installation. Consultant must approve sample and any relevant colours, finishes and sizes prior to Subcontractor placing final orders.

Indicate dimensions, sizes, assembly, anchorage and installation details for each furnishing specified. This approved sample will be the standard to be maintained throughout the Work.

A manufacturer’s warranty is required for all pre-manufactured site furnishings specified in this section.

2. Products

2.1 Materials

Benches:

Type 1: Flat Top

Custom 2.5m length IPE Natural Finish wood benches complete with surface mount, tie rods, plugs supplied and manufactured by Francis Andrew or approved alternative.

Type 2: Free Standing bench

Nu Bench, 2.6m long, IPE natural wood finish, seat and backrest, powder coated silver, complete with surface mount, concrete footing supplied and manufactured by Landscape Forms or approved alternative.

Trash Receptacles:

Cash Allowance: Combined trash and recycling complete with lockable door and liner. Model type to be confirmed. Stainless steel finish.

Drinking Fountains:

Cash Allowance: Wheelchair accessible with pet bowl. Model type to be confirmed. Stainless steel finish.
APPENDIX E
JOHNSON STREET BRIDGE
DRAFT LANDSCAPE WORKS

Bike Racks:

Ring, by Landscape Forms; 2 bikes per fixtures; Height 32", Width 25", Depth 1/5"; embedded;
Stainless steel finish. (Refer to Landscape Plans for quantities).

3. Execution

3.1 General

The Contractor shall be responsible for protection and maintenance of all completed work and finishes
from time of completion until acceptance of work and shall make good all damage to work caused
during protection and maintenance period, at no extra cost to the Owner.

Assemble furnishings in accordance with manufacturer's instructions.

END OF SECTION
1. **General**

1.1 **Documents**

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

1.2 **Section Includes**

Furnish all labour, materials, equipment and operations to maintain all landscaped areas on site including the irrigation system for a period of one (1) year following Substantial Completion, at which time maintenance will be turned over to the Owner.

The maintenance period begins at time of Final Completion or when Substantial deficiencies have been corrected to approval of Owner and continues to the end of the defined Maintenance Period. The minimum standard of maintenance for the West Side is “Level 4 - Open Space”; the East Side is to minimum “Level 2 – Groomed” as per BC Landscape Standard. The Landscape Establishment Maintenance is to be read in conjunction with Maintenance outlined in Section 32 93 10 - Trees, Shrubs, and Groundcover Planting.

The work includes, but not be limited to: maintenance of growing medium and monitoring the site for erosion; grass / meadow management including mowing, fertilization, liming, and watering; maintenance of site including plant replacement, tree support, pruning, fertilization and watering; weed control; control of insect pests and disease; and litter and landscape waste clean-up for the specified duration.

Best practices are tailored to provide corrective measures that are most cost effective. Herbicides and pesticides are prohibited unless approved by Municipal and or Regional regulators.

1.3 **Qualifications**

All work of this Section shall be carried out by fully experienced and licensed Contractors who are members of the British Columbia Landscape And Nursery Association with at least 5 years written and proven experience. Provide all required permits and insurance.

Maintenance crews must be skilled and equipped to recognize where innovative and improved sustainable practices are to be used.

Integrated Pest Management handling and application (if required) shall be done only by applicators holding current certification under the B.C. Pesticide Control Act.

1.4 **Submittals**

The Contractor shall prepare a monthly summary of maintenance work and site conditions and submit at the end of each calendar month, for the duration of the maintenance period prior to approval for payment. The log shall document the development and condition of plant material, as well as, preventative and/or corrective measures required which are outside the Contractor's immediate responsibility.
1.5 References

BCSLA/BCLNA Landscape Maintenance Standard.

2. Products – Not used

3. Execution

3.1 Plant Establishment

The Contractor shall be responsible for the maintenance of all plants. Maintenance shall include all measures necessary to maintain plants in a vigorous, healthy, normal growing condition, providing an appearance characteristic of their species and appropriate to their surroundings. Such maintenance shall include but not be limited to general cultivation; weed, pest and disease control, mulching, moisture conservation and watering, fertilizing, plant protection, pruning, and general clean up.

3.2 Meadow Grass Areas

The Contractor shall be responsible for the maintenance of all Meadow and lawn (natural grassed and minimal mown). Maintenance of grassed areas shall include all measures necessary to maintain grass in a vigorous, healthy, normal growing condition.

Meadow or ‘Natural Grass’ Areas shall be cut a maximum once per year as per recommendation of seed supplier, typically in the Fall after plants have flowered and dropped their seed. Maximum mowing height to be 15cm or 6”.

‘Mowed Grass’ Areas as determined by Owner, shall be cut at minimum once a week, and twice a week during heavy growth periods to ensure a 65 mm (2.5”) maximum height. Turf shall be cut to a height of 37.5 mm (1.5”). Equipment shall be sharp, level and prevent burning or gouging grass.

3.3 Replacements

Replace each defective or dead plant within 10 days hours after notification by the Consultant and continue to replace each plant until it has established itself to the satisfaction of the Consultant.

All required replacements shall be plants of the same size and species as specified on the plant list and shall be supplied and planted in accordance with the Drawings, Specifications and Change Orders thereto or as directed by Consultant.

The cost of replacements resulting from theft, accidental damage, vandalism, carelessness, neglect on the part of others, shall be borne by the Landscape Contractor until the Final Acceptance.

3.4 Acceptance

Maintenance of Planted areas will be accepted by Consultant at the end of Warranty Period provided that all deficiencies have been corrected to the satisfaction of the Consultant. Plant material will be accepted by the Consultant provided that plant material exhibits healthy growing condition and is free from disease, insects, and fungal organisms.

Plant material installed less than 4 days prior to frost will be accepted in following spring, thirty (30) days after start of growing season provided that acceptance conditions are fulfilled.

END OF SECTION
TREE PROTECTION
SECTION 32 01 90

1. General

1.1 Documents

This section of the specification forms part of the Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Section Includes

Work Included: Furnish all labour, materials, equipment and services necessary to protect existing trees on site and on adjacent road right-of-way and sites, including but not limited to:

- Survey and layout for locations of protective barriers.
- Installation, maintenance, adjustment during construction, and final removal of protective barriers and signs.
- Pruning as approved by the City of Victoria, including hand excavation and root pruning.
- Watering, fertilizing and all other measures directed by a Park Board Arborist as required to maximize the health and prospects for survival of the trees.

1.3 General

The “Tree Protection Area” (T.P.A.) shall be established on site under the direction of the Park Arborist. It must be demarcated on site and fenced off from all impacts of construction. The T.P.A. is defined as the “dripline”, which is a line drawn vertically to the ground from the furthest horizontal extent of the canopy branches as measured around the full circumference of the tree. Minor adjustments may be required to this rule to meet site species/specific conditions. Confirm T.P.A. on site with Arborist.

Excavation, soil stabilizing measures, shoring (if necessary) and related work shall be planned and executed such that no excavation or other construction activities occur within the Tree Protection Area. A variance may be obtained provided that the location, materials and methods are approved and supervised by a COV Staff Inspector/Arborist.

2. Products

2.1 PROTECTIVE BARRIER (SNOW FENCE)

Orange plastic web snow fencing, 1.2m high “Tenax”, as supplied by Ronco Sales Ltd., or approved alternative. Posts, minimum 75mm dia. or square wood posts or steel “Tee-Bar” posts minimum 1.8m lengths. Posts maximum 2.4m o.c.

3. Execution

3.1 Protective Barrier Fence Erection

Before starting site work, install a clearly visible 1.2m high continuous protective barrier fence at the approved lines for the “Tree Protection Area” (locations as shown on Drawings). Maintain this barrier until Substantial Performance and remove from the site at that time or as otherwise approved by the COV Inspector.
3.2 Tree Protection Area Signs

Install Tree Protection Area signs as specified on the protective barrier fence. Take all measures necessary to prevent the following activities within tree protection areas except as authorized by the COV Arborist:

- Storage of materials or equipment
- Stockpiling of soil or excavated materials
- Burning of any kind
- Excavation or trenching
- Cutting of roots or branches
- Travel of equipment or vehicles
- Disposal or spillage of toxic matter

3.3 Root Pruning

Before the start of any machine excavation, hand excavate along the established limit of excavation and prune all roots along the line. Cuts shall be clean, to approved arboricultural practice.

Retained Transplanted Trees shall be root pruned as directed by the Arborist.

3.4 Branch Pruning

Do not branch prune any “top growth” of any retained tree to compensate for reduction of roots unless specifically instructed by the Arborist.

3.5 Watering And Fertilizing

Retained trees shall be watered thoroughly and deeply, as necessary to supplement rainfall to maintain plant turgidity without prolonged saturation of the root zone. The method, amount and frequency of watering shall be as recommended by the Arborist. Suggested Summer Watering Schedule: The T.P.A. is to be watered via sprinkler, soaker hose, or by tank with a watering wand at least two times per week during June, July, August, and September or as directed by the Arborist.

Fertilize Retained Trees to stimulate regeneration of lost roots and foliage. Fertilization program as recommended by the Arborist.

3.6 Other Measures

Other measures may be necessary for tree protection and ongoing survival, depending on site conditions. These may be determined during the initial planning for retention and excavation, or may be recommended by the arborist during the course of construction. All additional measures, not clearly identified at time of bid will be considered “extra” to the work of this Contract.

END OF SECTION
CONCRETE FOR EXTERIOR IMPROVEMENTS
SECTION 32 05 23

1. General

1.1 Documents

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

1.2 Section Includes

Supply all labour, materials, and equipment necessary to CIP Concrete Banding, CIP Seat Walls as shown in Drawings including: grading associated with sub grade, preparation of granular base, filling and forming, compacting, reinforcing, dowels, backfilling and concrete finishing; construction joints and control joints, sealing of joints, trowelling, formwork, saw cut control joints, and precast concrete wall capstones.

1.3 References

Canadian Standards Association (CSA International) for formwork and reinforcement.

Installer: Company or person specializing in Portland cement and concrete paving with (5) five years minimum experience.

1.4 Submittals

Provide product data, sampling, mixes, sampling and testing.

Construct on-site samples (minimum 1200x1200mm) of proposed Landscape Architectural Concrete Finishes, for approval by Consultant at least (2) two weeks prior to commencing work. Include:

Forming materials, and architectural finishes including gaskets and ties, sealing materials, form Jointing system (as applicable), form release agent, joints (expansion, control, isolation joints, sawcut, trowel).

2. Products

2.1 Concrete Mixes

Banding, curbing, walks, slab-on-grade, stairs, footings, and precast:

Minimum compressive strength at 28 days = 35 MPa.

Exposure Class = C1

Air Content = 5-8%

Maximum water to cement ratio of 0.40

Slump = 80mm +/- 20mm
Footings, walls, and columns:

- Minimum compressive strength at 28 days = 30 Mpa.
- Exposure Class = F2
- Air Content = 4-7%
- Maximum water to cement ratio of 0.50

Proposed changes in material source to be approved by Consultant. New mix design to be approved by Consultant.

3. **Execution**

3.1 **Tolerances**

Tolerances shall not be cumulative. Deviations shall not exceed the following when checked with 15’ (4.5 m) straight edge placed in any direction.

- Deviation from vertical line – 6mm in 3000mm, 9mm in 6000mm and 18mm in 12000mm or more.
- Deviation from flat surface (walls and paving) – 3mm in 3000mm.
- Deviation from horizontal – 6mm in 3000mm
- Deviation of relative position of columns and walls, thickness of slabs and walls in plan – 6mm.

3.2 **Finishing**

No concrete paving shall be placed until the Consultant is satisfied that the Contractor’s proposed materials and methods will achieve a high quality product. Finishing of formed surfaces exposed to view shall be free of bulges, fins, lips, and stains. All imperfections shall be removed by chipping or grinding and shall be patched and repaired as specified. Prevent dislodgement of coarse aggregate particles.

Formed surfaces: The finishes to be provided for the various formed surfaces shall be:

**Unexposed Finish:**

This finish shall apply to formed surfaces which are not exposed to view and where roughness is not objectionable. Plywood square edged and wood formwork materials to CAN/CSA Standards

The surface, in general, shall not require any treatment after form removal, other than repair of defective concrete, snap-tie holes, and the removal of ridges and surface irregularities.

**Walls - Architectural Finish:**

Plywood or steel sheet finish - for all exposed surfaces unless otherwise specified.

Clean 90 degree corners and edges. No chamfers unless indicated on Drawings.

Form ties placed symmetrically in a uniform and consistent pattern. Form tie pattern to be illustrated in concrete shop drawings.
Curb Edge and Banding: Trowel Finish, saw-cut joints.

Precast Concrete Wall Capstones for stone veneer walls: 250mm thk x length to be confirmed as supplied by Sanderson Concrete or approved alternative.

3.3 Repair And Patching

Repair of defective concrete work:

Repairs shall match the surrounding area. Architectural concrete requiring repair is subject to rejection by the Consultant and shall be removed and replaced. Removal and replacement of work shall be at no additional cost to the Owner.

3.4 Quality Control

Inspection and testing of concrete and concrete materials will be carried out by an independent Testing Laboratory paid for by Contractor in accordance with CAN/CSA-A23.1-M90.

END OF SECTION
1. General

1.1 Documents

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

1.2 Section Includes

Labour, materials, equipment necessary to supply and install unit pavers including at grade subbase and base preparation, gravels, sand setting bed, jointing sand, edge restraints as specified herein and as indicated on Drawings.

1.3 References


1.4 Submittals

Submit Product and Installation Data, full size sample of each type, size, texture, and colour paver for Consultant approval.

Submit Shop Drawings indicating layout, pattern and relationship of paving joints to fixtures, project edges, and where cut pavers will be required to suit detail and layout for Consultant review and acceptance.

1.5 Quality Assurance

Qualifications: Installer, company or person specializing in precast concrete paver installations with 5 years documented experience and approved by Consultant.

Sample Mock-Ups: Construct Test mock-ups 2 x 2 m minimum area sample of each paving pattern, texture, colour, and or edge condition shown on Drawings for approval prior to paving works.

Comply with manufacturer’s written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

2. Products

2.1 Concrete Pavers

Concrete Paver Types: Refer to Drawings for type, locations, and patterns:

California Precast Concrete Unit Paver manufactured by Abbotsford Concrete Products or approved alternate. Color: 66% Natural, Charcoal (34%) Sand Blend. Size: 150mm x 300mm x 60mm; 150 x 150 x 60mm
2.2 Bedding Sand And Joint Material

Gradation: to CSA-A23.1, Table 4 - Grading Limits for Fine Aggregate, and CSA A179. Do not use limestone screenings or stone dust.

Joint Sand filling shall be Polymeric Joint Sand, Techni-Seal HP Polymeric Sand or approved alternative.

2.3 Sub-Base Materials

Base and subbase materials shall be specified under Excavation, Backfill, Compaction and Grading. and shall be approved by Consultant.

2.4 Edge Restraints

All edges of unit paving shall be restrained with concrete curb edge banding (dimension as per Drawings).

3. Execution

3.1 Structural Base

Verify that structural surfaces conform to levels and compaction required for installation of unit pavers. If discrepancies occur, notify Consultant and do not commence work until instructed by Consultant. Base Course shall be well drained and compacted to 98% Standard Proctor Density or as directed by Engineer. Compaction testing to be conducted by qualified Testing Agency.

Ensure that subgrade is not frozen or standing water is present during installation. Unsuitable material shall be removed and replaced with approved fill and or subbase material.

Sub-base shall not be less than 6" (150mm) in thickness for pedestrian areas unless otherwise shown on Drawings and to optimum moisture content and compacted to 98% Standard Proctor density as determined by compaction control tests conducted by a qualified Testing Agency. Sub-base shall be inspected and have written approval by the Consultant prior to sand and paver installation.

3.2 Structural Curbs And Edge Restraints

Install continuous edge restraint at edges of unit pavers.

3.3 Placing Of Bedding Material

Spread and screed material on structural surface to achieve minimum 19mm (¾") to maximum 38mm (1-1/2")" compacted thickness after vibrating pavers in place. Do not use joint sand for bedding sand.

3.4 Installation Of Concrete Pavers

Lay pavers to patterns indicated on Drawings on sand levelling course on approved compacted granular base course. Joints between pavers shall not exceed 1/8" (3mm) or as recommended by Manufacturer.

Paver to ensure radii, joint space standard, and to ensure ½ stagger pattern where possible and as determined in mock-up. Note: minimum ½ full size standard pieces at ends and edges.

Pavers shall be cut using an approved concrete saw to a straight even surface without cracks or chips. Guillotine cuts are not permitted. Fractured or broken pavers will not be accepted.

Tamp and level pavers to their final level by 2 or 3 passes with low amplitude, high frequency plate compactor capable of at least 22 kN centrifugal compaction force. Use a minimum 19mm thick plywood
or neoprene pad under plate compactor to vibrate pavers into bedding sand, to correct elevations and gradients. Do not tamp restrained edges.

Sweep jointing sand material over paver surface and vibrating pavers with plate compactor. Continue application of joint material and vibrating of pavers until joints are full. Do not vibrate within 1 m of unrestrained edges of pavers. Leave a thin layer if sand on the pavers until occupancy.

Final surface elevations not to exceed plus or minus 1/4” (6 mm) under 16’ (4.8 m) long straightedge.

END OF SECTION
1. **General**

1.1 **Documents**

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

1.2 **Section Includes**

Labour, materials, equipment necessary to supply and install finish rock, cobbles, stone gravels, rock boulders and ledgestone veneer walls, including base preparation, drain gravels, mortar, and weed control filter fabric as specified herein and indicated on Drawings.

1.3 **Samples And Mockup**

Submit samples of all stone materials (size, texture, and colour), weed control fabric, and edging specified for approval by Consultant. Samples can be approved at source before delivery to the site.

Final placement and arrangements may vary from the Drawings. The Consultant requests a full size mock-up field test section of material placement for approval of arrangement and placement.

1.4 **Quality Assurance**

Stonework shall be done by experienced tradesmen. Provide list or relevant projects and experience for approval prior to installation.

All rock shall be stored at source until site installation.

2. **Products**

2.1 **Materials**

Base Preparation: Crushed pit run, screened stone, gravel free from clay lumps, cementation, organic material, deleterious materials, or compacted subgrade.

Stone Types:

- Gravels: 20-25mm clear washed gravel free of silts, sand, and clay.
- Rock Ballast Mulch: Blend of: 75-100mm angular washed, local basalt.
- Boulders:
  
  Onsite boulders can be used. Contractor to review boulders with consultant prior to installation to determine quantity for the purposes of determining imported boulders required for approvals prior to placement.

  Boulders collected from site shall be stockpiled and handled in a manner and location to prevent breakage.
Imported basalt/sandstone boulders (or approved alternative).

Sizes: 50% (900-1200mm), and 50% (1.2m or greater) locally supplied and approved by Consultant prior to delivery. Flatter or angular natural shapes with ledges for sitting preferred.

Ledgestone Wall Veneer: Basalt Ledgestone: Available through Adera Stone (ph: 604.436.0204) or approved alternative. Finish: Sample to be approved prior to delivery.

Stone Setts: 150 x 150 x 75 thk cut flame finish Granite available through Adera Stone (ph: 604.436.0204) or approved alternative. Finish: Sample to be approved prior to delivery.

Drain Pipe: PVC.

Edging: CIP concrete bands, as indicated on Drawings.

Geotextile: Nilex heat bonded, rot proof, woven polypropylene fabric or approved alternate.

3. Execution

3.1 Subgrade

Ensure that subgrade preparation conforms to levels and compaction required to allow for installation of stone surface course. Compact to 95% maximum Dry Density or as directed by the Consultant.

Ensure positive drainage. Subgrade is to be approved by Consultant prior to placing surface course.

3.2 Geotextile Filter

Install geotextile filter fabric as indicated on Drawings.

3.3 Stone Placement

All material shall be located true to grade, plumb, in location and layout as indicated on Drawings and under direction of Consultant.

Place rockwork in depths, arrangement, on sand and sub-grade build-up as shown on Drawings prior to placement of growing medium. Ensure weed control fabric is not visible. On site inspection will be required for approval.

Dry mix concrete mortar may be used to stabilize material. No mortar may be visible upon completion. Mortar thickness for bedding stone minimum 25mm thick.

Boulders shall be placed to create a composition with similar orientation alignment. Set minimum 100mm below grade and placed by belts or chains. Boulders shall not be dumped or pushed in place.

END OF SECTION
LANDSCAPE IRRIGATION
SECTION 32 84 10

General

1.1 Documents

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

1.2 Section Includes

Furnish all labour, materials, equipment necessary for the complete supply and installation of irrigation system including: trenching excavation and backfill and subgrade preparation, piping, head, valves, controls, stubs outs for future work and maintenance as specified herein and as indicated on Drawings.

Contractor is responsible for coordination with the Mechanical, Electrical Consultants, and trades including sleeving under paved areas, walls as required.

Work includes verification of site measurements and irrigation coverage, location of the water supply/municipal connection point for the automatic irrigation system, and location of the electrical conduit for the low voltage wire from the controller. Notify Consultant if conditions observed on site will impair proper and intended uniform irrigation coverage prior to commencing work.

Irrigation Strategy:

i. West Bank: Temporary establishment irrigation (manual, or approved alternative) required to hydroseeded areas and tree plantings.

ii. East Bank: Automatic pop up to all shrub bed areas, median and lawn areas, and bubblers to median trees plantings.

1.3 References

Meet or exceed ASTM, and CSA Standards.

Conform to local plumbing and electrical code for piping and component requirements.

1.4 System Description

Automatic electric solenoid controlled underground irrigation system complete with rain sensor, and maintenance remote (LIMR) to City of Victoria Standards.

Source Power: CSA approved 120/240 VAC, 50-60Hz @ 30 VA or approved alternative.
1.5 Submittals For Review

Samples upon request of Consultant.

Provide Record As Built Record Drawing

1.6 Quality Assurance

Installer: Contractor performing the work must have minimum (5) five years documented experience in Victoria, and a member in good standing of the IIABC (Irrigation Industry Association BC).

Provide a written Guarantee for all workmanship and materials for (1) one year from date of Substantial Performance. Make all corrections, adjustments and maintenance operations required as a result of failure of the irrigation system to perform due to the work of this Section.

2. Products

2.1 Pipe Materials, Heads, Valves, Trenching, Controllers

To City of Victoria Standards.

3. Execution

3.1 Examination

Verify existing conditions and location of existing utilities before starting work. Verify that required utilities are available, in proper location, and ready for use.

Layout indicated is diagrammatic only. Confirm layout and locations of system components for approval of Consultant and COV.

Testing Prior to Backfilling:

i. Prior to backfilling, test system for leakage and obtain approval of Consultant. Work closed in before inspection will be required to be exposed for inspection at no extra cost to the Owner if required.

ii. Submit Certificate of Proof of Double Check Valve Assembly Test and Pass upon Date of Substantial Completion.

Coverage and Controller Test:

i. When the irrigation system has been completed, a coverage test will be completed in the presence of Consultant to determine water coverage to planting areas is complete and determine if any adjustments are required.

ii. Prior to Final Acceptance by Consultant, the automatic controller(s) shall be set in sequence and thoroughly tested thru each zone to determine if any adjustments are required.
Flushing: Flush out each section to remove any dirt accumulated after testing and prior to attaching sprinklers.

Winterize the system for the first time with the Owner’s designated representative present.

END OF SECTION
GROWING MEDIUM AND FINISH GRADING
SECTION 32 91 19

1. General

1.1 Documents

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

1.2 DESCRIPTION

Work includes for labour, equipment, and all procedures necessary for “Growing Medium Placement and Finish Grading”: include labour, equipment, and all procedures necessary for: preparation of subgrades, soil placement, structural soil, finish grading, as specified and as indicated on Drawings.

1.3 REFERENCES

BCSLA/BCLNA British Columbia Landscape Standard; and Canadian System of Soil Classification

1.4 INSPECTION

Notify Consultant when the site is prepared for growing medium placement. Do not place growing medium until subgrades have been inspected and approved.

1.5 SUBMITTALS

Soil testing: Submit a copy of an analysis by an approved independent soil testing laboratory, (Pacific Soil Analysis) or approved alternative. The analysis shall include a breakdown of the following components: total nitrogen by weight, available levels of phosphorous, potassium, calcium, magnesium, soluble salt content, organic matter by weight, % sand, % fines (silt and clay) and pH value. In addition, the analysis shall clearly indicate the Project Name, Date Tested and Contractor’s Name. Costs of the initial analysis, and subsequent tests to ensure compliance with the specification shall be borne by the Contractor. Failure to submit soils analysis is cause for immediate rejection of any placed growing medium.

1.6 PRODUCT HANDLING

DO NOT MOVE OR WORK GROWING MEDIUM OR ADDITIVES WHEN THEY ARE EXCESSIVELY WET, EXTREMELY DRY, OR FROZEN OR IN ANY MANNER WHICH WILL ADVERSELY AFFECT GROWING MEDIUM STRUCTURE. Growing medium whose structure has been destroyed by handling under these conditions will be rejected.

2. PRODUCTS

2.1 MATERIALS

Growing Medium: shall mean a mixture of mineral particulates, microorganisms and organic matter which provides suitable medium for supporting intended plant growth. Soil texture is based on the Canadian system of Soil Classification.
### TABLE 1: Growing Medium for Seeded and Planted Areas:

<table>
<thead>
<tr>
<th>TEXTURE: Particle Size Classes By The Canadian Soil Classification, And Other Parameters</th>
<th>PERCENT of Dry Weight of Mineral Fraction (%, UNO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel greater than 2mm less than 25mm</td>
<td>0%</td>
</tr>
<tr>
<td>Sand greater than 0.05 less than 2mm</td>
<td>50 - 70%</td>
</tr>
<tr>
<td>SILT Greater than 0.002mm less than 0.05mm</td>
<td>10 - 30%</td>
</tr>
<tr>
<td>CLAY less than 0.002mm</td>
<td>0 - 20%</td>
</tr>
<tr>
<td>Sand for lawns</td>
<td>70 - 80%</td>
</tr>
<tr>
<td>fines: Silt and clay</td>
<td>12 - 25%</td>
</tr>
<tr>
<td>organic CONTENT percent of dry weight</td>
<td>12 - 20%</td>
</tr>
<tr>
<td>lawns</td>
<td>6 - 8%</td>
</tr>
<tr>
<td>ACIDITY pH</td>
<td>6.17 pH</td>
</tr>
<tr>
<td>DRAINAGE minimum saturated hydraulic conductivity (cm/hr)</td>
<td>2.0 (cm/hr)</td>
</tr>
</tbody>
</table>
## TABLE 2: Texture for Structural Soil (Gap-Graded Growing Medium)

<table>
<thead>
<tr>
<th>TEXTURE OF GROWING MEDIUM</th>
<th>% OF MIXTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel: greater than 2mm-less than 75mm</td>
<td>0%</td>
</tr>
<tr>
<td>Sand: greater than 0.05mm-less than 2mm</td>
<td>50-65%</td>
</tr>
<tr>
<td>Silt: greater than 0.002-less than 0.05mm</td>
<td>20-35%</td>
</tr>
<tr>
<td>Clay: less than 0.002mm</td>
<td>5-15%</td>
</tr>
<tr>
<td>Clay and silt combined</td>
<td>25-40%</td>
</tr>
<tr>
<td>Organic matter: percent of dry weight.</td>
<td>8-12%</td>
</tr>
<tr>
<td>Acidity (pH)</td>
<td>6.0-7.0</td>
</tr>
<tr>
<td>Drainage: minimum saturated hydraulic</td>
<td>3.0</td>
</tr>
<tr>
<td>CONDUCTIVITY (cm/hr) IN PLACE</td>
<td></td>
</tr>
<tr>
<td>Salinity: saturated extract conductivity shall not exceed</td>
<td>3.0milliohms/cm at 25 degC</td>
</tr>
</tbody>
</table>

Mulch: Planted Areas: 50mm min depth

Fertilizers: Standard commercial brands, meeting the requirements of the Canada Fertilizer Act.

### 3. EXECUTION

**3.1 Temporary Erosion and Sedimentation Control**

Refer to sediment and erosion control plan, specific to site, and comply with local requirements.

**3.2 Subgrade Preparation**

Scarify compacted subgrade to a minimum depth of 150mm (6") immediately before placing growing medium and verify that subgrades are at the proper elevations before placing growing medium. Remove debris, roots, branches stones in excess of 50mm dia. and other deleterious materials. Remove any materials which protrude 25mm above the surface. Dispose of removed material off site.
3.3 Placing Growing Medium

Growing medium shall be moist but not wet when placed (25% of field capacity) and shall be allowed to settle or compacted by light rolling.

Spread topsoil in uniform layers not exceeding 150 mm (6 inches) and free of standing water.

Spread growing medium to following minimum depths measured after settlement. Typically:

50 mm (2 inches) minimum for seeded areas.

450 mm (18 inches) minimum for shrub beds and groundcover.

Tree pits: 900mm (36") minimum or depth of root ball, whichever is greater. For as large an area as possible around the base of each tree. Recommended 10m2 or twice the size of the root ball whichever greater.

Structural Soil: Place minimum1000mm depth, or 25 cubic meters of Structural Soil per tree, continuous tree trench is preferred.

Manually spread topsoil/planting soil around trees, shrubs and obstacles. Do not change grades around existing trees. Crown or slope for positive surface drainage.

Increase sand content to 90% in the planting soil below lawns where heavy wear by pedestrians or maintenance equipment is anticipated. On steep south or west facing banks, reduce sand content in lawns and planting beds to 50 - 60% to improve moisture retention.

3.5 Finish Grading

All growing medium shall be fine graded after placement to the finished elevations and contours. Ensure all rough spots and low areas are eliminated to ensure positive surface drainage. Gradients shall be within the ranges shown in Table 1, except where shown on Drawings.
## APPENDIX E
JOHNSON STREET BRIDGE
DRAFT LANDSCAPE WORKS

### TABLE 1

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>MINIMUM</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAWN AND GRASS</td>
<td>50:1 (2%)</td>
<td>3:1</td>
</tr>
<tr>
<td>GRASS SWALES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(without additional erosion protection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.1 Slope along invert</td>
<td>50:1 (2%)</td>
<td>10:1 (10%)</td>
</tr>
<tr>
<td>.2 Side slopes</td>
<td>6:1 (preferred)</td>
<td>4:1</td>
</tr>
<tr>
<td>UNMOWN AREAS</td>
<td>100:1 (1%)</td>
<td>3:1 *</td>
</tr>
<tr>
<td>PLANTED AREAS</td>
<td>50:1 (2%)</td>
<td>3:1 *</td>
</tr>
</tbody>
</table>

* Note: Area may require erosion control prior to top soil and planting/seeding application for slope at 2:1 or steeper.

END OF SECTION
1. **General**

1.1 **Documents**

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

1.2 **Section Includes**

All labour, materials, equipment necessary to complete, Hydraseeding or approved alternative, including site preparation, seed, mulch, and application. Establishment Maintenance will be required to meet conditions for Final Completion.

1.3 **References**


1.4 **Submittals**

Provide Product Data for: Seed, Mulch, Tackifier, and Fertilizer.

1.5 **Scheduling**

Carry out seeding of grass during periods which are most favourable for germination and establishment (preferred generally from March to May 30, or mid August to Mid September). If this cannot be achieved, alternate seed mix, combined with watering, mulch, and erosion control is to be provided for approval by Consultant.

Obtain Consultant’s approval of ground surface condition and growing medium before delivery and placement of Hydroseeding.

1.6 **Conditions For Substantial Performance**

Substantial Performance will be declared when all the conditions for Substantial Performance have been met including hydroseed and mulch germination and surface coverage.

1.7 **Establishment Maintenance**

Begin maintenance of Hydraulic Seeding immediately upon planting and continue until notice of Final Acceptance.

Landscape Maintenance shall be performed without the use of pesticides and herbicides. All municipal permits and bylaws shall be strictly adhered to.

A final inspection will be conducted by the Consultant at the end of the Warranty Period. The Consultant reserves the right to extend the Contractor’s Warranty responsibilities for an additional (1) year if, at the end of the initial Warranty Period, growth is not sufficient.
2. Products

2.1 Materials

Seed Mix Types are as follows:

Type One: ‘Enviro Turf Mix’ by Bluestem Nursery (Ph: 1.250.447.6363) or approved alternative.

Mixture composition (% Grass Seed by Weight) as follows:

- 10% Sheep Fescue \(Festuca\ ovina\)
- 20% Chewing Fescue \(Festuca\ commutata\)
- 30% Hard Fescue \(Festuca\ duriscula\)
- 20% Creeping Red Fescue \(Festuca\ rubra\)
- 20% Perennial Ryegrass \(Lolium\ perenne\)
- Lupinus perennis \((\text{Sundial Lupine})\)
- Erigeron cascadensis \((\text{Oregon Aster})\)

Note: Refer to Planting Plan for bulb plantings

Type 2: Modified Low Grow Coastal Fescue Mix or approved alternative.

Mixture composition (% Grass Seed by Weight) as follows:

- 20% Creeping Red Fescue \(Festuca\ rubra\)
- 20% Tall Fescue \(Festuca\ arundinacea\)
- 15% Hard Fescue \(Festuca\ duriscula\)
- 20% Perennial Ryegrass \(Lolium\ perenne\)
- 18% Sheep Fescue \(Festuca\ ovina\)
- 1.0% Red Top \(Agrostis\ alba\)
- 2.0% Canada Bluegrass \(Poa\ compressa\)

Note: No clover or BC noxious weeds

Growing Medium Refer also to Section 32 91 21 - Growing Medium and Finish Grading.

Mulch: Nontoxic, water activated hydraulic seeding solution dyed green for measurement

Tackifier (For Hydraseeding)

Fertilizer: Bio-Fert Manufacturing If required by soil analysis only:

Dolomite Lime: finely ground dolomite lime, containing not less than 90% calcium carbonate
3. **Execution**

3.1 **Preparation Of Surfaces**

Obtain Consultant's approval of grade and Growing Medium depth prior to seeding. Cultivate compacted areas to be seeded by scarification, discing, or harrowing to 150 mm. Fine grade areas to be seeded free of humps and hollows, free of weeds and refuse materials. Areas to be seeded must be moist to depth of 150 mm prior to seeding.

3.2 **Application**

Seeding Rates as per supplier recommendations. Blend seeded application 300 mm into adjacent grass areas or sodded areas to form uniform surfaces. Re-apply seed where application is damaged, not uniform, or having inadequate germination as directed by Consultant and at no cost to Owner.

Bulbs Plantings: install up to 48 hours prior to hydroseeding.

END OF SECTION
APPENDIX E
JOHNSON STREET BRIDGE
DRAFT LANDSCAPE WORKS

SODDING
SECTION 32 84 10

1. General

1.1 Documents

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

1.2 Section Includes

Provide all labour, materials, equipment necessary to supply and complete Sodding of site landscape including: subgrade preparation, growing medium placement, sod placement, and maintenance as specified herein and as indicated on Drawings.

2. Products

2.1 Materials

Nursery Sod: Turf Grass Nursery Sod type: Number One Premium Class 1 Lawn

3. Execution

3.1 Preparation

Unless otherwise specified, Growing Medium for turf shall be the supplier standard including gradation and type of sand with additional 50mm sand based growing medium. Verify that grades are correct and prepared to approval of Consultant.

3.2 Sod Placement

Obtain approval of subgrade and depth before starting sodding. Water immediately after placement. Lay sod sections in rows, joints staggered. Butt sections closely without overlapping or leaving gaps between sections and roll.

3.3 Sod Placement On Slopes And Pegging


3.4 Maintenance During Establishment Period

Water sodded areas in sufficient quantities and at frequency required to maintain optimum soil moisture condition to depth of 100 mm.

Eliminate weeds by hand means acceptable to Owner.

Fertilize sodded areas one month after installation. Spread evenly and water in well. Postpone fertilizing until next spring if application falls within four week period prior to expected end of growth season in locality.
3.5 Acceptance

Sod areas will be accepted by Consultant at Final Acceptance provided that:

- Sodded areas are properly established.
- Sod is free of bare and dead spots.
- No surface soil is visible and grass has been cut to height of 60mm at least 2 times.
- Lawns sodded in fall will be accepted in following spring one month after start of growing season provided acceptance conditions are fulfilled.

END OF SECTION
TREES, SHRUBS, AND GROUNDCOVER PLANTING
SECTION 32 93 10

1. General

1.1 Documents

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

1.2 Description

Furnish all labour, materials, equipment services necessary to supply and install Trees, Shrubs, and groundcover as shown on the Contract Drawings including all preparatory work, mulching, staking, and all related activities necessary including Establishment Maintenance to meet Conditions of Final Completion.

1.3 References

Latest edition: BCSLA and BCLNA Standards.

1.4 Quality Assurance

Nursery must have minimum (3) years documented experience specializing in growing and cultivating plants.

Installation Qualifications: Company must specialize in installation and planting with a minimum of (5) years documented experience including: Tree Pruning Qualifications and Qualified Maintenance Services.

1.5 Substitutions

Before substitutions of plant material are proposed, documented proof that materials are not available through search Lower Mainland of British Columbia, Vancouver Island, Washington and Oregon States, except as noted on the plant list.

Substitution will be considered for using the nearest equivalent size or variety with an equitable adjustment of the Contract price.

1.6 Inspection

Notify the Consultant, giving at least 48 hours’ notice when plants are assembled for inspection in one location ten (10) days prior to scheduled planting time. All plants are subject to inspection and may be rejected, replaced, and removed from the site at no cost.

1.7 Conditions Of Acceptance

The conditions for Acceptance of landscape areas and for turning over the landscape areas to the Owner for subsequent maintenance are:

Growing medium quality, fertility levels, depths and surface grading have been completed.

Plant quantities, sizes, quality and locations are approved.
Substantial Performance for the complete project shall have been declared.

1.8 Warranty

Replace for a period of one (1) year after Substantial Performance of the project, all unsatisfactory plant material and continue to replace such plant material until the replacement is acceptable to the COV, at no cost.

2. Products

2.1 Plant Material

Nursery stock shall be true to name, and of the size or grade stated and to the measurements specified in the plant list. Measurements specified are minimum size acceptable for each variety.

2.2 Growing Medium And Amendments

Growing Medium, Fertilizer, Peat Moss, Bone Meal, Lime and Mulch as per Section 32 91 21 - Growing Medium and Finish Grading.

2.3 Accessories

Wood Tree stakes: Fir, standard or better, 75mm x 75mm x 3000mm. Cable, Wire, Eye Bolts and Turnbuckles: Non corrosive.

Plant Protectors: Arborguard or approved alternative.

Mulch: Mulch: 50mm depth approved uniform blend of organic materials.

Tree ties: Transmission Type fabric belting 25mm in width.

Anti dessicant: horticulturally accepted non toxic, non hardening emulsion.

Flagging tape: Fluorescent colour to be removed at Substantial Completion.

3. Execution

3.1 Pre-Planting Preparation

Verify that prepared subsoil and subgrade is approved by Consultant. Ensure plant material is acceptable to Consultant and plant only during the season or seasons normal for such work determined by weather conditions and or as approved by Consultant. Plants planted before or after any stipulated dates will be rejected.

3.2 Excavation And Preparation Of Planting Beds

Preparation of planting beds, soil placement and finish grading as per Section 32 91 19.13 - Growing Medium Placement and Grading. For individual planting holes:

Stake out location and obtain approval from Consultant prior to excavating.

Scarify sides of planting hole and loosen bottom 6” – 12” (150 – 300 mm). Contractor to ensure positive drainage at bottom of planting hole prior to installation. Notify Consultant if water source, ground water is present.
3.3 PLANTING

Loosen and cut away top one third of wrapping and wire basket without damaging root ball. Do not pull burlap or rope from under root ball. Non-biodegradable wrappings must be removed.

Trees and Shrubs backfilling:

Backfill soil in 6” (150 mm) lifts. Tamp each lift to eliminate air pockets. When two thirds of depth of planting pit has been backfilled, fill remaining space with water. After water has penetrated into soil, backfill to finish grade.

Form watering saucer as indicated. Water thoroughly and ensure saturation of root ball.

Bulbs: plant at a depth of two to three times bulb’s width. Add handful of growing medium, compost, and bone meal to the planting hole. Plant up to 4-8 bulbs in random clumps for every square metre prior to seeding.

Water plant material thoroughly. After soil settlement has occurred, fill with soil to finish grade.

Dispose of burlap, wire, tags and labels, and container material off site.

3.4 Fertilizer Application

Fertilize as per soil testing recommendations.

3.5 Tree Supports

Double stake tree support for deciduous trees less than 3 m (10’) and evergreens less than 2 m (6-1/2’).

3 guy wires and anchors for deciduous trees greater than 10’ (3 m) and evergreens greater than 6-1/2’ (2 m).

3.6 Mulching

Mulch all trees, tree surrounds, shrub and groundcover planting areas to a 2” (50mm) depth.

3.7 Pruning

No pruning of any plant material shall commence without prior approval of Consultant or under direction of Arborist.

3.8 Maintenance During Establishment Period (Until Certificate Of Substantial Is Issued)

Begin maintenance at time of planting and continue for at least fifty five (55) days until Acceptance, at which time the Owner will take over maintenance.

3.9 Replacements

Replace each defective or dead plant within 72 hours after notification by the Consultant and continue to replace each plant until it has established itself to the satisfaction of the Consultant.
All required replacements shall be plants of the same size and species as specified on the plant list and shall be supplied and planted in accordance with the Drawings, Specifications and Change Orders thereto or as directed by Consultant.

The cost of replacements resulting from theft, accidental damage, vandalism, carelessness, neglect on the part of others, shall be borne by the Landscape Contractor until the certified date of Substantial Performance.

The cost of replacements resulting from theft, accidental damage, vandalism, carelessness or neglect on the part of others after the certified date of Substantial Performance shall be borne by the Owner.

3.10 Acceptance

Planting will be accepted by Consultant at the end of Maintenance Period provided that all deficiencies have been corrected to the satisfaction of the Consultant, material exhibits healthy growing condition and is free from disease, insects, and fungal organisms.

END OF SECTION
This document is a preliminary statement of intent setting out the nature of the control system required. This is not a final design or specification for the control system. This has been prepared in order to enable appropriate parties to arrive at outline costs and to consider wiring and installation issues arising from lighting control requirements.

This document should be read in conjunction with all other S+M 60% Design Development documentation.

General description of system

A lighting control system is required for the lighting scheme designed by Speirs + Major for the Johnson Street Bridge project.

The control system will be able to provide static lighting scenes to the bridge.

The system is potentially to incorporate an interface to the city management system and other systems as required by the Client as well as a user front-end for management, maintenance and over-ride.

Areas

Areas to be controlled by the system include the bridge to the scope lines as outlined in the Speirs + Major drawing package including:

Bridge Structure – Moving Portion and Fixed Spans
Roadway and Bikeway adjacent
Pedestrian and Pedestrian/Bikeway
Bus Shelter
Control Room

Other areas may be added to the system’s scope as the design develops.
Lighting Control System

The intent is to utilise the lighting control system to trigger a series of static lighting scenes depending on time of day, weather conditions, bridge opening and special event requirements.

On an average day the lighting will come on to a standard scene in response to sunset or low sunlight levels to light the structure and ensure that the roadway and pedestrian/bikeways are safe and pleasant environments.

For the average day bridge opening, there will be a specific scene triggered by the bridge operating systems.

The majority of the public realm lighting will remain on until one half hour before sunrise. At an agreed hour, perhaps 3am, all non-required/statutory lighting will switch off to reduce energy consumption and running costs.

The control room will have its own control panel to allow for local and personal control over this zone.

For special events additional event lighting will be brought in and will require interface with the control system.

Loads to be controlled are presently as shown on S+M 60% Design Development information.

Inputs will include external daylight sensing, timeclock, touch screen, push button panel and two-way data interfaces with other systems.

Various established manufacturers are capable of designing and supplying an appropriate system.

A performance specification will be prepared for the control system during detailed design.
Preliminary Logical Control Channel Schedule

| Project:       | Johnson Street Bridge  
| Project Number: | Victoria, B.C, Canada  
| Project Number: | 3410  
| Document Number: | 3410-CS-001  
| Revision: | 01  

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<th>Control Gear Type</th>
<th>Lamp Load Per Unit</th>
<th>Total Lamp Load</th>
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<th>Behaviour</th>
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1.0 The attached are preliminary estimated quantities, types and lamp loads only.

2.0 Electrical loads are nominal lamp loads only and do not include ballast and transformer losses, motors, fans or any other loads which may exist within a luminaire. Detailed information on these loads cannot be provided until detailed specification is undertaken.

3.0 Lamp Types
- Tungsten (Mains Voltage)
- Low-Voltage ≤24V (Tungsten Halogen/Xenon)
- Tungsten Halogen (Mains Voltage)
- FLU Linear Fluorescent
- CFLU Compact Fluorescent
- HID High Intensity Discharge
- LED Light Emitting Diode
- C/C Cold Cathode
- NONE None

4.0 Gear Types
- MTX Magnetic transformer
- MB Magnetic ballast
- ETX Electronic transformer
- EB Electronic ballast
- LED Electronic LED driver
- NONE None

5.0 Power Control
- CON Constant (Unswitched by lighting control system)
- LDIM Leading Edge Dim
- TDM Trailing Edge Dim
- SDIM Sine Wave Dim
- SW Switched (by lighting control system)

6.0 Control Data
- 0-10V 0-10V Analogue
- 1-10V 1-10V Analogue
- DALI DALI
- DMX DMX512
- DSI Tridonic DSI
- NONE None
- OTHER Other
- PROP Proprietary

7.0 Behaviour
This is a general description only of the intended behaviour of the lights indicated.

8.0 Quantities are estimated against current drawing information and should be checked by others. Speirs + Major are not responsible for final take-offs of quantities from drawings.

9.0 All quantities should be checked by Quantity Surveyor.

10.0 All electrical loads should be checked by Electrical Engineer.

11.0 Speirs + Major will not be held responsible for the content of electronic versions of this document if they are in any way changed by any other party.
APPENDIX E

JOHNSON STREET BRIDGE
MECHANICAL SPECIFICATION

RFP NO. 12-011

M1. GENERAL

The mechanical work shall be as shown on sheets M1 though M15 of the Contract Drawings and as specified in these Specification. This work shall consist of providing span drive machinery, span support machinery and toe lock machinery and also achieving satisfactory balance of the movable span.

The Contractor shall be responsible for the coordination of the mechanical work with all other work items as necessary to produce completed systems which meet the requirements and intent of the Contract Documents. This work shall include furnishing all labour, materials, tools, services and equipment required to perform the installation, adjustment and testing of the mechanical machinery shown on the Contract Drawings and as indicated herein.

Standards

All new machinery items must meet the requirements of the National Standard of Canada CAN/CSA-S6-06 Canadian Highway Bridge Design Code, hereinafter referred to as CHBDC.

Standards referred to in the Supplementary General Conditions and on the Contract Drawings are published by the following organizations and are directly applicable to the material and workmanship required for this work:

a) ASTM - American Society for Testing and Material
b) ANSI - American National Standards Institute
c) CSA - Canadian Standards Association
d) American Association of State Highway Transportation Officials (AASHTO)
e) American Iron and Steel Institute (AISI)
f) American Gear Manufacturers Association (AGMA)
g) Society of Automotive Engineers (SAE)
h) National Electrical Manufacturers Association (NEMA)
i) American Bearing Manufacturers Association (ABMA)
j) Society for Protective Coatings (SSPC)

Substitutions

Items specified by manufacturer name or part number within these Specifications may be replaced by an equivalent item by another manufacturer, subject to approval by the Consultant, with the understanding that all changes required by the substitution shall be made by the Contractor at no additional cost to the City. Item equivalency shall be determined at the sole discretion of the Consultant and may be based on one or more of the following: quality, function, ease of maintenance, physical size, reliability, value, load capacity (static and dynamic), durability, standardized components, availability and other criteria as deemed appropriate by the Consultant.

SUBMISSION REQUIREMENTS

Shop Drawings, Final Record Drawings, Certified Drawings, Shop Fabrication and Assembly Quality Assurance and Quality Control Documentation, Operation and Maintenance Manual, Machinery Installation Procedures and other required submittals specified within these Specifications shall be submitted to the City for review. Submittals that do not meet the minimum requirements identified below will be considered non-responsive and will be returned without review. Submittals that have not been approved or require correction shall be resubmitted until such time as they are acceptable to the Consultant, and such procedure shall not be considered cause for delay. The Contractor shall bear all costs for damages which may result from ordering or fabrication of any materials prior to acceptance of Shop Drawings. The Contractor may request in writing from the Consultant approval to order raw materials of the correct type for later fabrication from approved Shop Drawings after they have been accepted. Such approval by the Consultant shall be in writing. No installation or
assembly of mechanical components shall commence without approved installation and alignment procedures and supporting Assembly or Erection Drawings.

Material Submittals

The Contractor shall submit copies of producer or manufacturer data for raw materials or standard or proprietary products. These shall include specifications, tests, and installation instructions for the following items, but not excluding other items or materials not specifically mentioned.

- a) Couplings
- b) Speed Reducers
- c) Pillow block bearings
- d) Mill reports and physical tests of all metals
- e) Bolts, nuts, washers, and other fasteners
- f) Paint
- g) Lubricants
- h) Standard stocked items

Any submittals that do not contain all documents required for the manufacture, assembly and erection of the machinery system will be returned without review.

Dimensions/Certified Drawings

The dimensions indicated on the Contract Drawings for standard manufactured products have been obtained from information provided by various machinery manufacturers. The dimensions have not been obtained from certified drawings (certified drawings are drawings certified by the manufacturer to be dimensionally accurate and which contain sufficient details to determine if the requirements of the contract documents have been satisfied). The Contractor shall obtain certified drawings for all manufactured products and utilize the certified dimensions in the preparation of the Shop and Erection Drawings. The certified drawings shall be submitted in support of the Shop Drawings. The Contractor shall notify the Consultant of any dimensional deviations from the Contract Drawings.

Drawing Submittals

Working drawings shall be prepared to depict all work to be performed as part of this Contract. Shop and Assembly Drawings shall be submitted for all components that are custom built for this project. Any deviations from the work depicted on the Contract Drawings or alterations proposed by the Contractor which affect the integrity or capacity of the machinery shall be signed and sealed by a Professional Engineer licensed in British Columbia, Canada.

Under no circumstance shall machinery be fabricated, assembled, or erected from the Contract Drawings. Working drawings which are reproductions of the Contract Drawings, either in part or in their entirety, shall be considered non-responsive and shall be returned without review.

The Contractor shall submit six copies of all working drawings, unless otherwise directed, that include Shop, Assembly, and Erection Drawings. All working drawings shall conform to the following:

- a) All drawings shall be drawn to scale. All details of a given part shall be clearly visible at the scale selected for that part with the exception that enlarged views of small details within a part may be used to improve clarity and prevent excessively large drawings.
- b) Separate details shall be provided for all opposite hand components.
- c) Drawings shall be prepared using the SI system of units. This shall apply to all dimensions, surface finishes and fits between mating components. The Contractor may include English units parenthetically if so desired.
- d) The surface finish of machined surfaces.
e) Tolerances shall be provided for all drawing dimensions, either directly or via a standard tolerance block.

f) Parts shall be dimensioned with appropriate tolerances to ensure that components of a common purpose that are fabricated from the same detail are interchangeable.

g) Materials for each item shall be given using reference to standard specifications by the organizations listed under General Materials.

h) All appropriate weld symbols along with stress relieving process for weldments.

i) Instructions for painting the machinery.

j) The type of tightening, type of wrench, the required tension, and other pertinent information of all connection bolts for all items and machinery.

k) Proprietary parts shall be shown in outline on the drawings with sufficient dimensions and data to determine the clearances required for installation and operation.

l) Certified dimension prints from equipment manufacturers shall state pertinent ratings of the equipment, and shall indicate, when applicable, provisions for adding, draining, and checking the lubricant, method of lubrication, amount and type of lubricant required and type of fittings, the location of inspection openings and the location and type of venting devices.

m) The Contractor shall identify conflicts between manufacturers’ instructions and Contract Documents and submit resolution for review and approval.

n) The Contractor shall identify variations between Contract Documents and product or system limitations that may be detrimental to the successful performance of the completed work.

o) Complete shop Bill of Materials shall be included for all machinery parts. The computed shipping and operating weights of each piece of machinery shall be stated on the Shop Drawing upon which it is detailed.

p) Complete Assembly and Erection drawings shall be furnished. These drawings shall clearly indicate how the work is to be performed.

q) Assembly and Erection Drawings shall be given identifying marks and essential dimensions for locating each part or assembled unit with respect to the bridge or equipment foundation. Each part shall be cross-referenced to the Shop Drawing on which it is detailed.

r) Final “As-Built” Shop, Assembly and Erection Drawings shall be submitted at the completion of the project. Any deviations from the approved Shop Drawings shall be clearly indicated. Reproducible drawings shall be made on the City’s standard title block. These drawings shall be stamped “As Built”, immediately above the title block.

s) The Contractor shall sequentially number all transmittal forms. Resubmittals shall be numbered with original submittal number and an alphabetic suffix.

**Shop Fabrication and Assembly Quality Assurance and Quality Control Documentation**

The Contractor shall submit shop fabrication and assembly quality assurance and quality control documentation to the Consultant for approval. These forms shall verify that all the major features of the fabricated parts meet the requirements of the shop drawings. These forms shall also verify that alignment of all the machinery meets the requirements of the shop drawings. These forms as a minimum shall include the name of the entity responsible for the inspection, the inspectors name, date and time performed, requirements of the shop drawings, and actual measurements for the part. Once these documents are approved by the Consultant the assemblies can be shipped to the field.

**Procedure Submittals**

The Contractor shall submit procedures providing a step-by-step breakdown of all construction activities for each major work item identified on sheet M2 of the Contract Drawings. The procedures should clearly indicate the order in which each item is to be performed and should accurately reflect the flow of construction in the field. The procedures should constitute a suitable working document for construction supervision in the field.
The procedures shall address machinery installation means and methods, alignment methods and tolerances, bolt tightening methods, and torque values. The procedures shall contain sufficient detail to demonstrate to the Consultant that the Contractor has full knowledge of machinery connections, alignment procedures, and all other work to be performed as part of this Contract.

Installation procedures for components of standard manufacture shall contain the manufacturer’s recommended alignment tolerances for a new installation, which will be the basis for acceptance of such parts. Installation procedures for custom-manufactured components shall contain alignment tolerances as specified in the Contract Documents.

Submittal quantities and acceptance guidelines shall be per the Drawing Submittals requirements.

**Schedule Submittals**

The Contractor shall submit a detailed work schedule identifying the progression of work to be performed under this Contract. The schedule shall include, as a minimum, all major work items identified on sheet M2 of the Contract Drawings. When work is to be performed during a marine outage, the schedule shall provide a daily or hourly task breakdown clearly identifying those tasks on the critical path to return the bridge to service within the allotted outage. All tasks shall be referenced to the main work items in the approved work procedures.

Reference the XXX “Operational Constraints” of these Contract Documents for required notification for marine outages associated with the Mechanical Work.

Submittal quantities and acceptance guidelines shall be per the Drawing Submittals requirements.

**Operating, Maintenance, and Lubrication Manuals**

The Contractor shall provide an Operation, Maintenance, and Lubrication Manual for all components provided. Six preliminary copies of the Manual shall be submitted for review by the Consultant prior to shipment of machinery to the site. The preliminary manual shall be complete in all respects with regard to material content, organization and legibility. Preliminary copies need not comply with presentation requirements including page size, paper weight, paper reinforcement and protection including oil, moisture and wear resistant covers, and copy method.

Preliminary copies will be reviewed by the Consultant and all review comments shall be incorporated into the final manual by the Contractor. Six final hard copies of the Manual and one electronic copy (PDF or alternative format selected by the Contractor and approved by the Consultant) shall be submitted after the machinery is in operation. The final manual shall incorporate all of the Consultant’s comments on the preliminary manual and all field changes made during construction and installation. Final copies shall also comply with all presentation requirements to ensure permanence of the manuals.

The Operating, Maintenance, and Lubrication Manual shall include the following items:

a) Table of contents, in numerical order.

b) Index, in alphabetical order.

c) Manufacturer’s literature describing each piece of equipment, giving manufacturer’s model number and drawing number for standard manufactured units.

d) Manufacturer’s operating and maintenance manuals giving complete instructions relative to assembly, installation, operation, adjustment, lubrication, maintenance, and carrying complete parts lists. Manuals may be manufacturer’s standard publications for standard manufactured units provided that they comply with specified requirements relative to quantity and quality of information and data. Include copies of lubrication charts.

e) Copies of all warranties on equipment supplied to the project.

f) Copies of all approved machinery installation procedures.

g) Copies of all Shop, Assembly, and Erection drawings. These drawings to be included “as built” in the final version of the manual.

h) Complete details and procedures for adjusting all items that have adjustments to compensate for wear.
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MECHANICAL SPECIFICATION

i) Steps for cursory inspection that should be carried out annually.

j) Steps for semi-in-depth inspection that should be carried out every three years.

k) Steps for in-depth inspection that should be carried out every six years.

l) List of nearest local suppliers of all equipment parts.

m) List of parts and supplies that are to be furnished as part of the Contract.

n) Name, address, and telephone number of the local manufacturer’s representative and of the service company for each piece of equipment so that prices or spare parts can easily be obtained.

The covers and title page shall be neatly imprinted with a descriptive title and shall contain the name of the bridge, owner, and location. The title page shall also contain the names of the Consultant, the Contractor, and the date of issue. Divider pages with tabs shall separate the various sections which comprise the Manual. All parts information shall be correct for the equipment provided under this Contract. If standard parts drawings are used, they shall be modified to be suitable and irrelevant material shall be blocked out. All general information used as text shall be modified where necessary to show pertinence to the equipment furnished under this Contract, and irrelevant material shall be removed. The arrangement of the manual, method of binding, including material and text shall be submitted to the Consultant for approval.

Illustrations shall be clear. Printed matter, including dimensions and lettering on drawings, shall be easily legible. If reduced drawings are incorporated into the manuals, the original lines and letters shall be darkened if necessary to retain their legibility after reduction. Larger drawings may be folded into manuals to page size. Diagrams and prints used in the manual shall be reproduced to a size not to exceed 279 mm by 432 mm and shall be complete and legible in all respects. Diagrams shall be made on white paper and vacuum sealed in transparent plastic material impervious to moisture and oil, and resistant to abrasion. Other formats which are equal in clarity, sharpness, durability and permanence will be considered.

Manuals shall be prepared from the following materials:

a) Tear, water, and grease resistant paper.

b) Page size, 216 mm by 279 mm.

c) Fold out diagrams and illustrations.

d) Reproducible by dry copy xerography method.

e) Oil, moisture and wear resistant plastic covers.

Lubrication Charts

The Contractor shall furnish a lubrication plan for all machinery including all electrical machinery that requires periodic lubrication to the Consultant for approval. The plan shall be developed from recommendations made by the machinery manufacturers and shall be in accordance with the machinery lubrication described in these Supplementary General Conditions. The Contractor shall coordinate the lubrication plans for the various machinery elements and minimize the number of different lubricants required.

The Contractor shall furnish a minimum of five separate lubrication charts (one for the span drive machinery in the machinery room, two for the span support machinery, one in the vicinity of each support, one for the toe lock machinery at the toe locks, and a copy of each chart in the operator’s house) which shall show all points requiring lubrication with type of lubricant to be used at each point, the frequency and the method of lubrication and the minimum lubrication change frequency. All electrical components related to the span drive machinery and span lock machinery, which require lubrication, shall be shown on the charts. The lubrication charts shall be produced on a minimum of 297mm by 420mm. Make charts by laser engraving on 1.6mm thick, Type 316 stainless steel sheet. Use lettering that is a minimum of 6mm high. Paper copies of the charts shall be submitted to the Consultant for approval and once approved the stainless steel engraved charts shall be mounted using stainless steel hardware. Mount the lubrication charts in the machinery room, in the vicinity of each support, in the toe lock machinery area and in the operator’s house as directed by the City.

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QUALIFICATIONS

Only individuals of high competence shall be utilized to perform the work required by this Contract. Competence shall be evaluated through the following criteria:

Supervising Personnel

The installation and adjustment of all mechanical work as defined in these Supplementary General Conditions shall be supervised and directed by foremen and supervising Consultants who shall be on-site on a daily basis while work is on-going. Personnel proposed for this role shall have a minimum installation and design experience of two movable bridge machinery projects. Evidence of experience shall be submitted in resume format to the Consultant for approval and shall include the following:

a) Description of two movable bridge machinery projects to include the type of bridge and type and size of mechanical machinery drives associated with the project
b) Duration of each project including start and completion dates
c) Position held for each project
d) Location of each project
e) References, including names and current contact information for each project

Workforce

The installation and adjustment of all mechanical work defined in these Supplementary General Conditions shall be performed by millwrights experienced in this class of work. The millwrights must have a minimum of five years’ experience in the wide range of skills typically associated with the millwright profession. The workers’ experience shall include disassembly, installation, and precise alignment of bearings, shafts, gearing and other mechanical machinery of similar size to the machinery to be worked on or supplied under this Contract. In addition, the workers shall have demonstrated experience with all aspects of the tools and equipment typically associated with this type of work. Evidence of experience shall be submitted in resume format to the Consultant for approval and shall include the following:

a) Description of applicable projects over a five year period, to include types and size of mechanical machinery associated with the project
b) Duration of each project including start and completion dates
c) Position held for each project
d) Location of each project
e) References, including names and current contact information for each project

Any evidence indicating that the relevant aspects of the work for one or more of the projects submitted as experience was not performed by the candidate or that the work was not performed to the satisfaction of the owner/reference will be cause for rejection. The mechanical work shall be conducted only by personnel who have been approved by the Consultant.

General Quality Assurance

The Contracting Agency reserves the right to inspect all machinery at the point of manufacture prior to shipping. No items shall be fabricated, machined, welded, cast or forged without sufficient advance notification to the Consultant to permit scheduling of inspection. The Contractor shall furnish all facilities and provide for free access at the plant or shop for the inspection of material and workmanship, and to witness shop tests.

The Inspector shall base all inspections on the requirements of the Contract Drawings, the Supplementary General Conditions, any referenced codes or standards and the Contractor's approved submittal documents. The Inspector shall have the authority to recommend to the Consultant rejection of material or workmanship that does not satisfy Contract requirements. The final decision for rejection shall be made by the Consultant. The Contractor shall replace or repair to the satisfaction of the Consultant any such rejected item. All such replacements or repairs shall be made at no cost to the City.
The City or its designated representative will make inspections of equipment and machinery throughout the construction period. Any defects, deficiencies, or deviations from the Contract Drawings or Supplementary General Conditions discovered during such inspections shall be corrected at no cost to the City. Shop approval of machinery does not relieve the Contractor from making such repairs to parts which are found to be deficient at a later time (regardless of prior inspection or approval) as directed by the City.

The Contractor shall furnish without charge test specimens required and all labour, testing machines, tools, and equipment necessary for physical tests and chemical analyses. Copies of test reports for all tests shall be submitted to the Consultant.

MATERIALS

General Materials and Workmanship

a) All materials shall be new and conform to ASTM standards and other standards listed in these Supplementary General Conditions and on the Contract Drawings, unless noted otherwise.

b) Supply materials from manufacturers who have manufactured similar materials for similar applications for a period of not less than ten years.

c) Brinell or Rockwell hardness tests shall be made and results included on inspection reports for all materials for which hardness values are required on the Contract Drawings, in the material specifications, or specified herein.

d) Do not fabricate, machine, weld, cast or forge items without sufficient advance notification to the Consultant to permit scheduling of required inspection. Furnish all facilities and provide for free access at the plant or shop for the inspection of materials and workmanship, and to witness shop tests. The inspector has the authority to recommend to the Consultant rejection of material or workmanship that does not meet the requirements of the Contract Documents. The Consultant shall make the final decision for rejection.

e) Furnish the Consultant with the number of unpriced copies of purchase orders as may be required for scheduling tests as outlined in these Supplementary General Conditions.

f) Unless otherwise provided, furnish without charge, test specimens required herein and all labour, testing machines, tools and equipment necessary to prepare the specimens and to make the physical tests and chemical analyses. Submit copies of test reports and various tests to the Consultant.

Grout

Provide Non-Shrink Epoxy Grout for all grout identified in the Contract Drawings underneath machinery supports. See Non-Shrink Epoxy Grout section for details.

Bronze Castings

Material for bronze castings shall be as indicated on the Contract Drawings and shall meet the requirements for Castings. Bronze castings shall be provided with grease grooves as indicated on the Contract Drawings. The grease grooves shall have smooth edges that blend smoothly in the bearing surface. The entry hole from the grease fitting must intersect and lie completely within the grooves. All grease grooves shall be machine cut. Hand cutting of grease grooves is not acceptable.

Casting

Casting shall be free of defects such as sand and slag inclusions, cracks, cold shuts, shrink holes, blow holes, porosity, free of loose scale and sand, fins, seams, gates, risers and irregularities. Unfinished edges shall be neatly cast with rounded corners and inside angles shall have ample fillets.

Unless otherwise indicated in the Contract Drawings, perform visual surface examinations of steel castings per ASTM A802, liquid-penetrant exams in accordance with ASTM E165, or magnetic particle exams in accordance with ASTM E709 in the manufacturer’s shop, for each casting.
Unless otherwise indicated in the Contract Drawings, perform visual surface examinations of bronze castings per MIL-STD-271F, or liquid-penetrant exams in accordance with ASTM E165 in the manufacturer's shop, for each casting.

Identify and remove unacceptable surface discontinuities in accordance with ASTM A802. Obtain approval from the Consultant before making any necessary major (as defined in ASTM A781 S16 Weld Repair Charts) weld repairs. Perform radiographic examination of welds per ASTM E94. Any aberrant indications must be brought to the Consultant’s attention for review and may result in rejection of the weld repair.

**Fasteners**

Bolts smaller than 38mm (1 ½”): high strength heavy hex bolts made from material equal to ASTM A325M unless otherwise specified on the Contract Drawings.

Bolts greater than 38mm (1 ½”): made from material equal to ASTM A449-07b.

Hole size for all bolts not identified as turned bolts are to be 0.79 mm (1/32”) larger than the body diameter for bolts up to 25.4 mm (1”) diameter and 1.59 mm (1/16”) larger than the body diameter for bolts over 25.4 mm (1”) diameter.

All bolts: conform to the Unified Thread Standards, coarse thread series, for threads on bolts, nuts, and cap screws with a Class 2A tolerance for bolts and Class 2B tolerance for nuts, in accordance with ANSI/ASME B1.1-2003, unless otherwise specified. Bolt head and nut bearing surfaces must be flat and square with the axis of the bolt holes. Spot face as necessary to produce firm bearing around the entire perimeter of the mating surfaces.

Turned bolts are called out by nominal thread diameter on the Contract Drawings. The bodies of turned bolts shall be 1.6 micrometre (63 microinch) finish or finer, and as defined by CHBDC 13.8.17.8, unless noted otherwise on the Contract Drawings or herein. Turned bolt body diameters shall be 1.6 mm larger than thread diameter. Turned bolt heads shall be standard hex for bolts of the next nominal size larger than the thread diameter or heavy hex for nominal thread diameter, unless noted otherwise on the Contract Drawings. Unless otherwise noted, bolt holes in machinery parts required for connecting to supporting steel may be sub-drilled (in the shop) smaller than the turned bolt diameter and shall be reamed together with supporting structural steel either during assembly or at erection to provide an LC6 fit, after the parts are correctly assembled and aligned.

All hexagon socket flat countersunk head cap screws shall conform to ANSI B18.3.5. Where utilized as turned bolts, hex socket flat countersunk head cap screws shall be manufactured from ASTM F835 with turned body dimensions meeting the requirements for turned bolts dimensions provided above. Where called out as brass, flat countersunk cap screws shall meet ASTM F436 Alloy Cu270.

Hex socket head cap screws: ASTM A574M-08.

Hex socket flat countersunk head cap screws: ASTM F835-04e1.

Stainless Steel hex cap screws: ASTM F593-02 (2008)

Hex cap screws: ASTM A449-07b


Brass hex socket flat countersunk head cap screws: ASTM F468M-06e1

Bronze bolt or bronze cap screws: ASTM F468M-06e1, Alloy Cu 651

Furnish positive type lock nuts and hardened washers for all bolts and for all flat countersunk head cap screws used as bolts. Double heavy hex nuts conforming to ASTM A563-07a are required unless indicated otherwise on the Contract Drawings. Submit alternate locking methods to the Consultant for approval. All hardened steel washers shall be in accordance with ASTM F436-09.

Tighten fasteners to provide a tension of 50% of the bolt’s ultimate tensile strength unless otherwise specified on the drawings. Provide the method of tightening and of verifying the tension in all bolts on the Shop Drawings for approval by the Consultant.
Forgings

Forged shafts and bars shall be reduced to size from a single bloom or ingot until perfect homogeneity is obtained. Blooms and ingots shall have a cross section area equal to at least three times the required size. Forging shall be done at no less than red heat. Rounds for shafts shall be true, straight and free from all injurious flaws such as piping, laps, seams or cracks. Finished ends of shafts shall have a 60 degree lathe center with clearance hole at the exact center of the shaft. Shafts with bored holes shall have the ends prepared for a device equivalent to the lathe centering device furnished as part of the work unless detailed otherwise on the Contract Drawings. Stepped shafts shall have fillets finished smoothly to adjacent surfaces without tool marks or scratches. Surface finish for fillets shall have a maximum roughness of 1.6 micrometre (63 microinch) according to ANSI Standard B46.1 unless a finer finish is required. Forgings shall be subjected to ultrasonic examination in accordance with ASTM A388. Any indications using the straight beam method that cannot be readily explained by the geometry of the piece shall be cause for rejection. Any forgings that are rejected shall be replaced at no cost to the City.

Where ASTM A668 forgings are used in weldments with plate steel, the Contractor shall ensure that the forgings meet ASTM A668 supplemental requirement S4 for low carbon content.

General Speed Reducer Requirements

All speed reducers shall be designed to current AGMA standards unless otherwise specified in these Supplementary General Conditions or on the Contract Drawings. Reducer gearing shall have ANSI/AGMA 2015-1-A01 quality of A8 or better. Allowable gear loads shall be based on AGMA 2001 Grade 1 materials. Reducers shall have an AGMA durability rating equal to or greater than the full load-rated horsepower of the driving motor at full load motor torque and speed with a service factor of 1.5. The AGMA strength rating shall provide for an overload of 300 percent of the motor full load torque. All speed reducer bearings shall be anti-friction type and provide an L10 life of 40,000 hours at motor full load speed and torque. All reducer shaft extensions shall have a minimum of two seals. The two seals shall be separated by a grease cavity which shall be equipped with a lube fitting and a pressure relief fitting. The seals used at the shaft extensions shall be easily replaced without removal of the components mounted on the shaft extensions. Double lip type seals are acceptable. The speed reducer manufacturer shall submit a proposed seal arrangement for review by the Consultant. All reducers shall support any overhung load they are subjected to. All reducers are to have steel housings provided with access ports for borescope inspection of the internal gearing. Reducer manufacturers shall submit the model, size and manufacture of all bearings and seals to facilitate future repairs.

All reducers shall have brass or stainless steel nameplates permanently fastened to the housing stating the following:

a) AGMA symbol
b) Manufacturer's name and address
c) Type of reducer
d) Date of manufacture
e) Model and size
f) Service horsepower
g) High speed shaft rpm
h) Service factor
i) Gear reduction ratio
j) Lubrication specifications, including AGMA lubricant number and viscosity in SSU at 100° F. The lubricant shall be suitable for year-round exposure at the bridge site.

Oil drains shall be provided for each reducer with bronze or stainless steel drain cocks to permit easy replacement of oil. The proper oil level shall be marked on the side of all housings in a readily visible location. A stand pipe with a threaded pipe cap shall be provided adjacent to the oil level indicator to permit checking the oil level. All speed reducers shall be provided with a moisture and particle blocking breather, Mobile-gate reservoir breather by Vickers or approved equal.
The reducer manufacturer shall subject all speed reducers provided under this Contract to the following shop tests:

a) After the reducers are completely assembled, they shall be filled completely with SAE 10W oil in the manufacturer’s plant to test for leaks. No leakage shall occur around seals, covers, welds, etc., with the reducer filled with oil for a minimum of one hour.

b) The reducers shall be subjected to a no-load test run at rated speed by the manufacturer for a minimum of one hour in each direction. During the test, the reducer shall be checked for unusual heat buildup and unusual noise. Noise level shall not exceed 90 dB at a one meter offset around the perimeter of the reducer housing as measured with a microphone. Bearing and seal temperatures shall be monitored and recorded every 15 minutes. Temperatures shall not exceed 120 degrees Celsius.

c) At the completion of the no-load testing, each reducer shall be subjected to 150-percent full load motor torque at rated speed for 1 hour in each direction, and then 200-percent full load motor torque at rated speed for 5 minutes in each direction. During the testing, the reducers shall be checked for unusual heat buildup, and unusual noise. Noise level of the reducer shall not exceed 90 db with the microphone held one meter from the reducer housing.

d) At the completion of the load testing, the reducers shall be drained and completely disassembled for examination of all gears and bearings. All gear sets shall exhibit a minimum of 85 percent of full face contact and there shall be no visible damage to any part of the reducers including the gear teeth. The manufacturer shall blue the gear teeth prior to testing to aid in this portion of the inspection.

e) After successful completion of the internal inspection, the reducers shall be reassembled and subjected to a no-load spin test for 30 minutes in each direction. There shall be no significant variation in the performance of the gear box versus the previous no load spin test.

f) As a final step, the leak test outlined in Step (a) shall be repeated. No further load testing is required if leakage is not present. The leakage shall be corrected and this step repeated until satisfactory results are attained.

g) The coupling manufacturer’s written approval is required to ensure that the coupling warranty has not been voided, if the couplings used in the 200 percent load test are to be re-used as part of the new machinery installation. If such approval is granted, the couplings shall be disassembled following the test for inspection of the internal wearing components. Any deficiencies shall be repaired to the satisfaction of the Consultant at no cost to the City. If approval is not granted, new couplings shall be furnished and installed at no additional cost for the new machinery installation.

All testing shall be performed by the manufacturer and witnessed by the Consultant. Failure to successfully complete any portion of this testing shall be cause for repair, realignment, and replacement as necessary. All load and no-load testing shall then be re-performed. Testing and inspection will continue in this manner for each reducer until it successfully completes the testing.

The planetary speed reducers shall be manufactured by the Bonfiglioli, PEM, Flender or approved equal.

General Coupling and Coupling Guard Requirements

Couplings shall be gear-type couplings unless specified otherwise. All couplings shall be oil tight under all operating conditions. Coupling halves shall be bored and keywayed by the coupling manufacturer and mounted by the manufacturer of the equipment on which it is to be mounted, or mounted in the field by the Contractor if the erection procedure so dictates. All couplings shall have a minimum service factor of 2.0 on the torque produced at the respective coupling location from motor full load torque while the motor is rotating at full speed. Coupling hubs shall be mounted to shafts with fit and finishes that comply with CHBDC 13.8.20.2. Coupling arrangement relative to the mating machinery shall be such that inspection of the internal wearing components is possible without removal of the coupling hub from the shaft on which it is mounted.

Motor couplings (SD10) shall be covered by guards. The Contractor shall provide details of all coupling guards and any required supports on the Shop Drawings. The coupling guards shall be Orange Peel type CCG bottom hinged guards or approved equal. The covers are to be bolted to the machinery supports or adjacent structural steel as necessary. Guards shall be sized or trimmed so that gaps with adjacent equipment with the guards in place are 6mm. The guards shall incorporate finger tightened stainless steel fasteners, hinged covers and/or
other features to enable safe removal by one person and to provide easy access to the couplings for maintenance and inspection.

**Hardness Requirements**

Brinell or Rockwell hardness tests shall be made and results included on inspection reports for all materials for which hardness values are required on the Contract Drawings, in the material specifications, or specified herein.

**Keys and Keyways**

Keys and keyways shall conform to dimensions and tolerances in accordance with ANSI B17.1 including keyseat radii and key chamfers and shall meet ANSI Class 2 fit requirements unless otherwise indicated in the Contract Drawings. Keys shall be effectively held in place by closed end keyways milled into the shafts for all machinery, including motor shafts. Ends of keyways shall be rounded to half circle with a diameter equal to the width of the key. Keys shall be machined from ASTM A668 Class K forgings unless noted otherwise on the Contract Drawings. Where more than one key is required, keys shall be located 120° apart.

**Lubrication Fittings and Piping**

Size of grease lubricating fittings shall be standardized and shall be of the giant button head type unless indicated otherwise on the Contract Drawings or unless the location of the fitting requires the use of a fitting that is smaller than the giant button head fitting. The Contractor shall provide a grease gun with adequate pressure to lubricate all necessary items. The gun shall have a minimum two foot hose. Fittings shall be located in a protected and conveniently accessible position for use and shall be connected to the points requiring lubrication by pipe extensions where necessary. All fittings and pipe material shall be stainless steel meeting ASTM A312 Type 304 or 316. All piping necessary to provide access for lubrication shall be clearly indicated on the Shop Drawings and all pipe components listed in the Bill of Materials.

Pipe nipples shall meet the requirements of ASTM B 687.

Pipe fittings shall meet the requirements of ASTM B 584.

Pipe shall meet the requirements of ASTM B 43.

**Lubrication**

During installation, the Contractor shall lubricate all rotating and sliding parts with lubricant as indicated on the approved charts. The surfaces of components which will rotate or slide relative to one another once assembled shall be lubricated prior to assembly. All clearance fits involving mating steel components shall be coated with a marine duty anti-seize compound prior to assembly.

Contact the City to obtain a list of lubricants currently in use. The Contractor shall verify that the existing lubricants used by the City are acceptable with the new component manufacturers for year round use at the bridge. If no such lubricant exists, the Contractor shall choose a lubricant that is compatible with the lubricants currently used by the City and matches the requirements listed below. The Contractor shall submit written documentation to the Consultant documenting this selection.

a) Enclosed Gear Reducers: Enclosed gear reducer lubrication shall meet the requirements of the American Gear Manufacturers Association (AGMA) Standard 250.04 “Lubrication of Industrial Gear Drives.” The lubricant shall be manufactured by a reputable and knowledgeable supplier of lubrication and shall be as recommended by the reducer manufacturer. The lubricant should contain oxidation inhibitors, rust inhibitors, anti-foaming agents, and anti-wear additives. The maintenance of the lubricant, method of application, and re-lubrication intervals shall be as recommended by both the reducer manufacturer and the lubricant manufacturer.

b) Open Gears: The open gear lubricant utilized must bond strongly to gear teeth to maintain a continuous film on bearing surfaces despite high loading and high load repetition, contain an EP (Extreme Pressure) additive, repel water, resist throw-off and dripping, maintain consistency over wide temperature variations, and allow for ease in application and removal. The lubricant shall have an operating range of -20°C to 100°C and shall be considered a heavy bodied, adhesive type open gear lubricant by its reputable lubricant manufacturer. Some adhesive lubricants are available in a diluted form for ease of application. This type of lubricant is diluted with solvent that quickly evaporates after application leaving behind an adhesive tacky film. If such a lubricant is desired, the solvent must be
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JOHNSON STREET BRIDGE MECHANICAL SPECIFICATION

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non-flammable and the mixture must not pose any hazard to health. The detailed specifications for open gear lubricants that will satisfy the above requirements do vary. Lubricant to Use: Unleaded, non-diluent type, non-chlorinated open gear grease, SUS 7,000 @ 100°F viscosity, water resistant, anti-wear/extreme pressure.

c) Roller Bearings: The roller bearing lubricant, the maintenance of the lubricant, method of application, and re-lubrication intervals shall be recommended or approved by the roller bearing manufacturer unless specified otherwise in the Contract Plans.

d) Sleeve/Plain Bearings: The lubricant chosen shall be approved for use in sleeve bearings by the lubricant manufacturer. Recommended Lubricant: NLGI No. 2 grease with rust and oxidation inhibiting additives, 280 Worked Penetration at 77°F [25°C], 340°F [171°C] (or higher) ASTM Drop Point, SUS 900 @ 100°F [37.8°C], water resistant, anti-wear/extreme pressure.

e) Couplings: Coupling lubricant and its maintenance shall be specified by the coupling manufacturer.

f) Proprietary units will use lubricants approved by the manufacturer.

The Contractor shall furnish the City with copies of letters from the machinery manufacturers endorsing the lubricants that have been selected. Lubricants shall be selected for year round exposure at the bridge. All lubricants shall be selected to be compatible with lubricants currently in use by the City. The Contractor shall submit written documentation indicating compatibility for any lubricant which is not in current use by the City.

The Contractor shall furnish an additional supply for future maintenance use to include, 72 – 14 oz. grease cartridges of open gear lubricant, 24 – 14 oz. each of type of grease, a quantity of brake thrustor oil sufficient to replace the oil in each thrustor one time, and a quantity of gear oil sufficient to replace the oil in each speed reducer once time. All lubricant shall be provided in the original manufacturer’s sealed container to prevent contamination. Contractor shall protect all lubricants used during construction from contamination.

The Contractor shall furnish one 450 Liter flammable liquid storage cabinet approximately 1650mm high x 1500mm wide x 860mm deep to be placed in the machinery room and one 105 Liter flammable liquid storage cabinet approximately 1110mm high x 860mm wide x 450mm deep to be placed on the west pear near the toe locks for storing the lubricants. The cabinet shall meet all applicable standards for storing lubrication including all welded design, 18 gauge double walled steel with 38mm insulating air space for fire resistance, adjustable leveling feet, lockable, 50mm high leak proof sump, and built in grounding connector.

Non-Shrink Epoxy Grout

Provide non-shrink epoxy grout for use under the machinery supports.


Linear shrinkage: less than 0.0001 mm./mm.

Store, mix, place, and finish non-shrink epoxy grout in strict accordance with the manufacturer's recommendations. As a minimum, the following steps shall be followed for installation of grout.

a) Prepare concrete surface for grouting by chipping away the relatively weak laitance layer and surface concrete to provide a coarse aggregate surface that is conducive to epoxy bonding.

b) Use appropriate means and methods in setting machinery bases and pedestals, such as leveling screws or precision jacks such that the required positioning tolerances are obtained. Jackscrew leveling pads (if used) shall be radiused on the edges to reduce stress concentrations in the grout. Remove the shims prior to tightening anchor bolts.

c) Block out areas around the anchor bolts to prevent grout from filling around the anchor bolts. Provide key hole washers for all anchor bolts to allow the annular space between the support and anchor bolt to be filled with epoxy after the anchor bolts have been tensioned.

d) Install grout so that the top of the grout is flush with the bottom of the support.

e) After the grout has cured, remove all temporary support devices, including leveling screws, jacks, and shims, and then tighten anchor bolts.

f) Fill the area around the anchor bolt with epoxy grout.
g) Finish the grout pad by providing a 45° chamfer at all edges.

Open Gearing

All cutter burrs and sharp edges shall be removed from all edges of the new gear teeth. AGMA quality number shall not be less than 8 for all gears, per AGMA Standard 390.03. Pitch lines shall be inscribed on both sides of all gear teeth; the inscribed pitch line shall be approximately 0.8mm (1/32") wide by 0.8mm (1/32") deep. Specific gear requirements, backlash requirements and geometry are provided on the Contract Drawings. Provide full fillets at the root of all gear teeth.

Painting

Paint for machinery and touch-up of field damaged paint shall be in conformance with the requirements noted in S26 "ITEM NO. 21 OF THE UNIT PRICE TABLE: Blast Cleaning and Painting of Structural Steel" of these Contact Documents unless specifically stipulated otherwise herein.

All machinery, including supports and fasteners, shall be painted in the shop in its entirety except for machined contact surfaces (e.g. brakewheel friction surfaces, etc.) and corrosion resistant fasteners.

All painting shall be in accordance with these Supplementary General Conditions and with the paint manufacturer's most stringent specification for surface preparation. If there is a conflict between them the most stringent specification will govern. Detailed instructions for painting, including paint manufacture information and surface preparation of the machinery, shall be provided on the Shop Drawings for review by the Consultant.

Painting shall be three coat painting with an inorganic zinc rich paint for corrosive environments in accordance with the paint manufacturer's specifications for all non-machined surfaces that can be blast cleaned. A modified aluminum epoxy mastic primer shall be used for all machined surfaces that require paint (e.g., couplings, shafts, and all other machined surfaces that cannot be blast cleaned). All three coats shall be applied in the shop. All paint surfaces that are damaged after shop painting is complete shall be cleaned and repainted as necessary to achieve the same level of protection provided by the shop painting.

Preparation of surfaces prior to painting shall be as recommended by the paint manufacturer and as approved by the Consultant. Caution shall be exercised during cleaning and painting operations to prevent cleaning and painting materials from entering machinery components and coming into contact with sliding surfaces on components such as bearings, seals, gears, couplings, and other components which would be damaged by such intrusion. Nameplates shall be clean and kept free of paint.

Galvanized surfaces shall not be painted.

The third coat shall color code the machinery with approved safety colours for machinery components. Color for the final coat shall be safety orange for all moving parts including shafts, couplings, brakewheel hubs, and any other moving part. Color for the final coat shall be safety green for all stationary parts including machinery supports and any other stationary part. Submit the colour scheme to the City for Approval.

Shafts and Pins

Provide rolled shafts and pins that meet the requirements of ASTM A675/A675M-03(2009) Grade 75 unless indicated otherwise on the contract drawings.

Shafts shall be finished accurately, round, smooth, and straight. Straightness tolerances shall be 0.025mm per meter (0.003" per foot). Forged shafts and pins shall meet the requirements for forgings.

For shafts with bored holes, prepare the ends of the shaft for a device equivalent to the lathe centering device and furnish as part of the work. Otherwise, provide a 60 degree lathe center with clearance hole at the exact center of the shaft for finished ends of forged shafts.

For stepped shafts, finish fillets smoothly to adjacent surfaces without tool marks or scratches. The maximum surface finish roughness for fillets is 0.8 micrometres [32 microinch] according to ANSI B46.1-2002 unless a finer finish is required.
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Shims

Shims required for leveling and alignment of machinery and equipment shall be brass or ASTM A666 Type 316 stainless steel. All shims shall be neatly trimmed to the dimensions of the assembled part, and drilled for all bolts that pass through the shims. Sufficient shims shall be furnished to provide for a total thickness of not less than two times the dimensions given as "nominal shims" on the Contract Drawings, with one shim equal to the nominal thickness. Shims shall be provided to allow adjustments of 80 microns for machinery parts.

The contractor shall make every effort to use full size shims and achieve full contact between the shims and the mating components to achieve the specified alignment requirements. In some cases, full contact between the shims and the mating components and achieving the alignment requirements may be mutually exclusive. In these cases, the use of partial or custom machined tapered shims may be required to achieve the alignment requirements. Partial shims shall only be used when the gaps produced between mating parts by the use of partial shims is less than 0.4mm. At least one bolt shall pass through any partial shim that is used. In cases where partial shims would produce a gap greater than or equal to 0.4mm, a custom machined tapered shim shall be used. The cost of any partial or custom shims including materials, manufacturing, Consulting, shipping, installation, field measurements, etc. is considered incidental to the work and no additional compensation will be made for providing partial or custom shims. Any gaps that exist between shims and mating surfaces shall be sealed with silicone caulk to prevent moisture infiltration.

Shims not installed after final alignment shall be neatly assembled and tagged with the part number from the approved shop drawings, then delivered to the City for future use.

Spare Parts

The Contractor shall supply the following spare parts for the mechanical machinery:

a) One set of brake shoes for each of the brakes, four sets total.

b) Materials as required to replace the wearing components of the seals for the span drive machinery speed reducer shaft extensions. Sufficient materials shall be provided to re-place or repack each of the seals on each speed reducer at least one time. In the event that original manufacture includes a 1-piece seal (e.g., a lip-type seal) which cannot be replaced with a seal of one-piece construction after the machinery has been assembled, the Contractor shall supply seals of a construction which will permit replacement (e.g., a split lip-type seal).

c) One toe lock gearmotor with a spare coupling hub installed.

d) Bronze shoes and shims for each span lock guide (4 locations total) and each span lock receiver (2 locations total).

e) Lubricants, as indicated above under the lubrication item.

General Spherical Roller Pillow Block Bearings Requirements

The bearings shall meet the requirements of sections 13.8.17.5 of the CHBDC unless specifically stipulated otherwise herein. One manufacturer shall supply all bearings.

Tools

The Contractor shall supply the City with one complete set of specialized wrenches to facilitate the maintenance, adjustment, installation, and removal of all machinery items installed as part of this Contract. The set of wrenches shall be provided in a suitable high quality tool box complete with lock. The tool box shall be of sufficient size to store all wrenches in a given set. All tools shall be new and shall be of standard manufacture. Deliver the complete set of tools to the span drive machinery room.

The Contractor shall submit a list of all bolt, screw, and nut sizes to the Consultant along with the name, size, type, and manufacturer of the wrenches to be provided for approval by the Consultant. A wrench shall be provided in each set for each size and type of bolt, screw, or nut, including any special hardware which may be required as part of the Contract. Adjustable wrenches which fit more than one size bolt, screw, nut, or other item of hardware are not acceptable.
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Workbench
The Contractor shall supply one workbench to be placed in the span drive machinery room. The work bench shall be 1500mm long X 760mm wide. The workbench shall have a welded metal construction with a 57mm thick solid maple top and adjustable leveling feet. The workbench frame shall be able to hold at least 8,900 N.

Welding and Weldments
Perform welding required for the work and weld inspection in accordance with the requirements of the CSA W59-03 (R2008).

Treat all machinery and weldments that support machinery as main members, all welds as joining primary components, unless otherwise specified in the Contract Documents.

Do not perform field welding on these components unless specified in the Contract Documents.

Open ended welds are not acceptable under any circumstances.

Stress relieve welded machinery parts or supports by heat prior to final machining.

Include welding and stress relieving procedures with the shop drawings for parts that require welding.

SPAN DRIVE MACHINERY

General
The Contractor shall provide span drive machinery as shown on the Contract Drawings, including motors, brakes, reducers, couplings, bearings, rack pinion shafts, and machinery support pedestals. The machinery shall rotate the bascule leaf 77 degrees in approximately 90 seconds for normal operation, assuming 70 seconds of normal operation and two 10 second periods for acceleration and deceleration prior to reaching the fully raised position. Also the bearing support has been designed to prevent permanent machinery in a seismic event.

All operating machinery components shall be new, unless explicitly specified otherwise in these Supplementary General Conditions or on the Contract Drawings. Span drive machinery components subject to stipulations not detailed on the Contract Drawings or addressed under the General Materials section are as follows:

a) Motors
Two (2) required. Motor procurement, electrical installation and payment fall under the Electrical work. See Electrical Drawings and Supplementary General Conditions for details. Mechanical installation and alignment of the motor is to be performed by millwrights in accordance with the Mechanical Work Supplementary General Conditions.

b) Span Position Indicator
Two (2) required. Rotary Cam Limit Switch and encoder procurement, electrical installation and payment fall under the Electrical work. See Electrical Drawings and Supplementary General Conditions for details. Motor Shaft Adaptor, Position Indicator Coupling, and Position Indicator Reducer procurement, installation and payment falls under the Mechanical work. The mechanical installation and alignment of all these components is to be performed by millwrights in accordance with the Mechanical Work Supplementary General Conditions.

c) Reducer
Two (2) required. Foot mounted planetary reducer rated for 196 kN-M output torque with a 1.5 service factor with 144.9:1 reduction ratio.

d) Brakes
Four (4) required. Brake procurement, electrical installation, and payment falls under Electrical work. See Electrical Drawings and Supplementary General Conditions for details. Mechanical installation and alignment of the brake is to be performed by millwrights in accordance with the Mechanical Work Supplementary General Conditions.
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e) Motor Coupling
   Two (2) required. The motor couplings shall be double-engagement, grid-type couplings with horizontally split covers, and sized as indicated on the Contract Drawings. The motor coupling hubs shall be secured to shafts with an FN2 fit and one key.

f) Pinion Coupling
   Two (2) couplings required. The pinion coupling shall be double-engagement gear type couplings. All hubs shall be secured to their respective shafts with an FN2 fit and two keys.

g) Pinion Shaft
   Two (2) required. The pinion shaft shall contain an integral pinion gear as detailed on the Contract Drawings. Provide tip relief as detailed on the Contract Drawings.

h) Pinion Bearings (B1 and B2)
   Four (4) required - Two fixed and Two floating. The bearings shall be self aligning spherical roller split pillow block type with adapter mounting. The L-10 life of all bearings shall be a minimum of 40,000 hours at a maximum rotational speed of 8.28 rpm at the design loads indicated below. The outer race of the bearing shall be provided with a circumferential groove at the bearing centerline and radial holes through the groove to allow for lubrication of the bearing through the bearing housing. All bearing housings shall be provided with solid feet. Only cast steel bearing housings will be accepted and the bearings shall be of heavy duty construction. All bearings shall be of the same manufacture, size, type and capacity.

   A letter from the bearing manufacturer, certifying the use of the selected bearing for the intended application shall be provided by the Contractor. The bearings will rotate in both directions with the opening and closing of the bridge. The design load is 840 kN (radial load) and 126kN (axial load).

   The chosen bearings shall meet ABMA standards. The fit and surface finish of the shaft at the bearing locations shall be in accordance with the bearing manufacturer’s recommendations.

   The Contractor shall submit certification of the recommended fits and surface finishes at the bearing locations.

   The fits between bearing and the housing shall be in accordance with requirements of the bearing manufacturer and the bearing manufacturer shall provide these tolerances in their letter certifying the bearing for use on the bridge.

   Bearing data shall be provided on a nameplate mounted on the housing.

i) Motor Pedestal
   Support pedestals shall be of welded construction.
   Additional details to be provided.

j) Bearing Pedestal
   Support pedestals shall be of welded construction.
   Additional details to be provided.

k) Rack Pedestals
   Support pedestals shall be of welded construction.
   Additional details to be provided.

l) Rack
   Additional details to be provided.
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SPAN SUPPORT MACHINERY

General
The Contractor shall supply and install the span support machinery per the Contract Drawings. The span support machinery are designed to support the weight of the bascule leaf plus the loads generated by 957 N/m²² of wind on a vertical projection of the bascule leaf and corresponding machinery loads to hold the span when fully open. The span support components are also designed for 15% of the dead load as axial load.

TOE LOCK MACHINERY

General
The Contractor shall supply and install the toe lock assembly per the Contract Drawings. The toe locks are designed to produce a load to force down and hold the toe end of the bridge into its seats so that the leaf cannot be displaced either horizontally or vertically under the action of traffic or other conditions of service. The components are also designed to resist the maximum uplift created by the drive machinery at a stalled condition.

All of the machinery for the toe locks with the exception of the receivers shall be installed on the west pier.

SPAN BALANCE

General
The Contractor shall perform all work necessary to balance the new bascule span during construction prior to operation, during construction when operable, and to meet the final balance condition at the end of construction.

Under this item the contractor shall provide:

a) The services of Professional Engineer licensed in British Columbia, Canada to prepare calculations and a running spreadsheet for maintaining the balance of the movable span throughout the construction work.

b) Initial measurement of imbalance by xxxxxx.

c) The services of an approved testing company to perform complete dynamic strain gage testing and reporting.

d) All labour required to move balance blocks to obtain the required balance condition.

e) All labour required to provide and install temporary ballast to simulate the wind and ice loading conditions.

Balance Requirements
The bascule leaf balance is dependent upon the weight and position of all components (structural, architectural, mechanical and electrical, etc…) forward of the center of rotation on the bascule leaf vs. weight and position of all components rear of the center of rotation on the bascule leaf. Balance requirements are provided to monitor the balance condition of the bascule leaf at the various stages of construction prior to operation via the drive machinery, to monitor operating loads during the initial operation with the span drive machinery and then to finalize the balance of the bascule leaf. Weight adjustments shall be implemented as necessary to conform to the balance requirements provided in the following table prior to advancing to each subsequent stage of construction.

Balance table to be provided.

Positive (+) reaction indicates span heavy condition.

Negative (-) reaction indicates counterweight condition.
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Balance Calculations

The Contractor shall submit balance calculations as specified herein to the Consultant for review and approval. A Professional Engineer licensed in British Columbia, Canada shall perform the balance calculations.

Compute the weights and location of all components (structural, architectural, mechanical and electrical, etc…) that will be mounted on the bascule leaf based on approved shop details and material tests for the actual material. Compute weights of individual components to the nearest 0.1 kg accuracy. Summarize weights of assemblies to the nearest 0.5 kg accuracy. Summarize bascule leaf weight to the nearest 50 kg accuracy. Compute the quantity and location of balance material required within the counterweight and counterweight pockets, including balance blocks, based on the specified balance requirements and the weight and center of gravity of the movable span. The location of the center of gravity of all components in the X, Y and Z axis relative to the center of rotation shall be calculated.

Prepare a balance spreadsheet to monitor the bascule leaf balance. The spreadsheet shall itemize all additions and removals that are required as part of this work including any temporary removals or additions. The spreadsheet shall include the location of all weight added or removed and calculate the effect of individual weight changes and be capable of calculating a running tabulation of the balance of the bascule leaf as the work progresses. The spreadsheet shall be updated on a daily basis to track construction activities prior to the start of that construction activity at the bridge site in order to demonstrate that at no time will a construction activity result in an unacceptable balance condition. A narrative shall be included with the outline of the proposed phasing, the duration of the imbalance condition, and all other aspects of the work in accordance with the approved construction schedule. This information shall be coordinated with the Contractor's scheduling requirements and shall be submitted to the Consultant for review along with an electronic copy of the spreadsheet. Summary tables shall be developed using the spreadsheet for all phases of the balance and the proposed imbalances. Temporary balance material, if used, shall be accounted for in the summary tables. All summary tables and back-up materials shall be submitted for review.

It shall be the Contractor's responsibility to provide temporary bracing and supports and/or temporary balance material as required to stabilize the movable span during construction.

Review of the balance calculations, counterweight details, and quantity and location of balance material does not relieve the Contractor from making such changes in the counterweights and balance material as deemed essential to balance the bascule leaf in accordance with the final balance requirements. All changes shall be submitted for approval.

Initial Balance Measurements

Prior to attempting to operate the movable span with the operating machinery the Contractor shall perform an initial balance measurement using hydraulic jacks or similar devices at the toe of the span. The toe reaction with the span closed or nearly closed shall be measured while dynamically raising and lowering the jacks through a short range of stroke. The average of the raising and lowering loads shall be considered the imbalance reaction. Loads may be determined via hydraulic pressures or through the use of load cells.

Dynamic Strain Gage Testing Requirements

The movable span operating loads and imbalance shall be measured a minimum of two times using the dynamic strain gage method:

a) Strain gage testing shall be performed at the time of the initial start-up and operation of the drive machinery. Operating strains shall be monitored real time during the initial movement of the span with the machinery to verify that the operating loads do not exceed safe limits during the initial movement of the span. The recorded strains shall also be used to derive balance results. The balance shall be adjusted to conform to the required targets shown in the provided balance table.

b) Strain gage testing shall be performed following all construction activities after the balance has been adjusted to conform to the required targets for final balance shown in the provided balance table.

Strain gage testing shall be performed under the direct supervision of a testing company who has prior experience with imbalance testing, as demonstrated by successful completion of testing at a minimum of six movable bridges at least two of which are bascule bridges.
Two strain gages shall be mounted on each rack pinion or the reducer output shaft between the B2 pinion bearing and the reducer. The gages shall be mounted back to back (i.e. spaced 180 degrees circumferentially on the shaft) and wired in a Wheatstone bridge configuration so as to measure torsion only. After the gages are installed they shall be protected in accordance with the strain gage manufacturer’s recommendations.

The gages from the two rack pinion shafts shall be connected to a recording device capable of providing a permanent record of the strain in the shaft versus rotational angle. The bascule leaf rotational angle shall be recorded using a clinometer mounted on the bascule leaf. The output from the clinometer shall be recorded simultaneously and on the same device with the imbalance strain.

Imbalance recordings shall be recorded through at least three complete operations and a permanent record of each test shall be maintained. The data collected shall be used to determine the bascule leaf imbalance. The Contractor shall make balance adjustments to meet the Balance Requirements as listed in these Supplementary General Conditions. Following each balance adjustment the Contractor shall conduct additional strain gage testing and analysis to verify the span balance condition. The Contractor shall repeat the testing until the desired balance conditions have been achieved.

**Strain Gage Balance Testing Submittals**

A complete test procedure along with the qualifications of the Consultant conducting the tests shall be submitted for approval prior to any balance testing. The test procedure shall include the following:

- a) Prior strain gage balance test experience
- b) Test method
- c) List of equipment
- d) Gage protection endorsed by gage manufacturer
- e) Sample calculations relating strain in the instrumented shaft to leaf torque for this structure.
- f) Report format

After the final balance tests have been completed, the Contractor shall submit a formal report documenting the testing. The report shall include the following:

- a) Introduction
- b) Test procedure and equipment
- c) Method of analyzing recorded data
- d) Presentation of final balance results
- e) Discussion of error
- f) Figures depicting the location of the strain gages and basic wiring schematics
- g) Calculations
- h) Strip charts of the raw strain data and opening angle graphed against a time based scale for each of the three test runs
- i) Graphical representation of span balance vs. opening angle for each of the three test runs
- j) Table summarizing the results of the load testing as detailed below
- k) The electronic raw data files for the final balance condition and the load tests. The files shall be sufficiently annotated to identify the appropriate channels and units of measure.

All calculations shall be prepared in metric units.

**Balance Blocks**

See Structural Specifications for payment and details.
CONSTRUCTION

General
The Contractor shall supply all apparatus, tools, devices, materials and labour to install span drive machinery, span support machinery, toe lock machinery, and span balancing as noted herein and on the Contract Drawings. Any apparatus, tools, devices, materials and labour incidental to the work but not specifically stated or included, which may be necessary for the work, shall be furnished by the Contractor at no additional cost to the City. The installation and adjustment of all machinery shall be done by millwrights experienced in this class of work. The installation and alignment of machinery shall not be done by workers of any trade other than the millwright trade. The Contractor shall submit the resumes of the millwrights to the Consultant for approval. Refer the workforce section under qualifications of this Supplementary General Conditions for additional requirements.

The Contractor shall coordinate and schedule work to suit requirements of the City and the Canadian Coast Guard, as directed and approved by the Consultant.

Delivery, Storage, and Handling
All machinery items and material shall be delivered to the off-site assembly location in accordance with the approved schedule of work. All machinery, materials, and items shall be properly protected for shipment and storage.

All machinery items shall be stored so as to permit easy access for inspection and identification. Material shall be stored in a building in manner that will cause no distortion or damage. No outdoor storage of machinery components shall be used regardless of the methods of protection provided.

All finished metal surfaces and unpainted metal surfaces that would be damaged by corrosion, shall be coated as soon as practical after finishing with a protective coating such as No-Ox-Id, A-Special, as manufactured by Sanchem, Inc. of Chicago, IL or approved equal. This coating shall be removed from all surfaces prior to lubrication for operation and from all surfaces prior to painting after erection.

Assembled units shall be mounted on skids or otherwise crated for protection from weather, dirt and all other injurious conditions during shipment and storage as approved by the machinery manufacturer. The Contractor shall submit advance information as to methods and materials which will be used for protection for approval by the Consultant.

Any damage that occurs to the machinery components as a result of improper protection during shipment or storage shall be corrected by the Contractor to the satisfaction of the Consultant at no cost to the City.

Installation
Machinery installation shall not commence until all required components have been completed and approved for installation, all required procedures and schedules have been approved and preparations by others where required have been satisfactorily completed.

During installation, the Contractor shall maintain and lubricate all rotating and sliding parts of the machinery, including span drive machinery, span support machinery and toe lock machinery. The surfaces of new components which will rotate or slide relative to one another once assembled shall be lubricated prior to assembly. Any corrosion which should occur on machinery during the construction/installation period shall be removed and the surface returned to bare metal prior to applying fresh lubricant. Machinery disassembly may be required to facilitate this repair work if so directed by the Consultant. Where corrosion is extensive and cannot be removed without marring the base surface, or where the machinery surface is marred by corrosive pitting, the component shall be returned to the shop for repair.

The Contractor shall be responsible for the coordination of the machinery installation with all other aspects of the construction project. This coordination relates to the sequencing of work so that all machinery can be installed in a safe and effective manner. Certain sequences of installation may be required in order to ensure that all items can be installed on the bridge.
Alignment

a) General

All components of standard manufacture (i.e., couplings, rolling element bearings, brakes, etc) shall be aligned to the tolerances specified by the manufacturer of that component. The manufacturer’s recommended alignment tolerances for a new installation shall be the basis for alignment and shall be included in the relevant procedures.

All components of custom manufacture (i.e. live load supports, span locks, span guides, etc) shall be aligned to the tolerances provide in these Contract Documents.

Final field reaming of holes for turned bolts and dowel pins shall occur only after the Consultant’s approval of the field alignment.

b) Gearing

The alignment of the rack and pinion is considered acceptable when the total backlash is between .300mm and .340mm, with a nominal tip clearance of 10 mm, and when the tooth contact is at least 80% for both sides of the teeth. Alignment shall be checked at three points (at the middle and at each end) of every rack segment. The Contractor shall demonstrate acceptable face contact to the Consultant by bluing the teeth or other means acceptable to the Consultant. If it is impossible to check tooth contact because a given tooth face is not loaded during normal operation the maximum permissible cross mesh or taper between the tooth faces is .380mm.

c) Span Support Rollers and Tread Plates

A location diagram for span support rollers is provided in the Contract Plans. This diagram provides limited information regarding the placement of the bogie frames on the bascule pier and is only intended to convey some of the information necessary to align the support rollers. Additional criteria for the support roller alignment are provided below.

The bogie frames are to be installed so that the equalizer pin of each bogie frame is within .8mm of the absolute elevation shown on the Contract Plans. Individual equalizer pins shall be level to within .8mm over the length of the equalizer pin.

For each pair of equalizer pins that are in line in the transverse direction, the variation of the equalizer pin center lines from a line passing through the center of the outboard end of the strut pins shall be less than or equal to .8mm at any point along that line as verified by piano wire or equivalent measurements.

Tolerances for diagonal measurements to be determined and provided.

The alignment of the mating tread plates and support rollers will be considered acceptable when the following has been achieved by the Contractor and verified by the Consultant.

- Contact between the mating surfaces is at least 80% along the entire length of roll. The Contractor shall demonstrate contact using a bluing agent or other means of verifying contact that is acceptable to the Consultant.
- There is no contact between the roller guide plates and the sides of the tread plates along the entire length of roll. This shall be demonstrated by adjusting the position of the bridge to obtain the nominal clearance shown on the Contract Plans with the span in the closed position and then rolling the bridge to the full open position (roll test). During this test, a bluing agent or other means of verifying contact that is acceptable to the Consultant shall be applied to the roller guide plates. Any indication of contact between the roller guide plates and treads shall be cause for rejection. If the Consultant rejects the alignment due to contact between the roller guide plates and treads, the Contractor shall adjust the tread plates until no contact occurs during the test.

The dimensions provided on the Contract Plans are nominal. Tolerances have not been provided on the Contract Plans to achieve specified alignment criteria. The shop drawings must include all
tolerances required to meet the specified alignment criteria. In addition, the installation procedure must identify all methods to be employed to ensure that the specified alignment criteria are achieved.

d) Toe Locks

The final adjustment of the toe lock machinery shall take place after the live load supports are properly adjusted and the elevations at the bascule leaf meet alignment requirements with the approach span.

Acceptable alignment of the lock bar to the receiver shall be measured in the engaged position and shall include:

i) Full contact of the bottom of the lock bar with the receiver shoe. Contact will be considered full when an 80 micron (0.003") feeler gage cannot be inserted at any location between the bottom of the lock bar and the shoes.

Acceptable alignment of the lock bar to the front guide shall be measured in the engaged position and shall include:

i) 3mm gap between the lockbar and the bottom guide shoe.

ii) Full contact of the top of the lock bar and the top shoe. Contact will be considered full when an 80 micron (0.003") feeler gage cannot be inserted at any location between the bottom of the lock bar and the shoes.

Acceptable alignment of the lock bar to the rear guide shall be measured in the engaged position and shall include:

i) Full contact of the lock bar with the bottom shoe. Contact will be considered full when an 80 micron (0.003") feeler gage cannot be inserted at any location between the bottom of the lock bar and the shoes.

ii) RC6 clearance between the top of the lock bar and the top guide wear shoe. Taper in this clearance shall not exceed 25 micron (0.001") over the length and width of the lock bar.

BASIS OF PAYMENT

Span Drive Machinery

Lump Sum. No measurement will be made for this item. Payment at the Contract price for this tender item shall be full compensation for all labour, equipment, supplies and material to do the work. The basis of payment shall be as follows:

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Payment</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop Drawings Approved</td>
<td>5%</td>
<td>Engineer's approval of shop drawings</td>
</tr>
<tr>
<td>Procedures Approved</td>
<td>5%</td>
<td>Engineer's approval of required procedures</td>
</tr>
<tr>
<td>Components on Site</td>
<td>Direct</td>
<td>Components at site, stored as required by specifications.</td>
</tr>
<tr>
<td>Component Cost (DC)</td>
<td></td>
<td>Provide invoices for direct cost of components.</td>
</tr>
<tr>
<td>Installation</td>
<td>70%-DC</td>
<td>Component installation complete with all fasteners tightened and with final component alignment approved by the Engineer.</td>
</tr>
<tr>
<td>Completion of Functional Testing</td>
<td>14%</td>
<td>Successful completion of functional testing as defined by specifications.</td>
</tr>
<tr>
<td>Operation, Maintenance, and Lubrication Manuals Approved</td>
<td>1%</td>
<td>Engineer's approval of O&amp;M manuals</td>
</tr>
<tr>
<td>Completion of Endurance Testing</td>
<td>5%</td>
<td>Successful completion of endurance testing / no outstanding requirements from Contract Documents.</td>
</tr>
</tbody>
</table>

Total 100%
Span Support Machinery

Lump Sum. No measurement will be made for this item. Payment at the Contract price for this tender item shall be full compensation for all labour, equipment, supplies and material to do the work. The basis of payment shall be as follows:

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Payment</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop Drawings Approved</td>
<td>5%</td>
<td>Engineer's approval of shop drawings</td>
</tr>
<tr>
<td>Procedures Approved</td>
<td>5%</td>
<td>Engineer's approval of required procedures</td>
</tr>
<tr>
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<td>Direct</td>
<td>Components at site, stored as required by specifications.</td>
</tr>
<tr>
<td>Component Cost</td>
<td></td>
<td>Provide invoices for direct cost of components.</td>
</tr>
<tr>
<td>Installation</td>
<td>70%-DC</td>
<td>Component installation complete with all fasteners tightened and with final component alignment approved by the Engineer</td>
</tr>
<tr>
<td>Completion of Functional Testing</td>
<td>14%</td>
<td>Successful completion of functional testing as defined by specifications.</td>
</tr>
<tr>
<td>Operation, Maintenance, and</td>
<td>1%</td>
<td>Engineer's approval of O&amp;M manuals</td>
</tr>
<tr>
<td>Lubrication Manuals Approved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completion of Endurance Testing</td>
<td>5%</td>
<td>Successful completion of endurance testing / no outstanding requirements from Contract Documents.</td>
</tr>
</tbody>
</table>

Total 100%

Span Balance

Lump Sum. No measurement will be made for this item. Payment at the Contract price for this tender item shall be full compensation for all labour, equipment, supplies and material to do the work. The basis of payment shall be as follows:

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Payment</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Approval of required procedures</td>
</tr>
<tr>
<td>Balance Calculations</td>
<td>25%</td>
<td>Approval of balance calculations</td>
</tr>
<tr>
<td>Initial Balance Measurements</td>
<td>15%</td>
<td>Approval of submitted measurements</td>
</tr>
<tr>
<td>Initial Strain Gage Balance Test</td>
<td>20%</td>
<td>Approval of initial strain gage balance report</td>
</tr>
<tr>
<td>Final Strain Gage Balance Test</td>
<td>30%</td>
<td>Approval of final balance test report. This items includes testing for Simulated Ice and Wind Loading as required in these specifications.</td>
</tr>
</tbody>
</table>

Total 100%
APPENDIX E

JOHNSON STREET BRIDGE
DRAFT STRUCTURAL SPECIFICATIONS

1. Cofferdams

The Contractor shall be responsible for the design, construction, maintenance and removal of the cofferdam system required to build the piers and abutments in the dry in accordance with this specification.

The work shall include all temporary works, cofferdams, pressure relief systems and lean mix concrete plugs required to complete the excavations and construct the piers and abutments in the dry. The dewatering system shall prevent flooding, infiltration or water ponding.

All work shall be in accordance with the approved Environmental Management Plan, which shall be strictly adhered to by the Contractor during design, installation, maintenance and removal of the cofferdam(s).

The cofferdam shall be designed in accordance with the most recent versions of the Canadian Highway Bridge Design Code and the Canadian Foundation Engineering Manual. The cofferdam shall be designed and constructed to resist all loads developed from the adjacent earth pressures, hydrostatic pressures, any construction surcharge loads and the tidal and storm effects from the inner harbour.

The Contractor shall submit drawings, sealed by a professional engineer registered with the APEGBC, for review by the Consultant. Drawings shall be submitted a minimum of 21 days prior to start of the cofferdam installation. Cofferdam installation shall not proceed until completion of the Consultant’s review process.

All sheeting, bracing, working mats and other material used for the dewatering scheme shall be removed and disposed of off-site at the completion of the work.

2. Foundation Excavation and Backfill

a) Excavation

All materials shall be removed as necessary for the construction of foundations or other works. Foundation excavations shall not be larger than is reasonably necessary. Excavations and adjacent highways and other facilities shall be protected as necessary by barricades, shoring, dykes and/or cofferdams.

Excavations shall be constructed in compliance with the applicable Workers Compensation Act, Occupational Health and Safety Regulations, BC.
b) Preparation of Foundations

For excavations in material other than rock, care shall be taken to not disturb the bottom of the excavation. If the bottom of the excavation is disturbed, the Contractor shall remove and dispose of all disturbed material and shall replace it with material meeting the material, placement and compaction requirements of SS 201.40 "Bridge End Fill".

Where concrete is to be placed on rock, the rock surfaces shall be clean and free from any loose material.

Where, in the opinion of the Consultant, the bottom of an excavation is not competent, the Ministry Representative may direct the Contractor to excavate deeper. The Ministry Representative may direct replacement of the incompetent material with material meeting the requirements SS 201.40 "Bridge End Fill" or with a concrete fill or sub-footing.

Unless underwater concreting is approved by the Ministry, excavations for concrete structures shall be dewatered, so that concrete is placed in the dry.

c) Backfilling

After the structures are sufficiently built, excavations shall be backfilled to the original ground contours, or as directed by the Consultant.

Drainage course material shall be installed as shown on the Drawings. The gradation of drainage course material shall be as follows:

<table>
<thead>
<tr>
<th>SIEVE SIZE mm</th>
<th>% PASSING BY MASS OF TOTAL SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>0 - 100</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>
3. Supply and Installation of Pipe Piles

a) Mobilization for Pile Installation

The Contractor shall provide equipment that is capable of installing the piles into the bedrock as shown on the drawings.

b) Supply

Steel pipe for pipe piles shall conform to ASTM Specification A252, Grade 3. Previously used or coated pipe will not be accepted. Pipes fabricated with seams shall be fabricated with full penetration butt welds. Mill certificates and non-destructive testing records, confirming seam weld quality, shall be submitted to the Ministry Representative. Manufacturer’s identification marks on the pile shall be readily identifiable on Site and shall match the heat numbers on the mill certificates provided. Sections of piling shorter than 3 m, shall not be used, except to finish a pile to final cut off elevation.

c) Splicing

Piling shall be spliced if necessary in accordance with the details shown on the Drawings. Piling shall be aligned so that the finished piles are straight from end to end.

All welding shall conform in quality and workmanship to the latest edition of CSA W59. The weld area shall be temporarily enclosed during welding (dry and free from draft and wind) and shall cool in ambient air above 5 Degrees Celsius.

Welding shall be undertaken by a company approved by the Canadian Welding Bureau (CWB) to the requirements of CSA W47.1, Division 2 or better.

Prior to commencement of welding, the Contractor shall submit welding procedures and data sheets, approved by the CWB, for the type of weld being performed and copies of welding certificates for all welders confirming that the individuals are currently certified by the CWB in the processes and positions in which they are to be employed.
d) Installation

Pipe piles shall be installed in the locations shown on the Drawings. The bedrock may be fractured, stepped, weathered or sloping. The Contractor shall take this into account with regards to installing the piles.

The following apply to the installation of the pipe piles:

- The installation of each permanent steel liner shall not deviate by more than 150 mm laterally from the locations shown on the drawings.

- The shaft of each permanent steel liner shall not differ from the required batter by more than 15 mm per metre.

- The soil shall be excavated from within the liners and be removed from site in accordance with the Contractor’s environmental plan.

- The Contractor shall break-up, remove, core or drill through all obstructions above the accepted bearing elevation and during the excavation of the rock sockets.

The Contractor’s plan for sediment control measures for this operation shall be submitted to the Consultant for review. The operation shall not proceed unless an acceptable means of sediment control can be demonstrated.

The Contractor shall maintain pile driving records as directed by the Consultant.

Pile installation equipment shall be capable of installing the pile to the anticipated pile tip elevations. Piles shall be installed to such depths as ordered by the Consultant. The tip elevations shown on the Drawings are preliminary estimates of the depths required.

Piles shall be installed without causing damage to the pile. The top of piles shall be protected by a suitable driving cap to prevent damage to the piles. Any pile so damaged as to be unfit for the use for which it is intended, or any pile that cannot be brought within tolerance for location will be rejected. A rejected pile shall be extracted and replaced by a new pile.

Piles shall be cut off and filled with pipe pile infill concrete as per the Drawings and specifications. Concrete shall be placed in the dry or by an acceptable tremie method in accordance with SS 211.20.

All steel pipe piles shall be temporarily capped after installation for safety reasons.
The Contractor shall submit all details of his proposed construction methods to the Consultant at least two (2) weeks before the commencement of this work or any fabrication required for this work.

The Contractor shall demonstrate that the steel liner is properly and fully seated and sealed in the bedrock before constructing the rock socket of each caisson by demonstrating that the liner can be fully cleaned to its base (by air lift or other approved means) so that the water issuing from the caisson on pumping is clean and free from silt and other material.

4. Rock Socket Installation

The Contractor shall complete uncased rock sockets, a minimum length into the solid bedrock, as shown on the Drawings. All rock sockets shall be reinforced as shown on the Drawings. The Consultant may vary the rock socket elevation at each location based on the records of the installation.

The method used to construct the rock socket shall produce a side wall in the bedrock that is free from loose rock, smearing of fine grained materials or other contamination which may diminish the bond between the concrete and the wall of the bedrock. When the rock socket tip elevation has been reached, all loose and deleterious material shall be removed from the interior of the rock socket and the steel pipe pile. If muddy water is present, it shall be removed or replaced with clean water. Material adhering to the inside of the steel pipe pile and rock socket shall be removed.

The Contractor shall select its own method of installing the steel pipe piles, sealing it into the bedrock and drilling the rock sockets. The methods shall be reviewed by the Consultant prior to commencement of the work.

5. Crosshole Sonic Logging Access Tubes

As a means of testing voids in the concrete, every pile shall be equipped with access tubes to permit inspection by crosshole sonic logging (CSL). The Contractor shall supply and install 50 mm inside diameter schedule 40 steel tubes for probe access in each pile. The number of access tubes to be provided within each pile type is defined on the drawings.

Tubes supplied shall be round, have a regular internal diameter that is free from defects, obstructions and joints. Tubes shall be watertight, free from corrosion with clean internal and external faces to ensure a good bond between the concrete and the tubes. Tubes may be extended with watertight mechanical couplings.
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Tubes shall be installed by the Contractor such that the CSL probes will pass through the entire length of the tube without binding. The Contractor shall ensure that the access tubes are plumb and shall verify that unobstructed passage of the probes is achievable.

The Contractor shall fit the tubes with a watertight shoe on the bottom and a removable cap on the top. Tubes shall be secured to the interior of the reinforcement cage a minimum of every 1.2 metres. Tubes shall be installed uniformly and equidistantly around the circumference of the pile such that each tube is spaced parallel for the full length. Tubes shall extend to within 150 mm of the drilled shaft bottoms, and shall extend a minimum of 1,800 mm above the top of the steel casing.

The Contractor shall ensure that CSL tubes are not damaged during the installation of the reinforcement cage. Any tubes that are found to be damaged, or tubes that will not pass the probe through the entire length of the tube shall be replaced by the Contractor at no cost to the Consultant.

The Contractor shall ensure tubes are capped to prevent debris from entering the access tubes until such time as the Consultant accepts the placement of pile concrete.

The Contractor shall retain a CSL Testing Agency and provide test reports for Consultant’s review and approval. Contractor shall ensure the adequacy of all piles prior to continuation of construction.

6. Formwork and Falsework
Formwork and falsework shall be in accordance with SS 211.

7. Reinforcing Steel
Reinforcing steel shall be supplied and installed in accordance with SS 412 unless otherwise specified on the Drawings. Welding of reinforcing steel will be permitted only where shown on the Drawings or when acceptable to the Consultant and shall be in accordance with CSA W186-M.

Plain (uncoated) reinforcing steel shall comply with CAN/CSA G30.18, 400W unless otherwise specified on the Drawings.

8. Stainless Steel Reinforcing Bar
Stainless steel reinforcing bars shall be used only where shown on the Drawings. Substitution of epoxy-coated or galvanized reinforcing bars in place of stainless steel reinforcing bars will not be permitted.
Stainless steel reinforcing bars shall conform to ASTM A276 and ASTM A955M, minimum Grade 420, except as noted. Nominal dimensions, unit masses and deformation requirements for Metric bar sizes shall conform to CAN/CSA G30.18.

Stainless steel reinforcing bars shall be deformed unless indicated otherwise on the drawings.

Stainless steel reinforcing bars shall be of a stainless steel type specified in Table 1 of this specification.

### TABLE 1: TYPES OF STAINLESS STEEL

<table>
<thead>
<tr>
<th>TYPE / ASTM DESIGNATION</th>
<th>UNS DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>316 LN</td>
<td>S31653</td>
</tr>
<tr>
<td>DUPLEX 2205</td>
<td>S31803</td>
</tr>
<tr>
<td>DUPLEX 2304*</td>
<td>S32304</td>
</tr>
</tbody>
</table>

* Chemical composition of Duplex 2304 shall be within the ranges identified in Table 1 of and in conformance to the requirements of ASTM A276. The dimensioning and mechanical properties shall be in conformance with ASTM A955M.

Stainless steel reinforcing bars shall be hot-rolled, descaled and pickled to the required mechanical properties and dimensions.

Two copies of the mill certificates for each lot shall be submitted to the Ministry’s Representative prior to shipment of the stainless steel reinforcing bars.

Tie wire used to tie stainless steel reinforcing bars to stainless steel reinforcing bars, reinforcing steel bars and shear studs, shall be stainless steel wire of a type listed in Table 1 of this Special Provision. Tie wire shall be 1.6mm in diameter. Tie wire used to tie stainless steel reinforcing bars to coated reinforcing steel bars shall be coated wire.

Field bending of stainless steel reinforcing bars is only allowed upon prior written approval from the Consultant. Stainless steel reinforcement should only be bent on equipment assigned solely for this purpose.
For stainless steel reinforcing bars, the bend diameters shall be the same as required for 400R uncoated bars.

The bars shall be stored clear of the ground on timbers or other suitable protective cribbing spaced to prevent sags in the bundles. Stacks of bundles of straight bars shall have adequate blocking to prevent contact between the layers of bundles.

Stainless steel reinforcing bars shall be stored separately from reinforcing steel bars, with the bar tags maintained and clearly visible until ready for placing.

Bar chairs for supporting stainless steel reinforcing bars shall be non-metallic. Concrete chairs shall not be used to support stainless steel reinforcing bars.

Where a lap splice bar is to be used to connect stainless steel reinforcing bars, the lap splice bar shall be stainless steel of same type.

Except for splicing of stainless spirals, welding of stainless steel reinforcing bars is not permitted.

Where mechanical couplers are to be used to couple stainless steel reinforcing bars, the mechanical coupler shall be stainless steel of a type specified in Table 1 of this Special Provision.

9. Cast-in-Place Concrete

All concrete work shall be in accordance with SS 211, 413, 931 and 933, unless otherwise modified by this clause.

The Contractor shall be responsible for the design and quality control for all concrete used on this project.

All concrete materials and admixtures for concrete shall conform to the requirements of SS 211.04, unless otherwise specified in this section.

The Contractor shall be responsible for and shall provide the Consultant with current certified results for all of the applicable tests as outlined in Table 211-D of the SS 211 “Required Aggregate Testing for Normal Density Coarse and Fine Aggregate (Per Individual Product and Aggregate Source)”. Concrete mixes shall meet the requirements given in the following table:
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Notes:

(1) The maximum proportion of aggregate passing the 5 mm screen shall be 35% of the total mass of aggregate.

(2) Silica fume application rates shall be 8% maximum by mass of Portland Cement. Slump specification is based on superplasticized concrete.

(3) Concrete in marine environment shall use high sulphate resistant Type HS cement.

(4) East pier wall concrete to include 3% Xypex C-500 by weight of cement.

Duration of Concrete Placement

Deck Concrete – An extension to the duration of placement for Deck Concrete will be permitted for this project. Any time of placement extension shall be in accordance with and conform to SS211.08.02 and SS413.31.02.02.

Concrete Surface Finishes shall meet the requirements given in the following table:

<table>
<thead>
<tr>
<th>Surfaces submerged or buried</th>
<th>Class 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top and inner surfaces of parapets</td>
<td>Class 3</td>
</tr>
</tbody>
</table>

Classification | Minimum Compressive Strength at 28 days (MPa) | Nominal Maximum Size of Coarse Aggregate (mm) | Air Content (%) | Slump (mm) | Maximum W/C m Ratio by Mass

| Deck Concrete: Deck Slab, Approach Slabs, Curbs & Parapets (with silica fume) | 35 | 20(1) | 6 ± 1 | 80 ± 20(2) | 0.37 |
| Substructure Concrete: Abutments, Wing Walls, Pile Caps, Pier Shafts and Pier Walls | 35(3,4) | 28 | 5 ± 1 | 50 ± 20 | 0.40 |
| Foundation Concrete: Pipe Pile infill, Working Floors | 30(3) | 28(1) | 5 ± 1 | 50 ± 20 | 0.50 |
| MSE Wall Panels | 35 | 20(1) | 5 ± 1 | 50 ± 20 | 0.40 |
### 10. Supply and Fabrication of Structural Steelwork

The requirements for the supply and fabrication of Structural Steelwork is specified in the *British Columbia Ministry of Transportation and Infrastructure's 2012 Standard Specifications for Highway Construction - Section 421, Structural Steelwork*, amended as specified in this section.

The Structural steel shall conform to CAN/CSA – G40.20, G40.21 and be of the following grade and category:

**Bascule Span**

- Truss top chord, bottom chord, diagonals and stiffener plates – 350WT Category 2 Fracture Critical. Charpy impact tests to be provided on a per plate frequency
- Ring flanges and web plates, coverplate and stiffener plates – 350WT Category 2 Tension
- Floor beam and counterweight beam plates and orthotropic deck plates – 350WT Category 2
- Pedestrian / Multi-use deck members – 350W

**Approach Spans**

- Longitudinal girders – 350WT Category 2 Fracture Critical. Charpy impact tests to be provided on a per plate frequency
- Floor beams – 350WT Category 2 Tension
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- Pedestrian / Multi-use deck members – 350W

Other Locations
- Hot-rolled and other built up beams – 350W
- Hollow sections – Grade 350 Class C

ASTM Equivalent steel grade will be accepted as follows:
- Grade 50F Fine grained killed steel with Charpy Impact Energy of 27 Joules at -30 Degrees Celsius accepted as an equivalent to 350WT Category 2 Fracture Critical. Charpy V-Notch tests to be provided on a per plate frequency
- Grade 50F Fine grained killed steel with Charpy Impact Energy of 27 Joules at -20 Degree Celsius accepted as an equivalent to 350WT Category 2 Tension. Charpy V-Notch tests to be provided on a per heat frequency
- Grade 50 accepted as an equivalent to 350W
- Type B accepted as an equivalent to Grade 350 Class C for Hollow Sections

Counterweights

The lower counterweight steel box framed between the counterweight beams and the upper lobe counterweight boxes are to be filled with steel weights positioned so as not to shift through the design range of motion. The lower counterweight box is to be concrete topped to final grade and carry vehicular traffic. The counterweight boxes are provided with pockets for balance blocks for securing an initial balance of each bascule leaf and future balance adjustment. For future adjustment of the counterweights, the Contractor shall provide additional balance blocks over and above those required for the initial balance. These blocks shall be stored at the site at locations designated by the Consultant.

Section 421.40 Dimensional Tolerances shall be supplemented by AWS D1.5 Section 3.5 Dimensional Tolerances. These dimensional tolerances are acceptable for the fabrication of the following welded structural members;
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- Galloping Goose pedestrian bridge components
- East and West approach span girders and floor beams
- Bascule span sidewalk and multi-use deck cantilever and longitudinal beams
- Bascule span transverse sidewalk within rings
- Control building and canopy structural framing

Special tolerances are required for the fabrication of the following welded structural members:

- Bascule span truss between Grid Lines 1 and 10
- Bascule span floor beams and counterweight beams and struts
- Bascule ring assemblies and plate between rings

The ring assemblies are made up of the structural rings including upper lobes, the first diagonal and the truss bottom chord within the ring. This ring assembly is to be shop assembled to the radial tolerances noted below and any required splices designed such that the ring tolerances are maintained. The bascule span truss shall be spliced to the ring assemblies with complete penetration butt welds, again ensuring that the ring tolerances are maintained.

The ring assembly shall be fabricated such that the radial tolerance from the axis of rotation to the outside surface of the flange of the ring receiving the tread plate is +16 mm /- 0 mm in the unloaded condition. The outer flange of the ring assembly shall be machined to the correct final radius prior to the tread plate being bolted to the ring. The outside surface of the finished tread plate shall have a radial tolerance of +/- 0.5 mm to the design radius.

The Contractor’s attention is directed to the necessity for the correct alignment of the bascule span with regards to being centered on the support rollers and the toe lock. The bascule truss and floorbeams shall be cambered for dead load and the roadway profile as specified on the Contract Plans. The bascule span shall be assembled as a unit in the shop in its cambered position. Proper alignment of tread plates to the roller bearings shall be verified.

Prior to shop assembly of the bascule truss, the horizontal alignment of the trusses shall be verified relative to theoretical lines through the axis of rotation and the centerline of the roadway as shown on the Contract Plans, measured transversely and longitudinally, as follows:

a) Center of truss at the toe: +/- 3 mm
b) Center of truss at axis of rotation: +/- 3 mm
c) Center of truss at rear counterweight +/- 3 mm

Vertical alignment of the bascule truss shall be verified as follows, taking into consideration the effects of support conditions and camber in the shop:

a) Top of bottom chord at toe: +/- 3 mm
b) Top of bottom chord at axis of rotation: +/- 3 mm
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c) Top of bottom chord at other locations: +/- 12 mm

All alignment checks shall be conducted with the trusses plumb.

11. Shipping and Erection of Structural Steelwork

The requirements for the shipping and erection of Structural Steelwork is specified in the British Columbia Ministry of Transportation and Infrastructure’s 2012 Standard Specifications for Highway Construction - Section 421, Structural Steelwork, amended as specified in this section.

Temporary supports, tie-backs, shoring, falsework, jacking members and other similar elements used in the erection of the bascule span shall be designed and detailed by a Professional Engineer licensed to practice in the Province of British Columbia. Prior to use of these elements in the bascule leaf erection, the design calculations and details shall be signed and sealed and submitted to the Consultant for review. Design of these elements shall account for maximum leaf unbalance expected during erection and Contractor’s means and methods of construction, loads imposed by construction equipment and appropriate AASHTO LRFD Movable Specification wind loads. Redundancy shall be implemented into the temporary members and systems where practical. In applying loads from the AASHTO LRFD Movable Specification, consider the span as normally left in the open and closed positions. Where connections are to be made to the bascule span, include the connection details, (including required stiffeners, bolt holes, etc.) in the structural steel shop drawings and install them during fabrication.

12. Steel Orthotropic Deck

The steel orthotropic deck system shall be designed, fabricated and installed by the Contractor. The deck shall be designed to meet the requirements of Section 9 – decks and Deck Systems of AASHTO LRFD Bridge Design Specifications 5th edition – 2010.

The orthotropic steel deck designed and manufactured by Structal-Bridges or an approved equivalent shall be used for the project. The manufacturer of the orthotropic steel deck must provide a ten (10) year warranty against all defects of the deck.
13. Supply and Installation of Aluminum Sidewalk and Multi-use Deck

The specified aluminum sidewalk and multi-use deck planks are to be supplied by Alcan Singen GmgH of Germany. The 400mm wide by 57 mm deep Type 41220 planks are to be supplied with a crossmilled non-slip surface.

The planks are to be fastened down to the structural steel supporting members using the manufacturer’s mechanical fastener system.


Specifications for these restrainer and guide components to be provided at a later date.

15. Painting of New Structural Steelwork

Structural steelwork shall be prepared and painted in accordance with Ministry of Transportation and Infrastructure Standard Specifications for Highway Construction (BC MoTI SSHC). All steel shall be coated with a three coat system with a minimum total Dry Film Thickness of 12mils. Primer Coat shall be 3 mils, Intermediate coat 6 mils and Finish coat of 3 mils. The paint system shall be SS1.

16. Warranty

Provide coating manufacturer’s system manufacturer’s written seven (7) year warranty on coating system

Paint system on new hot dipped galvanized steel members.
The following shall apply:
- Hot dipped galvanized steel to be coated will be new material that has not been previously painted.
- Coatings will be shop applied to hot dipped galvanized coatings, with exception of field repairs and touchup work.
- All coatings will be applied within 6 months of removal of the steel member from the galvanizing kettle.
Surface preparation of Hot Dipped Galvanizing (HDG) Steel for handrail stanchions

ASTM D 6386-10 Standard Practice for Preparation of Zinc (HDG) Coated Iron and Steel Product and Hardware Surfaces for Painting describe surface preparation methods for painting of hot dipped galvanized steel. The standard provides methods for the identification and subsequent removal of zinc corrosion products and chromate conversion products that are considered detrimental to coating adhesion. It is considered critical that these methods described by ASTM D 6386-10 to be followed prior to coating application.

All high spots in the zinc shall be removed using power tools as per SSPC No2. or No3. Areas reduced below the minimum required thickness, before or after the removal of high spots, should be repaired in accordance with ASTM A 780 Standard Practice for Damaged and uncoated Areas of HDG Coatings.

Surfaces should be clean and free of oil and grease, as per SSPC SP1, prior to sweep blasting with rapid nozzle movement using abrasive material similar to 200-500um Aluminum/magnesium silicate.

Because of the reactivity of zinc with the atmosphere, coatings should be applied as soon as possible within eight hours following surface preparation to minimize the formation of zinc corrosion products.

Coating System

Components if the coating system is described in table 1 by generic material type. Section 216.03.01.01 of the BC MoT SSHC 2012 limits coatings of steelwork to the materials listed on the Ministry published recognized Products List (RPL). Suppliers of specific coatings identified by the RPL should be consulted before application of the selected materials to confirm compatibility with hot dipped galvanized steel.

Strip coats should be applied to all welds, lap joints, plate edges, corners, and area with radii prior to application of the first full mid coat. It is good practice to strip coat using a contrasting color to identify application.

Field repairs

It is recommended that field repair of hot dipped galvanized coatings be completed by metallizing with 85/15 zinc/aluminum in accordance with SSPC-CS23.00/AWS C2.23M/NACE No.12. The metallized coating should sealed and a top coat applied. Prior to application, all flame cut edges should be ground to remove carburized surfaces and the area to be coated subjected to near white metal blast cleaning as per SSPC SP10/Nace No.2 as described in section 421.51 of the BC MoTI SSHC. Zinc should be applied to the prepared surfaces within eight hours of blasting. Sealer should be applied to the zinc within eight hours if zinc application and in accordance with the manufacturers recommendations.

Table 1 – Handrail Stanchions

<table>
<thead>
<tr>
<th></th>
<th>Carbon Steel Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High-Dip Galvanized as per CSA G164 (and/or ASTM A 123)</td>
</tr>
<tr>
<td>2A</td>
<td>Shop Applied Coatings on Hot-Dip Galvanized Steel</td>
</tr>
</tbody>
</table>
**APPENDIX E**  
**JOHNSON STREET BRIDGE**  
**DRAFT STRUCTURAL SPECIFICATIONS**

### Surface Preparation System

<table>
<thead>
<tr>
<th>Surface Preparation</th>
<th>System Component</th>
<th>Binder</th>
<th>DFT¹ (mil/µm)</th>
<th>MoTI Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSPC SP1 Solvent Cleaning</td>
<td>Stripe Coat</td>
<td>Polyamide Cured Epoxy</td>
<td>3/76</td>
<td>216.12.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>216.12.01.01</td>
</tr>
<tr>
<td>Surface shall meet SSPC-SP12 NV-2</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>(less than 7 µg/cm² chloride ion, 10</td>
<td>Midcoat</td>
<td>Polyamide Cured Epoxy</td>
<td>6/152</td>
<td>216.03.01.01</td>
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<tr>
<td>µg/cm² soluble ferrous ion, 17 µg/cm²</td>
<td></td>
<td></td>
<td></td>
<td>308</td>
</tr>
<tr>
<td>sulphate) or below when tested using</td>
<td>Topcoat</td>
<td>Aliphatic Polyurethane</td>
<td>3/76</td>
<td>422.35</td>
</tr>
<tr>
<td>SSPC Guide 15 – Swabbing extraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>method</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSPC SP7 / NACE No. 4</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Brush Off Blast Cleaning (sharp 50-75 µm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>profile)</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### 2B. Field Applied Touch-up and Repair of Damaged Hot-Dip Galvanized Steel

<table>
<thead>
<tr>
<th>Surface Preparation</th>
<th>System Component</th>
<th>Binder</th>
<th>DFT¹ (mil/µm)</th>
<th>MoTI Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSPC SP1 Solvent Cleaning</td>
<td>Metallizing (Primer)</td>
<td>85/15 Zinc Aluminum</td>
<td>7/175</td>
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<tr>
<td></td>
<td>SSPC-CS23.00/</td>
<td>700 psi (4.8 MPa)</td>
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<td>216.03.04</td>
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<tr>
<td></td>
<td>AWS C2.23/</td>
<td>Minimum adhesion</td>
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<td>308</td>
</tr>
<tr>
<td></td>
<td>NACE No. 12</td>
<td>(Thermal Spray Coatings)</td>
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<tr>
<td></td>
<td>Stripe Coat</td>
<td>Polyamide Cured Epoxy</td>
<td>1/25²</td>
<td>421.42</td>
</tr>
<tr>
<td></td>
<td>Sealer</td>
<td>Polyamide Cured Epoxy</td>
<td>1/25</td>
<td>421.51</td>
</tr>
<tr>
<td></td>
<td>Topcoat</td>
<td>Aliphatic Polyurethane</td>
<td>3/76</td>
<td></td>
</tr>
</tbody>
</table>

(1) Dry Film thickness

(2) The achieving complete coverage of the zinc is more critical than DFT thickness and the coating should be visually assessed to determine complete coverage, similar to a wet film.

### 17. Bridge Deck Surfacing System

A polyurethane surfacing system such as Bimagrip LS in combination with dynagrip aggregates or an approved equivalent shall be applied to the surface of the orthotropic steel deck. The vehicle lanes on the bridge shall be seeded with 1 – 3 mm aggregate and bicycle lanes on each side of the roadway shall be seeded with 1mm aggregate. The supplier of the
surfacing system for both the vehicle and bicycle lanes must provide a ten (10) year warranty against all defects.

18. Deck Joints

Deck joints shall be fabricated and installed by the Contractor as shown on the Drawings and in accordance with SS 422. Steel components shall be hot-dipped galvanized in accordance with CAN/CSA G164, after fabrication.

The Contractor shall form a blockout for each deck joint as shown on the Drawings. Blockout concrete shall be bonded to the concrete previously cast by means of an epoxy bonding agent conforming to ASTM C881M-02, Type II, Grade 2. The Class of bonding agent shall be appropriate for the temperature at time of application. The bonding agent shall be applied in accordance with the manufacturer's recommendations.

Each joint seal shall be supplied in a single length, without splices. Before the joint seal is installed, the joint seal and armouring shall be thoroughly cleaned and all moisture removed from the joint seal and armouring.

The seal shall be installed in accordance with the manufacturer's recommendations.

19. Supply, Fabrication and Installation of Conventional Bearing Assemblies

Steel fabrication shall be in accordance with SS 422. All exposed steel surfaces shall be galvanized to CAN/CSA-G164-M or metallized to CSA G189. Shop drawings for all bearing assemblies shall be submitted to the Consultant for review prior to fabrication. Shop drawings shall show all details of the bearing assemblies and of the material proposed for use.

Stainless steel shall conform to ASTM A240-00. The face of the stainless steel in contact with PTFE (polytetrafluoroethylene polymer) shall have a bright annealed mirror finish. The roughness of the contact surface shall be less than 0.2 µm arithmetic average for plane surfaces and 0.4 µm arithmetic average for curved surfaces measured in accordance with CSA B95.

The elastomer shall conform to the requirements of CAN/CSA-S6-06, Section 11.6.6.2.2.

PTFE shall conform to the requirements of CAN/CSA-S6-06, Clause 11.6.3.2.

The Contractor shall submit test results and certificates of compliance to the Consultant for all materials incorporated into the bearings.

a) Unreinforced Elastomeric Bearings
Unreinforced elastomeric bearings and bearings cut from cured rolled stock shall be tested only for durometer hardness.

b) Steel Reinforced Elastomeric Bearings

**General**

Fabrication tolerances shall be in accordance with Clause 11.6 of CAN/CSA-S6-06 and the 17th edition of the AASHTO Standard Specifications for Highway Bridges, Division II Section 18.5. The requirements of Clause 11.6 of CAN/CSA-S6-06 shall govern in the event of a conflict with those of the AASHTO requirements. For steel reinforced elastomeric bearings the minimum cover of elastomer over the edges of reinforcing plates shall be 5 mm.

The bearing manufacturer shall conduct compression tests as described below, either by or in the presence of an independent certified testing agency. The testing agency shall submit test results to the Consultant.

**Nondestructive Testing - Compression Test**

Each bearing shall be tested by the Contractor as follows using a concentric compression load:

- The testing machine used shall have platens at least 20 mm greater in both plan dimensions than the bearing under test.
- At least two dial gauge micrometers shall be positioned at the centres of opposite sides of the bearing to measure deformation. When bearings are tested in single vertical stacks, a steel plate shall separate the bearings and a set of dial gauge micrometers shall be installed for each bearing.
- The bearing shall be loaded at the rate of 1.5 MPa/minute to a load of 7.5 MPa multiplied by the gross plan area. The deformations shall be recorded.
- The load shall be reduced at the same rate until the pressure on the bearing is 1.5 MPa, and the deformations recorded.
- The load on the bearing shall be maintained at 1.5 MPa for fifteen minutes, and the deformations shall be recorded.
- The bearing shall be reloaded to 7.5 MPa, and steps (d) to (e) shall be repeated.
- The bearing shall be reloaded to 10 MPa with deformations being recorded after each 1 MPa increment.
- A graph of the pressure versus average deformation with data recorded in (g) shall be developed.

The rates of loading specified in step (c) and (d) also apply to steps (f) and (g).

A bearing shall be rejected based on the following deficiencies:
• If it displays bulging patterns under compression load which indicate laminate placement which does not satisfy design criteria and manufacturing tolerances or poor laminate bond.
• If it has more than two surface cracks which are greater than 2 mm long and 2 mm deep.
• If the compressive deformation exceeds 7% of the total elastomeric thickness of the bearing during the application of the sum of the vertical serviceability loads shown on the Drawings; and
• If it does not meet the specified tolerances.

c) Installation

Bearings shall be installed as shown on the Drawings. Bearings shall be set to the dimensions and offsets prescribed by the manufacturer and the Drawings, and shall be adjusted as necessary to take into account the temperature at time of installation and future movements of the bridge due to temperature changes, release of falsework and shortening due to prestressing.

Installation tolerances shall be in accordance with the 17th edition of the AASHTO Standard Specification for Highway Bridges, Division II, Section 18.9.

20. Bridge Railings

Steel railing and steel components of the bridge railing system on the roadway bridge deck shall be supplied, fabricated and installed as shown on the Drawings and in accordance with SS 422. All steelwork shall be galvanized after fabrication.

Railing shall be adjusted to produce uniform height and smooth alignment.

21. Sidewalk / Multi-use Deck Railing

The specifications for the sidewalk / multi-use deck railing materials, fabrication and installation are provided in the architectural section of the specifications.

22. Silane Surface Treatment

Silane surface treatment shall conform to SS 418.
The tops and both faces of concrete barrier curbs and the exposed outside edges of the concrete deck slabs shall be treated with a silane solution.

23. Fendering System

References:
- AASHTO LRFD Bridge Design Specifications (latest version)
- Vessel Bridge collision Report by Dr. Foschi dated July 16, 2012

The fendering system has been developed to a conceptual level and the information has been provided on drawings, 5012802-100-S-FEN-501 to 5012802-100-S-FEN-505, Revision B.

The fendering system is envisioned to consist of fabricated steel fender panels attached to rubber fender units mounted to structural supports. Two fendering types are proposed as described below.

- Type 1 Fender, Trelleborg UE 500 x 2000 mm wide Fenders (or equivalent);
- Type 2 Fender, Trelleborg AM 800 x 2400 mm wide Fenders (or equivalent)

The fenders are to be mounted to structural supports, with the support conditions varying along the length of the channel opening under the main bascule span. Structural concepts have been developed for attachment to the existing piers, attachment to the new east pier, attachment to the steel dolphin structures and to the piled waler system in front of the west pier. These concepts have been provided on the referenced drawings.

The collision force applied to the fendering system is to be based on the governing vessel listed in Table 1 of the Vessel – Bridge Collision Report. The fendering system is to be designed assuming the vessel collides with the fenders at a speed of 4.75 knots and at a maximum collision angle of 20 degrees. The fenders shall be designed to provide a minimum fender efficiency (ratio of energy absorbed to the reaction force generated.) of 50%.

The Contractor shall engage a fendering supplier to optimize the conceptual design to meet the above noted requirements with all costs associated with the detailed design of the fenders and structural supports to be included in the price of the supplied and installed fendering system.
1.1 PROJECT MEETINGS

.1 The Contractor shall schedule and administer in consultation with the Consultant a start-up meeting and weekly project meetings throughout progress of Work. In this regard, the Contractor shall:

a) Prepare agenda for meetings.
b) Distribute written notice of each meeting to Consultant 2 days in advance of meeting date.
c) Provide physical space and make arrangements for meetings.
d) Preside at meetings.
e) Record minutes including proceedings and decisions and identify action by parties and due dates.
f) Reproduce copies of minutes within three days after each meeting and transmit to meeting participants, affected parties not in attendance and Consultant.

g)  

1.2 CONSTRUCTION START-UP MEETING

.1 Within 5 days of execution of the Contract or written notice from the City to do so, whichever is earlier, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.

.2 Establish time and location of meeting and notify parties concerned minimum 2 days before meeting.

.3 Agenda to include the following:

.1 Occupational Health and Safety;
.2 Quality Management;
.3 Appointment of City’s Representative and Contractor’s Representative;
.4 Work Schedule, and progress scheduling;
.5 Schedule of submission of shop drawings, and samples;
.6 Marine Communications Plan;
.7 Environmental Management Plan;
.8 Traffic Management Plan;
.9 Project communications;
.10 Requirements for temporary facilities, Site signage, offices, storage sheds, utilities, fences;
.11 Delivery schedule of specified equipment;
.12 Site security and Site maintenance;
.13 Record drawings;
.14 Hand over procedures, acceptance, and warranties;
.15 Monthly progress claims, administrative procedures, photographs, and holdbacks;
.16 Appointment of inspection and testing agencies or firms; and
.17 Insurance and transcript of policies.
1.3 CONSTRUCTION PROGRESS MEETINGS

.1 During course of the Work, schedule weekly progress meetings.

.2 Contractor, major Subcontractors involved in Work, Consultant and City are to be in attendance.

.3 Notify all parties minimum 5 days prior to meetings.

.4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 3 days after meeting.

.5 Agenda to include following:

.1 Occupational Health and Safety issues;

.2 Compliance with Quality Management Plan;

.3 Compliance with Environmental Management Plan;

.4 Compliance with Marine Communications Plan;

.5 Compliance with Traffic Management Plan;

.6 Compliance with communications protocols;

.7 Review and approval of minutes of previous meeting;

.8 Review of Work progress since previous meeting;

.9 Field observations, problems, conflicts;

.10 Problems which impede construction schedule;

.11 Review of off-site fabrication delivery schedule;

.12 Corrective measures and procedures to regain projected schedule;

.13 Revision to the Work Schedule;

.14 Progress schedule, during succeeding work period;

.15 Review submittal schedules: expedite as required;

.16 Maintenance of quality standards;

.17 Review proposed changes for effect on Work Schedule and on completion date; and

.18 Other business.

END OF SGC
1.4 WORK SCHEDULE

.1 Prepare Work Schedule in form of a horizontal Gantt chart.
.2 Provide a separate bar for each major item of work or operation.
.3 Split horizontally for projected and actual performance.
.4 Format for listings: chronological order of start of each item of work.
.5 The Work Schedule shall include dates for commencement and completion of each major element of construction associated with the Work. Each major element shall be expanded to show sub elements with durations not to exceed 20 consecutive calendar days.
.6 The Work Schedule shall be accompanied by a planned cash flow for the Project.
.7 The Contractor shall submit to the Consultant the Work Schedule within 10 working days of the start-up meeting. Within 10 working days of receipt of the Work Schedule, the Consultant will provide the Contractor comments. The Contractor will revise the Work Schedule in accordance with the Consultant’s comments and re-submit for approval by the Consultant.

1.5 PROGRESS REPORTING

.1 The Contractor shall submit monthly progress reports to the Consultant on a mutually agreed date. The monthly progress report shall include actual and predicted schedule and cash flow as well as a narrative and photographs.
.2 For the purpose of Progress Reporting, the Work Schedule shall:
  .1 show projected percentage of completion of each item.
  .2 show changes occurring since previous submission of Work Schedule:
    .1 major changes in scope,
    .2 activities modified since previous submission,
    .3 revised projections of progress and completion,
    .4 other identifiable changes.
.3 Provide a narrative report to define:
  .1 Problem areas, anticipated delays, and impact on Work Schedule,
  .2 Corrective action recommended and its effect,
  .3 Effect of changes on schedules of Subcontractors.

1.6 CONSTRUCTION PHOTOGRAPHS

.1 The Contractor shall document all work performed using photographs as follows:
  .1 Digital Format: 2048x1536 pixel JPEG files;
  .2 Identification: name and number of project and date of exposure indicated;
  .3 Number of viewpoints: four. Locations of viewpoints determined by Engineer;
  .4 Frequency: daily with progress statement, during excavations, and as directed by Consultant; and
.5 Will be provided to Consultant weekly.
.6 Selected photographs will be included in the Contractor’s monthly progress report.

END OF SGC
1.1 GENERAL


.2 Work affected by submittal shall not proceed until the Consultant has returned the submittal marked “Reviewed”.

.3 All submittals must be in SI units. Other units may be shown in brackets.

.4 The Contractor shall review submittals prior to submission to Consultant. The Contractor’s review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of the Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned for resubmission by the Contractor.

.5 The Contractor, at time of submission, shall identify deviations from requirements of Contract Documents stating reasons for deviations.

.6 The Contractor shall verify that field measurements and affected adjacent Work have been coordinated.

.7 Contractor’s responsibility for errors and omissions in submissions is not relieved by Consultant review of submittals.

.8 Contractor’s responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant review.

1.2 SHOP DRAWINGS

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochure, product data, samples and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.2 Shop drawings will indicate materials, methods of construction and 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 coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross-references to design drawings and specifications.

.3 Make changes in shop drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of any revisions other than those requested.

.4 Accompany submissions with transmittal letter containing:
   .1 Date;
   .2 Project title and number;
   .3 Contractor’s name and address;
   .4 Identification and quantity of each shop drawing, product data and sample; and
.5 Other pertinent data.

.5 Submissions shall include:

.1 Date and revision dates;
.2 Project title and number; and
.3 Name and address of the Subcontractor, supplier and manufacturer.

.4 Contractor's stamp, signed by the Contractor's Representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.

.5 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; and
.10 Relationship to adjacent work.

.6 Drawing Format:

.1 In AutoCAD electronic format (most current release) (on Compact Disk)
.2 Produced on ANSI-D size paper
.3 SI metric units
.4 Legible when reduced to 1/2 size
.5 In accordance with CSA Standard CAN/CSA-B78.2-86 - Dimensioning and Tolerancing of Technical Drawings

.7 After Consultant's review, distribute copies.

.8 Submit an electronic copy of product data sheets or brochures for requirements requested in specification Sections and as requested by Consultant where shop drawings will not be prepared due to standardized manufacture of product.

.9 Delete information not applicable to project.

.10 Supplement standard information to provide details applicable to the Work.

.11 If upon review by Consultant, no errors or omissions are discovered or if only 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.

.12 The review of shop drawings by the Consultant is for sole purpose of ascertaining conformance with general concept. This review shall not mean that Consultant approved detailed 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. 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 all Subcontractors.

.13 All structural details for the support of electrical equipment and signing as well as fence details as shown on the plans are functional only and are intended to illustrate a design concept. The shop drawings for all structural components shall be sealed by a Professional Engineer registered in the Province of British Columbia (APEGBC).

.14 Do not start fabrication on any component until the shop drawings or prototype samples are reviewed and accepted by the Consultant.

END OF SGC
1.1 SUBMITTALS

.1 Prior to mobilization to Site, submit Site Specific Occupational Health and Safety Plan (SSOHS Plan). The plan shall include a signed attestation by an Officer of the Contractor’s Company.

.2 Prior to mobilization to Site submit:
   .1 Workplace Safety and Insurance Board Clearance Certificate;
   .2 Insurance certificates;
   .3 Company Health and Safety Policy;
   .4 WHMIS Training Certificates for Personnel; and
   .5 Material Safety Data Sheets for chemicals or material to be used.

1.2 GENERAL REQUIREMENTS

.1 The Contractor shall provide the Consultant with a copy of its safety policy statement that expresses the Contractor’s commitment to safety, its guiding principles, and the responsibilities for safety delegated to its supervisors and workers. The Contractor shall also provide, prior to commencing work, a copy of its safety program, site-specific plan to implement the safety program for the construction to be performed and specific safe operating procedures, where requested.

.2 The Contractor may also be requested to provide evidence (records) of its safety program’s implementation for similar work and/or provide/demonstrate implementation of its safety plan for the Work being performed at the Johnson Street Bridge, as well as records of training of all workers on Site.

1.3 WHMIS

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials.

.2 Deliver copies of WHMIS training certificates to the Consultant on delivery and disposal of materials and provide a material safety data sheet (MSDS) for any controlled product to the Consultant planned for use in the project.

1.4 SITE SPECIFIC OCCUPATIONAL HEALTH AND SAFETY PLAN

.1 The SSOHS Plan will name the Contractor’s “Safety Officer” and shall detail safety plans for all components of the Work.

.2 The Contractor shall prepare the SSOHS Plan in collaboration with all intended subcontractors.

.3 Contractor shall ensure that all Site personnel are familiar with the contents of the SSOHS Plan and maintain records for proof.

.4 Contractor shall employ measures to ensure all personnel entering the Site are advised to abide by the SSOHS Plan.

.5 The Contractor shall revise SSOHS Plan as required when changes or modification to work occurs.

.6 The Contractor shall submit SSOHS Plan and any revisions to the Consultant prior to starting work. The plan shall contain a commitment by Contractor to abide by the plan duly executed by an officer of the Contractor’s Company.
.7 Submission of the SSOHS Plan to the Consultant shall not relieve the Contractor of any legal obligations for the provision of construction safety as specified by the local regulatory agencies.

END OF SGC
1.1 GENERAL

.1 Ten days prior to commencing the Work, the Contractor shall submit to the Consultant the necessary plans, notifications and permits, including the Soils Management Plan (SMP), for the management and disposal of hazardous materials and for executing the Work in accordance with all permits related to protection of the environment.

.2 The Contractor shall submit all manifests for imported and exported materials.

.3 At the conclusion of the Work, the Contractor shall submit a comprehensive report detailing the disposition of all deconstruction waste material generated from the Work including total tonnage of materials re-used or recycled and percentage of materials re-used or recycled.

1.2 DELIVERY AND HANDLING OF HAZARDOUS MATERIALS

.1 Segregate hazardous materials from other materials, in accordance with the approved Environmental Management Plan (EMP) and SMP. Avoid mixing hazardous materials with other materials.

.2 Place materials defined as hazardous or toxic in containers or areas designated for that material and in accordance with the SMP.

.3 Create manifests describing and listing waste created and transport containers by approved means to licensed treatment or disposal facility. A copy of all manifests will be submitted to the Consultant.

MATERIALS

1.3 GENERAL

.1 The Work shall be in accordance with the accepted EMP and SMP.

.2 Use equipment suitable for the removal and segregation of hazardous materials in a manner that protects worker and public safety and minimizes disturbance to environment.

.3 Use containers that are approved under all applicable regulations, for the storage and transport of the applicable wastes.

.4 Label all containers used in accordance with all applicable regulations.

1.4 LEAD PAINT

.1 Manage lead painted materials in accordance with all applicable regulations and health and safety requirements, including but not limited to notifications, planning, and inspection.

.2 Select methods to eliminate contamination of work areas.

1.5 CREOSOTE OR HYDROCARBON

.1 Manage railway ties, wharf piles or other wood treated with creosote preservative or other hydrocarbons in manner that protects worker and public safety and eliminates disturbance to environment.

.2 Place or store railway ties as directed by the Consultant.

1.6 STOCKPILE

.1 Stockpile excavated material in accordance with the requirements of the Soils Management Plan.
1.7 BACKFILL

.1 Backfill material and imported soils used as backfill must meet the following criteria in addition to the geotechnical requirements of the MMCD (latest version):

.1 Soil shall have no visible or odorous evidence of contamination;
.2 Soil shall originate from known sources with no evidence of disposal or release of hazardous materials, hydrocarbons, toxins, radioactive waste or other sources of negative environmental impact;
.3 Representative samples will be collected from import granular fill; and
.4 Contractor bears cost of removal associated with excavation and disposal of non-approved backfill.

END OF SGC
1.1 GENERAL

.1 An Environmental Management Plan (EMP) shall be submitted to the Consultant and applicable Regulatory Agencies ten days prior to commencing the Work. The EMP shall detail how the Contractor will comply with the Contract Documents, the Environmental Assessment Screening Report pursuant to the Canadian Environmental Assessment Act and all applicable permits.

.2 The Work shall be in accordance with the accepted EMP.

.3 Fires and burning of rubbish on Site are not permitted.

1.2 EMERGENCY RESPONSE

.1 Contractor must maintain Spill Response Equipment and establish Spill Response Procedures, including Site specific contacts identified by the City. The procedures must be adequate for the type of spill that may result from the handling and disposal of the identified hazardous materials or other spills and shall be detailed in the EMP.

.2 Report emergency spills immediately to Provincial Emergency Program (PEP) at (1-800-663-3456). Spills of deleterious substances should be immediately contained and cleaned up in accordance with federal and provincial regulatory requirements, as well as the EMP, or as directed by the Consultant.

.3 Report spills entering municipal storm drainage system during the day to contact (250)-514-2215 and after regular working hours to (250)-385-5711.

1.3 SANITATION

.1 Maintain appropriate employee hygiene procedures to avoid exposure to hazardous materials.

.2 Prohibit eating or smoking in areas where hazardous materials are handled, processed or stored.

1.4 DISPOSAL OF WASTES

.1 Do not bury rubbish and waste materials on-site.

.2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

.3 Wherever practical for waste reduction, all materials from the bascule bridge deconstruction should be re-used or recycled.

1.5 DRAINAGE

.1 Do not pump water containing suspended materials into waterways, sewer or drainage systems.

.2 Control disposal or runoffs of water containing suspended materials or other harmful substances in accordance with local authority requirements.

.3 Maintain and keep ditches open and free from debris at all times.

.4 Where necessary, provide drainage control devices in ditches to minimize flow rates and prevent erosion.

.5 Provide and maintain temporary erosion, pollution and sediment control features required to prevent contamination of ocean and storm systems from sediments caused by runoff as per the EMP.
1.6 WORK ADJACENT TO WATERWAYS

.1 Do not use waterway beds or riparian zones or intertidal areas for borrow material without the Consultant’s approval.

.2 Do not dump excavated fill, waste material or debris in waterways.

.3 Equipment handling contaminated soils will require decontamination prior to leaving Site. Contractor to decontaminate equipment by removing all soil from equipment including tracks, buckets and tires. Water usage in decontamination should be limited and disposed of by Contractor in approved manner.

1.7 POLLUTION CONTROL

.1 Provide and maintain temporary erosion, pollution and sediment control features required to prevent contamination of stormwater retention ponds and storm systems from sediments caused by runoff as per the EMP.

.2 Control emissions from equipment and meet all local authorities’ emission requirements.

.3 Prevent sandblasting and other extraneous materials from contaminating air beyond application area, by providing temporary enclosures.

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

.5 Eliminate potential for spills of hazardous substances through proper use, handling, storage and disposal of products.

.6 The EMP shall include a Spills/Environmental Emergency Response Plan for the Consultant’s review prior to the start of work.

.7 All spills of any nature must be reported to the Consultant and cleaned up immediately to the satisfaction of the Consultant.

1.8 SMOKE CONTROL

.1 The Contractor is to utilize only such equipment and construction procedures that will minimize the release of smoke to the environment in accordance with the accepted EMP.

1.9 DUST CONTROL

.1 The contractor is to mitigate dust from non-vegetated or disturbed areas during work. All reasonable attempts must be made to keep dust to a minimum. The following techniques are acceptable:

.1 Wetting excavation faces;

.2 Spraying water on buckets during excavation and dumping;

.3 Hauling materials in covered transports;

.4 Restricting speed limits;

.5 Covering excavations areas upon completion of excavations; and

.6 Minimizing the excavation size.

END OF SGC
1.1 GENERAL

.1 The Contractor shall submit a Quality Management Plan (QMP) defining how they will comply with and report on the requirements of the Contract Documents and as required for the Engineer of Record to complete the letters of assurance. The QMP shall include, the Inspection and Test Plans for each element, management of shop drawings, RFI’s, NCR’s, work procedures, drawing revisions and all other quality related documentation in accordance with the Contract Documents.

.2 No work will commence until the QMP is accepted by the Consultant.

.3 The Contractor shall provide the Consultant access to all quality documents to perform periodic audits. It is the Contractor’s responsibility to address and remediate concerns to the satisfaction of the Consultant.

.4 The Contractor shall be responsible for all costs associated with the management, coordination and implementation of the QMP.

.5 The Contractor will provide the Consultant all quality records required to satisfy the Engineer of Record’s requirements for completion of the letters of assurance required for Substantial and Total Completion.

1.2 INDEPENDENT INSPECTION AGENCIES

.1 Independent inspection/testing agencies will be engaged by the Contractor for purpose of inspecting and/or testing portions of the Work. The Contractor shall not restrict Consultant access to any testing information. The Consultant, at their discretion, may perform supplemental independent inspection and testing at its cost.

.2 All Non Conformance Reports (NCR’s) will be provided to the Consultant. The Contractor shall undertake additional inspection and/or testing to ascertain full degree of defects identified in the NCR’s.

.1 REPORTS

.1 Upon request, the Contractor shall provide copies of all inspection and test reports to the Consultant.

END OF SGC
1.1 GENERAL

.1 Provide construction facilities in order to execute the Work expeditiously.

.2 Remove from the Site all such facilities upon completion of the Work.

.3 The Contractor shall utilize clearly delineated entrance/egress routes and gates as access to the Site.

.4 The Site must be delineated by fencing or other means to keep the public, other workers and unauthorized personnel from entering the Site at all times.

.5 Site fencing shall look consistent, appropriate for downtown Victoria, neat and maintained in good order. Viewing opportunities shall be provided in the site fencing. All Site fencing to be acceptable to the City’s Representative, acting reasonably.

.6 The Contractor shall clean City roads as directed by the Consultant where used by Contractor’s equipment.

.7 Contractor to ensure all truck drivers provide a ‘walk around’ inspection of all trucks prior to returning to City road surfaces. This includes cleaning all tires, tailgates and

1.2 SANITARY FACILITIES

.1 Provide sanitary facilities on-site for work force.

.2 Keep area and premises in sanitary condition.

1.3 REMOVAL OF TEMPORARY FACILITIES

.1 Remove temporary facilities from the Site when directed by City.

END OF SGC
1.1 GENERAL

.1 Work shall conform to the current BC Ministry of Transportation criteria for Traffic Control for Work on Roadways.

.2 The Contractor shall retain an independent consultant and submit a Traffic Management Plan (TMP) in accordance with the Contract Documents and this SGC. The TMP shall be sealed by a Professional Engineer registered in the Province of British Columbia (APEGBC).

.3 The TMP shall avoid disruptions to local businesses and maintain all existing roadways, private accesses, sidewalks, pathways and other existing traffic patterns.

.4 The TMP shall integrate all temporary and permanent works associated with the Work and provide accommodation for third party work inside and within proximity to the Site.

.5 Implementation of the TMP shall be coordinated with the City.

.6 Provide temporary protection for safe handling of public, personnel and vehicular traffic.

.7 Permanent lane closures will not be permitted.

1.2 SUBMISSION REQUIREMENTS

.1 The Contractor shall submit the TMP to the Consultant for review. The Consultant will require 10 working days to review the Contractor’s TMP. Work will not be allowed to commence on Site until the Consultant has marked the TMP “Reviewed”.

.2 The TMP shall contain:

.1 A written project description including:

.1 Dates of Work

.2 Hours of Work including days of week

.3 Identify Site constraints such as construction, entrance and exit routes approved by the Consultant

.4 Identify all proposed haul routes and the haul routes intended for hazardous materials

.5 Site factors, such as:

.1 Volume of traffic

.2 Speed limits

.3 Types of traffic

.4 Number of lanes and types of lanes

.5 Road or Street Names

.6 Pedestrian/cyclist traffic

.1 Volume of pedestrians

.2 Protection offered

.3 Detours

.4 Contractor to get permits for existing bus stops that need to be relocated
.5 Access to private properties

.6 Potential conflicts between the Contractor’s operations and pedestrian/cyclist traffic.

.7 Emergency vehicle (EV) access
   .1 Nearest EV location
   .2 Effect to EV’s

.8 Work Zone Protections
   .1 Length of zone
   .2 Location of zone (barrier, divider, curb, sidewalk)
   .3 Details of protections

.9 Traffic Control Personnel including supervisor’s name

.10 Descriptions of intended advertisement and communications for activities as notice of construction

.11 General considerations

.12 Emergency telephone numbers, utility companies, nearest hospital, BC One, City Engineering department, points of contact

.13 Appendices:
   .1 Plan(s) including North arrow, detailing sign types, sign location, traffic control personnel locations, lane markings, directional flow, lane closures, traffic and pedestrian travel paths.

1.3 OPERATIONAL RESTRICTIONS AND CONSTRAINTS

.1 Buried power, communication and control cables and other underground structures and services in the vicinity of the construction areas are to be identified by the Contractor’s designated utilities locator and protected by the Contractor.

.2 Emergency Rescue Services mobility must be preserved at all times. Operating routes must be reviewed on a weekly basis to ensure all access is maintained at all times. Alternative and approved routes are to be established if new construction is anticipated by the Contractor.

.3 Do not start work until all temporary traffic control facilities are in place and the TMP is approved by the Consultant.
1.4 USE OF CRANES AND HEIGHT RESTRICTIONS

.1 Cranes and hoisting equipment (hereafter referred to as crane(s)), may not be erected without specific written permission of the Consultant. Contractor is to submit request to Consultant, allowing a minimum of 14 days, for crane use review and acceptance by Consultant, City, Transport Canada and/or Nav Canada. This request must include the exact location (coordinates or offset distances) of the planned crane work, the ground elevation and the maximum height of the crane to project above ground. When requested, top of crane boom to be marked with operational red obstruction lights.

.2 Crane usage protocols shall be included in the TMP.

END OF SGC
1.1 GENERAL

.1 This specification describes the performance requirements for the Work in proximity to the existing Johnson Street Bridge and associated decommissioning, demolition and deconstruction works. The demolition and deconstruction operation comprises removal of the existing bridge and fendering as required in the Contract Documents.

.2 Except as expressly allowed in or required by the Contract Documents, the Contractor shall ensure that the existing Johnson Street Bridge shall not be adversely impacted by the performance of the Work until such time that the new bridge is totally completed and all traffic has been routed onto the new structure.

.3 The Contractor shall ensure that the condition or operation of the New Bridge is in no way adversely affected by the deconstruction of the existing bridge.

.4 As soon as existing bridge deconstruction work commences, all parts and components of the existing bascule bridge are to be deconstructed as indicated in Appendix F - Drawings. The existing bridge is painted with lead based paints and the machine/control rooms have asbestos in them. Timber elements were treated with creosote.

.5 All parts and components of the existing bascule bridge shall, immediately upon their disconnection from the bridge, become the sole property of the Contractor and shall be disposed of by the Contractor in accordance with the Contract Documents and all applicable permits.

1.2 DECONSTRUCTION OF EXISTING BRIDGE

.1 The existing bridge superstructure shall be deconstructed as shown in Appendix F – Drawings. Piers and abutments shall be modified in accordance with the Contract Documents.

.2 The Contractor shall provide a Deconstruction Plan that includes plans and details of the proposed deconstruction, including a detailed work plan describing all aspects of the deconstruction, falsework and other temporary supports. Deconstruction Plan shall ensure stability of the new bridge through the entire performance of the deconstruction work. The Deconstruction Plan shall be submitted to the Consultant for review at least 10 working days prior to the commencement of the deconstruction work.

.3 The deconstruction procedures, work plans shall be sealed by a Professional Engineer registered in the Province of British Columbia (APEGBC); and shall clearly define procedures, equipment and the proposed schedule of such work. All falsework required for the deconstruction work shall be sealed by a Professional Engineer registered in the Province of British Columbia (APEGBC). Deconstruction work shall not commence until the Consultant has approved the Deconstruction Plan.

.4 The Contractor shall deconstruct all decks and curbs in accordance with the accepted Deconstruction Plan. Rubble, steel reinforcing and structural steel or any other material, deleterious or otherwise shall not be dropped into Victoria Harbour during the deconstruction operation. Any materials dropped into Victoria Harbour during deconstruction shall be removed at the Contractor’s expense. All deconstruction work shall be in accordance with the EMP, Marine Traffic Management Plan and applicable permits. All required protection or containment devices for the intent of prevention of aerial or water contamination shall be in place prior to the commencement of all deconstruction works.
1.3 SUBMITALS

.1 The Contractor will submit his Deconstruction Plans in accordance with this SGC.

.2 The Contractor shall submit Monitoring Plans and updates on structure movement for existing bridge during construction of the new bridge and new Bridge during the deconstruction of the existing bridge.

1.4 DISPOSAL

.2 Disposal shall be in accordance with the Environmental Management Plan (EMP) and all applicable permits.

1.5 RESTORATION

.3 Upon completion of the deconstruction work, the Contractor shall remove all temporary works and debris so as to leave the Site in a clean, safe and stable condition acceptable to the Consultant.

END OF SGC
1.1 GENERAL

.1 It is the Contractor’s sole responsibility to provide adequate schedule float for the submission of applications, Regulatory Agency and City review, and approval and notification process.

.2 The City, acting reasonably, shall provide assistance as and when required in order to meet the Regulatory Agency permitting application requirements.

.3 The City will obtain the Permits described in the following table. It is recognized that exact dates to obtain Permits cannot be established. Anticipated dates for obtaining permits are provided below.

<table>
<thead>
<tr>
<th>Permit or Authorization</th>
<th>Regulation</th>
<th>Issuing Agency</th>
<th>Status/Anticipated Date of Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Assessment Screening Report</td>
<td>Canadian Environmental Assessment Act</td>
<td>Transport Canada (TC), Fisheries and Oceans Canada (DFO), Canadian Housing and Mortgage Corporation (CMHC)</td>
<td>COMPLETE</td>
</tr>
<tr>
<td>Sign-Off</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Assessment Scope Change Approval Letter (to leave existing piers in place)</td>
<td>N/A</td>
<td>Transport Canada</td>
<td>Formal letter of approval for change in scope in the Environmental Assessment to leave the existing piers in place. Have requested Karen Hall (TC) to finalize the letter by October 24, 2012. All relevant regulatory agencies have been notified and have not indicated any issues or concerns. Harbour Master has requested a meeting with harbour users to inform them of the plan.</td>
</tr>
<tr>
<td>Navigable Waters Protection Act Permit</td>
<td>Navigable Waters Protection Act Section 5(2)</td>
<td>Transport Canada – Navigable Waters Protection Office</td>
<td>Received letter of understanding August 30, 2012. Permit cannot be issued until final design is determined.</td>
</tr>
<tr>
<td>Fisheries Act Authorization</td>
<td>Fisheries Act Section 35(2)</td>
<td>Fisheries and Oceans Canada</td>
<td>Updated Draft Habitat Compensation Plan was submitted to DFO October 22 2012. Once final design is confirmed a final habitat compensation plan will be submitted to DFO and upon approval authorization will be</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Permit or Authorization</th>
<th>Regulation</th>
<th>Issuing Agency</th>
<th>Status/Anticipated Date of Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heritage Conservation Act</strong> Section 12 Site Alteration Permit 2012-0010 (issued)</td>
<td><strong>Heritage Conservation Act Section 12</strong></td>
<td>Archaeology Branch – Ministry of Forests, Lands and Natural Resource Operations</td>
<td>Requested an extension for this permit to 2016. Comments from First Nations are due by the end of October and the extension is anticipated to be issued in the first week of November.</td>
</tr>
<tr>
<td><strong>Transport Canada</strong> Approval for abandonment of existing duct bank (cable will be removed)</td>
<td>Unknown</td>
<td>Transport Canada</td>
<td>COMPLETE</td>
</tr>
<tr>
<td><strong>Stormwater Outlet Placement</strong></td>
<td>N/A</td>
<td>DFO - Review</td>
<td>Have requested a response from DFO by October 24, 2012</td>
</tr>
<tr>
<td><strong>Facility Alteration Permit (FAP)</strong></td>
<td><strong>Federal Real Property Regulations and Federal Immovables Act</strong></td>
<td>Transport Canada</td>
<td>This will be organized, prepared and submitted by the Contractor (and the Contractor remains responsible for obtaining this Permit), but the City of Victoria must be the one to sign the application</td>
</tr>
<tr>
<td><strong>Licence to do work on or above the harbour</strong></td>
<td></td>
<td>Transport Canada</td>
<td>This will be organized, prepared and submitted by the Contractor (and the Contractor remains responsible for obtaining this Permit), but the City of Victoria must be the one to sign the application</td>
</tr>
<tr>
<td><strong>Tree Removal</strong></td>
<td><strong>Tree Preservation Bylaw 05-106</strong></td>
<td>City of Victoria</td>
<td>TBD, if required</td>
</tr>
</tbody>
</table>

**END OF SGC**
PART 1  GENERAL

1.1  SUMMARY

.1 Comply with requirements of this SGC when:
   1 removing more than one square meter of compounds that are asbestos containing materials have been used; and
   2 removing asbestos containing material from a pipe, duct or similar structure using a glove bag.

1.2  EXISTING CONDITIONS

.1 Notify City of material discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material pending instructions from City.

1.3  RELATED SECTIONS

.1 Environmental Management Plan (EMP).

1.4  DEFINITIONS

.1 Amended Water: water with non-ionic surfactant wetting agent added to reduce water tension to allow wetting of fibers.

.2 Asbestos Containing Materials (ACMs): materials that contain one per cent or more asbestos by volume and are identified under Existing Conditions including fallen materials and settled dust.

.3 Asbestos Work Area: area where work takes place which will, or may disturb ACMs.

.4 Authorized Visitors: City, Consultant[s], or designated representative[s], and representative[s] of regulatory agencies.

.5 Competent worker: 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.

.6 Friable Materials: material that when dry can be crumbled, pulverized or powdered by hand pressure and includes such material that is crumbled, pulverized or powdered.

.7 Glove Bag: prefabricated glove bag as follows:
   1 Minimum thickness 0.25 mm (10 mil) polyvinyl-chloride bag.
   2 Integral 0.25 mm (10 mil) thick polyvinyl-chloride gloves and elastic ports.
   3 Equipped with reversible double pull double throw zipper on top and at approximately mid-section of the bag.
   4 Straps for sealing ends around pipe.

.8 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with filter system capable of collecting and retaining fibers greater than 0.3 microns in any dimension at 99.97% efficiency.
.9 Non-Friable Material: material that when dry cannot be crumbled, pulverized or powdered by hand pressure.

.10 Occupied Area: any area of the building or work Site that is outside Asbestos Work Area.

.11 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required providing protection and isolation.

.12 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for work.

1.5 SUBMITTALS

.1 Submit proof to City that suitable arrangements have been made to dispose of asbestos-containing waste in accordance with requirements of authority having jurisdiction.

.2 Submit Provincial and/or local requirements for Notice of Project Form.

.3 Submit proof of Contractor's Asbestos Liability Insurance.

.4 Submit necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed.

.5 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.

.6 Submit proof that supervisory personnel have attended asbestos abatement course, of not less than two days duration.

.7 Submit documentation including test results, fire and flammability data, and Material Safety Data Sheets (MSDS) for chemicals or materials including: wetting agent and slow drying sealant.

.8 Submit proof employees have respirator fitting and testing.

1.6 QUALITY ASSURANCE

.1 Health and Safety:

.2 Instruct personnel on dangers of asbestos exposure, respirator use, wearing and maintenance of protective equipment and clothing, decontamination and applicable Federal, Provincial and Municipal Regulations.

.3 Complete work so that at no time does asbestos or asbestos fibers contaminate building and environment.

.4 Protective equipment and clothing to be worn by workers while in Asbestos Work Area must comply with Provincial and local regulations. Equipment and clothing must be properly cleaned and maintained for the duration of the Work. Decontamination procedures must be established for each work area. Defective equipment must be replaced immediately.

.5 Eating, drinking, chewing, and smoking are not permitted in Asbestos Work Area.
.6 Ensure workers wash hands and face when leaving Asbestos Work Area. Facilities for washing are to be established by the Contractor near the Asbestos Work Area.

.7 Ensure that no person required to enter an Asbestos Work Area has facial hair that affects seal between respirator and face.

.9 Provide visitors protection against health and safety hazards, including protective clothing and equipment and training for entry and exit from the Asbestos Work Area.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials that are not contaminated with asbestos for recycling.

.2 Remove from Site and dispose of packaging materials at appropriate recycling facilities.

.3 Place materials defined as hazardous or toxic in designated containers and handle and dispose of hazardous materials appropriately.

.4 Dispose of asbestos waste generated by removal activities appropriately.

.5 Provide manifests describing and listing waste created. Transport containers by approved means to licensed landfill for burial.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Drop Sheets:

.1 Polyethylene: 0.15 mm thick.

.2 FR polyethylene: 0.15 mm thick woven fiber 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: 0.15 mm thick sealable polyethylene bag or where glove bag method is used, glove bag itself.

.2 Outer container: sealable metal or fiber type where there are sharp objects included in waste material; otherwise outer container may be sealable metal or fiber type or second 0.15 mm thick sealable polyethylene bag.

.3 Labeling requirements: affix pre-printed cautionary asbestos warning that is visible when ready for removal to disposal Site.

.4 Glove bag to be equipped with features required by British Columbia regulations and policies.

.5 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 fibers.

.6 Tape: fiberglass – reinforced duct tape suitable for sealing polyethylene under both dry conditions and wet conditions using amended water.
PART 3 EXECUTION

3.1 SUPERVISION

.1 Minimum of one Supervisor for every ten workers is required.

.2 Approved Supervisor must remain within Asbestos Work Area during disturbance, removal, or other handling of asbestos-containing materials.

3.2 PROCEDURES

.1 Before beginning Work, at each access to Asbestos Work Area, install warning signs stating: ‘CAUTION ASBESTOS HAZARD AREA / NO UNAUTHORIZED ENTRY / WEAR ASSIGNED PROTECTIVE EQUIPMENT / BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM’.

.2 Before beginning such Work, remove visible dust from surfaces in the work area where dust is likely to be disturbed during course of such Work using approved methods that minimize the potential release of dust. Do not use compressed air for dust removal.

.3 Prevent spread of dust from Asbestos Work Area using measures appropriate to the Work to be done.

.4 Remove loose material by HEPA vacuum; thoroughly wet friable material containing asbestos to be removed or disturbed before and during Work unless wetting creates hazard or causes damage. Perform Work in a manner to reduce dust creation to lowest levels practicable.

.5 Pipe Insulation Removal Using Glove Bag:

.1 A glove bag not to be used to remove insulation from a pipe, duct or similar structure if the condition of the material or the pipe impedes the effectiveness of the glove bag.

.2 Inspect bag before use and at regular intervals for any damage or defects and repair or replace as required. The asbestos containing contents of the damaged or defective glove bag are to be contained an managed in an appropriate waste disposal container. Any damaged or defective glove bags are not to be reused.

.3 Remove bag after completion of stripping in manner that prevents the release of asbestos dust into atmosphere.

.4 Ensure that pipe is free of residue and sludge which after drying could release asbestos.

.6 Work is subject to visual inspection. Contamination of surrounding areas indicated by visual inspection will require complete enclosure and clean-up of affected areas.

.7 Cleanup:

.1 Frequently during Work and immediately after completion of the Work, clean up dust and asbestos containing waste using HEPA vacuum or by damp mopping.

.2 Manage asbestos waste to contain dust, during placing in containers and once in containers.

.3 Seal and remove double bagged waste from Site. Dispose of appropriately.
.4 Perform final thorough clean-up of Asbestos Work Areas and adjacent areas affected by Work using HEPA vacuum.

END OF SGC
1.1 EXECUTION

.1 The Contractor shall provide adequate notice, information and coordination with the Consultant prior to performing ground disturbing activities.

.2 The Work shall comply with the Heritage Conservation Act Section 12 Site Alteration Permit (# 11200-30/11A0422).

.3 The Consultant will provide an archeological monitor who will be present during the performance of ground alterations to the extent required by the subject permit.

.4 The Contractor shall allow for archeological related impacts including and not limited to schedule, production, management, and all costs associated with the performance of the Work under the direction of the monitor.

1.2 COORDINATION OF WORK WITH CONSULTANT

.1 All developments planned to include ground disturbing activities are to be reviewed by the Consultant prior to undertaking the Work. The Consultant will be responsible for data recovery methods and conduct archeological monitoring and data recovery as outlined on the Heritage Conservation Act Section 12 Site Alteration Permit (# 11200-30/11A0422). The Contractor is to implement scoped heritage management methods on a case by case basis.

1.3 ENFORCEMENT

.1 Protection of cultural artifacts is considered to be of importance during any works on City properties.

END OF SGC
1.1 GENERAL

.1 Submit to Consultant, prior to mobilizing to the Site, an Impact Assessment Report that shall identify and locate any existing condition that could potentially be damaged by the performance of the Work. This report shall include, but not be limited to, adjacent properties, utilities, existing bridge, new bridge and roadways within the zone that is influenced by performance of the Work.

.2 Submit to Consultant, prior to mobilizing to the Site, a Pre-Construction Survey that shall include a record of the state of existing conditions by means of video or photographs. The Contractor shall provide the Consultant with an opportunity to attend the Pre-Construction Survey. The Contractor shall ensure that an independent architect registered with the Architectural Institute of British Columbia or a Professional Engineer, as applicable assumes responsibility for any portion of the Pre-Construction Survey involving any structural or architectural aspects.

.3 Submit to Consultant, prior to mobilization to the Site, a Mitigation Plan, for each existing condition identified in the Impact Assessment Report as being vulnerable to damage or other impacts arising from the performance of the Work. The Mitigation Plan shall be sealed by an independent architect registered with the Architectural Institute of British Columbia or by a Professional Engineer, where such plan contains any design documents for methods, measures or procedures.

.4 Condition surveys during Construction. The Contractor shall, during the course of construction, monitor the pre-existing conditions and notify the Consultant of any damage. The Contractor is to provide additional reports including pictures or video, data and details. The Contractor is responsible to make good, to pre-existing condition or better, any damage as a result of the performance of the Work. The surveys during construction shall include existing bridge deconstruction influence on the new bridge and all other elements of the Work.

.5 Prior to making the application for Substantial Completion the Contractor is to submit a Post-Construction Survey. The Contractor shall, with respect to each existing condition within the zone of influence, prepare and submit a Post-Construction Survey summarizing all findings with respect to the post construction state. The report shall include photographs or video and all other data and information collected by the Contractor. Should a post construction survey identify damage as a result of the performance of the Work the Contractor shall be responsible to undertake the repair and mitigation.

END OF SGC
1.1 GENERAL

.1 The current bascule bridge is operated by the City and marine activity is governed by the Port of Victoria Traffic Scheme.

1.2 SUBMITTALS

.1 The Contractor shall submit a Marine Traffic Management Plan (MTMP) that details how all the requirements set out in the required permits and the Contract Documents shall be adhered to for all work over and in the wetted perimeter as defined by the Highest High Water Level (HHWL).

1.3 NAVIGATION REQUIREMENTS

.1 The extent of the navigable channel height considering both the vertical and horizontal width requirements will be subject to the approval of Transport Canada, Navigable Waters Protection Division and Harbour Master. The Contractor shall supply, install and maintain any lights, buoys, warning signs and any other aids to navigation as required by Transport Canada (TP), Marine Communications and Traffic Services (MCTS) of the Canadian Coast Guard (CCG) to mark the Contractor’s operations.

.2 All works are subject to the latest Navigable Waters Bridge Regulations and Navigable Waters Works Regulations and shall be to the satisfaction of the Navigable Waters Protection Program (NWPP) officer. During construction, navigation channel clearances must not be less than required for navigational purposes per Transport Canada requirements. The navigation channel shall at no time be blocked by construction equipment or debris without proper authorization from Transport Canada, NWPP and Harbour Master. The Contractor shall meet with the NWPA officer (Transport Canada, NWPP) and Harbour Master to develop a marking system that is approved by both parties to ensure the safety of vessels passing through the work Site. Channel markers may be required to indicate the safe channel during construction. The marking of the channel shall be determined by the NWPP officer.

.3 The Contractor shall control, supervise and be responsible for safety during all stages of deconstruction, ensuring the complete removal of all existing material and debris, not permitting any material to become waterborne. Existing piers on both sides of the navigation channel shall be kept clear of debris.

.4 The Contractor shall provide appropriate warning signage and directly advise known channel users of all channel closures and limited usage as required by the NWPP Officer Use equipment suitable for the removal and segregation of hazardous materials in a manner that protects worker and public safety and minimizes disturbance to environment.

.5 The Contractor shall conform to the terms and conditions of the approved permit.

.6 All temporary works, facilities, and any construction materials shall be completely removed prior to completion of the project.

.7 NWPA Permits and conditions shall be posted at the worksite where it is clearly visible to work crews and officers of the Department of Fisheries and Oceans (DFO) and Environment Agencies for the duration of the construction.

.8 The contractual obligations of the contractor from a NWPA perspective for the Project is included in the approved NWPA Permit administered through the Marine
Communication Plan, Regulatory requirements of Transport Canada and Navigable waters Protection Acts and the Port of Victoria.

END OF SGC
1.1 GENERAL

.1 This SGC specifies additional warranty requirements.

.2 Table 1 identifies the elements of work subject to special warranty requirements.

.3 Warranty requirements for all other elements of work not included in Table 1 are provided elsewhere in the Contract Documents.

.4 Warranty period commences at Substantial Completion date or date when item is in use by the City for purpose intended, whichever is the latest.

.5 The Contractor shall:

a) obtain or cause to be obtained any industry standard warranties which may be available which exceed the requirements of the Contract Documents; and

b) at the request of the City, cooperate with and assist the City in the enforcement of any claims under warranties constrained in any subcontract or otherwise given by a Subcontractor.

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
<th>Warranty Period</th>
<th>Requirements</th>
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<tbody>
<tr>
<td>2</td>
<td>Paint coating systems</td>
<td>7 years</td>
<td>Written warranty on coating system and application including field touch ups</td>
</tr>
<tr>
<td>3</td>
<td>Roofing general</td>
<td>15 years</td>
<td>RCABC warranty on materials and installations</td>
</tr>
<tr>
<td>4</td>
<td>Roofing material</td>
<td>15 years</td>
<td>Manufacturer’s warranty in addition to Item 3 above</td>
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END OF SGC
1.1 INSPECTION AND DECLARATION

.1 Completion: Submit written certificate that the following have been performed:

.1 The Work has been completed and inspected for compliance with the 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;

.2 Certificates required by utility companies, Governmental Authorities, Professional Schedules and others have been submitted;

.3 Operation of systems:

.1 all verification of individual components have been performed and satisfactory to the Consultant;

.2 all testing of equipment including and not limited to functional and endurance tests have been conducted in accordance with the Contract Documents and to the satisfaction of the Consultant;

.3 all training, to the extent required to operate and functionally maintain the bridge has been provided to City personnel;

.4 Operations and Maintenance Manuals including warranties and spare parts have been acquired and ready for submission;

.5 All Professional Schedules governing design, construction and final acceptance have been submitted;

.7 All other requirements of the Contract Document have been met.

END OF SGC
1.1 GENERAL

1. This section identifies the excavation and handling of materials including the associated permitting requirements in order to perform the Work.

1.2 EXCAVATION

1. Excavated material must be separated according to the following BC Ministry of Environment (MOE) soil quality classes known to be onsite: Industrial soil quality (<IL), Waste soil quality (>IL<HW) and Hazardous Waste soil quality (HW)

1. Industrial soil quality – soil that contains material less than the industrial land use standard identified in the BC Contaminated Sites Regulation

2. Waste soil quality – soil that contains materials that are greater than the industrial land use standard identified in the BC Contaminated Sites Regulation, but is not Hazardous Waste, as defined in the Hazardous Waste Regulation.

3. Hazardous Waste soil quality – as defined in the Hazardous Waste Regulation

2. It is the Contractors responsibility to retain a qualified environmental professional to develop and implement a Soils Management Plan (SMP) including material characterization and confirmatory sampling, as per all applicable law, regulation, guidance and the Contract Documents. This includes, and is not limited to, the BC Environmental Management Act, Contaminated Sites Regulation, Hazardous Waste Regulation, Waste Discharge Regulation, and BC Ministry of Environment Technical Guidance 1, “Site Characterization and Confirmation Testing” (January 2009).

It is the Contractors responsibility to issue a Notice of Independent Remediation to the Ministry of Environment promptly upon beginning soils site work and within 90 days of completing the soils site work.

The Contractor shall submit the SMP for the Consultant’s review and acceptance before any excavation occurs. The SMP shall be submitted to the Consultant at least 10 working days before excavation is scheduled to commence.

3. Excavated materials, defined as Hazardous Waste in accordance with the BC Hazardous Waste Regulation, shall be temporarily stockpiled as described in this document.

4. Excavated material that is categorized as Waste quality material shall be re-used onsite as described in this document and in accordance to the approved Waste Discharge Authorization.

5. The Contractor shall give the Consultant 48 hours notice prior to excavation.

6. Where existing drainage or services are encountered, it should be left undisturbed and the consultant notified. The Consultant, acting reasonably, will consult with the Contractor to mitigate schedule and servicing impacts.

7. The Contractor is to mitigate excavations and disturbance of in-situ materials to the grades shown on the Contract drawings and as required for geotechnical reasons.
The Contractor is responsible for the removal and disposal off site of materials such as large rocks, boulders, tree stumps, timber, asphalt, concrete rubble, existing Via Rail station house concrete foundation slab, rail and associated materials and other discontinuities that are required for the performance of the work.

1. The Contractor shall obtain all necessary documentation and comply with the requirements for the disposal of material at a licensed and authorized disposal site. This documentation shall be provided by the Contractor as and when requested by the Consultant.

1.3 RE-USE OF WASTE MATERIAL ONSITE

1. An initial soil characterization study has been conducted for the site. The results of this characterization have confirmed that soil, in certain areas, is above the industrial land quality standards, as set out in the Contaminated Sites Regulation and classed as Waste soil quality. The Contractor is to re-use Waste soil onsite in the designated area south of the Upper Trail Connector and north of the Lower Trail Connector on the west approach. In order to do so, a Waste Discharge Authorization, and/or other similar legal instrument(s), from the Ministry of Environment (MOE) are required.

2. It is the Contractor’s responsibility to consult with the MOE and obtain all necessary permits or approvals for the re-use of Waste soil onsite. Through preliminary discussions with MOE, it is anticipated that a Technical Assessment Report (TAR) including a Human Health and Ecological Risk Assessment and additional characterization may be required in support of the Waste Discharge Authorization permit application.

3. Public consultation may be required as part of the Waste Discharge Authorization application, of which publication, promotion and public outreach will be the responsibility of the City of Victoria. The Contractor will be responsible for providing all necessary support documentation as well as a consultation summary report.

4. An outline of what is expected to be included in the TAR, and the related consultation summary report shall be developed through discussions between the Contractor and the MOE.

5. The Contractor is to ensure that a Qualified Professional, as defined by the MOE, conduct the work associated with the Waste Discharge Authorization.

6. Further details on the site characterization activities that have been completed to date can be found in the 2011/2012 Soil Characterization Data Report Final Report.

1.4 IDENTIFICATION AND REMOVAL OF HAZARDOUS MATERIAL

1. The initial soil characterization that has been completed has confirmed an occurrence of leachable lead onsite through the presence of red paint chip fragments. This material has been identified as Hazardous Waste, as defined in the Hazardous Waste Regulation. It is the Contractors responsibility to ensure the adequate handling of this Hazardous Waste material in accordance with all law, regulation and guidance. The Contractor is to locate this Hazardous Waste material to onsite stockpile. It is then the City of Victoria’s responsibility to remove the Hazardous Waste from this onsite stockpile to an appropriate and authorized facility. It is the Contractors responsibility to manage, coordinate and mitigate the stockpile of
Hazardous Waste material. We anticipate there to be a small quantity of this type of material.

.2 The Hazardous Waste stockpile is to be located such that it is easily accessible for loading and offsite transportation.

.3 The Contractor shall schedule the work such that the excavations are continuous in order to minimize the handling of Hazardous Waste materials.

.4 Further details on the site characterization activities that have been completed to date can be found in the 2011/2012 Soil Characterization Data Report Final Report.

END OF SGC
1.1 GENERAL

The documents described in the following table form part of the Contract. Unless otherwise indicated, the Contractor may rely on the accuracy of the factual information contained in these documents, but may not rely on any interpretation or opinion, if any, as contained in these documents.

<table>
<thead>
<tr>
<th>Subject/Title</th>
<th>Author</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>Archaeological Impact Assessment Proposed Johnson street Bridge Replacement</td>
<td>I.R. Wilson Consultants</td>
<td>1-Jun-10</td>
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<tr>
<td>Environmental Assessment Screening Report</td>
<td>Transport Canada, Fisheries &amp; Oceans Canada, Canada Mortgage and Housing Corp.</td>
<td>16-Feb-11</td>
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<td>City of Victoria Bridge As-BUILTs for the Existing Johnson Street Bridge</td>
<td>City of Victoria</td>
<td>various</td>
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<tr>
<td>Agreement between the Crown and the City for the Johnson St. Bridge Replacement</td>
<td>Canada - City of Victoria Building Canada Fund</td>
<td>23-Mar-11</td>
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<td>Interim Design Report 2 - Johnson Street Bridge Replacement</td>
<td>MEG</td>
<td>25-Oct-11</td>
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<tr>
<td>Interim Geotechnical Design Report - Johnson Street Bridge Replacement</td>
<td>MEG</td>
<td>19-Aug-11</td>
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<td>Detailed On-Land Geotechnical Site Investigation, Johnson Street Bridge Replacement Project</td>
<td>Stantec</td>
<td>1-May-11</td>
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<td>Johnson Street Bridge Replacement Project Geotechnical Investigation Report</td>
<td>Stantec</td>
<td>19-Oct-09</td>
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<td>Hazardous Materials Survey, Johnson Street Bridge, Victoria BC</td>
<td>North West Environmental Group Ltd.</td>
<td>1-Jul-12</td>
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<tr>
<td>Limited Hazardous Materials Survey, Johnson Street Bridge, Victoria BC</td>
<td>North West Environmental Group Ltd.</td>
<td>1-Sep-11</td>
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<td>Soil Assessment and Management Options Johnson Street Bridge Final Report</td>
<td>Stantec</td>
<td>7-Jun-11</td>
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<td>Soil Management Plan Johnson Street Bridge Replacement Project Telus Duct Relocation</td>
<td>Stantec</td>
<td>4-Aug-11</td>
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<tr>
<td>Johnson Street Bridge Overwater Site Investigation - Factual Report</td>
<td>MEG</td>
<td>17-Oct-12</td>
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<td>Application for Permit (Application number 11200-30/11A0422): Alterations to archaeological sites DcRu-0025 and DcRu-1208 resulting from the City of Victoria's proposed Johnson Street Bridge Replacement Project, in the vicinity of Johnson Street between Store Street and Harbour Road, Victoria</td>
<td>Province</td>
<td>16-Jan-12</td>
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<td>Marine Communication Plan</td>
<td>TyPlan Planning and Management</td>
<td>02-Aug-12</td>
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<td>2011/12 Soil Characterization Data Report Final Report Rev 0</td>
<td>Stantec</td>
<td>1-Aug-12</td>
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<td>Habitat compensation plan</td>
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<td>22-Oct-12</td>
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<td>PDR and Appendices</td>
<td>MMM Group</td>
<td>31-Jul-12</td>
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<td>Seismic design criteria</td>
<td>MMM Group</td>
<td>17-Aug-12</td>
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<td>Regionally significant project tier 1 and 2 strategic priorities fund and/or Innovations Fund Funding Agreement under the Agreement on the Transfer of Federal Gas Tax Revenues for JSB Project</td>
<td>Union of British Columbia Municipalities</td>
<td>Draft</td>
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<td>Signed schedule B – City of Victoria Building Canada Fund – Agreement for JSB Replacement – Cash Flow Revision 4</td>
<td>Transport Canada</td>
<td>16-Jul-12</td>
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<td>JSB Discussions of Federal Interest in Bridge Construction/Decommissioning</td>
<td>City of Victoria</td>
<td>23-Aug-12</td>
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<td>Draft Building Code Compliance Report for Control Building</td>
<td>CFT Engineering Inc.</td>
<td>24-Oct-12</td>
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<td>DFO Land Development Guidelines for Aquatic Habitats</td>
<td>Department Fisheries and Oceans</td>
<td>Sept-93</td>
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<tr>
<td>MOE Technical Assessment Report Guidance</td>
<td>Ministry of Environment</td>
<td>10-Sep-10</td>
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<tr>
<td>MOE Technical Guidance 1 Site Characterization and Confirmatory Sampling</td>
<td>Ministry of Environment</td>
<td>Jan-09</td>
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</tbody>
</table>

END OF SGC
1.1 COORDINATION WITH OTHER PROJECTS

1. In GC. 4.8 add “or permit third parties or” after the words “right to engage” in the first line.

2. Add the following to GC. 4.8 as new paragraphs following GC. 4.8(b) beginning at the full left margin:

“The Contractor will coordinate the Work with the work of any third parties or other contractors engaged in undertaking work outside the boundaries of the Site but near the Site. The Contractor will not be entitled to, nor will the Contractor make any claim for, an adjustment to the Contract Price or the time for the performance of the Work on the basis that other work is being undertaken outside the boundaries of the Site but near the Site which impacts the performance or the cost to perform the Work.

Without limiting the nature or kind of work that may occur outside the boundaries of the Site but near the Site, the City has identified the following work which may occur outside the boundaries of the Site but near the Site:

(c) the development of the Janion Building;

(d) the development of the Northern Junk Site;

(e) the Dock Side Green Phase II; and

(f) the City sewer improvements along Wharf/Store Street.”

END OF SGC